Illinois Power Generating Company
1500 Eastport Plaza Dr.
Collinsville, IL 62234

June 10, 2025

Illinois Environmental Protection Agency
DWPC – Permits MC #15
Attn: Part 845 Coal Combustion Residual Rule Submittal
2520 W Iles Ave
P.O. Box 19276
Springfield, IL 62794-9276

Re: Coffeen Power Plant Ash Pond 1; IEPA ID # W1350150004-01

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Illinois Power Generating Company ("IPGC") is submitting a supplement to the previously submitted operating permit application for the Coffeen Power Plant Ash Pond 1 (IEPA ID # W1350150004-01) to address the corrective action requirements of Part 845.

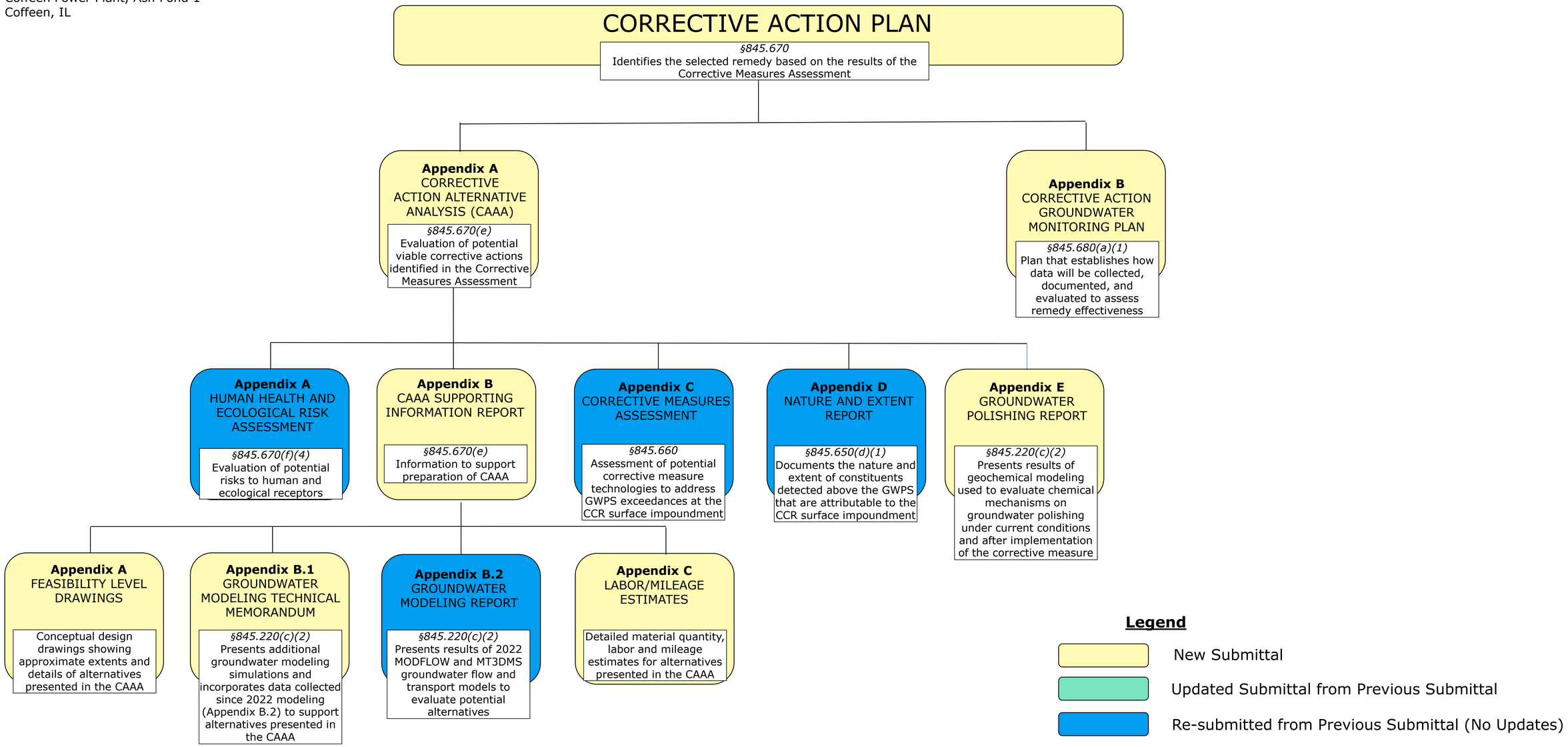
Coffeen previously submitted an operating permit application for Coffeen Power Plant Ash Pond 1 on October 25, 2021. The enclosed supplemental information is being submitted in accordance with 35 I.A.C. § 845.200(a)(3) in order to "[modify] the facility's operating permit when the approved corrective action does not require the modification of the CCR surface impoundment." This amendment includes a corrective action plan containing corrective action alternatives analysis, groundwater modeling, and corrective action groundwater monitoring program. One hardcopy is provided with this submittal.

Sincerely,

Phil Morris
Sr. Director, Environmental

Enclosures

Visual Road Map for Corrective Action
Supplement to Operating Permit Application
Coffeen Power Plant, Ash Pond 1
Coffeen, IL



Road Map for Corrective Action
Supplement to Operating Permit Application
Coffeen Power Plant, Ash Pond 1
Coffeen, IL

Section	Rule Text	Location of Information Demonstrating Compliance			Version History			Notes
		Document	Section or Appendix	PDF Page No. & Hyperlink	Submitted Previously	Updated Version	New Submittal	
Section 845.620 - Hydrogeologic Site Characterization								
845.620	Hydrogeologic Site Characterization	---	---	---	x			HCR was prepared on October 25, 2021 and was included as Appendix D to CP application submitted on July 28, 2022.
Section 845.660 - Assessment of Corrective Measures								
845.660	Assessment of Corrective Measures	CMA	---	364	x			Resubmittal with no updates. Attached as Appendix C in CAAA.
Section 845.670 - Corrective Action Plan								
845.670(a)	The owner or operator must prepare a semi-annual report describing the progress in selecting a remedy and developing a CAP. The semi-annual report must be submitted to IEPA and placed in the operating record as required by 35 I.A.C. § 845.800(d)(17).							
845.670(b)	Within one year after completing the assessment of corrective measures as specified in 35 I.A.C. § 845.660, and after completion of the public meeting in 35 I.A.C. § 845.660(d), the owner or operator of the CCR surface impoundment must submit, in a CP application [or modification to the facility's operating permit] to IEPA, a CAP that identifies the selected remedy. This requirement applies in addition to, not in place of, any applicable standards under any other State or federal law.	Supplement to Operating Permit Application	---	1			x	A corrective action CP is not required when the proposed corrective action does not require modification of the CCR SI or the installation or modification of related treatment or mitigation facilities per 845.200(a)(3)
845.670(c)	The CAP must meet the following requirements:							
845.670(c)(1)	Be based on the results of the CMA conducted under 35 I.A.C. § 845.660;	CMA	---	364	x			Resubmittal with no updates. Attached as Appendix C in CAAA.
845.670(c)(2)	Identify a selected remedy that at a minimum, meets the standards listed in subsection (d);	CAAA	Section 2	50			x	
845.670(c)(3)	Contain the corrective action alternatives analysis specified in subsection (e); and	CAAA	Section 2	50			x	
845.670(c)(4)	Contain proposed schedules for implementation, including an analysis of the factors in subsection (f).	CAP	Table 1	25			x	
845.670(d)	The selected remedy in the CAP must:							
845.670(d)(1)	Be protective of human health and the environment;	CAAA	Section 2.2.1	55			x	
845.670(d)(2)	Attain the GWPS specified in 35 I.A.C. § 845.600;	Groundwater Modeling Technical Memodandum	Section 5	166			x	
845.670(d)(3)	Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in 35 I.A.C. § 845.600 into the environment;	CAAA	Section 2.2.2	56			x	
845.670(d)(4)	Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and	CAAA	Section 2.5	70			x	
845.670(d)(5)	Comply with standards for management of wastes as specified in 35 I.A.C. § 845.680(d).	CAAA	Section 2	50			x	
845.670(e)	CAAA. In selecting a remedy that meets the standards of subsection (d), the owner or operator of the CCR surface impoundment must consider the following evaluation factors:							
845.670(e)(1)	The long- and short-term effectiveness and protectiveness of each potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of the following:	CAAA	Section 2.2	55			x	
845.670(e)(1)(A)	Magnitude of reduction of existing risks;	CAAA	Section 2.2.1	55			x	
845.670(e)(1)(B)	Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;	CAAA	Section 2.2.3	57			x	
845.670(e)(1)(C)	The type and degree of long-term management required, including monitoring, operation, and maintenance;	CAAA	Section 2.2.4	57			x	
845.670(e)(1)(D)	Short-term risks that might be posed to the community or the environment during implementation of a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;	CAAA	Section 2.2.5	58			x	
845.670(e)(1)(E)	Time until GWPS in 35 I.A.C. § 845.600 are achieved;	CAAA	Section 2.2.6	63			x	
845.670(e)(1)(F)	The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment, or changes in groundwater flow;	CAAA	Section 2.2.7	64			x	
845.670(e)(1)(G)	The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and	CAAA	Section 2.2.8	65			x	
845.670(e)(1)(H)	Potential need for replacement of the remedy.	CAAA	Section 2.2.9	66			x	
845.670(e)(2)	The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of each of the following potential factors:	CAAA	Section 2.2.2	56			x	
845.670(e)(2)(A)	The extent to which containment practices will reduce further releases; and	CAAA	Section 2.2.2	56			x	
845.670(e)(2)(B)	The extent to which treatment technologies may be used.	CAAA	Section 2.2.2	56			x	
845.670(e)(3)	The ease or difficulty of implementing each potential remedy based on consideration of the following types of factors:							
845.670(e)(3)(A)	Degree of difficulty associated with constructing the technology;	CAAA	Section 2.3.1	66			x	
845.670(e)(3)(B)	Expected operational reliability of the technologies;	CAAA	Section 2.3.2	67			x	
845.670(e)(3)(C)	Need to coordinate with and obtain necessary approvals and permits from other agencies;	CAAA	Section 2.3.3	67			x	
845.670(e)(3)(D)	Availability of necessary equipment and specialists; and	CAAA	Section 2.3.4	68			x	
845.670(e)(3)(E)	Available capacity and location of needed treatment, storage, and disposal services.	CAAA	Section 2.3.5	69			x	

Road Map for Corrective Action
Supplement to Operating Permit Application
Coffeen Power Plant, Ash Pond 1
Coffeen, IL

Section	Rule Text	Location of Information Demonstrating Compliance			Version History			Notes
		Document	Section or Appendix	PDF Page No. & Hyperlink	Submitted Previously	Updated Version	New Submittal	
845.670(e)(4)	The degree to which community concerns are addressed by each potential remedy.	CAAA	Section 2.4	69			x	
845.670(f)	The owner or operator must specify, as part of the CAP, a schedule for implementing, of and completing, remedial activities. The schedule must require the completion of remedial activities within a reasonable time, taking into consideration the factors in this subsection (f). The owner or operator of the CCR surface impoundment must consider the following factors in determining the schedule of remedial activities:							
845.670(f)(1)	Extent and nature of contamination, as determined by the characterization required under 35 I.A.C. § 845.650(d);	CAP	Section 3.3	16			x	
845.670(f)(2)	Reasonable probabilities of remedial technologies achieving compliance with the GWPS established by 35 I.A.C. § 845.600 and other objectives of the remedy;	CAP	Section 3.3	16			x	
845.670(f)(3)	Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;	CAP	Section 3.3	16			x	
845.670(f)(4)	Potential risks to human health and the environment from exposure to contamination before completion of the remedy;	CAP	Section 3.3	16			x	
845.670(f)(5)	Resource value of the aquifer, including:							
845.670(f)(5)(A)	Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses;	CAP	Section 3.3	16			x	
845.670(f)(5)(B)	Proximity and withdrawal rate of users;	CAP	Section 3.3	16			x	
845.670(f)(5)(C)	Groundwater quantity and quality;	CAP	Section 3.3	16			x	
845.670(f)(5)(D)	The potential impact to the subsurface ecosystem, wildlife, other natural resources, crops, vegetation, and physical structures caused by exposure to CCR constituents;	CAP	Section 3.3	16			x	
845.670(f)(5)(E)	The hydrogeologic characteristic of the facility and surrounding land; and	CAP	Section 3.3	16			x	
845.670(f)(5)(F)	The availability of alternative water supplies; and	CAP	Section 3.3	16			x	
845.670(f)(6)	Other relevant factors.	CAP	Section 3.3.1	21			x	
Section 845.680 Implementation of the Corrective Action Plan								
845.680(a)	Within 90 days after the Agency's approval of the corrective action plan submitted under Section 845.670, the owner or operator must initiate corrective action. Based on the schedule approved by the Agency for implementation and completion of corrective action, the owner or operator must:							
845.680(a)(1)	Establish and implement a corrective action groundwater monitoring program that:							
845.680(a)(1)(A)	At a minimum, meets the requirements of the monitoring program under Section 845.650;	CA GMP	Section 2.1	1359			x	
845.680(a)(1)(B)	Documents the effectiveness of the corrective action remedy; and	CA GMP	Section 3	1363			x	
845.680(a)(1)(C)	Demonstrates compliance with the groundwater protection standard under subsection (c).	CA GMP	Section 3	1363			x	
845.680(a)(2)	Implement the corrective action remedy approved by the Agency under Section 845.670; and	CAP	Section 1.4	10			x	
845.680(a)(3)	Take any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors. Interim measures must, to the greatest extent feasible, be consistent with the objectives of, and contribute to the performance of, any remedy that may be required by Section 845.670. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:							
845.680(a)(3)(A)	Time required to develop and implement a final remedy;	CAP	Section 3.4	21			x	
845.680(a)(3)(B)	Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in Section 845.600;	CAP	Section 3.4	21			x	
845.680(a)(3)(C)	Actual or potential contamination of sensitive ecosystems or current or potential drinking water supplies;	CAP	Section 3.4	21			x	
845.680(a)(3)(D)	Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;	CAP	Section 3.4	21			x	
845.680(a)(3)(E)	Weather conditions that may cause any of the constituents listed in Section 845.600 to migrate or be released;	CAP	Section 3.4	21			x	
845.680(a)(3)(F)	Potential for exposure to any of the constituents listed in Section 845.600 as a result of an accident or failure of a container or handling system; and	CAP	Section 3.4	21			x	
845.680(a)(3)(G)	Other situations that may pose threats to human health and the environment.	CAP	Section 3.4	21			x	

Notes:
CAA = Closure Alternatives Analysis
CAAA = Corrective Action Alternatives Analysis
CAP = corrective action plan
CCR = coal combustion residuals
CMA = Corrective Measures Assessment
CP = Construction Permit
GMP = Groundwater Monitoring Plan
GWPS = groundwater protection standards
HCR = Hydrogeologic Site Characterization Report
IEPA = Illinois Environmental Protection Agency
SI = Surface Impoundment

Intended for
Illinois Power Generating Company
134 Cips Lane
Coffeen, IL 62017

Date
June 10, 2025

Project No.
1940110241-001

CORRECTIVE ACTION PLAN

COFFEEN POWER PLANT, ASH POND NO. 1, IEPA ID NO. W1350150004-01

RAMBOLL Bright ideas. Sustainable change.

CORRECTIVE ACTION PLAN
COFFEEN POWER PLANT, ASH POND NO. 1, IEPA ID NO. W1350150004-01

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940110241-001**
Recipient	**Illinois Power Generating Company**
Document type	**Corrective Action Plan**
Revision	**FINAL**
Date	**June 10, 2025**
Prepared by	**Katlyn Nohr, Sarah Slagle-Garrett**
Checked by	**Melanie Conklin**
Approved by	**Brian G. Hennings, PG**
Description	**Corrective Action Plan for 35 I.A.C. § 845**

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Table 1 Proposed Milestone Schedule for Implementing Corrective Action Remedy (Source Control-Groundwater Polishing)

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Table A Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells

APPENDICES

Appendix A Corrective Action Alternatives Analysis (845.670(e)), including Corrective Measures Assessment (845.660)
Appendix B Corrective Action Groundwater Monitoring Plan

ACRONYMS AND ABBREVIATIONS

%	percent
35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
AP1	Ash Pond No. 1 ("the site")
CA GMP	Corrective Action Groundwater Monitoring Plan
CAAA	Corrective Action Alternatives Analysis
CAAA-SIR	Corrective Action Alternatives Analysis Supporting Information Report
CAP	Corrective Action Plan
CCR	coal combustion residuals
CCR Rule	40 C.F.R. § 257 Subpart D
CIP	closure-in-place
CMA	Corrective Measures Assessment
COC	constituent of Concern
COF	Coffeen Power Station
CPP	Coffeen Power Plant
COI	constituent of interest
CP	construction permit
CY	cubic yards
DA	deep aquifer
DCU	deep confining unit
Gradient	Gradient Corporation
GWE	groundwater extraction
GWP	groundwater polishing
GWPS	groundwater protection standard(s)
HCR	Hydrogeologic Site Characterization Report
ID	identification
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
ISGS	Illinois State Geological Survey
LCU	lower confining unit
No.	number
OP	operating permit
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
UCU	upper confining unit
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

1.1 Plant and Site Information

Illinois Power Generating Company (IPGC) is the owner of the inactive coal-fired Coffeen Power Plant (CPP), also referred to as the Coffeen Power Station (COF), in Coffeen, Montgomery County, Illinois. IPGC intends to complete groundwater corrective action for Ash Pond Number (No.) 1 (AP1) coal combustion residuals (CCR) surface impoundment (SI), which is identified by Illinois Environmental Protection Agency (IEPA) identification (ID) No. W1350150004-01, CCR Unit ID No. 101, and National Inventory of Dams No. IL50722. This Corrective Action Plan (CAP) has been prepared for AP1 at the CPP under the requirements of the Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments [1] and the requirements of Title 40 Code of Federal Regulations (40 C.F.R.) § 257 Subpart D, herein referred to as the Federal CCR Rule [2].

1.2 Organization of the Corrective Action Plan

This CAP is organized in the following manner:

- **Section 1** includes an introduction to AP1, lists the status of other 35 I.A.C. § 845 permit applications submitted to IEPA, identifies the selected remedy, and provides a narrative of remedy construction;
- **Section 2** includes an overview of the corrective action process, including the results of the Corrective Measures Assessment (CMA) and Corrective Action Alternatives Analysis (CAAA);
- **Section 3** provides the CAP requirements, the selected remedy, an evaluation of effectiveness, and an implementation schedule, as required by 35 I.A.C. § 845.670; and
- **Section 4** includes reference documents used in the development of this CAP.

This CAP was prepared as a supplement to the submitted operating permit (OP) application for AP1 as required by 35 I.A.C. § 845.200(a)(3).

1.3 Permit Status

The following 35 I.A.C. § 845 permit applications have previously been submitted to IEPA by IPGC for COF AP1:

- An OP application, as required by 35 I.A.C. § 845.200(a)(3), was submitted on October 25, 2021 [3].
- A construction permit (CP) application for final closure of AP1, as required by 35 I.A.C. § 845.220, including a CCR Surface Impoundment Final Closure Plan, as required by 35 I.A.C. § 845.720, was submitted on July 28, 2022 [4].
  - The Final Closure Plan selected hybrid closure-in-place (CIP) with a consolidate-and-cap approach as the most appropriate closure method for AP1 [5].

As of the date of this CAP, the OP and final closure CP applications for the AP1 are pending with IEPA.

1.4 Selected Corrective Action Remedy

Groundwater polishing (GWP) following source control (*i.e.,* consolidate-and-cap) presented within the Final Closure Plan [5] has been identified as the most appropriate remedy for AP1, based on the CAAA provided in **Appendix A**. Potential remedies evaluated in the CAAA included source control with GWP and source control with groundwater extraction (GWE).

The CAAA, which was prepared by Gradient Corporation (Gradient), was based on a CAAA Supporting Information Report (CAAA-SIR) that was prepared by Ramboll Americas Engineering Solutions, Inc. (Ramboll) and is attached to the CAAA. The CAAA-SIR includes the results of groundwater modeling and feasibility-level design information for each remedy.

A Groundwater Polishing Evaluation Report is also attached to the CAAA. This report presents results from geochemical modeling of exceedance[1] parameters addressed at AP1 by the CAP. Geochemical modeling supports the assessment of GWP as a component of the proposed corrective action by evaluating the potential for chemical attenuation of constituents of concern (COCs) before and after source control as a means of contextualizing the times to meet groundwater protection standards (GWPS) estimated in the flow and transport model.

1.4.1 Narrative Description of Selected Corrective Action Remedy

Corrective action will consist of source control, as outlined in the Final Closure Plan for AP1 [5]. The source control will be followed by GWP. The proposed closure exceeds the minimum Closure Performance Standards listed in 35 I.A.C. § 845.750. The closure will include removing free liquids in accordance with the performance standard in 35 I.A.C. § 845. The closure will control infiltration in accordance with the performance standard in 35 I.A.C. § 845, thus removing the hydraulic head that can force leachate into subsurface soils and is the mechanism that can drive risk (United States Environmental Protection Agency [6]):

> *EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water. Dewatered CCR surface impoundments will no longer be subjected to hydraulic head so the risk of releases, including the risk that the unit will leach into the groundwater, would be no greater than those from CCR landfills.*

AP1 will be closed using a hybrid consolidate-and-cap approach consisting of consolidating approximately 436,000 cubic yards (CY) of CCR in the current AP1, reducing the footprint from 26 acres down to 10.4 acres (the CIP area) at an elevation greater than 10 feet above the uppermost aquifer (UA) and above the estimated post-closure water table. The consolidated CCR will be covered with an alternate geomembrane final cover system that exceeds the 35 I.A.C. § 845.750(c)(2) minimum final cover requirements. The proposed source control is predicted to reduce water flux out of AP1 by 99.9 percent (%) in post-closure conditions as compared to pre-closure conditions as they were observed during plant operation and allow the GWPS to be achieved within approximately 40 years [7, 8]. These source control activities will serve as the primary groundwater corrective measure at AP1.

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPS as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of IPGC's OP application for COF AP1. That OP application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, IPGC has not identified any actual exceedances

1.4.1.1 Narrative Discussion of Remedy Design and Function

The USEPA has stated that source control is the most effective means of ensuring the timely attainment of remediation objectives [9]. Natural geochemical processes are appropriate as a "polishing step" for residual plume management after effective source control implementation (*i.e.*, GWP) because there are no risks to receptors and the contaminant plume is not expanding. GWP will achieve the GWPS by natural physical and chemical mechanisms within the groundwater, which reduce the concentrations of COCs. Therefore, selection of the groundwater monitoring network, groundwater monitoring, and adaptive management are critical components of remedy design and function, which are further described in **Section 1.4.2**.

1.4.2 Narrative Description of Proposed Groundwater Monitoring

Corrective action groundwater monitoring will be conducted during remedy operation to evaluate the effectiveness of the corrective action remedy and whether groundwater concentrations are achieving the GWPS as predicted by the groundwater model. Groundwater data collected as part of the monitoring program will be analyzed to determine if the remedy is on track to meet GWPS and to inform adaptive management decisions if performance metrics are not achieved. A Corrective Action Groundwater Monitoring Plan (CA GMP) with details on how the groundwater monitoring network will be monitored, how the data will be analyzed, and what will trigger adaptive site management directions is included as **Appendix B**. Information associated with these activities is described below.

- Regular groundwater monitoring will be conducted utilizing a corrective action groundwater monitoring network designed in accordance with 35 I.A.C. § 845.680(a)(1).
- Laboratory parameters include major ions for evaluating groundwater chemistry and COCs (*i.e.*, reported exceedances in accordance with the Operating GMP) the corrective action is intended to address. Sampling to evaluate corrective action effectiveness will begin the quarter after the corrective action remedy is implemented and commissioned. Samples will be collected on a quarterly basis initially and potentially reduced to a semiannual basis once five years of monitoring have occurred, in accordance with 35 I.A.C. § 845.650(b)(4). Monitoring results will be submitted to IEPA for each monitoring event, in addition to an Annual Groundwater Monitoring and Corrective Action Report, in accordance with 35 I.A.C. § 845.610(e).
- Routine maintenance of the monitoring well network will include inspecting the wells, making repairs to the wells (as needed) and rehabilitating and/or replacing wells to improve performance (as needed).
- Adaptive site management strategies will be employed as an integral part of ongoing corrective action at AP1. The adaptive site management approach will allow timely incorporation of new site information to ensure the achievement of the GWPS. The effectiveness of the remedy at each phase is evaluated using performance metrics designed to assess the goals of that phase. Performance metrics answer questions designed to evaluate multiple aspects of remedy effectiveness with the ultimate goal of holistically guiding management decisions [10]. The goals and performance metrics of each phase of remedy evaluation are presented in Section 3 of the CA GMP (**Appendix B**).
- Documentation of remedy progress metrics will be provided in the Annual Groundwater Monitoring and Corrective Action Report beginning after the second year of data collection: a

minimum of eight data points is required to complete meaningful statistical analysis required for evaluation of the remedy progress metrics, which will be available after two years of quarterly sampling. Per USEPA guidance [10], a thorough review of corrective action progress and remedy effectiveness will be conducted every five years. A Five-Year Annual Groundwater Monitoring and Corrective Action Report will evaluate the comprehensive data set and, if triggered by the results of the remedy progress evaluation metrics, evaluate whether adaptive management actions are needed. The five-year time frame allows adaptive management decisions to be based on a robust data sufficient to complete meaningful statistical analysis while remaining responsive to changing site conditions [10].

- Corrective Action Confirmation Monitoring and Completion
  - Per 35 I.A.C. § 845.680(c), corrective action is considered complete when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years." At that time, an attainment evaluation will be implemented. This will include monitoring each well for three additional years to confirm that GWPS have been achieved, in accordance 35 I.A.C. § 845.680(c).
  - After completion of the corrective action confirmation monitoring period, a Corrective Action Completion Report and Certification will be prepared and submitted to IEPA, in accordance with 35 I.A.C. § 845.680(e).

2. CORRECTIVE ACTION OVERVIEW

This CAP is based on the tiered assessment and analysis of alternative remedial technologies and remedies that were completed via the CMA and CAAA (**Appendix A**). The objective of these assessments was to determine the most appropriate alternative for AP1 that, when coupled with the source control proposed in the Final Closure Plan [5], would remediate groundwater and provide compliance with the GWPS specified under 35 I.A.C. § 845.600.

2.1 Integration of Corrective Action with Source Control (Final Closure)

All documents, assessments, and analyses performed as part of this CAP assume that the source control presented in the Final Closure Plan [5] for AP1 will also be implemented. Source control is the primary corrective action for AP1 and will consist of removing free liquids from the CCR and completing a hybrid CIP by consolidating approximately 436,000 CY of CCR in the current COF AP1 footprint from 26 acres down to 10.4 acres (the CIP area) and installing a geomembrane final cover system. When source control is completed, the remaining CCR in AP1 will be encapsulated on all sides by underlying native soils, low-permeability embankment dikes, and a low-permeability final cover system.

Source control alone, without other supplemental corrective action, has been estimated via groundwater modeling to reduce the infiltration of liquids out of AP1 by 99.9% relative to pre-closure conditions. Groundwater modeling performed to support CAAA-SIR estimates that source control activities are expected to result in GWPS being achieved approximately 40 years after closure completion, without implementing other forms of corrective action [7, 8].

The remedy presented in this CAP is supplemental to the removal of free liquids, completion of source control via closure, and placing the CCR above the groundwater table and UA, which when combined, are the primary remedial action that will be performed at the site.

2.2 Corrective Measures Assessment

The CMA [11] was performed for AP1 and submitted to the IEPA on June 12, 2024, after the exceedances of the GWPS were identified. The CMA considered a total of four corrective measures for AP1, including:

- Source control with GWP
- Source control with GWE
- Source control with groundwater cutoff wall
- Source control with *in-situ* treatment

Based on the CMA, two corrective measures, including source control with GWP and source control with GWE, were identified as potentially viable corrective measures for AP1 and were included for further evaluation, design advancement, and comparative assessment within the CAAA for AP1. The other corrective measures were determined by the CMA to be unlikely to be viable for AP1 and were not evaluated further within the CAAA.

2.3 Analysis of Corrective Action Alternatives

2.3.1 Corrective Action Alternatives Analysis Supporting Information Report

The CAAA for AP1 was prepared by Gradient based on a CAAA-SIR prepared by Ramboll. The CAAA-SIR, which is included as Attachment B of the CAAA provided in **Appendix A**, included additional evaluation, design advancement, and comparative assessment of the source control with GWP and source control with GWE corrective measures identified as potentially viable for AP1 by the CMA. The evaluation included the completion of feasibility-level design activities for each alternative and incorporated the following tasks:

- Performing predictive groundwater modeling to evaluate the scope (*i.e.,* location and extents) of each alternative and the corresponding estimated time to achieve GWPS;
- Developing feasibility-level design drawings showing the extents in plan and elevation view of each engineered remedy;
- Estimating the time required to design, construct, and implement each remedy, in addition to ongoing operational and maintenance requirements;
- Developing conceptual plans for the storage, treatment, and discharge of extracted groundwater for applicable remedies;
- Identifying future tasks required to implement each alternative, including permitting, investigation, and design efforts; and
- Estimating relevant material quantities, labor hours, delivery miles, equipment miles, and daily commuting miles associated with constructing each remedy.

2.3.2 Corrective Action Alternatives Analysis

The CAAA (**Appendix A**) included a detailed analysis of each of the corrective action alternatives presented in the CAAA-SIR, including an evaluation of:

- Long- and short-term effectiveness and protectiveness;
- Ease or difficulty of implementation;
- Degree to which community concerns are addressed; and,
- Relative amount of contamination removed from the environment.

Based on the CAAA, source control with GWP was identified as the most appropriate corrective action for AP1 and was selected for further design development as part of this CAP.

3. CORRECTIVE ACTION PLAN

The 35 I.A.C. § 845 requirements for the CAP and corresponding demonstrations that the proposed corrective measures meet these requirements are discussed individually in this section. Many of the CAP requirements are discussed within the CMA and CAAA documents that have been prepared to support the CAP. Therefore, the demonstrations will also refer to those documents.

3.1 General Requirements

35 I.A.C. § 845.670(c): The corrective action plan must meet the following requirements:

> *(1) Be based on the results of the corrective measures assessment conducted under 35 I.A.C. § 845.660;*
>
> *(2) Identify a selected remedy that at a minimum, meets the standards listed in subsection (d);*
>
> *(3) Contain the corrective action alternatives analysis specified in subsection (e); and*
>
> *(4) Contain proposed schedules for implementation, including an analysis of the factors in subsection (f).*

This CAP is based on the results of the CMA and CAAA, which are included within **Appendix A**. The proposed schedule for implementing the selected source control with GWP remedy is provided in **Table 1**.

3.2 Remedy Selection

35 I.A.C. § 845.670(d): The selected remedy in the corrective action plan must:

> *(1) Be protective of human health and the environment;*

Current conditions at AP1 pose no risk to human health or environment [12]. There are also no unacceptable risks to human health and the environment under future conditions as discussed in the risk assessment provided in the CAAA (**Appendix A**). Concentrations of CCR-derived constituents are anticipated to decline once AP1 is closed and the GWP remedy is in place, as presented in the CAAA (**Appendix A**).

> *(2) Attain the groundwater protection standards specified in 35 I.A.C. § 845.600;*

Groundwater modeling indicates source control with GWP (Appendix B of the CAAA-SIR which is attached in **Appendix A**), which is selected as the remedy of this CAP, will result in attainment of the GWPS within the current monitoring network within 40 years of final closure completion.

> *(3) Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in 35 I.A.C. § 845.600 into the environment;*

AP1 will be closed using a hybrid consolidate-and-cap approach which will act as the main control mechanism to prevent further releases of CCR-derived constituents. If the remedy is found to be unsuccessful in meeting remediation goals, adaptive site management actions will be taken as described within the CA GMP (**Appendix B**).

(4) Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and

No known releases of CCR due to a structural integrity issue have occurred at AP1.

(5) Comply with standards for management of wastes as specified in 35 I.A.C. § 845.680(d).

The CCR managed as part of the closure will be done in accordance with all 35 I.A.C. § 845 requirements and the submitted closure plan [5].

3.3 Schedule for Implementation

As presented in Section 4.1 of the CMA and in **Section 1.4.1.1** of this CAP, source control is the most effective means of ensuring the timely attainment of remediation objectives [11]. With groundwater from the AP1 impoundment and potential groundwater contributions to surface water posing no unacceptable risks to human health or the environment [12], GWP is an appropriate "polishing step" provided the corrective action is managed within a reasonable timeframe.

The source control with GWP remedy will successfully attain GWPS in a reasonable time[2] as discussed in the following subsections. Timeframes to attain GWPS in the groundwater monitoring wells summarized in **Table A** indicate that 92% of progress is expected to occur within the first 20 years.

Table A. Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells

Description	2 years**	5 years**	10 years**	20 years**	30 years**	40 years**
Percentage of Wells Predicted to Attain GWPS*	8%	15%	23%	92%	92%	100%

*: 13 wells were used to estimate time to reach GWPS in the 2025 Groundwater Modeling Technical Memorandum.
**: Years counted starting from completion of source control.

35 I.A.C. § 845.670(f): The owner or operator must specify, as part of the corrective action plan, a schedule for implementing, of and completing, remedial activities. The schedule must require the completion of remedial activities within a reasonable time, taking into consideration the factors in this subsection (f). The owner or operator of the CCR surface impoundment must consider the following factors in determining the schedule of remedial activities:

The schedule for implementing and completing the source control with GWP remedy at AP1 is included in **Table 1**.

The schedule was developed considering the factors required by 35 I.A.C. §§ 845.670(f)(1) through (5), as summarized below.

[2] Groundwater Modeling Technical Memorandum is an appendix to CAAA-SIR which is attached to CAAA, Appendix A of this CAP.

35 I.A.C. § 845.670(f)(1): Extent and nature of contamination, as determined by the characterization required under 35 I.A.C. § 845.650(d);

The Nature and Extent Report [13] was submitted to the IEPA on June 12, 2024 and is included as an attachment to the CAAA (**Appendix A**). Groundwater modeling and geochemical analysis were performed by Ramboll as part of the CAAA-SIR and the modeling considered the nature and extent of contamination.

35 I.A.C. § 845.670(f)(2): Reasonable probabilities of remedial technologies achieving compliance with the GWPS established by 35 I.A.C. § 845.600 and other objectives of the remedy;

Remedies were evaluated in the CAAA (**Appendix A**), and it was determined that the selected remedy (source control with GWP) is expected to achieve compliance with 35 I.A.C. § 845.600 in a reasonable timeframe. The potential for remedial technologies to achieve compliance with the GWPS were evaluated using groundwater modeling [8]. For the selected remedy, the results indicate that groundwater will achieve compliance with the GWPS approximately 40 years after completion of source control, which is described in **Section 1.4.1**. Further, the groundwater modeling indicates flux out of AP1 will be reduced by 99.9%, indicating a high probability of successful source control.

As discussed in the CMA, source control via consolidate-and-cap approach is a proven method for addressing groundwater contamination [11]. The proposed consolidate-and-cap approach is consistent with the requirements of 40 C.F.R. § 257 and 35 I.A.C. § 845. The proposed cover has been demonstrated to be compliant by equivalency in the Final Closure Plan [5].

GWP processes include both physical and chemical mechanisms within the groundwater which reduce the concentrations of COCs in the groundwater. Physical components of GWP are described by groundwater flow and transport modeling [8]. The contribution of chemical mechanisms to GWP under current conditions and after source control implementation are evaluated using a geochemical modeling-based approach [14]. When combined with source control, GWP processes will achieve the GWPS in a reasonable timeframe.

35 I.A.C. § 845.670(f)(3): Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;

The selected remedy includes source control followed by GWP. The CCR will be managed within the footprint of the existing CCR Unit as proposed in the CP for final closure [4]. GWP is not expected to result in the management of any appreciable volume of CCR. Therefore, the treatment and disposal capacity of CCR is not an applicable consideration for the selected remedy.

35 I.A.C. § 845.670(f)(4): Potential risks to human health and the environment from exposure to contamination before completion of the remedy;

A Human Health and Ecological Risk Assessment was completed and included as an attachment to the CAAA (**Appendix A**) that considers the potential risks to human health and the environment before completion of the remedy. The overall conclusion is that groundwater from the AP1 impoundment and potential groundwater contributions to surface water pose no unacceptable risks to human health or the environment. This conclusion was reached using methodology consistent with applicable USEPA risk assessment principles. The assessment relied

on conservative assumptions meant to overestimate possible exposures and risks and provide an additional level of certainty in the conclusions [12].

35 I.A.C. § 845.670(f)(5): Resource value of the aquifer, including:

The resource value of the aquifer is discussed in the Hydrogeologic Site Characterization Report (HCR), which is included as Appendix D in the CP application for final closure [4]. The UA includes the sands, silty sands, and clays at the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member. This unit is absent in some locations at the CPP due to weathering and in others due to excavation during construction of the CCR units. The underlying lower confining unit (LCU), and where present the deep aquifer (DA), have been identified as potential migration pathways (PMPs) because downward vertical gradients indicate that there is the potential for impacts to migrate towards these units. Groundwater flows northward through AP1 toward a historic process flume, then east toward an unnamed tributary leading to Coffeen Lake, consisting of two lobes which are located approximately 1,300 feet southwest and 150 feet east of AP1.

As set forth in 35 I.A.C. § 620.210, groundwater within the UA at AP1 meets the definition of Class I – Potable Resource Groundwater, as geologic material with a hydraulic conductivity of 1×10^{-4} centimeters per second or greater and located 10 feet or more below the land surface. This information was also considered in the CAAA as part of the Human Health and Ecological Risk Assessment, which concluded that groundwater from the AP1 impoundment and potential groundwater contributions to surface water pose no unacceptable risks to human health or the environment.

Source control followed by GWP will result in decline of concentrations of CCR-derived constituents in the UA and PMPs. No off-site migration of CCR-derived constituents is expected to occur. GWP and adaptive site management following source control will function until the GWPS is achieved in accordance with the CA GMP (**Appendix B**). Paragraphs (A) through (F) from 35 I.A.C. § 845.670(f)(5) are further addressed, as summarized below.

35 I.A.C. § 845.670(f)(5)(A): Current and future uses, including potential residential, agricultural, commercial industrial and ecological uses; and

Current uses and users of the groundwater are discussed in the HCR, Section 5.1 and attachments; and were considered in the CAAA as part of the Human Health and Ecological Risk Assessment which concluded that groundwater from the AP1 impoundment and potential groundwater contributions to surface water pose no unacceptable risks to human health or the environment. Exceedances of the GWPS will remain within the property boundary[3] which is controlled by IPGC. No changes in future residential, commercial, or ecological use are expected. In the absence of changes to current and future uses, there is no applicable scheduling consideration.

35 I.A.C. § 845.670(f)(5)(B): Proximity and withdrawal rate of users;

A water well inventory was completed in 2021 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of AP1. A search of the Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map identified 12 wells located within 1,000-meters of AP1. The wells that were identified

[3] Based on the Nature & Extent Report attached to the CAAA with addendum as Appendix D.

included four monitoring wells and eight farm/domestic wells. One (121352283200) of the eight farm/domestic wells is located north of AP1, side-gradient to AP1 and on the west side of the unnamed tributary to Coffeen Lake. The well, which was installed in 1981, is located near the former location of several prior residences. The well was removed during the construction of the Gypsum Management Facility Recycle Pond (GMF RP) in 2010. Additionally, the property in this area has been purchased by IPGC and no residents are currently living or using groundwater in the area. While there is no information available on the current use of the remaining seven farm/domestic wells, they are located on the east/southeast side of Coffeen Lake's eastern branch and the unnamed tributary, *i.e.*, the opposite side of the lake from AP1. These surface water bodies are hydraulic boundaries that prevent shallow groundwater from flowing past or underneath them.

The assessment concluded there are no existing off-site water wells, potable or non-potable, that could potentially be impacted by groundwater from AP1. This information was also considered in the CAAA as part of the Human Health and Ecological Risk Assessment, which concluded that groundwater from the AP1 impoundment and potential groundwater contributions to surface water pose no unacceptable risks to human health or the environment. In the absence of changes in current and future uses, there is no applicable scheduling consideration for proximity and withdrawal rates of users.

35 I.A.C. § 845.670(f)(5)(C): Groundwater quantity and quality;

Per 35 I.A.C. § 620.210, groundwater within the UA at AP1 meets the definition of Class I – Potable Resource Groundwater [12]. The Human Health and Ecological Risk Assessment (Appendix A in the CAAA) concluded that groundwater from the AP1 impoundment and potential groundwater contributions to surface water pose no unacceptable risks to human health or the environment. The selected remedy includes source control followed by GWP. GWP does not include the management of any volume of groundwater.

35 I.A.C. § 845.670(f)(5)(D): The potential impact to the subsurface ecosystem, wildlife, other natural resources, crops, vegetation, and physical structures caused by exposure to CCR constituents;

Potential surface receptors are discussed in HCR Sections 5.2 and 5.3. A survey to identify surface water features, nature preserves, and historic sites was conducted for a 1,000-meter radius around AP1. Section 3.5 of the Human Health and Ecological Risk Assessment included as Appendix A of the Closure Alternatives Analysis and CMA/CAAA discusses the ecological risk evaluation.

1. Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the constituents of interest (COIs) in surface water exceeded protective screening benchmarks.
2. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks, therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors.
3. Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.,* plants, invertebrates, small mammals, fish). Mercury was the only ecological COI identified as having

potential bioaccumulative effects. However, the modeled concentrations did not exceed benchmarks protective of bioaccumulative effects. Therefore, mercury is not considered to pose an ecological risk via bioaccumulation. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors. In the absence of unacceptable risks to ecological receptors there is no applicable scheduling consideration.

35 I.A.C. § 845.670(f)(5)(E): The hydrogeologic characteristic of the facility and surrounding land; and

In addition to the CCR present in AP1, five hydrostratigraphic units have been identified at AP1 based on stratigraphic relationships, geologic composition, and common hydrogeologic properties. The units, listed from surface downward, are summarized as follows:

- **Upper Confining Unit (UCU):** Composed of the Roxana and Peoria Silts (Loess Unit) and the upper clayey portion of the Hagarstown member, which are classified as silts to clayey silts and gravelly clay below the surficial soil. Loess Unit thickness ranges from 0 feet (absent) to 16 feet and the clayey portion of the Hagarstown member is up to 6 feet thick. The UCU has been eroded east of AP1, near the unnamed tributary.
- **Uppermost Aquifer (UA)**: The UA is the Hagarstown Member which is classified as primarily sandy to gravelly silts and clays with thin beds of sands. Where present, the sandy portion of the Hagarstown is generally 2 to 4 feet thick. Similar to the Loess Unit, the Hagarstown is absent in some locations near the unnamed tributary. Hydraulic conductivity in the UA is moderate.
- **Lower Confining Unit (LCU):** Comprised of the Vandalia Member, Mulberry Grove Member, and Smithboro Member. These units include a sandy to silty till with thin, discontinuous sand lenses, a discontinuous and limited extent sandy silt which has infilled prior erosional features, and silty to clayey diamicton, respectively. The unit was encountered in all borings on the CPP. This LCU has been identified as a PMP because downward vertical gradients indicate that there is the potential for impacts to migrate within this unit despite very low permeability.
- **Deep Aquifer (DA):** Sand and sandy silt/clay units of the Yarmouth Soil, which include accretionary deposits of fine sediment and organic materials, typically less than 5 feet thick and discontinuous across the CPP. Where present, the DA has been identified as a PMP due to presence of downward gradients in the overlying LCU and the relatively greater hydraulic conductivities measured in the DA. Hydraulic conductivity in the DA is moderate.
- **Deep Confining Unit (DCU):** Comprised of the Banner Formation, and generally consists of clays, silts, and sands. The Lierle Clay Member is the upper layer of the Banner Formation, which was encountered at the Site. No boring locations penetrated the full thickness of the Lierle Clay.

The effects of these hydrostratigraphic units on schedule were considered by incorporating the geometry, hydraulic, and geochemical properties of these units into the Groundwater Modeling and Groundwater Polishing Reports, attached to the CAAA-SIR and CAAA, respectively, included in **Appendix A**, which estimate the time to reach the GWPS for remedial alternatives.

35 I.A.C. § 845.670(f)(5)(F): The availability of alternative water supplies.

As discussed in subsection 35 I.A.C. § 845.670(f)(5)(B) above, there were potentially 12 water wells identified within 1,000 meters of AP1 [15]. There is currently no need for an alternative water supply well as there are no current unacceptable risks to human or ecological receptors at the site. There are no applicable schedule concerns regarding the availability of alternative water supplies.

3.3.1 Other Relevant Factors

35 I.A.C. § 845.670(f)(6): Other relevant factors.

No additional factors were identified for consideration.

3.4 Necessity of Interim Measures

Source control using the hybrid consolidate-and-cap approach is projected to be complete within four to six years after approval of the final closure CP application [4]. 35 I.A.C § 845.680(a)(3) states the owner or operator must take any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors. Upon completion of source control, AP1 will immediately transition to GWP, therefore no interim measures are required. Further, all subsections of this requirement are discussed as follows.

35 I.A.C. § 845.680(a)(3)(A): Time required to develop and implement a final remedy.

Source control with GWP will be completed in accordance with the schedule provided in **Table 1**. The GWPS will be achieved within a reasonable time frame.

35 I.A.C. § 845.680(a)(3)(B): Actual or potential exposure of nearby populations or environmental receptors to any of the constituents listed in 35 I.A.C. § 845.600.

There are no current unacceptable risks to human or ecological receptors at the site (**Appendix A**). It was concluded that shallow groundwater and surface water are not a source of drinking water [12].

35 I.A.C. § 845.680(a)(3)(C): Actual or potential contamination of sensitive ecosystems or current or potential drinking water supplies.

The nature and extent of exceedances have been evaluated in the Nature and Extent Report [13]. Although there are exceedances of GWPS, there are no impacts to current or potential drinking water supplies. As stated above, there are no current unacceptable risks to human or ecological receptors at the site. Additionally, an ecological risk assessment was completed, and no unacceptable risks were identified for ecological receptors exposed to surface water and sediment [12]. No potential groundwater receptors are in the vicinity of AP1 [12].

35 I.A.C. § 845.680(a)(3)(D): Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously.

The selected remedy of source control with GWP will achieve the GWPS in a reasonable time frame and no unacceptable risks to human health or the environment have been identified. No interim measure is expected to prevent further degradation of the groundwater more expeditiously than implementation of the selected remedy.

35 I.A.C. § 845.680(a)(3)(E): Weather conditions that may cause any of the constituents listed in 35 I.A.C. § 845.600 to migrate or be released.

As stated above, the selected remedy of source control with GWP will achieve the GWPS in a reasonable timeframe and no unacceptable risks to human health or the environment have been identified. No interim measure is expected to further prevent migration of constituents more expeditiously than implementation of the selected remedy.

35 I.A.C. § 845.680(a)(3)(F): Potential for exposure to any of the constituents listed in 35 I.A.C. § 845.600 as a result of accident or failure of a container or handling system.

As stated above, GWP will be implemented immediately after source control is complete. As AP1 is closed in place within a consolidated footprint, no container or handling system will be in use.

35 I.A.C. § 845.680(a)(3)(G): *Other situations that may pose threats to human health and the environment.*

No other situations have been identified where AP1 CCR leachate poses threats to human health and environment.

4. REFERENCES

[1] Illinois Administrative Code, "Title 35, Subtitle G, Chapter I, Subchapter J, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," effective April 21, 2021.

[2] Code of Federal Regulations, "Title 40, Chapter I, Subchapter I, Part 257, Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," April 17, 2015.

[3] Burns & McDonnell Engineering Company, Inc., "Initial Operating Permit, Coffeen Ash Pond No. 1," Coffeen, IL, October 25, 2021.

[4] Golder Associates USA, Inc., "Part 845 Construction Permit Application for Ash Pond 1," Coffeen, IL, July 28, 2022.

[5] Golder Associates USA, Inc., "Final Closure Plan for Ash Pond No. 1," Coffeen, IL, July 28, 2022.

[6] United States Environmental Protection Agency (USEPA), "40 CFR Parts 257 and 261 Hazardous and Solid Waste [EPA–HQ–RCRA–2009–0640; FRL–9919–44–OSWER]," April 17, 2015.

[7] Ramboll Americas Engineering Solutions, Inc., "Groundwater Modeling Report Ash Pond 1," Coffeen, IL, July 28, 2022.

[8] Ramboll Americas Engineering Solutions, Inc., "Groundwater Modeling Technical Memorandum, Coffeen Power Plant, Ash Pond No. 1," Coffeen, IL, June 10, 2025.

[9] United States Environmental Protection Agency, "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Directive No. 9200.U-17P.," Office of Solid Waste and Emergency Response, Washington D.C., 1999.

[10] United States Environmental Protection Agency, "Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind," Office of Solid Waste and Emergency Response, 2014.

[11] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845 Corrective Measures Assessment, Ash Pond No. 1, Coffeen Power Plant," Coffeen, IL, June 12, 2024.

[12] Gradient Corp, "Human Health and Ecological Risk Assessment, Ash Pond 1, Coffeen Power Plant," Coffeen, IL, July 28, 2022.

[13] Ramboll Americas Engineering Solutions, Inc., "Nature and Extent Report, Coffeen Power Plant, Ash Pond No. 1, IEPA ID NO. W1350150004-01," Coffeen, IL, June 12, 2024.

[14] Geosyntec Consultants, Inc., "Groundwater Polishing Evaluation Report, Coffeen Power Station - Ash Pond No. 1 (EPA ID No. 101)," Coffeen, IL, June 10, 2025.

[15] Ramboll Americas Engineering Solutions, Inc., "Hydrogeologic Site Characterization Report, Coffeen Power Plant, Ash Pond No. 1," Coffeen, IL, October 25, 2021.

TABLES

Table 1. Proposed Milestone Schedule for Implementing Corrective Action Remedy (Source Control-Groundwater Polishing)

Implementation Phase	Implementation Task	Timeframe* (Preliminary Estimates)
Source Control Pre-Implementation	Final Closure Plan Submittal	July 2022
	Corrective Action Plan Submittal	June 2025
Source Control Construction	Source Control (Closure) Construction • Complete Implementation of Source Control	4 to 6 years (after approval of closure plan and All Other Closure-Related Permits)
	Timeframe to Complete Source Control Construction[1]	**4 to 6 years** (after receipt of all permits required for closure)
Corrective Action Implementation	Corrective Action Operations (Time to Meet GWPS) • Perform groundwater monitoring and reporting per Corrective Action Groundwater Monitoring Plan	40 years (after completion of Source Control[2])
	Corrective Action Groundwater Confirmation Monitoring • Perform groundwater monitoring to demonstrate compliance with GWPS for 3 years, per 35 I.A.C. § 845.680(c)	3 years (after Corrective Action Operations and Maintenance)
	Corrective Action Completion • Prepare Corrective Action Completion Report, per 35 I.A.C. § 845.680(E)	3 to 6 months (after Corrective Action Confirmation Monitoring)
	Timeframe to Complete Corrective Action Implementation[1]	**44 years** (after completion of Source Control)

[1]All timeframes are preliminary and may change as the project develops. Timeframes may also be affected by regulatory review and/or permit approval processes, for both 35 I.A.C. § 845 and non-35 I.A.C. § 845 permits.

[2]See Table A in **Section 3.3** of the report, 92% of progress toward meeting the GWPS is expected to occur within the first 20 years.

GWPS = Groundwater Protection Standard(s)

APPENDIX A
CORRECTIVE ACTION ALTERNATIVES ANALYSIS (845.670(E)), INCLUDING CORRECTIVE MEASURES ASSESSMENT (845.660)

Corrective Action Alternatives Analysis for the Ash Pond No. 1 at the Coffeen Power Plant, Coffeen, Illinois

June 10, 2025

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Abbreviations

AP1	Ash Pond No. 1
BMP	Best Management Practice
CAA	Closure Alternatives Analysis
CAAA	Corrective Action Alternatives Analysis
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CMA	Corrective Measures Assessment
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPP	Coffeen Power Plant
DA	Deep Aquifer
DCU	Deep Confining Unit
GHG	Greenhouse Gas
GWE	Groundwater Extraction
GWP	Groundwater Polishing
GWPS	Groundwater Protection Standard
HUC	Hydrologic Unit Code
IAC	Illinois Administrative Code
ID	Identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
ISGS	Illinois State Geological Survey
LCU	Lower Confining Unit
LLDPE	Linear Low-Density Polyethylene
N_2O	Nitrous Oxide
NID	National Inventory of Dams
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
PM	Particulate Matter
SFWA	State Fish and Wildlife Area
Source Control-GWE	Source Control with Groundwater Extraction
Source Control-GWP	Source Control with Groundwater Polishing
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
UA	Uppermost Aquifer
UCU	Upper Confining Unit
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Summary of Findings

Title 35, Part 845 of the Illinois Administrative Code (IAC) (IEPA, 2021) requires that a Corrective Action Alternatives Analysis (CAAA) be performed as part of the remedy selection, prior to undertaking any corrective actions at certain coal combustion residual (CCR)-containing impoundments, where exceedances of groundwater protection standards (GWPSs) have been identified. This report presents a CAAA for Ash Pond No. 1 (AP1) at the Coffeen Power Plant (CPP) pursuant to the requirements under IAC Section 845.670. The goal of performing a CAAA is to holistically evaluate the potentially viable corrective actions identified in the Corrective Measures Assessment (CMA; Appendix C; Ramboll, 2025a) in order to remediate groundwater and achieve compliance with the GWPSs specified under IAC Section 845.600 (IEPA, 2021). These analyses assess potentially viable corrective action alternatives based on a wide range of factors, including the efficiency, reliability, and ease of implementation of a corrective action; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by the community (IEPA, 2021).

It is important to note that many CCR sites are complex groundwater environments where remedial actions will inherently take many years to complete. While no formal definition of a complex groundwater environment exists, most would agree that there are a number of common characteristics at complex groundwater sites, including the following (National Research Council, 2013):

- Highly heterogeneous subsurface environments;
- Large source zones;
- Multiple, recalcitrant constituents; and
- Long timeframes over which releases occurred.

Each of these characteristics are common at CCR sites. Surface impoundments are often tens to hundreds of acres in size and many have operated for decades, leading to large source zones and prolonged releases. Furthermore, CCR impoundments are often located in alluvial geologic settings where sands are interbedded with silts and clays. This results in a heterogeneous environment where constituent mass may persist for many years in low-permeability deposits. Finally, the constituents that are most common at CCR sites include metals and inorganics that do not naturally biodegrade. The combination of these factors results in a complex groundwater environment where remediation, even under the best of circumstances, may take many years to achieve GWPSs. It is for these reasons that the United States Environmental Protection Agency (US EPA) refused to specify what is a reasonable *versus* an unreasonable timeframe for groundwater corrective actions at CCR sites, stating that it "was truly unable to establish an outer limit on the necessary timeframes—including even a presumptive outer bound" (US EPA, 2015a).

In this CAAA, both corrective actions that have been evaluated consist of source control and residual plume management. Source control is generally considered to be one of the more effective remedial action approaches. Source control involves removing the hydraulic head from an impoundment (*i.e.*, unwatering and dewatering) and preventing further downward migration of constituents. US EPA has found that "releases from surface impoundments [to groundwater] drop dramatically after closure" (US EPA, 2014). US EPA has also stated that source control is the most effective means of ensuring the timely attainment of remediation objectives (US EPA, 2015b). As a result, the implementation of source control often has a substantial and immediate effect on groundwater quality improvements.

The specific source control method that is the central component of all the corrective active alternatives evaluated in this CAAA is closure-in-place (CIP) using a consolidate-and-cap approach. Specifically, this includes the removal of free liquids, excavation and consolidation of CCR into the western portion of Ash Pond No. 1 (AP1), and the installation of a low-permeability geomembrane final cover system. The excavation and consolidation would decrease the total CCR footprint from approximately 26 acres to 10.4 acres. The final cover system consisting of a 40-mil linear low-density polyethylene (LLDPE) geomembrane layer, nonwoven geotextile cushion, and 24 inches (in) of protective soil cover would be installed over the final footprint of AP1. These activities are designed to control, minimize, or eliminate, post-closure infiltration of liquids into the impounded CCR. This source control approach would result in CCRs being separated vertically between 3.2 and 10 feet (ft) from underlying groundwater (Ramboll, 2022). As demonstrated by the groundwater modeling in support of the Closure Alternatives Analysis (CAA; Gradient, 2022), this source control approach would result in a reduction of the migration of water into AP1 by 99.9% compared to pre-closure conditions. Additionally, source control would result in a reduction of hydraulic flux out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022), demonstrating that source control will control, minimize, or eliminate post-closure releases of leachate.

Two potential corrective actions are evaluated in this CAAA: Source Control with Groundwater Polishing (Source Control-GWP) and Source Control with Groundwater Extraction (Source Control-GWE). Both alternatives consist of source control and residual plume management, and both alternatives were identified as a viable approach in the CMA (Appendix C; Ramboll, 2025a). The residual plume management portions of these corrective action alternatives include groundwater polishing (GWP) and a groundwater extraction (GWE) trench.

Under the Source Control-GWP alternative, constituent concentrations in groundwater would attenuate naturally over time due to physical and geochemical mechanisms. Site-specific evaluations demonstrated that GWP is appropriate at AP1 because Site conditions are favorable for natural attenuation of inorganic contaminants *via* adsorption (Appendix E; Geosyntec Consultants, Inc., 2025). Under the Source Control-GWE alternative, a groundwater extraction trench would be constructed along the northern side of AP1 to remove impacted groundwater. The trench would extend from the ground surface to a depth of 38 ft below ground surface (bgs) which is below the bottom of the uppermost aquifer (UA). The extraction trench would be approximately 1,600 ft long and 3 ft wide. Collection pipes would be installed at the bottom of the trenches. The trenches would be backfilled with clean granular fill and capped with compacted clay to reduce surface water infiltration. The collection pipes would drain to sumps spaced throughout the trenches to extract groundwater. Extracted groundwater would be collected and sent to a new on-Site lined settling pond and discharged through an outfall managed under the National Pollutant Discharge Elimination System (NPDES) permit for the Site. As part of each corrective action alternative, an adaptive site management plan would be implemented in order to optimize the selected remedy based on real-time data that are collected.

Table S.1 evaluates the two potentially viable corrective actions evaluated in this CAAA (Source Control-GWP and Source Control-GWE) with regard to each of the factors specified under IAC Section 845.670(d) and IAC Section 845.670(e) (IEPA, 2021). Based on this evaluation and the details provided in Section 2 of this report, the most appropriate corrective action for this Site is Source Control-GWP. The timeframe for achieving the GWPS under the Source Control-GWP alternative was predicted to be similar to the Source Control-GWE alternative. However, the expected impacts on workers and the environment under the Source Control-GWP alternative are lower than those under the Source Control-GWE alternative. Thus, Source Control-GWP is the most appropriate corrective action alternative for AP1.

Table S.1 Comparison of Proposed Corrective Action Alternatives with Respect to Factors Specified in IAC Section 845.670(d) and IAC Section 845.670(e)

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
Magnitude of Reduction of Existing Risks/Be Protective of Human Health and the Environment (Section 2.2.1; IAC Section 845.670(e)(1)(A)/ IAC Section 845.670(d)(1))	Because current conditions do not present a risk to human health or the environment at AP1, there will be no unacceptable risk to human health or the environment for future conditions when the unit has been closed and source control has been implemented. Concentrations of CCR-derived constituents will decline over time and, consequently, potential exposures to CCR-derived constituents in the environment will also decline. The magnitude of the reduction of existing risks is the same for the three potential corrective action alternatives, and both corrective action alternatives are equally protective of human health and the environment.	Because current conditions do not present a risk to human health or the environment at AP1, there will be no unacceptable risk to human health or the environment for future conditions when the unit has been closed and source control has been implemented. Concentrations of CCR-derived constituents will decline over time and, consequently, potential exposures to CCR-derived constituents in the environment will also decline. The magnitude of the reduction of existing risks is the same for the three potential corrective action alternatives, and both corrective action alternatives are equally protective of human health and the environment.
Effectiveness of the Remedy in Controlling the Source (Section 2.2.2; IAC Section 845.670(e)(2))		
Extent to Which Containment Practices Will Reduce Further Releases/Control the Sources of Releases to Reduce or Eliminate, to the Maximum Extent Feasible (IAC Section 845.670(e)(2)(A)/IAC Section 845.670(d)(3))	Both alternatives include source control (which is the primary remedial measure) and residual plume management. Modeling results (see the CAA; Gradient, 2022; Ramboll, 2022) indicate that source control would result in a reduction of hydraulic flux in and out of AP1 by 99.9% compared to pre-closure conditions. Source control is thus effective at controlling releases. Under the residual plume management for Source Control-GWP alternative, physical and geochemical attenuation mechanisms would mitigate impacts to downgradient groundwater quality and control the residual plume (Geosyntec Consultants, Inc., 2025). If necessary, remedy optimizations would be implemented under the adaptive site management program.	Both alternatives include source control (which is the primary remedial measure) and residual plume management. Modeling results (see the CAA; Gradient, 2022; Ramboll, 2022) indicate that source control would result in a reduction of hydraulic flux in and out of AP1 by 99.9% compared to pre-closure conditions. Source control is thus effective at controlling releases. Under the residual plume management for Source Control-GWE alternative, groundwater extraction trench would remove impacted groundwater and control migration of impacted groundwater. If necessary, remedy optimizations would be implemented under the adaptive site management program.
Extent to Which Treatment Technologies May Be Used (IAC Section 845.670(e)(2)(B))	Source Control-GWP would rely on physical and geochemical attenuation processes. If necessary, remedy optimizations would be implemented	For the Source Control-GWE alternative, it would require construction of a new on-Site settling pond to treat extracted groundwater prior to discharge *via* an

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
	under the adaptive site management program.	NPDES permitted outfall. Other treatment and management technologies may be evaluated at later phases of the design. The remedy would also rely on physical and geochemical attenuation processes. If necessary, remedy optimizations would be implemented under the adaptive site management program.
Likelihood of Future Releases of CCR (Section 2.2.3; IAC Section 845.670(e)(1)(B))	Both corrective action alternatives include source control using CIP with a consolidate-and-cap approach. Free liquids would be removed, a new cover system would be installed, which would consist of a 40-mil low density polyethylene (LLDPE) geomembrane layer, a geotextile cushion, and 24 in of protective soil. Relative to current conditions, this cover system would provide increased protection against berm and surface erosion, precipitation infiltration, and other adverse effects that could potentially trigger a release of CCR (Appendix B; Ramboll, 2025b). There would be minimal risk of accidental CCR releases occurring post-closure under any of the potential alternatives.	Both corrective action alternatives include source control using CIP with a consolidate-and-cap approach. Free liquids would be removed, a new cover system would be installed, which would consist of a 40-mil LLDPE geomembrane layer, a geotextile cushion, and 24 in of protective soil. Relative to current conditions, this cover system would provide increased protection against berm and surface erosion, precipitation infiltration, and other adverse effects that could potentially trigger a release of CCR (Appendix B; Ramboll, 2025b). There would be minimal risk of accidental CCR releases occurring post-closure under any of the potential alternatives.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.4; IAC Section 845.670(e)(1)(C))	Minimal long-term O&M efforts would be required under Source Control-GWP because it would not require the installation, operation, or maintenance of any engineered systems or structures other than maintenance of the monitoring well network. Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Additionally, corrective action groundwater monitoring would continue for 3 years after GWPS have been achieved. Based on the adaptive site management approach, remedy optimizations may be implemented to ensure achievement of the GWPSs.	Long-term O&M efforts required under Source Control-GWE would include the maintenance of the groundwater collection trench system and discharge of extracted groundwater. Extracted groundwater would be managed and treated by a newly-constructed on-Site settling pond before discharge *via* an NPDES permitted Outfall. Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Additionally, corrective action groundwater monitoring would continue for 3 years after GWPS have been achieved. Based on the adaptive site management approach, remedy optimizations may be implemented to ensure achievement of the GWPSs.

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
Short-Term Risks to the Community or the Environment During Implementation of Remedy (Section 2.2.5; IAC Section 845.670(e)(1)(D))		
Safety Impacts	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. While appropriate controls would be established to prevent accidents and injuries from occurring, the risks of accidents and injuries occurring during source control would be the same for both corrective action alternatives. These source control risks were evaluated in the CAA (Gradient, 2022). Overall, no worker accidents or injuries would be expected under the Source Control-GWP alternative because no installation, operation, and maintenance of engineered systems or structures would be required. Similarly, no off-Site impacts on nearby residents would be expected under the Source Control-GWP alternative.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. While appropriate controls would be established to prevent accidents and injuries from occurring, the risks of accidents and injuries occurring during source control would be the same for both corrective action alternatives. These source control risks were evaluated in the CAA (Gradient, 2022). Overall, considering both on- and off-Site activities, 0.28 worker injuries and 4.4×10^{-3} worker fatalities would be expected to occur under the Source Control-GWE alternative. In total, an estimated 6.2×10^{-2} injuries and 7.8×10^{-4} fatalities would be expected to occur among community members due to off-Site activities under the Source Control-GWE alternative.
Cross-Media Impacts to Air	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both corrective action alternatives. Air impacts occurring during source control would be the same for both corrective action alternatives. Impacts associated with CIP using a consolidate-and-cap approach were evaluated in the CAA (Gradient, 2022). Cross-media impacts to air can include air pollutants and GHG emissions, which are proportional to the potential impact of each alternative on other emissions from construction vehicles and equipment. Residual plume management for the Source Control-GWP alternative would be expected to have minimal air impacts	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both corrective action alternatives. Air impacts occurring during source control would be the same for both corrective action alternatives. Impacts associated with CIP using a consolidate-and-cap approach were evaluated in the CAA (Gradient, 2022). Cross-media impacts to air can include air pollutants and GHG emissions, which are proportional to the potential impact of each alternative on other emissions from construction vehicles and equipment. Residual plume management for the Source Control-GWE alternative would have greater air impacts due to the

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
	because it would not require the construction of any engineered systems or structures.	construction and operation of the extraction trench system.
Cross-Media Impacts to Surface Water and Sediments	Groundwater modeling performed in support of the CAA (Gradient, 2022) predicted that source control (*i.e.*, CIP using a consolidate-and-cap approach) would result in a reduction of hydraulic flux in and out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022). Under residual plume management for the Source Control-GWP alternative, minimal surface water and sediment impacts would be expected, because it would not require the construction of any engineered systems or structures.	Groundwater modeling performed in support of the CAA (Gradient, 2022) predicted that source control (*i.e.*, CIP using a consolidate-and-cap approach) would result in a reduction of hydraulic flux in and out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022). Under residual plume management for the Source Control-GWE alternative, groundwater collected by the extraction trench would be treated through the on-Site settling pond and discharged *via* an NPDES-permitted outfall. Surface water and sediment impacts associated with this alternative would be higher than the impacts associated with Source Control-GWP alternative due to the construction of the extraction trench system and the settling pond. Erosion and sediment runoff may occur due to the close proximity to the wetlands and surface water bodies during construction activities.
Control of Exposure to Any Residual Contamination During Implementation of the Remedy	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. While appropriate controls would be established to prevent exposures of CCR during source control, the risks of CCR exposure during source control would be the same for both corrective action alternatives. Risks to workers arising from potential contact with residual contamination during construction activities associated with residual plume management would be minimal under the Source Control-GWP alternative, which would not involve exposure to soil or groundwater waste streams.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. While appropriate controls would be established to prevent exposures of CCR during source control, the risks of CCR exposure during source control would be the same for both corrective action alternatives. Risks to workers arising from potential contact with residual contamination during construction, operation, and maintenance activities associated with residual plume management would be higher for the Source Control-GWE alternative than for the Source Control-GWP alternative, because Source Control-GWE would involve the production, management, and treatment of extracted

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
		groundwater, as well as on-Site disposal of excavated spoils generated during extraction trench construction.
Other Identified Impacts	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, impacts during source control would be the same for both corrective action alternatives (see the CAA; Gradient, 2022). The energy demands under the Source Control-GWP would be minimal because this alternative would not require any significant construction activity. Similarly, traffic and noise impacts associated with residual plume management would be expected to be lower for the Source Control-GWP alternative compared to Source Control-GWE alternative since no significant construction activities would be required. There would be no impacts to natural resources and habitat under the Source Control-GWP alternative because no additional construction activities would occur after implementation of the source control.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, impacts during source control would be the same for both corrective action alternatives (see the CAA; Gradient, 2022). The energy demands of construction equipment and vehicles associated with residual plume management would be greater under the Source Control-GWE alternative due to the activities that would be required to construct the extraction system. Similarly, traffic and noise impacts associated with residual plume management would be expected to be higher under the Source Control-GWE alternative than the Source Control-GWP alternative, due to the construction activities required to construct the extraction trench system and settling pond. Under the Source Control-GWE alternative, there would be some negative impacts to natural resources and habitat, including disturbance of some existing habitat atop portions of the construction areas and potential impacts to aquatic and wetland species in Coffeen Lake and other wetlands due to sediment runoff during construction.
Time Until Groundwater Protection Standards Are Achieved (Section 2.2.6; IAC Section 845.670(e)(1)(E))	Groundwater modeling performed in support of the CAA (Gradient, 2022; Ramboll, 2022) concluded that source control (*i.e.*, CIP using a consolidate-and-cap approach) alone would result in a 99.9% reduction into and out of AP1 compared to pre-closure conditions. Additional modeling was conducted to evaluate future groundwater quality in	Groundwater modeling performed in support of the CAA (Gradient, 2022; Ramboll, 2022) concluded that source control (*i.e.*, CIP using a consolidate-and-cap approach) alone would result in a 99.9% reduction into and out of AP1 compared to pre-closure conditions. Additional modeling was conducted to evaluate future groundwater quality in

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
	the vicinity of AP1 under each of the proposed source control with corrective action alternatives. The results indicate that groundwater would attain the GWPSs for all constituents identified as having potential exceedances within 40 years in all wells after completion of source control under the Source Control-GWP alternative (Appendix B; Ramboll, 2025c).	the vicinity of AP1 under each of the proposed source control with corrective action alternatives. The results indicate that groundwater would attain the GWPSs for all constituents identified as having potential exceedances within 40 years in all wells after completion of source control under the Source Control-GWE alternative (Appendix B; Ramboll, 2025c).
Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (Section 2.2.7; IAC Section 845.670(e)(1)(F))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives and, thus, potential exposures to CCR remaining in AP1 would be the same under all alternatives. Once source control activities have been completed, this corrective action alternative is expected to limit exposure of humans and environmental receptors to CCR remaining in AP1. Furthermore, as a result of the source control, there would be minimal risks of CCR releases post-closure. The Source Control-GWP alternative would not involve exposure to the soil or groundwater waste streams and, thus, there is no potential for exposure of humans and environmental receptors to wastes.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives and, thus, potential exposures to CCR remaining in AP1 would be the same under all alternatives. Once source control activities have been completed, this corrective action alternative is expected to limit exposure of humans and environmental receptors to CCR remaining in AP1. Furthermore, as a result of the source control, there would be minimal risks of CCR releases post-closure. Potential risks to workers that come in contact with residual contamination of CCR-derived constituents during groundwater extraction and treatment would be managed through the use of rigorous safety protocols and personal protective equipment. Some changes in groundwater flow may occur under the Source Control-GWE alternative, due to the operation of the extraction system. Hydrogeological changes would also be expected under this alternative, such as lowering groundwater table in the vicinity of the extraction trenches, altering flow patterns in the UA, and causing changes in hydraulic gradients. However, changes to groundwater flow would not be expected to have an effect on the potential for the exposure of humans and environmental receptors to remaining wastes.

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.8; IAC Section 845.670(e)(1)(G))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, long-term reliability during source control would be the same for both corrective action alternatives (see the CAA; Gradient, 2022). Residual plume management under the Source Control-GWP alternative would be reliable because it is a proven process that would rely on physical and geochemical attenuation processes and active monitoring. Site specific evaluations have shown that chemical attenuation is feasible, and attenuation should remain stable under post-closure conditions. Remobilization is unlikely to impact the time to achieve GWPSs as groundwater returns to background conditions (Geosyntec Consultants, Inc., 2025). If necessary, remedy optimizations would be implemented under the adaptive site management program.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, long-term reliability during source control would be the same for both corrective action alternatives (see the CAA; Gradient, 2022). Residual plume management under the Source Control-GWE alternative would be reliable, as long as the extraction trench and pumps are maintained and operated appropriately, because it is a proven remedy that has been implemented at many sites. Routine and non-routine maintenance of the extraction system is required to ensure reliable operation of the extraction trench and pumps, as well as other system components. If necessary, remedy optimizations would be implemented under the adaptive site management program.
Potential Need for Replacement of the Remedy (Section 2.2.9; IAC Section 845.670(e)(1)(H))	Replacement of the residual plume management remedy under the Source Control-GWP alternative would likely be unnecessary because this alternative would not require the installation, operation, and maintenance of engineered systems or structures. Adaptive site management strategies would be used to implement remedy optimizations, if necessary, to ensure that remedial goals are achieved.	Replacement of the residual plume management remedy under the Source Control-GWE alternative would likely be unnecessary, as long as the extraction trench and treatment system are maintained and serviced appropriately. Adaptive site management strategies would be used to implement remedy optimizations, if necessary, to ensure that remedial goals are achieved.
Degree of Difficulty Associated with Constructing the Remedy (Section 2.3.1; IAC Section 845.670 (e)(3)(A))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, construction difficulties would be the same for both corrective action alternatives. Difficulties associated with implementing CIP using a consolidate-and-cap approach were evaluated in the CAA (see the CAA; Gradient, 2022).	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, construction difficulties would be the same for both corrective action alternatives. Difficulties associated with implementing CIP using a consolidate-and-cap approach were evaluated in the CAA (see the CAA; Gradient, 2022).

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
	Residual plume management under the Source Control-GWP alternative would rely on physical and geochemical attenuation processes and therefore would not pose any significant construction challenges.	Residual plume management under the Source Control-GWE alternative would rely on the extraction trench and a settling pond to extract and treat impacted groundwater, as well as physical and geochemical attenuation processes. The construction of the groundwater trench required by this alternative would require the use of specialized contractors and equipment (*i.e.*, one-pass trenching contractor and equipment) for the installation of the trench, in addition to general construction equipment (Appendix B; Ramboll, 2025b). Groundwater monitoring would be conducted using a groundwater monitoring network designed in accordance with IAC Section 845.680(c).
Expected Operational Reliability of the Remedy (Section 2.3.2; IAC Section 845.670 (e)(3)(B))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, the operational reliability of the remedy would be the same for both corrective action alternatives. The reliability associated with implementing CIP using a consolidate-and-cap approach was evaluated in the CAA (see the CAA; Gradient, 2022). Residual plume management under the Source Control-GWP alternative would have high operational reliability because this alternative would rely on physical and geochemical processes and active monitoring. Adaptive site management strategies would be used to implement remedy optimizations, if necessary.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, the operational reliability of the remedy would be the same for both corrective action alternatives. The reliability associated with implementing CIP using a consolidate-and-cap approach was evaluated in the CAA (see the CAA; Gradient, 2022). Residual plume management under the Source Control-GWE alternative would have high operational reliability because it is an established technology, as long as the extraction trench and treatment system are maintained and operated appropriately. Adaptive site management strategies would be used to implement remedy optimizations, if necessary.
Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies (Section 2.3.3; IAC Section 845.670 (e)(3)(C))	Specific permits and approvals associated with source control using a consolidate-and-cap approach were the same for both corrective action alternative and were evaluated in the CAA (Gradient, 2022).	Specific permits and approvals associated with source control using a consolidate-and-cap approach were the same for both corrective action alternative and were evaluated in the CAA (Gradient, 2022).

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
	Residual plume management under the Source Control-GWP alternative would not need additional permits from other agencies, other than the approval of the eventual Corrective Action Plan.	Residual plume management for the Source Control-GWE alternative would require regulatory approvals. Groundwater extracted from the extraction trench would require a modified NPDES permit, which would likely require renewals depending on the timeline of corrective action implementation. Permits from the IEPA for construction stormwater controls and BMPs, placement of excavated spoils beneath the AP1 final cover system *via* an amendment to the AP1 Closure Plan and Construction Permit Application, and an operating permit would be required. An Illinois Department of Natural Resources (IDNR) Dam Safety modification permit would be obtained for modifications of the embankment.
Availability of Necessary Equipment and Specialists (Section 2.3.4; IAC Section 845.670 (e)(3)(D))	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, equipment and specialist needs would be the same for both corrective action alternatives. An assessment of necessary equipment and specialists associated with implementing CIP using a consolidate-and-cap approach was evaluated in the CAA (see the CAA; Gradient, 2022). Residual plume management under the Source Control-GWP alternative would require standard environmental monitoring equipment and groundwater professionals. Specialists such as geologists, hydrogeologists, statisticians (*i.e.*, statistical analysis), and geochemists would be available to collect and evaluate the data.	Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, equipment and specialist needs would be the same for both corrective action alternatives. An assessment of necessary equipment and specialists associated with implementing CIP using a consolidate-and-cap approach was evaluated in the CAA (see the CAA; Gradient, 2022). Residual plume management under the Source Control-GWE alternative would require specialists to manage the extraction system throughout its construction and operational period: 1. Construction of the groundwater extraction system on the Site is expected to require a specialized contractor. The contractor would most likely need specialized and often custom-built equipment including one-pass construction equipment. The availability of contractors with such equipment may be limited. 2. Specialists including design engineers, construction managers

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
		and contractor staff experienced in trench construction and similar geologic environments would be required as well. In addition, specialists and equipment may have backlogs from similar specialty ground improvement projects in the area. 3. Geotechnical specialists would be required to design the working platform and oversee the AP1 embankment, monitoring for any signs of distress during the one-pass trench installation. 4. After the construction phase, specialists and equipment would be required during the operation of the extraction system. Routine maintenance would include inspection of system components such as totalizers, instrumentation, and the extraction and transfer pumps. Non-routine maintenance such as flushing or jetting of the conveyance lines, replacement of faulty system components, replacement of pumps or pump controllers, and replacement of faulty system instrumentation would also be necessary. Specialists and replacement equipment needed to operate the system would be generally available at the Site, although some of the more complex equipment (*i.e.*, transfer pumps and transfer pump controller) may have extended lead times for servicing. 5. This alternative would necessitate the use of equipment and the expertise of specialists for tasks such as field data collection, groundwater sampling, analysis, and periodic corrective action groundwater monitoring and reporting. Similar to those in the GWP alternative, these activities are already being conducted as part of routine groundwater monitoring in

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
		accordance with IAC Section 845.220(c)(4).
Available Capacity and Location of Needed Treatment, Storage, and Disposal Services/Comply with Standards for Management of Wastes as Specified in Section 845.680(d) (Section 2.3.5; IAC Section 845.670 (e)(3)(E)/ IAC section 845.670(d)(5))	No treatment, storage, or disposal services would be required with the residual plume management under the Source Control-GWP alternative, as GWP would not generate any significant volume of waste or wastewater.	Residual plume management for the Source Control-GWE alternative would require the construction of the extraction trench system, which would generate spoils during the construction phase, and the waste materials would be used as subgrade fill beneath the AP1 final cover system. Extracted groundwater would be treated at an on-Site settling pond. Discharge from the settling pond would be conveyed to an NPDES permitted outfall.
The Degree to Which Community Concerns Are Addressed by the Remedy (Section 2.4; IAC Section 845.670(e)(4))	The combination of source control (*i.e.*, CIP using a consolidate-and-cap approach) with residual plume management would cause groundwater concentrations to decline over time under both corrective action alternatives, as suggested by the groundwater modeling (Appendix B; Ramboll, 2025c). A public meeting was held on May 1, 2025, pursuant to requirements under IAC Section 845.660(d). Questions raised by attendees were addressed at the meeting; a written summary of the questions and responses were prepared.	The combination of source control (*i.e.*, CIP using a consolidate-and-cap approach) with residual plume management would cause groundwater concentrations to decline over time under both corrective action alternatives, as suggested by the groundwater modeling (Appendix B; Ramboll, 2025c). A public meeting was held on May 1, 2025, pursuant to requirements under IAC Section 845.660(d). Questions raised by attendees were addressed at the meeting; a written summary of the questions and responses were prepared.
Remove from the Environment as Much of the Contaminated Material That Was Released from the CCR Surface Impoundment as Is Feasible, Taking into Account Factors Such as Avoiding Inappropriate Disturbance of Sensitive Ecosystems (Section 2.5; IAC Section 845.670(d)(4))	There have been no known releases of CCR at the AP1. Both potential corrective action alternatives would have source control and residual plume management efforts. The source control would include a consolidate-and-cap approach to limit the infiltration of precipitation into the impounded CCR. Additionally, residual plume management under the Source Control-GWP alternative would address impacted groundwater by relying on physical and geochemical attenuation processes to reduce the residual concentrations of CCR-derived constituents in groundwater. Site specific evaluations demonstrate that attenuation *via* sorption onto mineral surfaces should remain stable under post-	There have been no known releases of CCR at the AP1. Both potential corrective action alternatives would have source control and residual plume management efforts. The source control would include a consolidate-and-cap approach to limit the infiltration of precipitation into the impounded CCR. Additionally, residual plume management under the Source Control-GWE alternative would rely on the extraction trench to reduce or prevent migration of impacted groundwater. The construction activities would likely result in some negative impacts to the ecosystem, including disturbance of some existing habitat near the construction

Evaluation Factor (Report Section; Part 845 Section)	Source Control-GWP	Source Control-GWE
	closure conditions, and remobilization is unlikely to impact the time to achieve GWPS (Appendix E; Geosyntec Consultants, Inc., 2025). No ecosystems would be disturbed because no construction activities are expected under the Source Control-GWP alternative.	areas. Short-term impacts could also occur to sensitive aquatic and wetland species in Coffeen Lake and surface water bodies near the AP1 due to sediment runoff during construction.

Notes:
AP1 = Ash Pond No. 1; BMP = Best Management Practices; CAA = Closure Alternatives Analysis; CCR = Coal Combustion Residual; CIP = Closure-in-Place; GHG = Greenhouse Gas; GWE = Groundwater Extraction; GWP = Groundwater Polishing; GWPS = Groundwater Protection Standard; IAC = Illinois Administrative Code; IEPA = Illinois Environmental Protection Agency; NPDES = National Pollutant Discharge Elimination System; O&M = Operations and Maintenance; Source Control-GWE = Source Control with Groundwater Extraction; Source Control-GWP = Source Control with Groundwater Polishing; UA = Uppermost Aquifer.

1 Introduction

1.1 Site Description and History

1.1.1 Site Location and History

Coffeen Power Plant (CPP) is an electric power generating facility with coal-fired units and is operated by Illinois Power Generating Company (IPGC). The Site is located about two miles south of the City of Coffeen, Illinois, and situated approximately between two lobes of Coffeen Lake. Historically, three room and pillar coal mines operated within the boundaries of the Site. From south to north, they are the Hillsboro Mine, which operated from 1964 to 1983; the Clover Leaf No. 1 Mine, which operated from 1889 to 1901; and the Clover Leaf No. 4 Mine, which operated from 1906 to 1924 (Ramboll, 2021; ISGS and University of Illinois at Urbana-Champaign, 2011). The Coffeen Power Plant operated from 1964 to November 2019 when it was retired (Ramboll, 2021).

1.1.2 CCR Impoundment

The Coffeen Power Plant produced and stored coal combustion residuals (CCRs) as a part of its historical operations. Ash Pond No. 1 (AP1; Vistra identification [ID] No. CCR Unit 101, Illinois Environmental Protection Agency [IEPA] ID No. W1350150004-01, and National Inventory of Dams [NID] ID No. IL50722) is the subject of this report.

AP1 (also known as the Bottom Ash/Recycle Pond; Figure 1.1) is a 26.2-acre unlined surface impoundment constructed in 1964 for the management of bottom ash and other non-CCR waste generated historically by the facility (Ramboll, 2021). AP1 began operating in 1964 and stopped receiving sluiced ash in November 2019 (Ramboll, 2021; AECOM, 2016). Four additional CCR units exist on the Site including Ash Pond 2 (operated from 1970s to 1980s), the Gypsum Management Facility (GMF) Gypsum Stack Pond (GSP) (operated from 2010 to 2021), the GMF Recycling Pond (RP) (operated from 2010 to 2021), and a lined landfill that managed fly ash beginning in 2010 (Ramboll, 2021).

Initially, AP1 received CCR from the coal-fired units of the power plant, operating as a flow-through structure with outflow discharging to Coffeen Lake. AP1 primarily received bottom ash as well as low volume wastes *via* floor drains in the main power building. Later, AP1 was modified to recycle water on-Site. Reconstruction occurred from approximately 1979 to 1981 to abandon the discharge pipe to Coffeen Lake, add a recycle intake structure, and redirect flow through AP1 such that the outflow was returned to the Coffeen Power Plant for reuse as process water (Appendix B). Bottom ash was also removed for beneficial reuse from AP1 by third-party contractors (Ramboll, 2021).

Figure 1.1 Site Location Map. Adapted from Ramboll (2021).

1.1.3 Surface Water Hydrology

The CPP is bordered by Coffeen Lake to the west, south, and east. Additionally, to the east, the CPP is also bordered by the Unnamed Tributary, which flows south into the eastern lobe of Coffeen Lake. The facility is permitted to discharge to Coffeen Lake under National Pollutant Discharge Elimination System (NPDES) Permit No. IL 0000108 (IEPA, 2023; Ramboll, 2021). The northeast corner of AP1 is located approximately 160 ft west of Coffeen Lake within the Shoal Creek Watershed (Hydrologic Unit Code [HUC] 07140203; Ramboll, 2021). The Unnamed Tributary flows south into Coffeen Lake approximately 760 ft northeast of AP1; the East Fork of Shoal Creek is located approximately 4,300 ft east of AP1. Within 1,000 meters of AP1, there are several unnamed freshwater ponds and two freshwater emergent wetlands (Ramboll, 2021). The ponds range in size from 0.2 acres to 4.8 acres. Emergent wetlands are 0.4 acres in size, located south of AP1, and 1.6 acres, located northeast of AP1 where the Unnamed Tributary enters Coffeen Lake.

The 1,100-acre Coffeen Lake was constructed by damming the McDavid Branch of the East Fork of Shoal Creek to aid with cooling for the facility (Ramboll, 2021). The IEPA classifies Coffeen Lake as a General Use Water (IEPA, 2007) meaning that it is designated for aquatic life and use in primary contact recreation; however, it is not designated for use in food processing or as a public water supply. Coffeen Lake (Assessment Unit ID IL_ROG) is listed on the 2018 Illinois Section 303(d) List as being impaired for fish consumption due to mercury (IEPA, 2019; US EPA, 2022). In addition, US EPA approved in 2007 a Total

Maximum Daily Load (TMDL) for phosphorus to address aesthetic quality impairments in Coffeen Lake due to excess algae and total suspended solids (IEPA, 2007).

1.1.4 Hydrogeology

The geology underlying the Site in the vicinity of AP1 consists of five distinct hydrostratigraphic units (Ramboll, 2021):

- **Upper Confining Unit (UCU):** The UCU underlies AP1. It consists of a Loess Unit and the upper portion of the Hagarstown Member, which has low permeability clays and silts with generally greater than 60% fines. The UCU was encountered across most of the Coffeen Power Plant except for the eastern edge of AP1 where soils were excavated during construction of the pond.
- **Uppermost Aquifer (UA):** The UA comprises moderately permeable sands, silty sand, and clayey gravel of the Hagarstown Member and, in some portions of the Site, the Vandalia Member. The UA unit is missing in several locations due to both excavation and weathering.
- **Lower Confining Unit (LCU):** The LCU underlies the UA. It consists of three low hydraulic conductivity soils: the sandy clay till of the Vandalia Member, the silt of the Mulberry Grove Formation, and the compacted clay till of the Smithboro Member.
- **Deep Aquifer (DA):** The DA is a thin (generally less than 5 ft thick), discontinuous unit composed of sands and silty sands.
- **Deep Confining Unit (DCU):** The DCU underlies the DA. It consists of the Lierle Clay of the Banner Formation and acts as an aquitard due to its low hydraulic conductivity (Ramboll, 2021).

There is a groundwater flow divide within the UA in the center of the CPP property between the two lobes of Coffeen Lake. Groundwater in the UA flows from the center of the CPP property west toward Coffeen Lake and east toward the Unnamed Tributary, the eastern lobe of Coffeen Lake, and the discharge flume. Groundwater near AP1 flows north to northeast toward a former discharge structure and the Unnamed Tributary (Ramboll, 2021). Groundwater flow within the UA is predominantly horizontal due to the underlying low-permeability LCU. The flow direction in the UA is consistent and likely influenced by the proximity to and hydraulic connection with Coffeen Lake (Ramboll, 2021, 2022).

During groundwater interaction with surface water, CCR-derived constituents may partition between sediments and the surface water column. It should be noted that many CCR-derived constituents occur naturally in sediments and surface water (and can also arise from other industrial sources). As a result, their presence in the sediments and/or surface water of the Coffeen Lake and the Unnamed Tributary does not necessarily signify contributions from AP1.

1.1.5 Site Vicinity

The CPP property is bordered by Coffeen Lake to the west and south, by the Unnamed Tributary and Coffeen Lake to the east, and by agricultural land to the north (Ramboll, 2021, Figure 1.1). Coal mining operations occurred in the vicinity of AP1 from 1906 until 1983. AP1 partially overlies the former Hillsboro Mine (Illinois State Geological Survey [ISGS] Mine No. 871), which operated from 1964 until 1983. The Clover Leaf No. 4 Mine (ISGS Mine No. 442) was located north to northwest of AP1 and operated from 1906 until 1924 (Ramboll, 2021).

Although the area surrounding the Coffeen Power Plant is predominantly agricultural, Coffeen Lake and the surrounding land are used for recreational activities. Since 1986, Coffeen Lake State Fish and Wildlife Area (SFWA) has been open to the public under a lease and management agreement between the Illinois Department of Natural Resources (IDNR) and Ameren Energy Generating Company (IDNR, 2014). To the north of the Coffeen Power Plant, there are walking and hiking trails and bank fishing. Coffeen Lake also entertains fishing and picnicking on the western shore. Based on a review of the IDNR Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of AP1 (Ramboll, 2021).

1.2 Part 845 Regulatory Review and Requirements

Title 35, Part 845 of the Illinois Administrative Code (IAC) (IEPA, 2021) requires that a Corrective Action Alternatives Analysis (CAAA) be performed as part of the remedy selection, prior to undertaking any corrective actions at certain CCR-containing impoundments where exceedances of groundwater protection standard (GWPSs) have been identified. Because exceedances[1] of GWPSs in groundwater associated with AP1 have been identified for sulfate, boron, and total dissolved solids (TDS) (Appendix D; Ramboll, 2024), this report presents a CAAA for AP1 pursuant to the requirements under IAC Section 845.670. The goal of a CAAA is to holistically evaluate a range of factors for the various corrective actions being considered at an impoundment, including the efficiency, reliability, and ease of implementation of the corrective action; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by the community (IEPA, 2021). A CAAA is a decision-making tool that is designed to aid in the selection of a corrective action alternative.

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or Groundwater Protection Standards (GWPS) as described in the proposed groundwater monitoring program, which was submitted to IEPA on October 25, 2021 as part of IPRG's operating permit application for the AP (Burns & McDonnell, 2021). That operating permit application, including the proposed groundwater monitoring program, remains under review by IEPA and therefore IPRG has not identified any actual exceedances.

2 Corrective Action Alternatives Analysis

This section presents the CAAA pursuant to requirements under IAC Section 845.670 (IEPA, 2021). The goal of a CAAA is to fully evaluate proposed viable corrective measures that were identified in the CMA. The CAAA evaluates potential corrective actions with respect to a wide range of factors, including the performance, reliability, and ease of implementation of the corrective action; its potential impacts on human health and the environment; and its ability to address concerns raised by the community (IEPA, 2021).

Per IAC Section 845.670(d) (IEPA, 2021), any corrective actions selected under a Corrective Action Plan must:

1. Be protective of human health and the environment;
2. Attain the groundwater protection standards specified in Section 845.600;
3. Control the sources of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents listed in Section 845.600 into the environment;
4. Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5. Comply with standards for management of wastes as specified in Section 845.680(d).

At AP1, a CAAA is required because groundwater monitoring associated with AP1 identified exceedances of the GWPSs. Groundwater monitoring was conducted in accordance with the proposed groundwater monitoring plan between 2023 and 2024 (Appendix D; Ramboll, 2024). The groundwater samples collected from groundwater compliance monitoring wells were used to monitor groundwater quality and evaluate compliance with the groundwater quality standards listed in IAC Section 845.600(a). As of the date of this report, sulfate, boron, and TDS were identified as constituents detected in groundwater at concentrations in excess of their GWPS (Appendix D; Ramboll, 2024).

Two potentially viable corrective actions for AP1 were selected in the CMA for further consideration in this CAAA. The corrective actions alternatives that are considered in this CAAA are Source Control (closure-in-place [CIP] using a consolidate-and-cap approach) with Groundwater Polishing (Source Control-GWP) and Source Control with Groundwater Extraction Trench (Source Control-GWE). Each of these corrective action alternatives are described below in Section 2.1.

2.1 Corrective Action Alternatives Descriptions

For each corrective action evaluated in this CAAA, source control is the primary remedy. US EPA has stated that source control is the most effective means of ensuring the timely attainment of remediation objectives (US EPA, 2015b). The source control for AP1 consists of closure-in-place (CIP) using a consolidate-and-cap approach. Specific elements of this approach include (Golder Associates USA Inc., 2022):

- Unwatering and dewatering of the impoundment *via* pumping and the construction of drilled sumps, engineered trenches, and/or horizontal wells. If needed, perimeter drains would be used to

pump and lower the groundwater level beneath AP1. Pumped water would be sent to the existing drainage system to the north to be discharged through an outfall under the NPDES permit for the facility;

- Excavation and consolidation of approximately 436,000 cubic yards of CCR and subsoil with CCR staining (up to 1 foot) from the eastern portion of AP1 and into the western portion of AP1;
- Construction of a berm with a north-south orientation on the east end of the consolidated footprint;
- Removal and disposal of the existing earthen embankments not required for the consolidated footprint and excavation of a stormwater channel to allow flow off-Site in accordance with the NPDES permit for the facility;
- Construction of an alternative cover system consisting of a 40-mil linear low-density polyethylene (LLDPE) geomembrane layer, a nonwoven geotextile cushion, and 24 in of protective soil cover suitable for supporting vegetative growth; and
- Contouring and grading to manage stormwater.

These source control activities include the removal of free liquids, excavation, and consolidation of CCR into the western portion of AP1, and a reduction of the final impoundment footprint from 26 acres to approximately 10.4 acres (Appendix B; Ramboll, 2025b). A low permeability final geomembrane cover system consisting of a 40-mil LLDPE geomembrane layer, a geocomposite drainage layer, a nonwoven geotextile cushion, and 24 in of protective soil cover would be installed over the closed portion of the AP1. These measures (installation of a geosynthetic cap and consolidation of CCR) will control to the maximum extent feasible the migration of CCR constituents to groundwater, thus facilitating the achievement of the GWPSs in accordance with IAC Section 845.600. Additionally source control would result in CCRs being separated vertically between 3.2 and 10 ft from underlying groundwater (Ramboll, 2022). As demonstrated by the groundwater modeling in support of the Closure Alternatives Analysis (CAA; Gradient, 2022), this source control approach would result in a reduction of the migration of water into AP1 by 99.9% compared to pre-closure conditions. Additionally, source control would result in a reduction of hydraulic flux out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022).

In addition to source control, the corrective actions evaluated in this CAAA include residual plume management. Two potential corrective actions, identified as viable in the CMA, are evaluated in this CAAA for AP1:

- **Alternative 1:** Source Control with Groundwater Polishing (Source Control-GWP)
- **Alternative 2:** Source Control with Groundwater Extraction (Source Control-GWE)

For each potential corrective action alternative, adaptive site management strategies would be integrated into residual plume management. This approach ensures the timely incorporation of new Site information throughout the corrective action process in order to optimize the remediation and expedite achievement of the GWPSs. As part of the adaptive site management approach, system performance and residual plume conditions would be monitored throughout the implementation of the selected corrective action. If groundwater concentrations do not respond as expected to the corrective action, the adaptive site management approach would enable prompt adjustments, optimizations, or replacement of the remedy to ensure overall effectiveness.

2.1.1 Alternative 1: Source Control-GWP

The first corrective action alternative is Source Control-GWP. This remedy includes source control (CIP using a consolidate-and-cap approach) combined with residual plume management based on natural physical and geochemical processes that would reduce groundwater concentrations downgradient of AP1. GWP mechanisms were evaluated using geochemical speciation and reaction models. The primary objective of the geochemical model was to support the evaluation of GWP as a potential remedy for the Site. The model focused on evaluating the dominant geochemical reactions that may occur at time scales relevant to groundwater flow, including adsorption and mineral dissolution/precipitation reactions (*i.e.*, iron and aluminum hydroxides, carbonates, and some sulfates) (Appendix E; Geosyntec Consultants, Inc., 2025). Model inputs included geochemically reactive solid mineral phases, downgradient groundwater composition, and background groundwater composition derived from Site-specific data. Speciation models analyzed the distribution of chemical constituents between solid and aqueous phases, while reaction models assessed how these distributions may shift in response to changing Site conditions (US EPA, 2015b).

Components of residual plume management for this Source Control-GWP alternative include:

- Groundwater concentrations would be reduced in the downgradient plume as a result of physical and geochemical attenuation processes. Site-specific evaluations have shown that GWP would reduce the groundwater concentrations and mobility of inorganic contaminants under post-closure conditions. Specifically, chemical attenuation of contaminants is feasible *via* sorption to aquifer solids, particularly iron and aluminum oxides under current conditions. Attenuation *via* sorption onto mineral surfaces should remain stable under future conditions, and remobilization is unlikely to impact the time to achieve GWPS as groundwater returns to background conditions (Appendix E; Geosyntec Consultants, Inc., 2025);
- Corrective action groundwater monitoring using a new groundwater monitoring system designed in accordance with IAC Section 845.680(c), which would be installed within the plume that lies beyond the facility boundary;
- Adaptive site management strategies for this alternative would include geochemical modeling. Groundwater monitoring results would be evaluated and compared to the model-predicted concentrations. In situations in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques would be evaluated, and if viable, incorporated as per IAC Section 845.680(b);
- Corrective action confirmation groundwater sampling would be performed for 3 years after GWPSs have been achieved; and
- Following the completion of the corrective action confirmation monitoring period, a report and certification for Corrective Action Completion would be prepared and submitted to IEPA as per IAC Section 845.680(e).

The overall corrective action implementation duration for this alternative is approximately 43.5 years (522 months) after completion of source control or a corrective action permit has been issued by IEPA, whichever is later (Appendix B, Ramboll, 2025b) including:

- Approximately 40 years (480 months) of corrective action monitoring (*i.e.*, time to meet GWPSs),

- At least 3 years (36 months) of corrective action confirmation monitoring,[2] and
- Approximately 6 months associated with post-closure reporting.

Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the labor time, equipment usage, and mileage linked to source control were previously estimated in the Closure Alternative Analysis (CAA) (Gradient, 2022) and are not repeated in this analysis. Moreover, there is no labor and mileage incurred with the residual plume management under the Source Control-GWP alternative, because no construction would be required under this alternative. Mileage and labor associated with corrective action monitoring was not included in this analysis (Appendix B; Ramboll, 2025b).

2.1.2 Alternative 2: Source Control-GWE

The second corrective action alternative is Source Control-GWE. This remedy includes source control (CIP using a consolidate-and-cap approach) with a groundwater extraction trench as the residual plume management approach. This residual plume management approach would include the construction of a downgradient extraction trench located along the northern perimeter of AP1 to remove impacted groundwater. The trench would extend from ground surface to an elevation of 602 to 604 ft above mean seal level (msl) or to a depth of approximately 38 ft bgs which is below the bottom of the UA.[3] The extraction trench would be constructed by excavation of existing soils, installing collection pipes and sumps, backfilling with clean fill, and installing a compacted clay cap to reduce infiltration (Appendix B; Ramboll, 2025b). The trench would be about 1,600 ft long, and 3 ft wide. Groundwater that is captured would be pumped to a new on-Site lined settling pond for treatment and discharged through a new or existing outfall, managed by a National Pollutant Discharge Elimination System (NPDES) permit for the Site.

Implementation of the Source Control-GWE is expected to include various tasks across three major phases: pre-construction activities (Phase 1), corrective action construction (Phase 2), and corrective action operations, maintenance, and closeout (Phase 3). The activities associated with each of these phases are summarized below:

- **Phase 1:** Pre-construction activities, including obtaining permits from agencies and completing Site investigations and engineering designs;
- **Phase 2:** Construction of the extraction trench, settling pond, and minor Site restoration of disturbed areas;
    - Mobilization of equipment and materials to the Site, and preparation for Site construction, such as installation of stormwater best management practices (BMPs), construction of a staging area and a level working platform, and/or temporary access roads;
    - The extraction trench would be constructed using one-pass trenching methods by excavating subgrade soils, placing collection piping and pumps, and backfilling the trench. Excavated spoils would be used as contouring fill beneath the final AP1 cover system;
    - The 1-acre, geomembrane-lined settling pond would be constructed to manage extracted groundwater using conventional construction equipment; although other groundwater treatment and management technologies may be evaluated during a later phase of design. Underground trenches with HDPE piping would be constructed to convey extracted

[2] It should be noted that post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c).
[3] All elevations in this report are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

groundwater from the trench to the settling pond and ultimately to an appropriate NPDES outfall. This would require installation of electrical, mechanical, and pneumatic infrastructure to operate the conveyance piping system;

- Site restoration would be completed following the construction of the extraction trench and settling pond.

- **Phase 3:** Operations, Maintenance (O&M), and Closeout of the GWE system. Details pertaining to each of these activities are outlined below.
  - Operation of the GWE system;
  - Corrective action O&M would involve routine maintenance of extraction pumps, air compressor, and other system components; non-routine maintenance would include repair or replacement of the system components, flushing or jetting of water conveyance lines to remove accumulated organic or inorganic solids from the interior walls;
  - Monitoring of extracted groundwater under the NPDES permit;
  - Adaptive site management strategies would be employed to track remediation progress and incorporate new Site information to assure the achievement of the GWPSs;
  - Corrective action monitoring would be performed using a new corrective action groundwater monitoring network designed in accordance with IAC Section 845.680(c), which would be installed within the plume that lies beyond the facility boundary;
  - Following the completion of the corrective action confirmation monitoring period, a report and certification for Corrective Action Completion would be prepared and submitted to IEPA as per IAC Section 845.680(e).

The overall corrective action implementation duration is approximately 47.5 to 49.5 years (Appendix B; Ramboll, 2025b), including:

- Approximately 3.5 to 5 years (42 to 60 months) of pre-construction activities (Phase 1; assumed to occur concurrently with source control),
- Approximately 6 to 12 months of corrective action construction (Phase 2; assumed to occur concurrently with source control), and
- Approximately 43.5 years (522 months) of O&M and closeout (Phase 3; assumed to start after completion of the source control or a corrective action construction permit application has been issued by IEPA, whichever is longer):
  - It is estimated to include 40 years (480 months) of corrective action monitoring (*i.e.*, time to meet GWPSs), at least 3 years (36 months) of corrective action confirmation monitoring,[4] and 6 months associated with post-closure reporting.

[4] It should be noted that post-closure care groundwater monitoring would continue for a minimum of 30 years or until such time as GWPSs are achieved, whichever is longer, as required by IAC Section 845.780(c).

Key parameters for the Source Control-GWE corrective action alternative are shown in Table 2.1, below.

Table 2.1 Key Parameters for the Source Control-GWE Corrective Action Alternative[a]

Parameter[b]	Value[c]
Labor Hours	
Total On-Site Labor	16,400 hours
Total Off-Site Labor	0 hours
40% Contingency	6,550 hours
Total Labor Hours:	22,900 hours
Vehicle and Equipment Travel Miles	
Vehicles On-Site	17,700 miles
On-Site Haul Trucks (Unloaded + Loaded)	5,500 miles
Labor Mobilization	154,000 miles
Equipment Mobilization (Unloaded + Loaded)	20,800 miles
Off-Site Haul Trucks (Unloaded + Loaded)	63,400 miles
Material Deliveries (Unloaded + Loaded)	9,310 miles
Total On-Site Vehicle and Equipment Travel Miles:	23,200 miles
Total Off-Site Vehicle and Equipment Travel Miles:	248,000 miles
Total Vehicle and Equipment Travel Miles:	270,000 miles

Notes:
Source Control-GWE = Source Control with Groundwater Extraction.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the labor time, equipment usage, and mileage linked to source control were previously estimated in the Closure Alternative Analysis (CAA) and are not repeated in this analysis.
(b) Site activities are expected to occur during the corrective action construction and operation and maintenance phases for this alternative.
(c) Values reported in this table were rounded to reflect 3 significant figures.
Source: Appendix B; Ramboll, 2025b.

2.2 Long- and Short-Term Effectiveness and Protectiveness of Corrective Action Alternative (IAC Section 845.670(e)(1))

2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.670(e)(1)(A))

There are no current unacceptable risks to human or ecological receptors at this Site associated with AP1 (Appendix A; Gradient, 2022). Because current conditions do not present a risk to human health or the environment at AP1, there will be no unacceptable risk to human health or the environment for future conditions when the unit has been closed and source control/residual plume management has been implemented. Concentrations of CCR-derived constituents will decline over time and, consequently, potential exposures to CCR-derived constituents in the environment will also decline. As a result of this, the magnitude of the reduction of existing risks is the same for the two potential corrective action alternatives (IAC Section 845.670(e)(1)(A)), and each corrective action alternative is equally protective of human health and the environment (IAC Section 84.670(d)(1)).

2.2.2 Effectiveness of the Remedy in Controlling the Source (IAC Section 845.670(e)(2)/IAC Section 845.670(d)(3))

Extent to Which Containment Practices Will Reduce Further Releases/Control the Sources of Releases to Reduce or Eliminate, to the Maximum Extent Feasible (IAC Section 845.670(e)(2)(A)/IAC Section 845.670(d)(3))

Source control (CIP using a consolidate-and-cap approach), which includes removal of free liquids, excavation and consolidation of CCR in AP1 into the western portion of the impoundment, and the installation of a low-permeability final geomembrane cover system designed to limit the infiltration of precipitation into the impounded CCR, would be implemented for both corrective action alternatives. Groundwater modeling performed in support of the CAA (Gradient, 2022) concluded that source control alone would result in a 99.9% reduction in mass flux from the AP1 into the underlying groundwater (Ramboll, 2022). Because source control would be undertaken at the Site prior to the implementation of any residual plume management, both corrective action alternatives would remove the potential for CCR within the impoundment to impact groundwater. Both corrective action alternatives would therefore be equally and fully protective with regard to source control. The effectiveness of the corrective action alternatives with respect to residual source control are summarized as follows:

- Under the Source Control-GWP alternative, the attenuation of dissolved constituent concentrations remaining after source control would be achieved through natural physical and geochemical processes. Site-specific evaluations have shown that GWP would reduce the groundwater concentrations and mobility of inorganic contaminants, especially after implementation of source control. Specifically, chemical attenuation of contaminants is feasible *via* sorption to aquifer solids, particularly iron and aluminum oxides under current conditions. Attenuation *via* sorption onto mineral surfaces should remain stable as groundwater returns to background conditions, and remobilization is unlikely to impact the time to achieve GWPS for sulfate (Appendix E; Geosyntec Consultants, Inc., 2025). In cases in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques would be evaluated under the adaptive site management program, and if viable, incorporated as per IAC Section 845.680(b);
- Under the Source Control-GWE alternative, residual contamination control would be achieved by extracting impacted groundwater and preventing downgradient migration through installation of an extraction trench along the northern perimeter of AP1. GWE is a widely used corrective measure that has been effectively implemented at many sites to contain and capture dissolved-phase groundwater plumes. Physical and geochemical attenuation would also help control secondary sources and prevent downgradient migration. In cases in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques would be evaluated under the adaptive site management plan, and if viable, incorporated as per IAC Section 845.680(b).

Because both corrective action alternatives include source control and residual plume management, both potential corrective action alternatives would be equally effective at reducing releases from both primary and residual sources (IAC Section 845.670(e)(2)(A)/IAC Section 845.670(d)(3)).

Extent to Which Treatment Technologies May Be Used (IAC Section 845.670(e)(2)(B))

Because Source Control-GWP would rely on physical and geochemical processes, no additional treatment technologies would be required. For the Source Control-GWE alternative, in addition to natural attenuation, extracted groundwater would be managed and treated by a newly constructed on-Site settling pond to

remove solids, although other treatment and management technologies may be evaluated at later phases of the design (Appendix B; Ramboll, 2025b). For both corrective action alternatives, remedy optimizations would be implemented, if necessary, under the adaptive site management program.

2.2.3 Likelihood of Future Releases of CCR (IAC Section 845.670(e)(1)(B))

Both corrective action alternatives include source control using CIP with a consolidate-and-cap approach. Free liquids would be removed; a new cover system would be installed, which consists of a 40 mil LLDPE geomembrane layer, a nonwoven geotextile cushion, and 24 in of protective soil cover. Relative to current conditions, this cover system would provide increased protection against berm and surface erosion, precipitation infiltration, and other adverse effects that could potentially trigger a release of CCR. There would be minimal risk of accidental CCR releases occurring post-closure for both corrective action alternatives.

2.2.4 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.670(e)(1)(C))

The type and degree of long-term residual groundwater plume management associated with each corrective action alternative is summarized as follows:

- The Source Control-GWP alternative would not require the installation, operation, or maintenance of any engineered systems or structures. The only long-term management activity required under this alternative would be regular corrective action groundwater monitoring and routine maintenance of the monitoring wells, which would continue at least 3 years after GWPSs have been achieved for all wells, in accordance with IAC Section 845.680(c)(2). Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Based on the adaptive site management approach, remedy optimization (additional methods or techniques) may be implemented to ensure the achievement of the GWPSs.
- Source Control-GWE would require the construction of the groundwater extraction trench. Multiple tasks would be completed over three phases: pre-construction activities (Phase 1), corrective action construction (Phase 2), and corrective action O&M, and closeout (Phase 3). Once pre-construction activities are completed, construction of the extraction trench would occur during the latter stages of AP1 closure. This approach allows for the spoils generated from the trench extraction to be disposed beneath the final cover system of AP1. Corrective action O&M would require regular inspection and maintenance of the extraction trench system, such as extraction pumps, filter system, and other system components. Extracted groundwater would be managed and treated by a newly-constructed on-Site settling pond before discharge *via* NPDES Outfall to Coffeen Lake. Additionally, corrective action groundwater sampling and routine maintenance of the monitoring well network would continue for at least 3 years after GWPSs have been achieved at all wells, in accordance with IAC Section 845.680(c)(2). Post-closure care groundwater monitoring would continue for a minimum of 30 years as required by IAC Section 845.780(c). Based on the adaptive site management approach, remedy optimization (additional methods or techniques) may be implemented to ensure the achievement of the GWPSs.

2.2.5 Short-Term Risks to the Community or the Environment During Implementation of Remedy (IAC Section 845.670(e)(1)(D))

2.2.5.1 Safety Impacts

Best practices would be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate risks to workers during construction and/or other corrective action activities. For example, injuries and fatalities can occur due to truck accidents or equipment malfunctions. Truck accidents that occur off-Site can also result in injuries or fatalities to community members. The safety impacts associated with source control (CIP using a consolidate-and-cap approach), which were evaluated in the CAA (Gradient, 2022), are the same for both corrective action alternatives. The safety impacts associated with residual plume management (*i.e.*, construction and O&M) for each corrective action alternative are described below.

- The Source Control-GWP alternative would not require the construction and maintenance of any engineered systems or structures, and therefore no safety impacts are expected.
- The Source Control-GWE alternative would include the construction of a groundwater extraction trench system and settling pond to collect, extract, and treat CCR-impacted groundwater. Potential safety concerns would be related to the construction and O&M of the extraction trench and settling pond.

Worker Risks

On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during Site activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization/demobilization, as well as materials/supplies hauling and deliveries.

As discussed in section 2.1.1, there are no construction activities or operational requirements associated with residual plume management for the Source Control-GWP alternative. As shown in Tables 2.1, Ramboll estimates that residual plume management for the Source Control-GWE corrective action alternative would require 16,400 on-Site labor hours (Appendix B; Ramboll, 2025b). The US Bureau of Labor Statistics (US DOL, 2020a, 2020b) provides an estimate of the hourly fatality and injury rates for construction workers. Based on the accident rates reported by the US Bureau of Labor Statistics and the on-Site labor hours reported in Appendix B, we estimate that approximately 0.17 worker injuries and 1.5×10^{-3} worker fatalities would occur on-Site under the Source Control-GWE corrective action alternative (Table 2.2). No worker accidents would be expected under the Source Control-GWP alternative. The number of on-Site worker accidents is therefore expected to be higher under the Source Control-GWE alternative.

Table 2.2 Expected Number of On-Site Worker Accidents Under Each Corrective Action Alternative[a,b]

Corrective Action Alternative	Injuries	Fatalities
Source Control-GWP	0	0
Source Control-GWE	0.17	1.5×10^{-3}

Notes:
Source Control-GWE = Source Control with Groundwater Extraction; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Although source control (*i.e.*, control-in-place [CIP]) is a primary component of the corrective action, the worker accidents associated with source control were previously estimated in the Closure Alternative Analysis (CAA) and are not repeated in this analysis.
(b) Worker accidents associated with groundwater sampling and monitoring are not included in this analysis for any of the alternatives.

Off-Site, haul truck miles, labor and equipment mobilization/demobilization miles, and material delivery miles would be required under the Source Control-GWE (Table 2.1). For residual plume management under the Source Control-GWE corrective action alternative, 248,000 total off-Site vehicle and equipment travel miles would be required. No off-Site travel miles would be expected under the Source Control-GWP alternative (Appendix B; Ramboll, 2025b). The United States Department of Transportation (US DOT) provides estimates of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks and passenger vehicles (US DOT, 2023). Table 2.3 shows the expected number of off-Site accidents under each corrective action alternative due to all categories of off-Site vehicle usage. For these calculations, it was assumed that labor mobilization/demobilization would rely upon passenger vehicles (cars or light trucks, including pickups, vans, and sport utility vehicles) and that hauling, equipment mobilization/demobilization, and material deliveries would rely upon large trucks. Based on US DOT's accident statistics and the mileage estimates in Appendix B, an estimated 0.11 worker injuries and 2.9×10^{-3} worker fatalities would be expected to occur due to off-Site activities under the Source Control-GWE alternative. No worker accidents would be expected under the Source Control-GWP alternative.

Table 2.3 Expected Number of Off-Site Worker Accidents Related to Off-Site Car and Truck Use Under Each Corrective Action Alternative[a]

Off-Site Vehicle Use Category	Source Control-GWP		Source Control-GWE	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0	0	1.3×10^{-2}	1.0×10^{-3}
Labor Mobilization/Demobilization	0	0	9.2×10^{-2}	1.5×10^{-3}
Equipment Mobilization/Demobilization	0	0	4.4×10^{-3}	3.3×10^{-4}
Material Deliveries	0	0	2.0×10^{-3}	1.5×10^{-4}
Total:	0	0	0.11	2.9×10^{-3}

Notes:
Source Control-GWE = Source Control with Groundwater Extraction; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the worker accidents associated with source control were previously estimated in the Closure Alternative Analysis (CAA) and are not repeated in this analysis.

Overall, considering accidents occurring both on- and off-Site, no worker injuries and worker fatalities would be expected to occur for residual plume management under the Source Control and GWP alternative; 0.28 worker injuries and 4.4×10^{-3} worker fatalities would be expected to occur for residual plume management under the Source Control-GWE alternative. Thus, overall risks to workers would be higher under the Source Control-GWE alternative.

Community Risks

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members as well as workers. Based on the accident statistics reported by US DOT (2023) and the off-Site travel mileages reported in Appendix B (and summarized in Table 2.1), off-Site vehicle accidents could result in an estimated 6.2×10^{-2} injuries and 7.8×10^{-4} fatalities among community members (*e.g.*, people involved in haul truck accidents that are neither haul truck drivers nor passengers, including pedestrians, drivers of other vehicles) for residual plume management under the Source Control-GWE alternative (Table 2.4). No community risks are expected under the Source Control-GWP alternative. Therefore, off-Site impacts on nearby residents, including injuries or fatalities, would be the higher under the Source Control-GWE alternative.

Table 2.4 Expected Number of Community Accidents Under Each Corrective Action Alternative[a]

Off-Site Vehicle Use Category	Source Control-GWP		Source Control-GWE	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0	0	1.7×10^{-2}	1.2×10^{-4}
Labor Mobilization/Demobilization	0	0	3.7×10^{-2}	5.9×10^{-4}
Equipment Mobilization/Demobilization	0	0	5.5×10^{-3}	4.0×10^{-5}
Material Deliveries	0	0	2.4×10^{-3}	1.8×10^{-5}
Total:	0	0	6.2×10^{-2}	7.8×10^{-4}

Notes:
Source Control-GWE = Source Control with Groundwater Extraction; Source Control-GWP = Source Control with Groundwater Polishing.
(a) Although source control (*i.e.*, closure-in-place [CIP]) is a primary component of the corrective action, the community accidents associated with source control were previously estimated in the Closure Alternative Analysis (CAA) and are not repeated in this analysis.

2.2.5.2 Cross-Media Impacts to Air

Air pollution can occur both on-Site (*e.g.*, construction activities) and off-Site (*e.g.*, along transportation routes), potentially impacting workers as well as community members. Diesel emissions are a major source of air pollutants and greenhouse gas (GHG) emissions at construction sites. Diesel exhaust contains air pollutants, including nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOCs) (Hesterberg *et al*., 2009; Mauderly and Garshick, 2009). Construction equipment also emits GHGs, including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each corrective action alternative on GHG emissions is proportional to the potential impact of each alternative on other emissions from construction vehicles and equipment.

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Air impacts occurring during source control would be the same for both corrective action alternatives. Impacts associated with CIP using a consolidate-and-cap approach were evaluated in the CAA (Gradient, 2022). On-Site emissions would be higher for residual plume management under the Source Control-GWE alternative due to the greater amount of on-Site vehicle travel miles required under this corrective action (23,200 total on-Site travel miles under the Source Control-GWE and no on-Site travel miles under the Source Control-GWP alternative; Section 2.1.1; Table 2.1). Off-Site emissions would similarly be higher for residual plume management under the Source Control-GWE alternative due to the greater amount of off-Site vehicle and equipment travel miles required under this alternative (248,000 total off-Site travel miles under the Source Control-GWE and no off-Site travel miles under the Source Control-GWP alternative; Section 2.1.1; Table 2.1). In summary, air impacts would be

highest for the Source Control-GWE alternative due to greater vehicle travel miles, and minimal under the Source Control-GWP alternative, because no construction activities would be expected under this alternative.

2.2.5.3 Cross-Media Impacts to Surface Water and Sediments

Under both corrective action alternatives, the constituent mass flux from groundwater into surface water would decline over time after source control has been completed (Ramboll, 2022). Source control would include removal of free liquids, excavation and consolidation of CCR in AP1 and the installation of a low-permeability geomembrane cover system to limit the precipitation infiltration into the CCR unit. This approach would minimize the amount of water retained within the impoundment, which further reduces the hydraulic flux through the CCR. As demonstrated by the groundwater modeling in support of the CAA (Gradient, 2022), this source control approach would result in CCRs being separated vertically between 3.2 and 10 ft from underlying groundwater (Ramboll, 2022). The source control approach would also result in a reduction of the migration of water into and out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022). Additionally, source control would result in a reduction of hydraulic flux out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022). Due to the reduction in the hydraulic flux out of the AP1, the mass flux out of the AP1 would also be controlled or minimized.

Under the Source Control-GWP alternative, minimal surface water and sediment impacts would be expected to be associated with residual plume management, because it would not require the construction of any engineered systems or structures (other than utilizing a newly designed monitoring network in accordance with IAC Section 845.680(c)).

Under the Source Control-GWE alternative, surface water and sediment impacts would be higher than the Source Control-GWP alternative due to the construction of the extraction trench system and the settling pond. Construction can have short-term negative impacts on surface water and sediment quality immediately adjacent to a site due to erosion and sediment runoff. Extracted groundwater would be discharged to an NPDES permitted outfall. Any associated impacts would be addressed through BMPs in accordance with Site land disturbance permits.

2.2.5.4 Control of Exposure to Any Residual Contamination During Implementation of the Remedy

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both corrective action alternatives. While appropriate controls would be established to prevent exposures of CCR during source control, the risks of CCR exposure during source control would be the same for both corrective action alternatives. For each of the corrective action components for the two potential alternatives, no residual CCR exposures would be expected to occur. However, impacted soils and groundwater can be a source of CCR-derived constituent exposure for workers. Risks to workers arising from potential contact with residual contamination during construction, operation, and maintenance activities associated with residual plume management would be higher for the Source Control-GWE than for the Source Control-GWP alternative. The Source Control-GWE would involve the production, management, and treatment of extracted groundwater, as well as on-Site disposal of excavated spoils generated during extraction trench construction. The Source Control-GWP alternative would not involve exposure to either of these soil or groundwater waste streams. Any potential CCR-exposures during the Source Control-GWE alternative would be managed through the use of rigorous safety protocols and personal protective equipment.

2.2.5.5 Other Identified Impacts

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both corrective action alternatives. Thus, impacts during source control would be the same for each of the corrective action alternatives (see the CAA; Gradient, 2022).

In addition to safety impacts, cross-media impacts, and the potential for workers to be exposed to residual contamination, construction activities and remedial operations can have significant energy demands and can cause nuisance impacts such as traffic and noise. Energy consumption at a construction site is synonymous with fossil fuel consumption because the energy to power construction vehicles and equipment comes from the burning of fossil fuels. Fossil fuel demands considered here include the burning of diesel fuel during construction equipment and vehicle travel miles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed in Section 2.2.5.2 with respect to GHG emissions also apply to the evaluation of energy demands. Specifically, the energy demands of construction equipment and vehicles associated with residual plume management would be greater under the Source Control-GWE, while the energy demands under the Source Control-GWP alternative associated with residual plume management are expected to be lower; because the Source Control-GWP would not require any significant construction activity. In addition, energy would be required for the operation of the extraction trench system under the Source Control-GWE alternative; while there is no operational energy required under the Source Control-GWP alternative because the Source Control-GWP alternative would rely on natural physical and geochemical processes.

Traffic and noise impacts associated with residual plume management are expected to be higher under the Source Control-GWE than the Source Control-GWP alternative, due to the construction activities required to construct the extraction trench system and settling pond under the Source Control-GWE alternative. Traffic may increase temporarily around the Site under the Source Control-GWE alternative due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts would be expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). Traffic and noise impacts associated with residual plume management from the Source Control-GWP alternative are expected to be significantly less than those associated with the Source Control-GWE alternative.

Construction activities can negatively impact natural resources and habitats near the Site, as well as scenic, historical, and recreational value. Based on a review of the IDNR Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of AP1 (Ramboll, 2021). There would be no impacts under the Source Control-GWP alternative because no additional construction activities would occur after implementation of source control. However, the Source Control-GWE alternative would require construction of an extraction trench and a 1-acre on-Site settling pond, which would occur during the latter phase of AP1 closure construction. These impacts would include disturbance of some existing habitats atop portions of the construction areas, and habitats in the immediate vicinity of these locations by causing alarm and escape behavior in nearby wildlife (*e.g.*, due to noise disturbances). It is also possible that limited negative short-term impacts could occur to sensitive aquatic and wetland species in Coffeen Lake and other wetlands or surface water bodies located within the SFWA near AP1 (see Section 1.1.3) due to sediment runoff during construction.

2.2.6 Time Until Groundwater Protection Standards Are Achieved/Attain the Groundwater Protection Standards Specified in Section 845.600 (IAC Section 845.670(e)(1)(E)/IAC Section 845.680(d)(2))

This section of the report evaluates the time required to achieve GWPSs, pursuant to requirements under IAC Section 845.670(e)(1)(E) (IEPA, 2021) and under IAC Section 845.680(d)(2).

Groundwater and dissolved constituents move downward through the UCU in the vicinity of AP1 until they reach the UA. Further downward migration is limited by the LCU. Near AP1, groundwater flows north to northeast toward a former discharge structure and the Unnamed Tributary (Ramboll, 2021). Groundwater flow within the UA is predominantly horizontal due to the underlying low-permeability LCU. The flow direction in the UA is consistent and likely influenced by the proximity to and hydraulic connection with Coffeen Lake (Ramboll, 2021, 2022).

Groundwater elevations may vary seasonally, but are primarily controlled by surface topography, geologic unit topography, and water levels within Coffeen Lake, discharge flume and the Unnamed Tributary (Ramboll, 2022). Water elevations or phreatic surfaces within the impoundment have been relatively consistent and have not been observed to fluctuate with groundwater elevations, indicating limited hydraulic connection between groundwater and the impoundment (Ramboll, 2022).

Groundwater modeling was performed in support of the CAA (Ramboll, 2022). The modeling predicted that source control would result in a reduction of the migration of water into AP1 by 99.9% compared to pre-closure conditions. Additionally, source control would result in a reduction of hydraulic flux out of AP1 by 99.9% compared to pre-closure conditions (Ramboll, 2022). Additional modeling was conducted for each of the corrective action alternatives to evaluate future groundwater quality in the vicinity of AP1 as a result of residual plume management (Appendix B; Ramboll, 2025c), and the results of the modeling indicate that groundwater concentrations would meet the GWPSs for all of the constituents[5] identified as having potential groundwater exceedances in all monitoring wells within approximately 40 years under the Source Control-GWP alternative after source control is completed or a corrective action permit application has been issued by IEPA, whichever is longer (Appendix B; Ramboll, 2025b). Under the Source Control-GWE alternative, the time to achieve GWPSs in all monitoring wells would be approximately 40 years after source control is completed or a corrective action construction permit application has been issued by IEPA, whichever is longer[6]. The time to achieve GWPS under both alternatives is, thus, predicted to be similar (Table 2.5).

[5] Sulfate was selected as a surrogate for the contaminant fate and transport simulations to evaluate the effectiveness of each of the corrective action alternatives. Sulfate was detected in AP1 groundwater at the highest concentrations relative to its GWPS and it is expected to take the longest time to achieve GWPS. Sulfate has also been detected above the GWPS at more well locations adjacent to AP1 and AP2 than any other IAC Section 845.600 parameter which contributed to its selection for modeling at both units. Modeling all constituents that exceed GWPS or have been detected at lower concentrations relative to their GWPSs is unnecessary, as these constituents will likely more quickly achieve their GWPSs (Appendix B; Ramboll, 2025c).

[6] It is assumed that pre-construction activities (Phase 1) and construction activities (Phase 2) will occur concurrently with source control under the Source Control-GWE alternative (Appendix B; Ramboll, 2025).

Table 2.5 Estimated Timeline and Implementation Schedule Under Each Corrective Action Alternative

Implementation Phase	Implementation Task	Timeframe	
		Source Control-GWP[a]	Source Control- GWE[b]
1: Pre-Construction Activities	Agency Coordination, Approvals, and Permitting	NA	18 to 24 months
	Final Design and Bid Process		24 to 36 months
	Total Timeframe to Complete Pre-Construction Activities		42 to 60 months (3.5 to 5 years)
2: Corrective Action Construction	Corrective Action Construction	NA	6 to 12 months
	Total Timeframe to Complete Corrective Action Construction		6 to 12 months
3: Corrective Action O&M and Closeout	Corrective Action Operation (Time to Meet GWPS)	480 months (40 years)	480 months (40 years)
	Corrective Action Confirmation Monitoring	36 months	36 months
	Corrective Action Completion Reporting	6 months	6 months
	Total Timeframe to Complete Corrective Action O&M and Closeout	522 months (43.5 years)	522 months (43.5 years)
Total Timeline to Complete Corrective Action (all phases)		522 months (43.5 years)	570 to 594 months (47.5 to 49.5 years)

Notes:
Source Control-GWP = Source Control with Groundwater Polishing; Source Control- GWE= Source Control with Groundwater Extraction.
(a) All timelines are assumed to occur after completion of source control (*e.g.*, final closure of the SI) and a corrective action permit has been issued by IEPA, whichever is longer, for the Source Control-GWP Alternative.
(b) Pre-construction and construction activities are assumed to occur concurrently with source control, and corrective action O&M tasks are assumed to occur after completion of source control (*e.g.*, final closure of the SI) and a corrective action construction permit application has been issued by IEPA, whichever is longer, for the Source Control-GWE alternative.
Source: Appendix B; Ramboll, 2025b.

2.2.7 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.670(e)(1)(F))

Section 2.2.1 describes the magnitude of reduction of existing risks under each corrective action alternative. Section 2.2.2 describes the effectiveness of the remedy in controlling the source, including the extent to

which containment practices would reduce further releases. Section 2.2.3 describes the likelihood of future releases of CCR occurring under each corrective action alternative, and Section 2.2.5 describes the short-term risks to workers, the community, and the environment during implementation of the remedy, including safety impacts and control of exposure to any residual contamination. In summary, source control measures (*i.e.*, CIP using a consolidate-and-cap approach) would be undertaken at the Site. Thus, both corrective action alternatives would completely eliminate the potential for a sudden CCR release to occur post-closure (due, *e.g.*, to flooding or a dike failure event). Similarly, due to the source control common to both corrective action alternatives, the alternatives would all involve installing a new cover system over AP1, and no residual CCR exposures would be expected to occur during the implementation of any of the alternatives. Both corrective action alternatives would therefore be equally and fully protective with regard to exposure to residual CCR. There are no current or future risks to any human or ecological receptors at the Site, and there would be no risk of CCR releases post-closure.

For construction workers, risks arising from potential contact with residual contamination during construction, operation, and maintenance activities associated with residual plume management would be higher for the Source Control-GWE alternative than for the Source Control-GWP alternative. The Source Control-GWE would involve the production, management, and treatment of extracted groundwater, as well as on-Site disposal of excavated spoils generated during extraction trench construction. The Source Control-GWP alternative would not involve exposure to any soils, surface waters or groundwater waste streams. Any potential CCR exposures occurring under Source Control-GWE groundwater extraction and treatment would be managed through the use of rigorous safety protocols, personal protective equipment, and appropriate disposal practice.

Some changes in groundwater flow (*i.e.*, potential controlled discharge into Coffeen Lake) may occur under the Source Control-GWE alternative, due to the operation of the groundwater extraction system. Hydrogeological changes would be expected under the Source Control-GWE alternative, such as lowering groundwater table in the vicinity of the extraction trench, altering flow patterns in the UA, and causing changes in hydraulic gradients. However, changes to groundwater flow would not be expected to have an effect on the potential for the exposure of humans and environmental receptors to remaining wastes under either of these alternatives.

2.2.8 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.670(e)(1)(G))

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, the long-term reliability during source control would be the same for each corrective action alternative (CAA) (Gradient, 2022). The long-term reliability of the engineering and institutional controls associated with residual plume management of each corrective alternative are summarized below:

- Residual plume management under the Source Control-GWP alternative would be reliable because it would rely on natural physical and geochemical processes, rather than the installation, operation, and maintenance of engineered systems or structures. Site specific evaluations have shown that chemical attenuation is feasible, and attenuation should remain generally stable under post-closure conditions. Remobilization is unlikely to impact the time to achieve GWPS as groundwater returns to background conditions (Appendix E; Geosyntec Consultants, Inc., 2025). Under this alternative, engineering failure would not occur, and no O&M activities would be required to ensure the success of the alternative (other than those required for groundwater monitoring). Active groundwater monitoring would be in place to track the remediation progress. Should the predicted decrease in groundwater concentrations not occur, the adaptive site management approach would enable

prompt adjustments or enhancements to the corrective action in accordance with IAC Section 845.680(b). This strategy would allow continuous improvement of AP1 groundwater remediation in response to new Site information and/or the performance of the corrective action alternative.

- GWE is a proven remedy that has been implemented at many sites. Thus, residual plume management under the Source Control-GWE alternative would be expected to be reliable. Under this alternative, the extraction trench system and settling pond would require engineering design and installation for groundwater extraction and treatment. Routine and non-routine maintenance of the extraction system is required to ensure reliable operation of the extraction trench and pumps, as well as other system components. Active groundwater monitoring would be in place, similar to those required under the Source Control-GWP alternative.

For both corrective action alternatives, remedy optimizations would be implemented if necessary under the adaptive site management program.

2.2.9 Potential Need for Replacement of the Remedy (IAC Section 845.670(e)(1)(H))

The potential need for the eventual replacement of the residual plume management remedy under each corrective action alternative is summarized as follows:

- Source Control-GWP would rely on natural physical and geochemical processes to achieve reductions in groundwater concentrations to below the GWPSs. Because no installation, operation, and maintenance of engineered systems or structures would be required, it would be unlikely that the residual plume management remedy under the Source Control-GWP alternative would need to be replaced. Adaptive site management strategies would be used to implement remedy optimizations or replacement, as necessary based on data that are collected, to ensure that remedial goals are achieved.
- Source Control-GWE would utilize an extraction trench and settling pond to extract and treat contaminated groundwater to achieve reductions in groundwater concentrations to below GWPSs. While the extraction system would need ongoing maintenance and potential replacement of system components over time, it is unlikely that the residual plume management remedy under the Source Control-GWE alternative would need to be replaced. Adaptive site management strategies would be used to implement remedy optimizations or replacement, as necessary based on data that are collected, to ensure that remedial goals are achieved.

2.3 The Ease or Difficulty of Implementing a Remedy (IAC Section 845.670 (e)(3))

2.3.1 Degree of Difficulty Associated with Constructing the Remedy (IAC Section 845.670(e)(3)(A))

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both corrective action alternatives. Thus, construction difficulties regarding source control would be the same for each of the corrective action alternatives. Difficulties associated with implementing CIP using a consolidate-and-

cap approach were evaluated in the CAA (Gradient, 2022). The expected degree of difficulty associated with residual plume management for each of the corrective action alternatives is summarized below.

- Residual plume management under the Source Control-GWP alternative would rely on physical and geochemical attenuation processes and therefore would not pose any significant construction challenges. Therefore, there would be minimal difficulty in constructing the Source Control-GWP remedy.
- Residual plume management under the Source Control-GWE would involve the construction of an extraction trench, settling pond and conveyance system to extract and treat impacted groundwater. The construction of the groundwater trench required by this alternative would require the use of specialized contractors and equipment (*i.e.*, one-pass trenching contractor and equipment) for the installation of the trench, in addition to general construction equipment (Appendix B; Ramboll, 2025b). Groundwater monitoring would be conducted using a groundwater monitoring network designed in accordance with IAC Section 845.680(c).

2.3.2 Expected Operational Reliability of the Remedy (IAC Section 845.670(e)(3)(B))

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for each potential corrective action alternative. Thus, the operational reliability of the remedy would be the same for each corrective action alternative. The reliability associated with implementing CIP using a consolidate-and-cap approach was evaluated in the CAA (Gradient, 2022). Both corrective action alternatives would likely be highly reliable with respect to operational controls associated with residual plume management; specific details for each corrective action alternative are discussed below.

- Residual plume management under the Source Control-GWP alternative would have high operational reliability because it would rely on natural processes and active monitoring, rather than the installation, operation, and maintenance of engineered systems or structures (other than monitoring wells). Under the Source Control-GWP alternative, engineering failure would not occur and no O&M activities would be required to ensure the success of the alternative;
- Residual plume management under the Source Control-GWE alternative would also have high operational reliability because it is an established and commonly used remedial technique, as long as the extraction trench system is constructed in accordance with the design and specifications. In addition, the remedy operates as a mechanical system and would require routine and non-routine maintenance of the extraction system to ensure reliable operation (in addition to those required for groundwater monitoring).

2.3.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies (IAC Section 845.670(e)(3)(C))

Both corrective action alternative would require regulatory approvals. Specific permits and approvals associated with source control (CIP using a consolidate-and-cap-approach) are the same for each corrective action alternative and are discussed in the CAA (Gradient, 2022). The specific approvals and permits associated with residual plume management for each corrective action alternative are discussed below.

- The Source Control-GWP alternative would not need additional permits from other agencies, other than the permits issued by IEPA for source control (*i.e.*, Closure Plan and Construction Permit Application) and approval of the eventual Corrective Action Plan (Appendix B; Ramboll, 2025b).

- The Source Control-GWE alternative would require approvals and permits. Groundwater extracted from the trench would require a modified NPDES-permit. The NPDES permits would likely require renewals depending on the timeline of corrective action implementation. In addition, permits from the IEPA for construction of stormwater controls and BMPs, placement of excavated spoils beneath the AP1 final cover system *via* an amendment to the AP1 Closure Plan and Construction Permit Application, and an operating permit would be required. An Illinois Department of Natural Resources (IDNR) Dam Safety modification permit would be obtained for modifications of the AP1 embankment. These permits and plans typically take 18-24 months to obtain, although some may already be obtained during the AP1 final closure (Appendix B; Ramboll, 2025b).

2.3.4 Availability of Necessary Equipment and Specialists (IAC Sections 845.670(e)(3)(D) and 845.660(c)(1), "Ease of Implementation")

Source control (*i.e.*, CIP using a consolidate-and-cap approach) would be implemented for both potential corrective action alternatives. Thus, equipment and specialist needs would be the same for each corrective action alternative. An assessment of necessary equipment and specialists associated with implementing CIP using a consolidate-and-cap approach was evaluated in the CAA (see the CAA; Gradient, 2022). Specialized equipment and personnel are essential for field data collection and groundwater sampling for residual plume management under each potential corrective action alternative. Additionally, the assessment of groundwater concentrations for Site constituents would necessitate laboratory equipment and specialists for each alternative. The availability of equipment and specialists associated with residual plume management for each corrective action alternative is summarized below.

- Residual plume management under the Source Control-GWP alternative would require groundwater professionals, such as geologists, hydrogeologists, statisticians (*i.e.*, statistical analysis), and geochemists to evaluate all monitoring data, ensuring that physical and geochemical processes function as anticipated for this alternative. The equipment and specialists needed for Site groundwater monitoring and analysis are currently engaged in these tasks as part of the routine groundwater monitoring program outlined in accordance with IAC Section 845.220(c)(4).
- Residual plume management under the Source Control-GWE alternative would require specialists to manage the extraction system throughout its operational period.
    - Construction of the groundwater extraction system (*i.e.*, the trench and settling pond) on the Site is expected to require a specialized contractor. The contractor would most likely need specialized and often custom-built equipment including one-pass construction equipment. The availability of contractors with such equipment may be limited.
    - Specialists including design engineers, construction managers and contractor staff experienced in trench construction and similar geologic environments would be required as well. In addition, specialists and equipment may have backlogs from similar specialty ground improvement projects in the area.
    - Geotechnical specialists would be required to design the working platform and oversee the AP1 embankment, monitoring for any signs of distress during the one-pass trench installation.
    - After the construction phase, specialists and equipment would be required during the operation of the extraction system. Routine maintenance would include inspection of system components such as totalizers, instrumentation, and the extraction and transfer pumps. Non-routine maintenance such as flushing or jetting of the conveyance lines, replacement of faulty system components, replacement of pumps or pump controllers, and replacement of faulty system

instrumentation would also be necessary. Specialists and replacement equipment needed to operate the system would be generally available to the Site, although some of the more complex equipment (*i.e.*, transfer pumps and transfer pump controller) may have extended lead times for servicing.

- This alternative would necessitate the use of equipment and the expertise of specialists for tasks such as field data collection, groundwater sampling, analysis, and periodic corrective action groundwater monitoring and reporting. Similar to those in the GWP alternative, these activities are already being conducted as part of routine groundwater monitoring in accordance with IAC Section 845.220(c)(4).

2.3.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services /Comply with Standards for Management of Wastes as Specified in Section 845.680(d) (IAC Section 845.670(e)(3)(E)/IAC Section 845.670(d)(5))

The available capacity and location of needed treatment, storage, and disposal services associated with residual plume management under each corrective action alternative is summarized below. All the practices employed in each alternative would comply with standards for the management of wastes as specified in IAC Section 845.670(e)(3)(E) and IAC Section 845.680(d)(5).

- Residual plume management for the Source Control-GWP remedy would not require any treatment, storage, or disposal services, because GWP is not anticipated to produce a substantial amount of waste or wastewater, aside from minor purge water volumes generated during routine groundwater sampling activities for residual plume management. This could be managed by a standard waste management contractor.
- Residual plume management for the Source Control-GWE alternative would require the construction of the extraction trench system and a new settling pond on-Site:
  - The construction of the extraction trench would generate spoils, and the waste materials would be used as subgrade fill beneath AP1 final cover system during the closure construction. Completing the extraction trench construction at the same time as the AP1 closure would provide sufficient on-Site capacity for the disposal of generated spoils.
  - The extraction trench system would send extracted groundwater to an on-Site settling pond, which collects solids removed during groundwater recovery *via* the pneumatic extraction pumps and transfer piping. The settling pond would need to be sited, designed, constructed, and maintained properly. The siting of the settling pond would need to consider limiting impacts to the AP1 final closure construction, existing Site infrastructure, and future solar redevelopment at CPP.
  - Discharge from the settling pond would be conveyed to an NPDES permitted outfall. Renewal of the NPDES permits may be necessary to continue operations, depending on the timeline of the corrective action implementation in relation to the source control completion.

2.4 The Degree to Which Community Concerns Are Addressed by the Remedy (IAC Section 845.670(e)(4))

Several nonprofits raised concerns regarding the potential impacts of AP1 on groundwater and surface water quality including Earthjustice, the Prairie Rivers Network, and the Sierra Club (Earthjustice *et al.*,

2018; Lydersen, 2017; Sierra Club and CIHCA, 2014; Sierra Club, 2021). The combination of source control (*i.e.*, CIP using a consolidate-and-cap approach) and residual plume management would cause groundwater concentrations to decline over time under both corrective action alternatives, as suggested by the groundwater modeling (Ramboll, 2022), thus addressing community concerns.

A public meeting was held on May 1, 2025, pursuant to requirements under IAC Section 845.660(d). Questions raised by attendees were addressed at the meeting; a written summary of the questions and responses were prepared.

2.5 Remove from the Environment as Much of the Contaminated Material that Was Released from the CCR Surface Impoundment as Is Feasible, Taking into Account Factors such as Avoiding Inappropriate Disturbance of Sensitive Ecosystems (IAC Section 845.670(d)(4))

There have been no documented releases of CCR from the unit (Ramboll, 2025). Both corrective action alternatives would have source control (CIP using a consolidate-and-cap approach) and residual plume management efforts. The source control would include the excavation and consolidation of CCR in AP1 into the western portion of the impoundment and the installation of a low-permeability final geomembrane cover system designed to limit the infiltration of precipitation into the impounded CCR. Groundwater modeling performed in support of the CAA (Gradient, 2022) concluded that source control alone would result in a 99.9% reduction in mass flux from AP1 into the underlying groundwater (Ramboll, 2022). Therefore, source control will prevent further releases of CCR-derived constituents from AP1 into the environment.

Moreover, residual plume management under each corrective action alternative will further result in the removal of contaminated material from the environment and/or the improvement of downgradient groundwater quality. Groundwater modeling has predicted that GWPSs would be achieved in all monitoring wells within approximately 40 years under both the Source Control-GWP and Source Control-GWE alternatives[7] (Appendix B; Ramboll, 2025c). Specific considerations for residual plume management for each alternative are provided below.

- Residual plume management under the Source Control-GWP alternative would address impacted groundwater by relying on physical and geochemical attenuation processes to reduce the residual concentrations of CCR. Site-specific evaluation demonstrated conditions are favorable for the attenuation of inorganic contaminants *via* adsorption. Attenuation *via* sorption onto mineral surfaces should remain stable under post-closure conditions, and remobilization is unlikely to impact the time to achieve GWPS for sulfate (Appendix E; Geosyntec Consultants, Inc., 2025) In cases in which observed groundwater concentrations deviate significantly from modeled conditions, alternative methods or techniques would be evaluated under the adaptive site management, and if viable, incorporated as per IAC Section 845.680(b). No ecosystems would be disturbed, because no construction activities would be expected under the Source Control-GWP alternative.
- Residual plume management under the Source Control-GWE alternative would rely on the extraction trench to remove constituent mass in groundwater and prevent migration of impacted

[7] The 40-year time frame to achieve GWPSs is assumed to start after source control is complete and a corrective action permit application has been issued by IEPA under the Source Control-GWP alternative, whichever is longer. The 40-year time frame to achieve GWPSs is assumed to start after source control is complete and a corrective action construction permit application has been issued by IEPA under the Source Control-GWE alternative, whichever is longer (Appendix B; Ramboll, 2025).

groundwater. Groundwater quality would also be improved as a result of physical and geochemical attenuation processes. The construction activities would likely result in some negative impacts to the ecosystem, including disturbance of some existing habitats atop portions of the construction areas and habitats in the immediate vicinity of these locations, by causing alarm and escape behavior in nearby wildlife (*e.g.*, due to noise disturbances). Short-term impacts could also occur to sensitive aquatic and wetland species in Coffeen Lake and other wetlands or surface water bodies located within the SFWA near AP1 (see Section 1.1.3) due to sediment runoff during construction at the Site.

2.6 Summary

This CAAA evaluates two corrective action alternatives identified as potentially viable in the CMA with regard to each of the factors specified in IAC Section 845.670(d) and 845.670(e) (IEPA, 2021). Based on this evaluation, the most appropriate corrective action for this Site is Source Control-GWP. The estimated timeframe for achieving GWPS under for the Source Control-GWP and Source Control-GWE alternatives is similar. However, the expected impacts on workers, nearby communities, and the environment under the Source Control-GWP alternative are expected to be lower than those under the Source Control-GWE alternative. Thus, Source Control-GWP is the most appropriate corrective action alternative for AP1.

References

AECOM. 2016. Letter Report to Illinois Power Resources Generating, LLC (Bartonville, IL) re: History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Coffeen Power Station, Coffeen, Illinois. 185p., October.

Earthjustice; Prairie Rivers Network; Environmental Integrity Project (EIP); Sierra Club. 2018. "Cap and Run: Toxic Coal Ash Left Behind by Big Polluters Threatens Illinois Water." 45p.

Geosyntec Consultants, Inc. 2025. "Groundwater Polishing Remedy Feasibility Review, Coffeen Power Plant, Ash Pond No. 1 (Unit No.: 101) (Final)." Report to Illinois Power Generating Co.

Golder Associates USA Inc. 2022. "Final Closure Plan for Ash Pond No. 1, Coffeen Power Plant." Report to Illinois Power Resources Generating, LLC, Collinsville, IL. 20p.

Gradient. 2022. "Closure Alternatives Analysis and for Ash Pond No. 1 at the Coffeen Power Plant, Coffeen, Illinois." 95p. July 28.

Hesterberg, TW; Valberg, PA; Long, CM; Bunn, WB III; Lapin, C. 2009. "Laboratory studies of diesel exhaust health effects: Implications for near-roadway exposures." *EM Mag.* (August):12-16. Accessed at http://pubs.awma.org/gsearch/em/2009/8/hesterberg.pdf.

Illinois Dept. of Natural Resources (IDNR). 2014. "Coffeen Lake State Fish & Wildlife Area." 2p.

Illinois Environmental Protection Agency (IEPA). 2007. "Greenville Old Lake and Coffeen Lake Watersheds." IEPA/BOW/07-014, 155p., August.

Illinois Environmental Protection Agency (IEPA). 2019. "Appendix A-1. Illinois' 2018 303(d) List and Prioritization." In "Illinois Integrated Water Quality Report and Section 303(d) List, 2018 (Final as submitted to US EPA Region V on February 22, 2021)." 40p., May 20. Accessed at https://www2.illinois.gov/epa/topics/water-quality/watershed-management/tmdls/Documents/Appendix%20A-1_303d_by_priority_FINAL_5-20-19.pdf.

Illinois Environmental Protection Agency (IEPA). 2021. "Standards for the disposal of coal combustion residuals in surface impoundments." Accessed at https://www.ilga.gov/commission/jcar/admincode/035/03500845sections.html.

Illinois Environmental Protection Agency (IEPA). 2023. "Draft Reissued NPDES Permit to Discharge into Waters of the State, Coffeen Power Station, Coffeen, Illinois." Submitted to Coffeen Power Station, Coffeen, IL. NPDES Permit No. IL0000108. 23p., September 14.

Illinois State Geological Survey (ISGS); University of Illinois at Urbana-Champaign. 2011. "Directory of Coal Mines in Illinois 7.5-Minute Quadrangle Series, Coffeen Quadrangle, Montgomery & Bond Counties." Report to Illinois Mine Subsidence Insurance Fund. 20p.

Lydersen, K. 2017. "Citizens fill void in oversight of potentially hazardous Illinois coal ash impoundments." *Energy News Network.* January 20. Accessed at https://energynews.us/2017/01/20/citizens-fill-void-in-oversight-of-potentially-hazardous-illinois-coal-ash-impoundments/.

Mauderly, JL; Garshick, E. 2009. "Diesel exhaust." In *Environmental Toxicants: Human Exposures and Their Health Effects (Third Edition)*. (Ed.: Lippmann, M), John Wiley & Sons, Inc., Hoboken, NJ. p551-631.

National Research Council. 2013. "Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites." Division of Earth and Life Sciences, Water Science and Technology Board, Committee on Future Options for Management in the Nation's Subsurface Remediation Effort. National Academies Press, Washington, DC. Accessed at http://www.nap.edu/catalog.php?record_id=14668.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois (Final)." Report to Illinois Power Generating Co. 700p., October 25.

Ramboll. 2022. "Groundwater Modeling Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois (Final)." Report to Illinois Power Generating Co. 180p., July 28.

Ramboll. 2024. "Nature and Extent Report, Coffeen Power Plant, Ash Pond No. 1, IEPA ID No. W1350150004-01." Report to Illinois Power Generating Co., Coffeen, IL. 544p., June 12.

Ramboll. 2025a. "35 I.A.C. § 845 Corrective Measures Assessment, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois, IEPA ID: W135015004-01 (Final)." Report to Illinois Power Generating Co.

Ramboll. 2025b. "Corrective Action Alternatives Analysis Supporting Information Report: Ash Pond No. 1, Coffeen Power Plant, IEPA ID No. W1350150004-01 (Final)." Report to Illinois Power Generating Co., Coffeen, IL.

Ramboll. 2025c. "Groundwater Modeling Technical Memorandum, Ash Pond No. 1, Coffeen Power Plant, IEPA ID No. W1350150004-01 (Final)." Report to Illinois Power Generating Co.

Sierra Club. 2021. "Sierra Club statement on Joppa closure and settlement agreement with Vistra Energy." April 7. Accessed at https://www.sierraclub.org/press-releases/2021/09/sierra-club-statement-joppa-closure-and-settlement-agreement-vistra-energy.

Sierra Club; Central Illinois Healthy Community Alliance (CIHCA). 2014. "Dynegy's Toxic Assets: Legacy Coal Pollution in the Heartland." 17p.

US Dept. of Labor (US DOL). 2020a. "Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2019." Bureau of Labor Statistics, December. Accessed at https://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2019hb.xlsx.

US Dept. of Labor (US DOL). 2020b. "Table R100. Incidence rates for nonfatal occupational injuries and illnesses involving days away from work per 10,000 full-time workers by occupation and selected events or exposures leading to injury or illness, private industry, 2019." Bureau of Labor Statistics, October. Accessed at https://www.bls.gov/iif/oshwc/osh/case/cd_r100_2019.xlsx.

US Dept. of Transportation (US DOT). 2023. "Large Truck and Bus Crash Facts 2021." Federal Motor Carrier Safety Administration, Analysis Division, FMCSA-RRA-23-002, 118p., November.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery. Submitted to US EPA Docket. EPA-HQ-OLEM-2020-0107-0885. 1237p., December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2015a. "Hazardous and solid waste management system; Disposal of coal combustion residuals from electric utilities (Final rule)." *Fed. Reg.* 80(74):21302-21501. 40 CFR 257, 40 CFR 261, April 17.

US EPA. 2015b. "Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER Directive 9283.1-36, 83p., August.

US EPA. 2022. "Coffeen, Illinois, Watershed: Rocky Fork Lakes-East Fork Shoal Creek (071402030305)." Accessed at https://mywaterway.epa.gov/community/coffeen/overview.

Appendix A

Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
Ash Pond 1
Coffeen Power Plant
Coffeen, Illinois

July 28, 2022

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Abbreviations

ADI	Acceptable Daily Intake
AP1	Ash Pond 1
BCF	Bioconcentration Factor
BCG	Biota Concentration Guide
CAA	Closure Alternatives Assessment
CPP	Coffeen Power Plant
CCR	Coal Combustion Residuals
CEM	Conceptual Exposure Model
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
DA	Deep Aquifer
DCU	Deep Confining Unit
ESV	Ecological Screening Value
GMF	Gypsum Management Facility
GWPS	Groundwater Protection Standards
GWQS	Groundwater Quality Standards
HTC	Human Threshold Criteria
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
ILWATER	Illinois Water and Related Wells
IPGC	Illinois Power Generating Company
ISGS	Illinois State Geological Survey
LCU	Lower Confining Unit
MCL	Maximum Contaminant Level
NRWQC	National Recommended Water Quality Criteria
ORNL RAIS	Oak Ridge National Laboratory Risk Assessment Information System
PRG	Preliminary Remediation Goal
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SI	Surface Impoundment
SWQC	Surface Water Quality Criteria
UA	Uppermost Aquifer
UCU	Upper Confining Unit
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1 Introduction

Illinois Power Generating Company's (IPGC) Coffeen Power Plant (CPP, or "the Site") is an electric power generating facility with coal-fired units located approximately two miles south of the City of Coffeen, Illinois. The CPP operated as a coal-fired power plant from 1964 until November 2019 and has five coal combustion residuals (CCR) management units (Ramboll, 2021). The CCR unit that is the subject of this report is Ash Pond 1 (AP1) (Vistra Identification No. 101, Illinois Environmental Protection Agency [IEPA] ID No. W1350150004-01, and National Inventory of Dams No. IL50722). AP1 is a 23-acre, unlined surface impoundment (SI) that was used to manage CCR and non-CCR waste streams at the CPP (Ramboll, 2021).

This report presents the results of an evaluation that characterizes potential risk to human and ecological receptors that may be exposed to CCR constituents in environmental media originating from AP1. This risk evaluation was performed to support the Closure Alternatives Assessment for AP1 in accordance with requirements in Title 35 Part 845 of the Illinois Administrative Code (IEPA, 2021a). Human and ecological risks were evaluated for Site-specific constituents of interest (COIs). The conceptual site model (CSM) assumed that Site-related COIs in groundwater may migrate to the adjacent Coffeen Lake and affect surface water and sediment in the vicinity of the Site.

Consistent with United States Environmental Protection Agency (US EPA) guidance (US EPA, 1989), this report used a tiered approach to evaluate potential risks, which included the following steps:

1. Identify complete exposure pathways and develop a conceptual exposure model (CEM).
2. Identify Site-related COIs: Constituents detected in groundwater were considered COIs if their maximum detected concentration over the period from 2015 to 2021 exceeded a groundwater protection standard (GWPS) identified in Part 845.600 (IEPA, 2021a), or a relevant surface water quality standard (IEPA, 2019; US EPA Region IV, 2018).
3. Perform screening-level risk analysis: Compare maximum measured or modeled COI concentrations in surface water and sediment to conservative, health-protective benchmarks to determine constituents of potential concern (COPCs).
4. Perform refined risk analysis: If COPCs are identified, perform a refined analysis to evaluate potential risks associated with the COPCs.
5. Formulate risk conclusions and discuss any associated uncertainties.

This assessment relies on a conservative (*i.e.*, health-protective) approach and is consistent with the risk approaches outlined in US EPA guidance. Specifically, we considered evaluation criteria detailed in IEPA guidance documents (*e.g.*, IEPA, 2013, 2019), incorporating principles and assumptions consistent with the Federal CCR Rule (US EPA, 2015a) and US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014).

US EPA has established acceptable risk metrics. Risks above these US EPA-defined metrics are termed potentially "unacceptable risks." Based on the evaluation presented in this report, no unacceptable risks to human or ecological receptors resulting from CCR exposures associated with AP1 were identified. This means that the risks from the site are likely indistinguishable from normal background risks. Specific risk assessment results include the following:

- No completed exposure pathways were identified for any groundwater receptors; consequently, no risks were identified relating to the use of groundwater.
- No unacceptable risks were identified for recreators boating in Coffeen Lake adjacent to the Site.
- No unacceptable risks were identified for recreators exposed to sediment in Coffeen Lake adjacent to the Site.
- No unacceptable risks were identified for anglers consuming locally caught fish.
- No unacceptable risks were identified for ecological receptors exposed to surface water or sediment.
- No bioaccumulative ecological risks were identified.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. Moreover, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when AP1 is closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline.

2 Site Overview

2.1 Site Description

The CPP is located in Montgomery County, Illinois, approximately 2 miles south of the City of Coffeen and about 8 miles southeast of the City of Hillsboro, Illinois. Five CCR units are present on the CPP property, including AP1, Ash Pond 2, Gypsum Management Facility (GMF) Recycle Pond, GMF Gypsum Stack Pond, and the Landfill (Ramboll, 2021). AP1, the subject of this report, was constructed in 1964; it is an unlined SI that covers an area of approximately 23 acres (Ramboll, 2021). Sluicing of waste to AP1 ceased prior to November 2019 (Ramboll, 2021). The CPP is bordered by Coffeen Lake to the west, east, and south, and is bordered by agricultural land to the north. An unnamed tributary, located east of AP1, flows south into Coffeen Lake (Figure 2.1) (Ramboll, 2021). Coffeen Lake (approximately 1,100-acres) was formed in 1963 for use as an artificial cooling lake for the CPP, by damming the McDavid Branch of the East Fork of Shoal Creek (Ramboll, 2021).

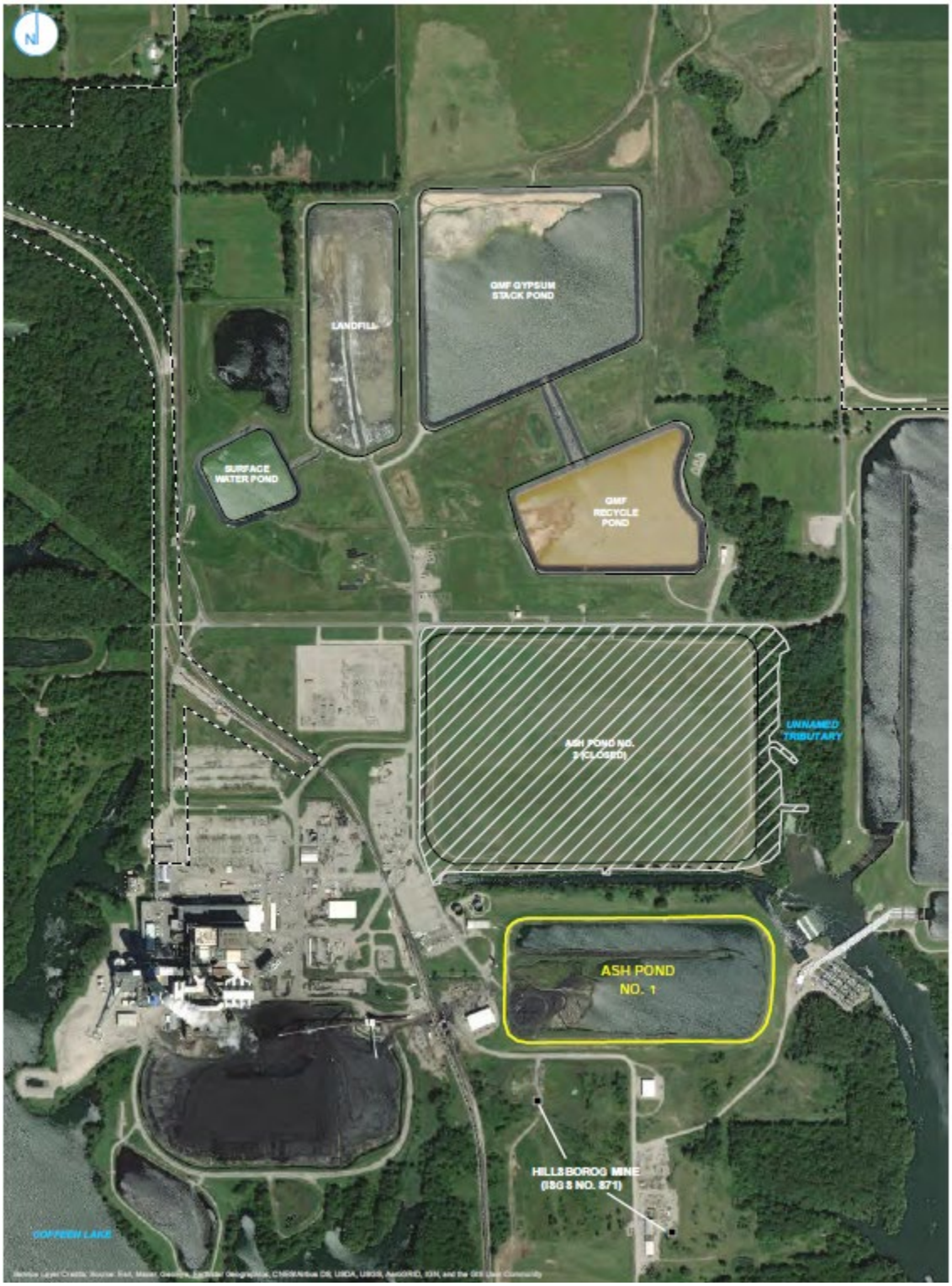

Figure 2.1 Site Location Map. Source: Ramboll (2021).

2.2 Geology/Hydrogeology

The geology underlying the CPP Site in the vicinity of AP1 primarily consists of unlithified deposits (Ramboll, 2021). The unlithified deposits were categorized into the following hydrostratigraphic units (moving downward from the ground surface): the Upper Confining Unit (UCU), which is composed of Roxana and Peoria Silts (Loess Unit); the Uppermost Aquifer (UA), which is primarily composed of sandy to gravelly silts and clays of the Hagarstown Member; the Lower Confining Unit (LCU), which is composed of the Vandalia Member, the Mulberry Grove Member, and the Smithboro Member; the Deep Aquifer (DA), which is composed of sand and sandy silts/clays of the Yarmouth Soil; and the Deep Confining Unit (DCU), which is composed of clays, silts, and sands of the Banner Formation (Ramboll, 2021).

The Hagarstown Member is separated into two units: a gravelly clay till unit on top of a sandy unit (Ramboll, 2021). The sandy unit at the base of the Hagarstown Member was identified as the UA. However, in some locations, the uppermost weathered sandy clay portion of the underlying Vandalia Member was also identified as the UA (Ramboll, 2021). The UA (*i.e.*, sandy portion of the Hagarstown Member) is generally less than 3 feet (ft) thick, but it is absent at several locations (Ramboll, 2021). The top of the UA is separated from overlying CCR materials by the low permeability Loess (*i.e.*, the UCU) and the gravelly clay till portions of the Hagarstown Member. The bottom of the UA is separated from the DA by low-permeability tills of the LCU (Ramboll, 2021). Near AP1, the UA has moderate permeability with a geometric mean horizontal hydraulic conductivity of 2×10^{-3} cm/s (Ramboll, 2021).

Groundwater within the UA flows generally from the south towards the north and northeast across AP1 and ultimately flows into a drainage ditch and the eastern branch of Coffeen Lake (Ramboll, 2021). Horizontal hydraulic gradients calculated for the UA range from 0.004 to 0.012 ft/ft, which correspond to a groundwater flow velocity ranging from 0.19 ft/day to 0.95 ft/day (Ramboll, 2021).

2.3 Conceptual Site Model

A CSM describes sources of contamination, the hydrogeological units, and the physical processes that control the transport of water and solutes. In this case, the CSM describes how groundwater underlying AP1 migrates and interacts with surface water and sediment in the adjacent Coffeen Lake. The CSM was developed using available hydrogeologic data specific to AP1, including information on groundwater flow and surface water characteristics (Ramboll, 2021).

CCR-related constituents may migrate vertically downward through the UCU from AP1 into the underlying groundwater of the UA. Once in groundwater, CCR-related constituents may migrate in a north/ northeasterly direction, consistent with the direction of groundwater flow, into a drainage ditch and the eastern branch of Coffeen Lake (Ramboll, 2021). Groundwater flow within the UA is mostly in the horizontal direction because the UA is underlain by the LCU, which is a low-permeability till unit inhibiting vertical flow of groundwater. Groundwater near AP1 may mix with surface water in the eastern branch of Coffeen Lake, and dissolved constituents in groundwater may partition between the sediments and surface water in Coffeen Lake.

2.4 Groundwater Monitoring

A total of 17 wells have been used to monitor the groundwater quality near and downgradient of AP1. Of these, 13 wells are screened in the UA, 3 wells are screened in the LCU, and 1 well is screened in the DA (Table 2.1). The analyses presented in this report relied on all available data from the 17 wells collected between 2015 and 2021, which is the period subsequent to the promulgation of the Federal CCR Rule. Groundwater samples were analyzed for a suite of total metals, specified in Illinois CCR Rule Part 845.600 (IEPA, 2021a).[1] A summary of the groundwater data used in this risk evaluation is presented in Table 2.2. The AP1 well locations used in this risk evaluation are shown in Figure 2.2. The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with AP1 or that they have been identified as potential groundwater exceedances.

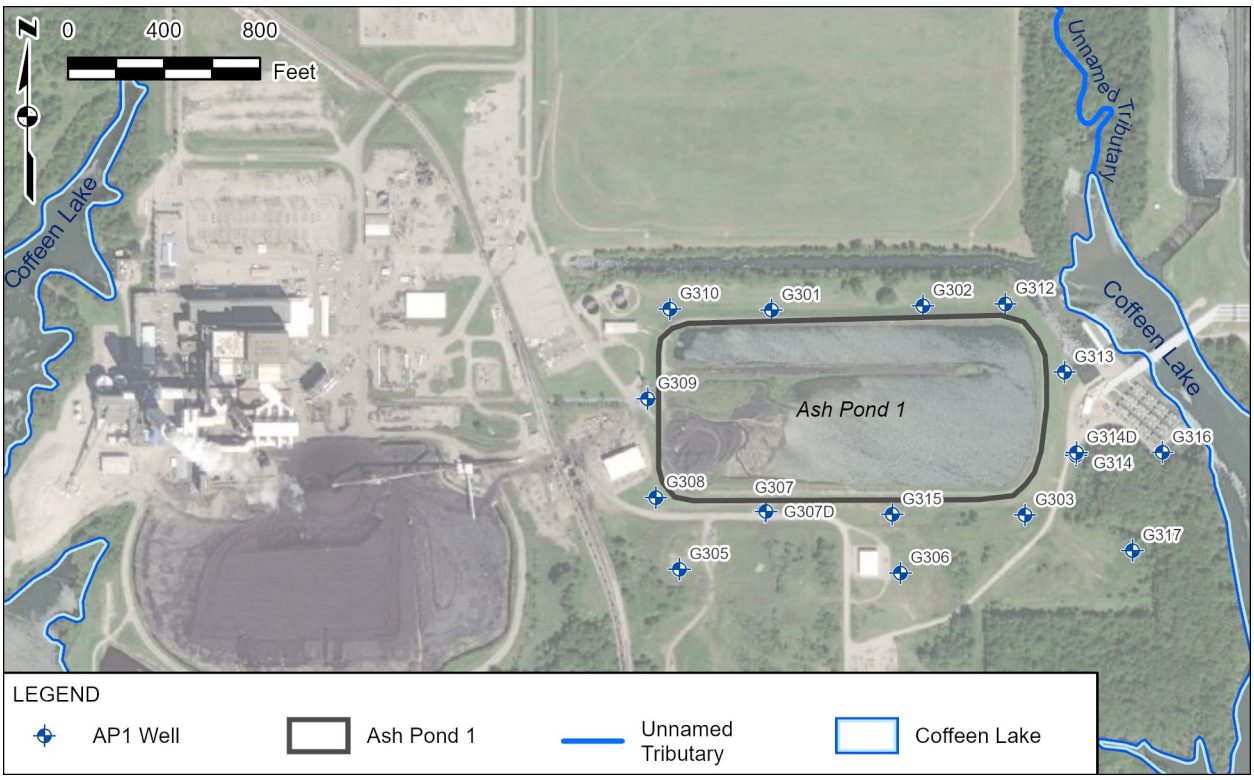

Figure 2.2 Monitoring Well Locations. Source: Ramboll (2021, Figure 3-1). AP1 = Ash Pond 1.

[1] Samples were analyzed for a longer list of inorganic constituents and general water quality parameters (chloride, fluoride, sulfate, and total dissolved solids), but these constituents were not evaluated in the risk evaluation.

Table 2.1 Groundwater Monitoring Wells Related to Coffeen Ash Pond 1

Well	Hydrogeologic Unit	Date Constructed	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Well Depth (ft bgs)
G301	UA	9/4/2015	11.31	15.96	16.21
G302	UA	9/4/2015	13.21	17.86	18.39
G303	UA	8/26/2010	10.00	20.00	20.40
G305	UA	5/3/2016	13.44	18.27	18.50
G306	UA	5/3/2016	13.07	17.68	17.90
G307	UA	7/27/2016	12.96	17.80	18.22
G307D	LCU	1/19/2021	48.98	58.75	59.60
G308	UA	1/18/2021	10.10	14.89	15.24
G309	UA	1/21/2021	12.97	17.75	18.10
G310	UA	2/9/2021	10.24	15.03	15.38
G312	UA	1/15/2021	9.79	14.58	14.93
G313	UA	2/5/2021	6.30	11.11	11.46
G314	LCU	2/5/2021	14.56	19.58	20.02
G314D	DA	2/4/2021	39.34	49.11	49.47
G315	UA	1/14/2021	9.69	14.48	14.85
G316	LCU	2/26/2021	10.02	14.82	15.16
G317	UA	2/12/2021	30.14	34.93	35.28

Notes:
Source: Ramboll (2021).
bgs = Below Ground Surface; DA = Deep Aquifer; ft = Feet; LCU = Lower Confining Unit; UA = Uppermost Aquifer.

Table 2.2 Groundwater Data Summary

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Laboratory Detection Limit
Total Metals (mg/L)					
Antimony	0	152	ND	ND	0.0030
Arsenic	72	172	0.0010	0.041	0.0010
Barium	172	172	0.013	0.38	0.0010
Beryllium	2	167	0.0013	0.0029	0.0010
Boron	177	177	0.019	7.5	0.20
Cadmium	8	172	0.0011	0.027	0.0010
Chromium	31	172	0.0040	0.11	0.0040
Cobalt	81	173	0.0020	0.034	0.0020
Lead	41	172	0.0010	0.068	0.0010
Lithium	62	172	0.010	0.10	0.020
Mercury	8	152	0.00022	0.0013	0.0040
Molybdenum	111	172	0.0010	0.026	0.0010
Selenium	15	167	0.0011	0.0043	0.0010
Thallium	0	152	ND	ND	0.0010
Radionuclides (pCi/L)					
Radium-226+228	163	163	0	18	5.0
Other (mg/L)					
Chloride	171	175	1.1	180	250
Fluoride	121	175	0.25	1.4	2.5
Sulfate	175	175	5.9	2,400	500
Total Dissolved Solids	175	175	640	4,000	26

Notes:
Source: Ramboll (2021).
ND = Not Detected; pCi/L = PicoCuries Per Liter.

2.5 Surface Water Monitoring

Geosyntec collected a total of six surface water samples from Coffeen Lake in the vicinity of AP1 in August 2021 (Geosyntec, 2021). The sample locations are shown in Figure 2.3, and the sampling results are summarized in Table 2.3.

Figure 2.3 Surface Water Sampling Locations. Source: Geosyntec (2021).

Table 2.3 Surface Water Data Summary

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Laboratory Detection Limit
Total Metals (mg/L)					
Boron	5	5	0.086	0.33	0.05
Calcium	5	5	21	53	0.2
Cobalt	0	5	0	0	0.005
Iron	5	5	0.23	0.38	0.2
Lithium	0	5	0	0	0.01
Magnesium	5	5	10	16	0.1
Manganese	5	5	0.03	0.2	0.01
Potassium	5	5	2.5	4.9	0.5
Sodium	5	5	11	19	1
Other (mg/L)					
Chloride	5	5	7.2	11	0.4
Phosphorus	5	5	0.095	0.24	0.15
Sulfate	5	5	31	110	2
Total Dissolved Solids	5	5	120	240	10

Notes:
Source: Geosyntec (2021).
Surface water was analyzed for both total and dissolved metals; only the total metals are reported here because they generally have higher concentrations than dissolved metals. The only exception was iron, which had a maximum dissolved concentration 1.8 times higher than the maximum total concentration. However, iron was not measured in groundwater and, therefore, was not identified as a COI.

3 Risk Evaluation

3.1 Risk Evaluation Process

A risk evaluation was conducted to determine whether constituents present in groundwater underlying and downgradient of AP1 have the potential to pose adverse health effects to human and ecological receptors. The risk evaluation is consistent with the principles of risk assessment established by US EPA and has considered evaluation criteria detailed in Illinois guidance documents (*e.g.*, IEPA, 2013, 2019).

The general risk evaluation approach is summarized in Figure 3.1 and discussed below.

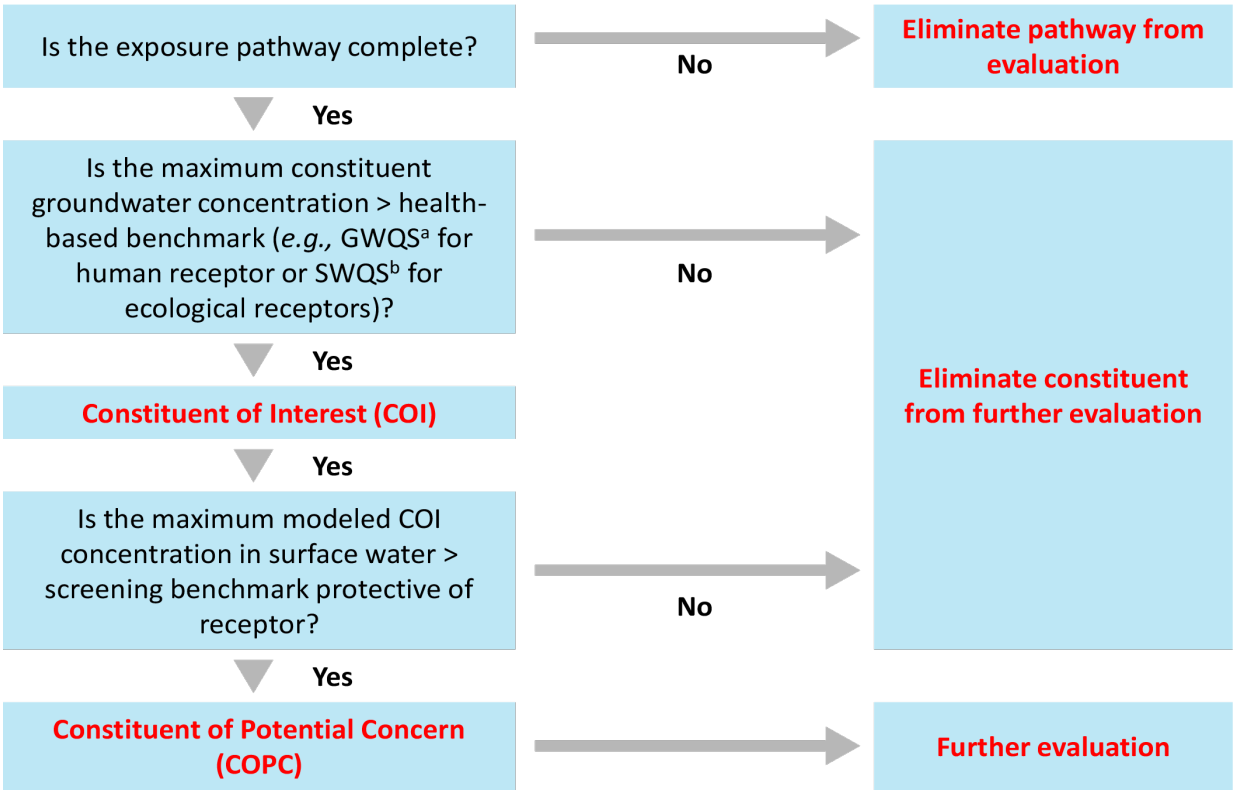

Figure 3.1 Overview of Risk Evaluation Methodology. GWQS = Groundwater Quality Standard; IEPA = Illinois Environmental Protection Agency; SWQS = Surface Water Quality Standard. (a) The IEPA Part 845 GWPS were used to identify COIs. (b) IEPA SWQS protective of chronic exposures to aquatic organisms were used to identify ecological COIs. In the absence of a SWQS, US EPA Region IV ecological screening values were used.

The first step in the risk evaluation was to develop the CEMs and identify complete exposure pathways. All potential receptors and exposure pathways based on groundwater use and surface water use in the vicinity of the Site were considered. Exposure pathways that are incomplete were excluded from the evaluation.

Groundwater data were used to identify COIs. COIs were identified as constituents with maximum concentrations in groundwater in excess of groundwater quality standards (GWQS)[2] for human receptors and surface water quality standards (SWQS) for ecological receptors. Based on the CSM (Section 2.3), some groundwater underlying AP1 has the potential to interact with surface water in Coffeen Lake. Therefore, potential AP1-related constituents in groundwater may potentially flow toward and flow into surface water in Coffeen Lake.

Surface water samples have been collected from Coffeen Lake adjacent to the Site; however, sediment samples have not been collected from the lake. Gradient modeled the potential migration of COIs from groundwater to surface water and sediment to evaluate potential risks to receptors (see Section 3.3.3).

Gradient modeled the COI concentrations in surface water and sediment based on the groundwater data from the AP1-related wells. The measured and modeled COI concentrations in surface water and sediment were compared to conservative, generic risk-based screening benchmarks for human health and ecological receptors. These generic screening benchmarks rely on default assumptions with limited consideration of site-specific characteristics. Human health benchmarks are receptor-specific values calculated for each pathway and environmental medium that are designed to be protective of human health. Ecological benchmarks are medium-specific values designed to be protective of all potential ecological receptors exposed to surface water. Ecological and human health screening benchmarks are inherently conservative because they are intended to screen out chemicals that are of no concern with a high level of confidence. Therefore, a measured or modeled COI concentration exceeding a screening benchmark does not indicate an unacceptable risk, but only that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as COPCs requiring further evaluation.

As described in more detail below, this evaluation relied on the screening assessment to demonstrate that constituents present in groundwater underlying AP1 do not pose an unacceptable human health or ecological risk. That is, after the screening step, no COPCs were identified and further assessment was not warranted.

3.2 Human and Ecological Conceptual Exposure Models

A CEM provides an overview of the receptors and exposure pathways requiring risk evaluation. The CEM describes the source of the contamination, the mechanism that may lead to a release of contamination, the environmental media to which a receptor may be exposed, the route of exposure (exposure pathway), and the types of receptors that may be exposed to these environmental media.

3.2.1 Human Conceptual Exposure Model

The human CEM for the Site depicts the relationships between the off-Site environmental media potentially impacted by constituents in groundwater and human receptors that could be exposed to these media. Figure 3.2 presents a human CEM for the Site. It considers a human receptor who could be exposed to COIs hypothetically released from AP1 into groundwater, surface water, sediment, and fish. The following human receptors and exposure pathways were evaluated for inclusion in the Site-specific CEM.

[2] As discussed further in Section 3.3.2, GWQS are protective of human health and not necessarily of ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially enter into the adjacent surface water and impact ecological receptors. Therefore, two sets of COIs were identified: one for humans and another for ecological receptors.

- Residents – exposure to groundwater/surface water as drinking water;
- Residents – exposure to groundwater/surface water used for irrigation;
- Recreators in the lake adjacent to the Site:
  - Boaters – exposure to surface water and sediment while boating;
  - Swimmers – exposure to surface water and sediment while swimming;
  - Anglers – exposure to surface water and sediment and consumption of locally caught fish.

All of these exposure pathways were considered to be complete, except for residential exposure to groundwater or surface water used for drinking water or irrigation, and swimming. Section 3.2.1.1 explains why the residential drinking water and irrigation pathways are incomplete, and Section 3.2.1.2 provides additional description of the recreational exposures. While a recreator's potential exposure to surface water in Coffeen Lake was evaluated, swimming is prohibited in Coffeen Lake and thus was not evaluated (IDNR, 2014).

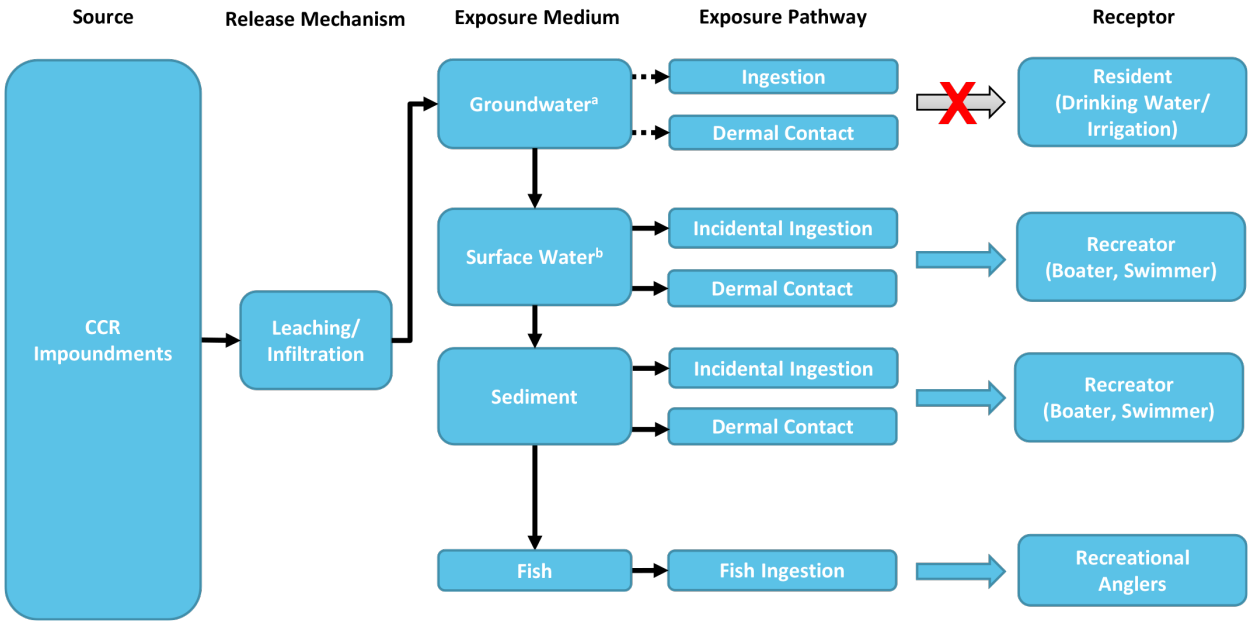

Figure 3.2 Human Conceptual Exposure Model. CCR = Coal Combustion Residuals. Dashed line/Red X = Incomplete or insignificant exposure pathway. (a) Groundwater in the vicinity of the Site is not used as a drinking water or irrigation source. (b) Surface water is not used as a drinking water source.

3.2.1.1 Groundwater or Surface Water as a Drinking Water/Irrigation Source

Using groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for CCR-related constituents originating from AP1. Specifically, there are no users of shallow groundwater from the UA in the vicinity of AP1; thus, no receptors can be exposed to any CCR-related constituents in groundwater originating from AP1.

Relying on state databases, Ramboll completed a water well survey in 2021 (Ramboll, 2021). A total of 12 water wells were identified within a 1,000-meter radius of the AP1 boundary during a comprehensive search of the Illinois State Geological Survey's (ISGS) Illinois Water and Related Wells (ILWATER) Map (Ramboll, 2021). These included four monitoring wells and eight farm/domestic wells (Ramboll, 2021) (Figure 3.3). There is no information available about the current use of these wells. However, site-specific groundwater flow conditions support the conclusion that none of the eight farm/domestic wells are or can ever be affected by potential CCR-related constituents originating from AP1.

- **There is no off-Site migration of CCR-related constituents in groundwater**. Groundwater from the UA flows north/northeast before flowing into the eastern branch of Coffeen Lake (Ramboll, 2021). Seven of the eight farm/domestic wells within a 1,000 m radius of AP1 are located on the east/southeast side of Coffeen Lake's eastern branch and the unnamed tributary, *i.e.*, the opposite side of the lake from AP1. These surface water bodies are hydraulic boundaries that prevent shallow groundwater from flowing past or underneath them. Furthermore, the surface waters are regional "sinks", meaning that groundwater flows into the surface water bodies both from the east and the west, but cannot flow past. Thus, because the eastern branch of Coffeen Lake and the unnamed tributary separate the farm/domestic wells from AP1 (Figure 3.3), there is no plausible mechanism by which the wells could be impacted by any potential constituents in groundwater associated with the AP1. There is one domestic/farm well located north of AP1 (Well ID 32 on Figure 3.3), side-gradient to AP1 and on the west side of the unnamed tributary. It is likely that this well is not in use and no longer in existence. The well, which was installed in 1981, is located near the former location of several prior residents (Figure 3.4). However, the property in this area has been purchased by IPGC and no residents are currently living or using groundwater in the area.
- **Coffeen Lake is not used as a public water supply.** Coffeen Lake is a cooling water pond owned and maintained by IPGC, and IPGC restricts the use of the lake as a source of drinking water. Therefore, the human exposure pathway of surface water ingestion (as potable water) adjacent to AP1 is not a complete pathway and was not evaluated further.
- **AP1 has a limited hydraulic connection to underlying groundwater.** The LCU underlying the UA forms a hydraulic barrier between AP1 and deeper groundwater resources. Due to the very low hydraulic conductivity of the LCU, downward migration of shallow groundwater is expected to be limited. Therefore, the likelihood of AP1-related impacts to deep groundwater is minimal.

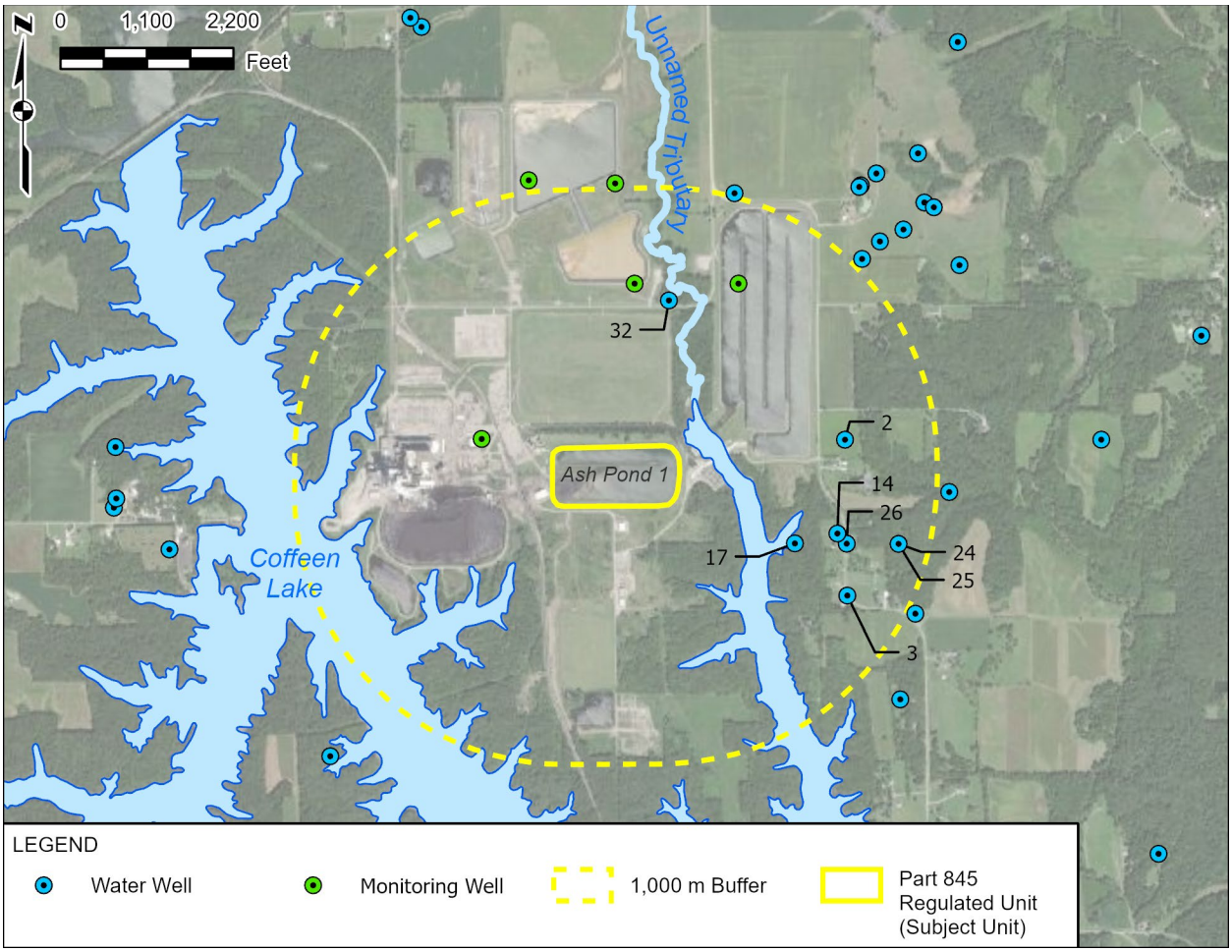

Figure 3.3 Water Wells Within 1,000 Meters of AP1. Source: Ramboll (2021).

Figure 3.4 Historic Property Use In the Vicinity of Well 32. (a) 1998; (b) 2005; (c) 2009. Sources: USGS (1998a,b, 2005a,b); USDA (2009a,b).

3.2.1.2 Recreational Exposures

Coffeen Lake is located adjacent to the Site and is owned by IPGC. Property along the lake has been leased to IDNR for use as a State Fish and Wildlife Area (Ramboll, 2021), and the lake is used for recreational fishing (IDNR, 2022). Recreational exposure to surface water and sediment may occur during activities such as boating or fishing in the lake. Recreational anglers may also consume locally caught fish from Coffeen Lake. Swimming does not occur in Coffeen Lake because it is owned by IPGC and used as a cooling reservoir (IDNR, 2022).

3.2.2 Ecological Conceptual Exposure Model

The ecological CEM for the Site depicts the relationships between off-Site environmental media (surface water and sediment) potentially impacted by COIs in groundwater and ecological receptors that may be exposed to these media. The ecological risk evaluation considered both direct toxicity and secondary toxicity *via* bioaccumulation. Figure 3.5 presents the ecological CEM for the Site. The following ecological receptor groups and exposure pathways were considered:

- **Ecological Receptors Exposed to Surface Water:**
  - Aquatic plants, amphibians, reptiles, and fish.
- **Ecological Receptors Exposed to Sediment:**
  - Benthic invertebrates (*e.g.*, insects, crayfish, and mussels).
- **Ecological Receptors Exposed to Bioaccumulative COIs:**
  - Higher trophic-level wildlife (avian and mammalian) *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of prey (*e.g.*, plants, invertebrates, small mammals, and fish).

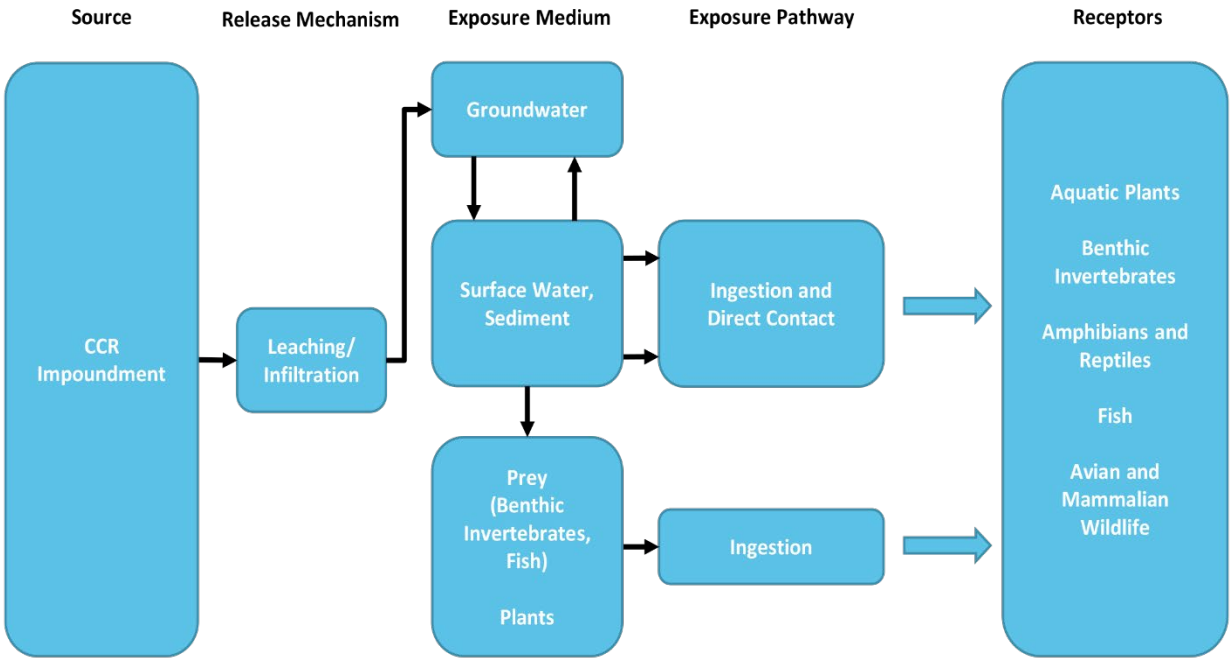

Figure 3.5 Ecological Conceptual Exposure Model. CCR = Coal Combustion Residuals.

3.3 Identification of Constituents of Interest

Risks were evaluated for COIs. A constituent was considered a COI if the maximum detected constituent concentration in groundwater exceeded a health-based benchmark. According to US EPA risk assessment guidance (US EPA, 1989), this screening step is designed to reduce the number of constituents carried through the risk evaluation that are anticipated to have a minimal contribution to the overall risk. Identified COIs are the constituents that are most likely to pose a risk concern in the surface water adjacent to the Site.

3.3.1 Human Health Constituents of Interest

For the human health risk evaluation, COIs were conservatively identified as constituents with maximum concentrations in groundwater above the GWPS listed in the Illinois CCR Rule Part 845.600 (IEPA, 2021a). Gradient used the maximum detected concentrations from groundwater samples collected from all of the AP1-associated wells, regardless of hydrostratigraphic unit. The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with AP1 or that they have been identified as potential groundwater exceedances. Using this approach, eight COIs (arsenic, boron, cadmium, chromium, cobalt, lead, lithium, and radium-226+228) were identified for the human health risk evaluation *via* the surface water pathway (Table 3.1).

The water quality parameters that exceeded the GWPS included sulfate and total dissolved solids; however, these constituents were not included in the risk evaluation because the GWPS are based on aesthetic quality. The US EPA secondary maximum contaminant levels (MCLs) for sulfate and total dissolved solids are based on aesthetic quality. The secondary MCL for sulfate (250 mg/L) is based on salty taste (US EPA, 2021a). The secondary MCL for total dissolved solids (500 mg/L) is based on hardness, deposits, colored water, staining, and salty taste (US EPA, 2021a). Given that these parameters are not likely to pose a human health risk concern in the event of exposure, they were not considered to be human health COIs.

Table 3.1 Human Health Constituents of Interest

Constituent[a]	Maximum Concentration	GWPS[b]	Human Health COI[c]
Total Metals (mg/L)			
Antimony	ND	0.0060	No
Arsenic	0.041	0.010	Yes
Barium	0.38	2.0	No
Beryllium	0.0029	0.0040	No
Boron	7.5	2.0	Yes
Cadmium	0.027	0.0050	Yes
Chromium	0.11	0.10	Yes
Cobalt	0.034	0.0060	Yes
Lead	0.068	0.0075	Yes
Lithium	0.10	0.040	Yes
Mercury	0.0013	0.0020	No
Molybdenum	0.026	0.10	No
Selenium	0.0043	0.050	No
Thallium	ND	0.0020	No
Radionuclides (pCi/L)			
Radium-226+228	18	5.0	Yes
Other (mg/L)			
Chloride	180	200	No
Fluoride	1.4	4.0	No
Sulfate	2,400	400	No[d]
Total Dissolved Solids	4,000	1,200	No[d]

Notes:
COI = Constituent of Interest; GWPS = Groundwater Protection Standard; MCL = Maximum Contaminant Level; pCi/L = PicoCuries Per Liter.
Shaded = Compound identified as a COI.
(a) The constituents are those listed in the Illinois Part 845.600 GWPS (IEPA, 2021a).
(b) The Illinois Part 845.600 GWPS (IEPA, 2021a) were used to identify COIs.
(c) COIs are constituents for which the maximum concentration exceeds the groundwater standard.
(d) This constituent is not likely to pose a human health risk concern due to the absence of studies regarding toxicity to human health. Therefore, this constituent is not considered a COI.

3.3.2 Ecological Constituents of Interest

The Illinois GWPS, as defined in IEPA's guidance, were developed to protect human health, but not necessarily ecological receptors. While ecological receptors are not exposed to groundwater, groundwater can potentially migrate into the adjacent surface water and impact ecological receptors. Therefore, to identify ecological COIs, the maximum concentrations of constituents detected in groundwater were compared to ecological surface water benchmarks protective of aquatic life.

The surface water screening benchmarks for freshwater organisms were obtained from the following hierarchy of sources:

- IEPA (2019) SWQC. IEPA SWQC are health-protective benchmarks for aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The SWQC for several metals are hardness-dependent (cadmium, chromium, copper, lead, manganese, nickel, and zinc). Screening benchmarks for these constituents were calculated assuming US EPA's default hardness of 100 mg/L (US EPA, 2022).[3]
- US EPA Region IV (2018) surface water Ecological Screening Values (ESVs) for hazardous waste sites.

Benchmarks from the United States Department of Energy's (US DOE) guidance document ("A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota") were used for radium (US DOE, 2019). US DOE (2019) presents benchmarks for radium-226 and radium-228 (4 and 3 picoCuries per liter [pCi/L], respectively). Given that radium concentrations are expressed as total radium (radium-226+228, *i.e.*, the sum of radium-226 and radium-228), Gradient used the lower of the two benchmarks (3 pCi/L for radium-228) to evaluate total radium concentrations.

Consistent with the human health risk evaluation, Gradient used the maximum detected concentrations from groundwater samples collected from all of the AP1-associated wells (regardless of hydrostratigraphic unit) without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation. Cadmium, cobalt, lead, mercury, and radium-226+228 were identified as COIs for ecological receptors (Table 3.2).

[3] Hardness data are not available for Coffeen Lake adjacent to the Site; therefore, the US EPA (2022) default hardness of 100 mg/L was used. Use of a higher hardness value would result in less stringent screening values; thus, use of the US EPA default hardness is conservative.

Table 3.2 Ecological Constituents of Interest

Constituent[a]	Maximum Groundwater Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Total Metals (mg/L)				
Antimony	ND	0.19	US EPA R4 ESV	No
Arsenic	0.041	0.19	IEPA SWQC	No
Barium	0.38	5.0	IEPA SWQC	No
Beryllium	0.0029	0.064	US EPA R4 ESV	No
Boron	7.5	7.6	IEPA SWQC	No
Cadmium	0.027	0.0011	IEPA SWQC	Yes
Chromium	0.11	0.21	IEPA SWQC	No
Cobalt	0.034	0.019	US EPA R4 ESV	Yes
Lead	0.068	0.020	IEPA SWQC	Yes
Lithium	0.10	0.44	US EPA R4 ESV	No
Mercury	0.0013	0.0011	IEPA SWQC	Yes
Molybdenum	0.026	7.2	US EPA R4 ESV	No
Selenium	0.0043	1.0	IEPA SWQC	No
Thallium	ND	0.0060	US EPA R4 ESV	No
Radionuclides (pCi/L)				
Radium-226 + 228	18	3.0	US DOE	Yes
Other (mg/L)				
Chloride	180	500	IEPA SWQC	No
Fluoride	1.4	4.0	IEPA SWQC	No
Sulfate	2,400	NA	NA	No
Total Dissolved Solids	4,000	NA	NA	No

Notes:
AP1 = Ash Pond 1; COI = Constituent of Interest; ESV = Ecological Screening Value; GWPS = Groundwater Protection Standards; IEPA = Illinois Environmental Protection Agency; NA = Not Available; ND = Nondetect; pCi/L = picoCuries Per Liter; SWQC = Surface Water Quality Criteria; US DOE = United States Department of Energy; US EPA R4 = US Environmental Protection Agency Region IV.
Shaded = Compound identified as a COI.
(a) The constituents are those listed in the Illinois Part 845.600 GWPS (IEPA, 2021a).
(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQC (IEPA, 2019); US EPA Region IV "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018); and US DOE's guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).
(c) Constituents with maximum detected concentrations exceeding a benchmark protective of surface water exposure are considered ecological COIs.

3.3.3 Surface Water and Sediment Modeling

Surface water sampling has been conducted in Coffeen Lake adjacent to the Site. To estimate the potential contribution to surface water (and sediment) from groundwater specifically associated with AP1, Gradient modeled concentrations in Coffeen Lake surface water and sediment from groundwater flow into the lake for the detected human and ecological COIs. This is because the constituents detected in groundwater above an ecological- or health-based benchmark are most likely to pose a risk concern in the adjacent surface water. Gradient modeled human health and ecological COI concentrations in the surface water and sediment using a mass balance calculation based on the surface water and groundwater mixing. The model assumes a well-mixed groundwater-surface water location. The maximum detected concentrations in groundwater (regardless of well location) from 2015 to 2021 were conservatively used to model COI

concentrations in surface water and sediment. The groundwater data were measured as total metals. Use of the total metals concentration for these COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.

This modeling approach does not account for geochemical transformations that may occur during groundwater mixing with surface water. Gradient assumed that predicted surface water concentrations were influenced only by the physical mixing of groundwater as it enters the surface water, and were not further influenced by the geochemical reactions in the water and sediment, such as precipitation. In addition, the model only predicts surface water and sediment concentrations as a result of the potential migration of COI concentrations in AP1-related groundwater and does not account for background concentrations in surface water or sediment.

For this evaluation, Gradient adapted a simplified and conservative form of US EPA's indirect exposure assessment methodology (US EPA, 1998) that was used in US EPA's coal combustion waste risk assessment (US EPA, 2014). The model is a mass balance calculation based on surface water and groundwater mixing and the concept that the dissolved and sorbed concentrations can be related through an equilibrium partitioning coefficient (K_d). The model assumes a well-mixed groundwater-surface water location, with partitioning among total suspended solids, dissolved water column, sediment pore water, and solid sediments.

Sorption to soil and sediment is highly dependent on the surrounding geochemical conditions. To be conservative, we ignored the natural attenuation capacity of soil and sediment and estimated the surface water concentration based only on the physical mixing of groundwater and surface water (*i.e.*, dilution) at the point of entry of groundwater to the surface water.

The aquifer and surface water properties used to estimate the volume of groundwater flowing into Coffeen Lake and surface water concentrations are presented in Table 3.3. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partitioning coefficients and the sediment properties presented in Table 3.4. In the absence of Site-specific information for Coffeen Lake, Gradient used default assumptions (*e.g.*, depth of the upper benthic layer and bed sediment porosity) to model sediment concentrations. The modeled surface water and sediment concentrations are presented in Table 3.5. These modeled concentrations reflect conservative contributions from groundwater flow. A description of the modeling and the detailed results are presented in Appendix A.

Table 3.3 Groundwater and Surface Water Properties Used in Modeling

Parameter	Unit	Values	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent-specific	Maximum detected concentration in groundwater
Cross Section Area for the UA[a]	m^2	613	The average thickness of the UA (*i.e.*, 3 ft or 0.9144 m) multiplied by the potential length of AP1 affected groundwater intersecting Coffeen Lake (*i.e.*, about 670 m) (Ramboll, 2021)
Hydraulic Gradient	m/m	0.0080	The average hydraulic gradient for the UA (Ramboll, 2021)
Hydraulic Conductivity of the UA	cm/s	0.0020	The geometric mean horizontal hydraulic conductivity measured for the UA (Ramboll, 2021)
Surface Water			
Surface Water Flow Rate in the Eastern Branch of Coffeen Lake	L/yr	8.0×10^{10}	There are no flow records available for the eastern branch of Coffeen Lake. The flow rate was assumed to be the same (*i.e.*, 90 cfs) as estimated for the unnamed tributary that flows from north to south into the eastern branch of Coffeen Lake (Golder Associates Inc., 2020).
Total Suspended Solids	mg/L	3.2	Average Coffeen Lake concentration (Hanson Professional Services, Inc., 2020 222-4807)
Depth of the Water Column	m	5.7	Mean depth of Coffeen Lake (Austen *et al*., 1993)
Suspended Sediment to Water Partition Coefficient	mg/L	Constituent-specific	Values based on US EPA (2014)

Notes:
AP1 = Ash Pond 1; cfs = Cubic Feet Per Second; COI = Constituent of Interest; ft = Feet; L/yr = Liter Per Year; UA = Uppermost Aquifer; US EPA = United States Environmental Protection Agency.
(a) Cross-sectional area represents the area through which groundwater flows from the UA into Coffeen Lake (*i.e.*, the groundwater flow area that intersects with Coffeen Lake).

Table 3.4 Sediment Properties Used in Modeling

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014)
Depth of Water Body	m	5.73	Sum of depth of water column (5.7 m, depth of Coffeen Lake) (Austen *et al*., 1993) and depth of upper benthic layer (0.03 m) (US EPA, 2014)
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014)
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014)
TSS Mass Per Unit Area	kg/m^2	0.0342	Depth of water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3)
Sediment Mass Per Unit Area	kg/m^2	30	Depth of upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3)
Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014)

Notes:
TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.5 Surface Water and Sediment Modeling Results

COI	Groundwater Concentration (mg/L or pCi/L)	Mass Discharge Rate (mg/yr or pCi/yr)	Total Water Column Concentration (mg/L or pCi/L)	Concentration Sorbed to Bottom Sediments (mg/kg or pCi/kg)
Total Metals				
Arsenic	0.041	1.3E+05	1.6E-06	3.8E-04
Boron	7.5	2.3E+07	2.9E-04	1.7E-03
Cadmium	0.027	8.4E+04	1.0E-06	1.4E-03
Chromium	0.11	3.4E+05	4.3E-06	1.9E-01
Cobalt	0.034	1.1E+05	1.3E-06	1.2E-03
Lead	0.068	2.1E+05	2.6E-06	2.6E-02
Lithium	0.10	3.1E+05	3.9E-06	(a)
Mercury	0.0013	4.0E+03	5.0E-08	1.8E-03
Radionuclides				
Radium-226 + 228	18	5.4E+07	6.8E-04	4.8E+00

Notes:
COI = Constituent of Concern; K_d = Equilibrium Partition Coefficient; pCi/L = PicoCuries Per Liter; pCi/kg = PicoCuries Per Kilogram.
(a) Lithium does not readily sorb to soil or sediment particles; a K_d value of 0 was used for the modeling.

3.4 Human Health Risk Evaluation

The section below presents the results of the human health risk evaluation for recreators (boaters and anglers) in Coffeen Lake adjacent to the Site. Risks were assessed using the maximum measured or modeled COIs in surface water.

3.4.1 Recreators Exposed to Surface Water

Screening Exposures: Recreators could be exposed to surface water *via* incidental ingestion and dermal contact while boating. In addition, anglers could consume fish caught in Coffeen Lake. The maximum measured or modeled COI concentrations in surface water were used as conservative upper-end estimates of the COI concentrations to which a recreator might be exposed directly (incidental ingestion of COIs in surface water while boating) and indirectly (consumption of locally caught fish exposed to COIs in surface water).

Screening Benchmarks: Illinois surface water criteria (IEPA, 2019), known as human threshold criteria (HTC), are based on incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities, as well as the consumption of fish. The HTC values were calculated from the following equation (IEPA, 2019):

$$\mathrm{HTC} = \frac{\mathrm{ADI}}{\mathrm{W} + (\mathrm{F} \times \mathrm{BCF})}$$

where:

HTC = Human health protection criterion in milligrams per liter (mg/L)
ADI = Acceptable daily intake (mg/day)
W = Water consumption rate (L/day)
F = Fish consumption rate (kg/day)
BCF = Bioconcentration factor (L/kg-tissue)

Illinois defines the acceptable daily intake (ADI) as the "maximum amount of a substance which, if ingested daily for a lifetime, results in no adverse effects to humans" (IEPA, 2019). US EPA defines its chronic reference dose (RfD) as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure for a chronic duration (up to a lifetime) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (US EPA, 2011a). Illinois lists methods to derive an ADI from the primary literature (IEPA, 2019). In accordance with Illinois guidance, Gradient derived an ADI by multiplying the MCL by the default water ingestion rate of 2 L/day (IEPA, 2019). In the absence of an MCL, Gradient applied the RfD used by US EPA to derive its Regional Screening Levels (RSLs) (US EPA, 2021b) as a conservative estimate of the ADI. The RfDs are given in mg/kg-day, while the ADIs are given in mg/day; thus, Gradient multiplied the RfD by a standard body weight of 70 kg to obtain the ADI in mg/day. The calculation of the HTC values is shown in Appendix B, Table B.1.

Gradient used bioconcentration factors (BCFs) from a hierarchy of sources. The primary BCFs were those that US EPA used to calculate the National Recommended Water Quality Criteria (NRWQC) for human health (US EPA, 2002). Other sources included BCFs used in the US EPA coal combustion ash risk assessment (US EPA, 2014) and BCFs reported by Oak Ridge National Laboratory's Risk Assessment Information System (ORNL RAIS) (ORNL, 2020).[4] Lithium did not have a BCF value available from any authoritative source; therefore, the water quality criterion for lithium was calculated assuming a BCF of 1. This is a conservative assumption, as lithium does not readily bioaccumulate in the aquatic environment (ECHA, 2020).

Illinois recommends a fish consumption rate of 0.020 kg/day (20 g/day) for an adult weighing 70 kg (IEPA, 2019). Illinois recommends a water consumption rate of 0.01 L/day for "incidental exposure through contact or ingestion of small volumes of water while swimming or during other recreational activities" (IEPA, 2019). Appendix B, Table B.1 presents the calculated HTC for fish consumption and water ingestion, and for fish consumption only.

The HTC for fish consumption for radium-226+228 was calculated as follows:

$$\mathrm{HTC} = \frac{\mathrm{TCR}}{(\mathrm{SF} \times \mathrm{BAF} \times \mathrm{F})}$$

where:

HTC = Human health protection criterion in picoCuries per liter (pCi/L)
TCR = Target cancer risk (1×10^{-5})
SF = Food ingestion slope factor (risk/pCi)
BAF = Bioaccumulation factor (L/kg-tissue)
F = Fish consumption rate (kg/day)

[4] Although recommended by US EPA (2015c), US EPA EpiSuite 4.1 (US EPA, 2019) was not used as a source of BCFs because inorganic compounds are outside the estimation domain of the program.

The food ingestion slope factor (lifetime excess total cancer risk per unit exposure, in risk/pCi) used to calculate the HTC was the highest value of those for radium-226 (Ra-226), radium-228 (Ra-228), and "Ra-228+D" (US EPA, 2001). According to US EPA (2001), "+D" indicates that "the risks from associated short-lived radioactive decay products (*i.e.,* those decay products with radioactive half-lives less than or equal to 6 months) are also included."

Screening Risk Evaluation: The maximum modeled and measured COI concentrations in surface water were compared to the calculated Illinois HTC values (Table 3.6). All surface water concentrations were below their respective benchmarks. The HTC values are protective of recreational exposure *via* water and/or fish ingestion and do not account for dermal exposures to COIs in surface water while boating. However, given that the measured and modeled COI surface water concentrations are orders of magnitude below an HTC protective of water and/or fish ingestion, dermal exposures to COIs are not expected to be a risk concern. Moreover, the dermal uptake of metals is considered to be minimal and only a small proportion of ingestion exposures. Thus, none of the COIs evaluated would be expected to pose an unacceptable risk to recreators exposed to surface water while boating or anglers consuming fish caught in Coffeen Lake.

Table 3.6 Risk Evaluation for Recreators Exposed to Surface Water

COI	Maximum Surface Water Concentration		HTC for Water and Fish	HTC for Water Only	HTC for Fish Only	COPC	
	Modeled	Measured[a]				Based on Modeled Concentrations	Based on Measured Concentrations
Total Metals (mg/L)							
Arsenic	1.6E-06	NA	0.022	2.0	0.023	No	NA
Boron	2.9E-04	0.33	467	1,400	700	No	No
Cadmium	1.0E-06	NA	0.0018	1.0	0.0019	No	NA
Chromium	4.3E-06	NA	0.61	20	0.63	No	NA
Cobalt	1.3E-06	ND	0.0035	2.1	0.0035	No	No
Lead	2.6E-06	NA	0.015	0.015	0.015	No	NA
Lithium	3.9E-06	ND	4.7	14	7.0	No	No
Radionuclides (pCi/L)							
Radium-226+228	6.8E-04	NA	1,000	1,000	87,413	No	NA

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; HTC = Human Threshold Criteria; NA = Not Applicable; ND = Not Detected; pCi/L = PicoCuries Per Liter.
(a) Measured concentrations are listed only for the constituents identified as COIs. Measured surface water concentrations may be different from modeled concentrations because measured data include the effects of background and other industrial sources. Modeled concentrations only represent the potential effect on surface water quality resulting from the measured groundwater concentrations. COIs with no measured surface water data were listed as NA.

3.4.2 Recreators Exposed to Sediment

Recreational exposure to sediment may occur during boating activity in Coffeen Lake; exposure to sediment may occur through incidental ingestion and dermal contact.

Screening Exposures: COIs in impacted groundwater flowing into the river can sorb to sediments. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations.

Screening Benchmarks: There are no established recreator RSLs that are protective of recreational exposures to sediment (US EPA, 2021c). Therefore, benchmarks that are protective of recreational exposures to sediment *via* incidental ingestion and dermal contact were calculated using US EPA's RSL guidance (US EPA, 2021c). These benchmarks were calculated using the recommended assumptions (*i.e.*, oral bioavailability, body weights, and averaging time) and toxicity reference values (*i.e.*, RfD and cancer slope factor [CSF]), with the following changes: Recreators were assumed to be exposed to sediment while recreating 60 days per year (or two weekend days per week for 30 weeks per year, from April to October). The exposure duration was assumed for a child 6 years of age and an adult 20 years of age, per US EPA guidance (Stalcup, 2014). The daily recommended residential soil ingestion rates of 200 mg/day for a child and 100 mg/day for an adult are based on an all-day exposure to residential soils (Stalcup, 2014; US EPA, 2011b). Since recreational exposures to sediment are assumed to occur for less than 4 hours per day, one-third of the daily residential soil ingestion (67 mg/day for a child and 33 mg/day for an adult) was used as a conservative assumption. For dermal exposures, recreators were assumed to be exposed to sediment on their lower legs and feet (1,026 cm^2 for the child and 3,026 cm^2 for the adult, based on the age-weighted surface areas reported in US EPA, 2011b). While other body parts may be exposed to sediment, the contact time will likely be very short, as the sediment would wash off in the surface water. Gradient used US EPA's recommended adherence factor of 0.2 mg/cm^2 based on child exposure to wet soil (US EPA, 2004; Stalcup, 2014), which was used in the US EPA RSL User's Guide for a child recreator exposed to soil or sediment (US EPA, 2021c). The sediment screening benchmarks were calculated based on a target hazard quotient of 1, or a target cancer risk of 1×10^{-5}. Appendix B, Table B.2 presents the calculation of screening benchmarks protective of recreational exposures to sediment. A recreator sediment screening benchmark for radium-226+228 was based on soil Preliminary Remediation Goals (PRGs) calculated for radium-226 and radium-228 using US EPA's PRG calculator (US EPA, 2020). The lower of the two values was used as the recreator sediment screening benchmark for radium-226+228 (Appendix B, Table B.3).

Screening Risk Evaluation: The modeled sediment concentrations were well below the recreational sediment screening benchmarks (Table 3.7). Therefore, exposure to sediment is not expected to pose an unacceptable risk to recreators while boating.

Table 3.7 Risk Evaluation for Recreators Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	Recreator Sediment Screening Benchmark (mg/kg)	COPC
Total Metals (mg/kg)			
Arsenic	3.8E-04	6.8E+01	No
Boron	1.7E-03	2.7E+05	No
Cadmium	1.4E-03	1.2E+02	No
Chromium	1.9E-01	2.1E+06	No
Cobalt	1.2E-03	4.1E+02	No
Lead	2.6E-02	4.0E+02	No
Lithium	(a)	2.7E+03	NA
Radionuclides (pCi/kg)			
Radium-226+228	4.8E+00	7.9E+03	No

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; K_d = Equilibrium Partition Coefficient; mg/kg = Milligram Per Kilogram; NA = Not Applicable; pCi/kg = PicoCuries Per Kilogram.
(a) Lithium does not readily sorb to soil or sediment particles; a K_d value of 0 was used for the modeling.

3.5 Ecological Risk Evaluation

Based on the ecological CEM (Figure 3.4), ecological receptors could be exposed to surface water and dietary items (*i.e.*, prey and plants) potentially impacted by identified COIs (*i.e.*, cadmium, cobalt, lead, mercury, and radium-226+228).

3.5.1 Ecological Receptors Exposed to Surface Water

Screening Exposures: The ecological evaluation considered aquatic communities in Coffeen Lake potentially impacted by identified ecological COIs. Measured and modeled surface water concentrations were compared to risk-based ecological screening benchmarks.

Screening Benchmarks: Surface water screening benchmarks protective of aquatic life were obtained from the following hierarchy of sources:

- IEPA SWQC (IEPA, 2019), regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). For cadmium, the surface water benchmark is hardness-dependent and calculated using a default hardness of 100 mg/L (US EPA, 2022)[5];
- US EPA Region IV (2018) surface water ESVs for hazardous waste sites; and
- US DOE benchmarks from the guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).

[5] Conservatisms associated with using a default hardness value are discussed in Section 3.6.

Risk Evaluation: The maximum measured and modeled COI concentrations in surface water were compared to the benchmarks protective of aquatic life (Table 3.8). The measured and modeled surface water concentrations for the COIs were below their respective benchmarks. Thus, none of the COIs evaluated are expected to pose an unacceptable risk to aquatic life in Coffeen Lake.

Table 3.8 Risk Evaluation for Ecological Receptors Exposed to Surface Water

COI	Maximum Surface Water Concentration		Ecological Freshwater Benchmark	Basis	COPC	
	Modeled	Measured[a]			Based on Modeled Concentrations	Based on Measured Concentrations
Total Metals (mg/L)						
Cadmium	1.0E-06	NA	0.0011	IEPA SWQC	No	NA
Cobalt	1.3E-06	ND	0.019	US EPA R4 ESV	No	No
Lead	2.6E-06	NA	0.020	IEPA SWQC	No	NA
Mercury	5.0E-08	NA	0.0011	IEPA SWQC	No	NA
Radionuclides (pCi/L)						
Radium-226+228	6.8E-04	NA	3.0	US DOE	No	NA

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; IEPA = Illinois Environmental Protection Agency; NA = Not Applicable; ND = Nondetect; pCi/L = PicoCuries Per Liter; SWQC = Surface Water Quality Criteria; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) COIs with no measured surface water data were listed as NA.

3.5.2 Ecological Receptors Exposed to Sediment

Screening Exposures: COIs in impacted groundwater discharging into Coffeen Lake can sorb to sediments *via* chemical partitioning. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations. Therefore, the modeled COI sediment concentrations reflect the potential maximum Site-related sediment concentration from groundwater discharge.

Screening Benchmarks: Sediment screening benchmarks were obtained from US EPA Region IV (2018). The majority of the sediment ESVs are based on threshold effect concentrations from MacDonald *et al.* (2000), which provide consensus values that identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed. In the absence of an ESV for radium-226+228, a sediment screening value of 90,000 pCi/kg was used, based on the biota concentration guide (BCG) for radium-228 (US DOE, 2019).[6] Chloride and fluoride are not expected to sorb to sediment; therefore, risk to ecological receptors exposed to sediment was not evaluated for these constituents. The benchmarks used in this evaluation are listed in Table 3.9.

Screening Risk Results: The maximum modeled COI sediment concentrations were below their respective sediment screening benchmarks (Table 3.9). The modeled sediment concentrations attributed to potential contributions from Site groundwater for all COIs were less than or equal to 1% of the sediment screening benchmark. Therefore, the modeled sediment concentrations attributed to potential contributions from Site

[6] US DOE (2019) reported the biota concentration guide (BCG) for sediment as 90 pCi/g for Ra-228 and 100 pCi/g for Ra-226; the lower of the two values was used for Ra-226+228, and converted to pCi/kg.

groundwater are not expected to significantly contribute to ecological exposures in Coffeen Lake adjacent to the Site.

Table 3.9 Risk Evaluation for Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration	ESV[a]	COPC	% of Benchmark
Total Metals (mg/kg)				
Cadmium	1.4E-03	0.99	No	0.14%
Cobalt	1.2E-03	50	No	0.0024%
Lead	2.6E-02	35.8	No	0.073%
Mercury	1.8E-03	0.18	No	1%
Radionuclides (pCi/kg)				
Radium-226 + 228	4.8E+00	90,000[b]	No	0.0053%

Notes:
COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; pCi/kg = PicoCuries Per Kilogram; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) ESV from US EPA Region IV (2018).
(b) ESV from US DOE (2019); value converted from 90 pCi/g to 90,000 pCi/kg.

3.5.3 Ecological Receptors Exposed to Bioaccumulative Constituents of Interest

Screening Exposures: COIs with bioaccumulative properties can impact higher-trophic-level wildlife exposed to these COIs *via* direct exposures (surface water and sediment exposure) and secondary exposures through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, and fish).

Screening Benchmark: US EPA Region IV (2018) and IEPA SWQC (IEPA, 2019) guidance were used to identify constituents with potential bioaccumulative effects.

Risk Evaluation: With the exception of mercury, the ecological COIs (*i.e.*, cadmium, cobalt, lead, and radium-226+228) were not identified as having potential bioaccumulative effects. Therefore, these COIs are not considered to pose an ecological risk *via* bioaccumulation. IEPA (2019) identifies mercury as the only metal with bioaccumulative properties. US EPA Region IV (2018) also identifies mercury (including methyl mercury) as having potential bioaccumulative effects.[7]

The modeled mercury concentration in surface water (5.1×10^{-9} mg/L) was below the mercury surface water ESV for wildlife (1.3×10^{-6} mg/L), and the modeled mercury concentration in sediment (1.9×10^{-4} mg/kg) was below the sediment ESV for wildlife (0.18 mg/kg) (US EPA Region IV, 2018). Both the modeled surface water and sediment concentrations were below benchmarks protective of receptors accounting for bioaccumulative properties. Therefore, in addition to not posing an ecological risk from direct toxicity, mercury does not pose a risk from bioaccumulation exposures.

[7] US EPA Region IV (2018) identifies selenium as having potential bioaccumulative effects. Although selenium was detected in groundwater, it was not considered an ecological COI.

3.6 Uncertainties and Conservatisms

A number of uncertainties and their potential impact on the risk evaluation are discussed below. Wherever possible, conservative assumptions were used in an effort to minimize uncertainties and overestimate rather than underestimate risks.

Exposure Estimates:

- The risk evaluation included the Illinois Part 845.600 constituents detected in groundwater samples (above GWPS) collected from wells associated with AP1. However, it is possible that not all of the detected constituents are related specifically to AP1.
- The human health and ecological risk characterizations were based on the maximum measured or modeled COI concentrations, rather than on averages. Thus, the variability in exposure concentrations was not considered. Assuming continuous exposure to the maximum concentration overestimates human and ecological exposures, given that receptors are mobile and concentrations change over time. For example, US EPA guidance states that risks should be estimated using average exposure concentrations as represented by the 95% upper confidence limit on the mean (US EPA, 1992). Given that exposure estimates based on the maximum concentrations did not exceed risk benchmarks, Gradient has greater confidence that there is no risk concern.
- Only constituents detected in groundwater were used to identify COIs and model COI concentrations in surface water and sediment. For the constituents that were not detected in AP1 groundwater, the detection limits were below the Illinois Part 845.600 GWPS and thus do not require further evaluation.
- COI concentrations in surface water were modeled using the maximum detected total COI concentrations in groundwater. Modeling surface water concentrations using total metal concentrations may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.
- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-AP1-related sources were not considered in the evaluation of modeled concentrations; only exposure contributions potentially attributable to Site groundwater mixing with surface water were evaluated. While not quantified, exposures from potential AP1-related groundwater contributions are likely to represent only a small fraction of the overall human and ecological exposure to COIs that also have natural or non-AP1-related sources.
- Screening benchmarks for human health were developed using exposure inputs based on US EPA's recommended values for reasonable maximum exposure (RME) assessments (Stalcup, 2014). RME is defined as "the highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures" (US EPA, 2004). US EPA states the "intent of the RME is to estimate a conservative exposure case (*i.e.*, well above the average case) that is still within the range of possible exposures" (US EPA, 1989). US EPA also notes this high-end exposure "is the highest dose estimated to be experienced by some individuals, commonly stated as approximately equal to the 90th percentile exposure category for individuals" (US EPA, 2015b). Thus, most individuals will have lower exposures than those presented in this risk assessment.

Toxicity Benchmarks:

- Screening-level ecological benchmarks were compiled from IEPA and US EPA guidance and designed to be protective of the majority of Site conditions, leaving the option for Site-specific refinement. In some cases, these benchmarks may not be representative of the Site-specific conditions or receptors found at the Site, or may not accurately reflect concentration-response relationships encountered at the Site. For example, the ecological benchmark for cadmium is hardness-dependent. However, hardness data are not available for Coffeen Lake; therefore, Gradient relied on US EPA's default hardness of 100 mg/L. Use of a higher hardness value would increase the cadmium SWQC because benchmarks become less stringent with higher levels of hardness. Regardless of the hardness, the maximum modeled cadmium concentration is orders of magnitude below the SWQC.
- In addition, for the ecological evaluation, Gradient conservatively assumed all constituents to be 100% bioavailable. Modeled COI concentrations in surface water are considered total COI concentrations. In addition, the measured surface water data used in this report represent total concentrations. US EPA recommends using dissolved metals as a measure of exposure to ecological receptors because it represents the bioavailable fraction of metal in water (US EPA, 1993). Therefore, the modeled surface water COI concentrations may be an overestimation of exposure concentrations to ecological receptors.
- In general, it is important to appreciate that the human health toxicity factors used in this risk evaluation are developed to account for uncertainties, such that safe exposure levels used as benchmarks are often many times lower (even orders of magnitude lower) than the levels that cause effects which have been observed in human or animal studies. For example, toxicity factors incorporate a 10-fold safety factor to protect sensitive subpopulations. This means that a risk exceedance does not necessarily equate to actual harm.

4 Summary and Conclusions

A screening-level risk evaluation was performed for potential Site-related constituents in groundwater at the CPP in Coffeen, Illinois. The CSM developed for the Site indicates that groundwater beneath AP1 flows into Coffeen Lake adjacent to the Site and may potentially impact surface water and sediment.

CEMs were developed for human and ecological receptors. The complete exposure pathways for humans include recreators (boaters) in Coffeen Lake who are exposed to surface water and sediment, and anglers who consume locally caught fish. Based on the local hydrogeology, residential exposure to groundwater used for drinking water or irrigation is not a complete pathway and was not evaluated. The complete exposure pathways for ecological receptors include aquatic life (including aquatic and marsh plants, amphibians, reptiles, and fish) exposed to surface water; benthic invertebrates exposed to sediment; and avian and mammalian wildlife exposed to bioaccumulative COIs in surface water, sediment, and dietary items.

Groundwater data collected from 2015 to 2021 were used to estimate exposures. Surface water data collected from Coffeen Lake in 2021 were also evaluated. For groundwater constituents retained as COIs, surface water and sediment concentrations were modeled using the maximum detected groundwater concentration. Surface water and sediment exposure estimates were screened against benchmarks protective of human health and ecological receptors for this risk evaluation.

US EPA has established acceptable risk metrics. Risks above these US EPA-defined metrics are termed potentially "unacceptable risks." Based on the evaluation presented in this report, no unacceptable risks to human or ecological receptors resulting from CCR exposures associated with AP1 were identified. This means that the risks from the site are likely indistinguishable from normal background risks. Specific risk assessment results include the following:

- For recreators exposed to surface water, all COIs were below the conservative risk-based screening benchmarks. Therefore, none of the COIs evaluated in surface water are expected to pose an unacceptable risk to recreators in Coffeen Lake adjacent to the Site.
- For recreators exposed to sediment *via* incidental ingestion and dermal contact, the modeled sediment concentrations were below health-protective sediment benchmarks. Therefore, the modeled sediment concentrations are not expected to pose an unacceptable risk to recreators exposed to sediment in Coffeen Lake adjacent to the Site.
- For anglers consuming locally caught fish, the modeled concentrations of all COIs in surface water (as well as the measured data) were below conservative benchmarks protective of fish consumption. Therefore, none of the COIs evaluated are expected to pose an unacceptable risk to recreators consuming fish caught in Coffeen Lake.
- Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the modeled or measured COIs in surface water exceeded protective screening benchmarks. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks; therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors.

- Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher-trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, and fish). Mercury was the only ecological COI identified as having potential bioaccumulative effects. However, the modeled concentrations did not exceed benchmarks protective of bioaccumulative effects. Therefore, mercury is not considered to pose an ecological risk *via* bioaccumulation. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

It should be noted that this evaluation incorporates a number of conservative assumptions that tend to overestimate exposure and risk. The risk evaluation was based on the maximum detected COI concentration for each constituent; however, US EPA guidance states that risks should be based on a representative average concentration such as the 95% upper confidence limit on the mean. Thus, using the maximum concentration tends to overestimate exposure. Although the COIs identified in this evaluation also occur naturally in the environment, the contributions to exposure from natural background sources and nearby industry were not considered; thus, CCR-related exposures were likely overestimated. In addition, exposure estimates assumed 100% metal bioavailability, which likely results in overestimates of exposure and risks. Further, exposure estimates were based on inputs to evaluate the "reasonable maximum exposure"; thus, most individuals will have lower exposures than those estimated in this risk assessment.

Finally, it should be noted that because current conditions do not present a risk to human health or the environment, there will also be no unacceptable risk to human health or the environment for future conditions when AP1 is closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline.

References

Austen, DJ; Peterson, JT; Newman, B; Sobaski, ST; Bayley, PB. [Illinois Natural History Survey]. 1993. "Compendium of 143 Illinois Lakes: Bathymetry, Physico-chemical Features, and Habitats. Volume 2 - Lakes in Regions 4 and 5 (Final)." Report to Illinois Dept. of Conservation, Division of Fisheries, Center for Aquatic Ecology. Aquatic Ecology Technical Report 93/9 (2); F-69-R(4-6) 273p., June.

European Chemicals Agency (ECHA). 2020. "REACH dossier for lithium (CAS No. 7439-93-2)." Accessed at https://echa.europa.eu/registration-dossier/-/registered-dossier/14178.

Geosyntec Consultants. 2021. "Draft Surface Water Analytical Results, Coffeen Site." August 3. 2p.

Golder Associates Inc. 2020. "Construction Completion Report, Unnamed Tributary Relocation at the Illinois Power Generating Company Coffeen Site." Report to Illinois Power Generating Co., 161p., November.

Hanson Professional Services Inc. 2020. "Antidegradation Assessment for Discharge of Gypsum Management Facility Waters to Coffeen Lake, Coffeen Power Plant, Illinois Power Generating Company, NPDES Permit No. IL000108." Report to Illinois Power Generating Co., Collinsville, IL. 37p., July 20.

Illinois Dept. of Natural Resources (IDNR). 2014. Coffeen Lake State Fish and Wildlife Area.

Illinois Dept. of Natural Resources (IDNR). 2022. "Coffeen Lake profile." Accessed at https://www.ifishillinois.org/profiles/waterbody.php?waternum=00600.

Illinois Environmental Protection Agency (IEPA). 2013. "Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter I: Pollution Control Board, Part 620: Ground Water Quality." Accessed at https://www.ilga.gov/commission/jcar/admincode/035/035006200D04200R.html.

Illinois Environmental Protection Agency (IEPA). 2019. "Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, Part 302: Water Quality Standards." Accessed at https://www.epa.gov/sites/production/files/2019-11/documents/ilwqs-title35-part302.pdf.

Illinois Environmental Protection Agency (IEPA). 2021. "Standards for the disposal of coal combustion residuals in surface impoundments." Accessed at https://www.ilga.gov/commission/jcar/admincode/035/03500845sections.html.

MacDonald, DD; Ingersoll, CG; Berger, TA. 2000. "Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems." *Arch. Environ. Contam. Toxicol.* 39:20-31. doi: 10.1007/s002440010075.

Oak Ridge National Laboratory (ORNL). 2020. "Risk Assessment Information System (RAIS) Toxicity Values and Physical Parameters Search." Accessed at https://rais.ornl.gov/cgi-bin/tools/TOX_search?select=chem.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois (Final)." Report to Illinois Power Generating Co. 700p., October 25.

Stalcup, D. 2014. Memorandum to Superfund National Policy Managers, Regions 1-10 re: Human Health Evaluation Manual, Supplemental Guidance: Update of standard default exposure factors. US EPA, Office of Solid Waste and Emergency Response (OSWER), OSWER Directive 9200.1-120, February 6. Accessed at https://www.epa.gov/sites/production/files/2015-11/documents/oswer_directive_9200.1-120_exposurefactors_corrected2.pdf.

US Dept. of Agriculture (USDA). 2009a. "Aerial imagery of the Coffeen, IL area [Northeast]." National Agricultural Imagery Program. Accessed on March 29, 2022 at https://earthexplorer.usgs.gov/.

US Dept. of Agriculture (USDA). 2009b. "Aerial imagery of the Coffeen, IL area [Southeast]." National Agricultural Imagery Program. Accessed on March 29, 2022 at https://earthexplorer.usgs.gov/.

US Dept. of Energy (US DOE). 2019. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota." DOE-STD-1153-2019. Accessed at https://www.standards.doe.gov/standards-documents/1100/1153-astd-2019/@@images/file.

US EPA. 1989. "Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A) (Interim final)." Office of Emergency and Remedial Response, NTIS PB90-155581, EPA-540/1-89-002, December.

US EPA. 1992. "Risk Assessment Guidance for Superfund: Supplemental Guidance to RAGS: Calculating the Concentration Term." Office of Emergency and Remedial Response, OSWER Directive 9285.7-08I, NTIS PB92-963373, May.

US EPA. 1993. Memorandum to US EPA Directors and Regions re: Office of Water policy and technical guidance on interpretation and implementation of aquatic life metals criteria. Office of Water, EPA-822-F93-009, October 1.

US EPA. 1998. "Methodology for assessing health risks associated with multiple pathways of exposure to combustor emissions." National Center for Environmental Assessment (NCEA), EPA 600/R-98/137, December. Accessed at http://www.epa.gov/nceawww1/combust.htm.

US EPA. 2001. "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors (Federal Guidance Report No. 13 Morbidity Risk Coefficients, in Units of Picocuries)." Health Effects Assessment Summary Tables (HEAST) 72p. Accessed at https://www.epa.gov/radiation/radionuclide-table-radionuclide-carcinogenicity-slope-factors.

US EPA. 2002. "National Recommended Water Quality Criteria [NRWQC]: 2002. Human Health Criteria Calculation Matrix." Office of Water, EPA-822-R-02-012, November.

US EPA. 2004. "Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (Final)." Office of Superfund Remediation and Technology Innovation, EPA/540/R/99/005, OSWER 9285.7-02EP; PB99-963312, July. Accessed at http://www.epa.gov/oswer/riskassessment/ragse/pdf/part_e_final_revision_10-03-07.pdf.

US EPA. 2011a. "IRIS Glossary." August 31. Accessed at https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=IRIS%20Glossary#formTop.

US EPA. 2011b. "Exposure Factors Handbook: 2011 Edition." Office of Research and Development, US EPA, National Center for Environmental Assessment (NCEA) EPA/600/R-090/052F. September. Accessed at https://www.epa.gov/expobox/about-exposure-factors-handbook.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery, December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

US EPA. 2015a. "Hazardous and solid waste management system; Disposal of coal combustion residuals from electric utilities (Final rule)." *Fed. Reg.* 80(74):21302-21501, 40 CFR 257, 40 CFR 261, April 17.

US EPA. 2015b. "Conducting a Human Health Risk Assessment." October 14. Accessed at http://www2.epa.gov/risk/conducting-human-health-risk-assessment#tab-4.

US EPA. 2015c. "Human Health Ambient Water Quality Criteria: 2015 Update." Office of Water, EPA 820-F-15-001. June.

US EPA. 2019. "EPI Suite™ - Estimation Program Interface." March 12. Accessed at https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

US EPA. 2020. "Preliminary Remediation Goals for Radionuclides (PRG): PRG Calculator." Accessed at https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search. July 24.

US EPA. 2021a. "Secondary drinking water standards: Guidance for nuisance chemicals." January 7. Accessed at https://www.epa.gov/sdwa/secondary-drinking-water-standards-guidance-nuisance-chemicals.

US EPA. 2021b. Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1). November. 11p. Accessed at https://semspub.epa.gov/work/HQ/401635.pdf.

US EPA. 2021c. "Regional Screening Levels (RSLs) - User's Guide." 82p. Accessed at https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide. November.

US EPA. 2022. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table. January 6.

US EPA Region IV. 2018. "Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018 Update)." Superfund Division, Scientific Support Section. March. Accessed at https://www.epa.gov/sites/production/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf.

US Geological Survey (USGS). 1998a. "Aerial imagery of the Coffeen, IL area [Northeast]." Accessed on March 29, 2022 at https://earthexplorer.usgs.gov/.

US Geological Survey (USGS). 1998b. "Aerial imagery of the Coffeen, IL area [Southeast]." Accessed on March 29, 2022 at https://earthexplorer.usgs.gov/.

US Geological Survey (USGS). 2005a. "Aerial imagery of the Coffeen, IL area [Northeast]." Accessed on March 29, 2022 at https://earthexplorer.usgs.gov/.

US Geological Survey (USGS). 2005b. "Aerial imagery of the Coffeen, IL area [Southeast]." Accessed on March 29, 2022 at https://earthexplorer.usgs.gov/.

Appendix A

Surface Water and Sediment Modeling

Gradient modeled concentrations in Coffeen Lake surface water and sediment based on available groundwater data. First, Gradient estimated the flow rate of constituents of interest (COIs) that may flow into Coffeen Lake *via* groundwater. Then, Gradient adapted United States Environmental Protection Agency's (US EPA's) indirect exposure assessment methodology (US EPA, 1998) in order to model surface water and sediment water concentrations in Coffeen Lake.

Model Overview

Groundwater flow into Coffeen Lake is represented by a one-dimensional steady-state model. In this model, the groundwater plume migrates horizontally in the Uppermost Aquifer (UA) before flowing into the eastern branch of Coffeen Lake. The groundwater flow entering the lake is the flow going through a cross-sectional area with a length equal to the length of the lake adjacent to Ash Pond 1 (AP1) with potential CCR-related impacts and a height equal to the average saturated thickness of the UA. It was assumed that groundwater flowing through the UA may flow into the eastern branch of Coffeen Lake.

Groundwater flow into Coffeen Lake mixes with the surface water in the lake. The COIs entering the lake *via* groundwater can dissolve into the water column, sorb to suspended sediments, or sorb to benthic sediments. Using US EPA's indirect exposure assessment methodology (US EPA, 1998), the model evaluates the surface water and sediment concentrations at a location downstream of the groundwater discharge, assuming a well-mixed water column.

Groundwater Discharge Rate

The groundwater discharge rate was evaluated using conservative assumptions. Gradient conservatively assumed that the groundwater concentrations were uniformly equal to the maximum detected concentration for each individual COI. Gradient ignored adsorption by subsurface soil and assumed that groundwater flowing through the shallow aquifers was discharged into the lake.

For each groundwater unit, the groundwater flow rate into the lake was derived using Darcy's Law:

$$Q = K \times i \times A$$

where:

Q = Groundwater flow rate (m^3/s)
K = Hydraulic conductivity (m/s)
i = Hydraulic gradient (m/m)
A = Cross-sectional area (m^2)

For each COI, the mass discharge rate into the lake was then calculated by:

$$m_c = C_c \times Q \times CF$$

where:

m_c = Mass discharge rate of the COI (mg/year)
C_c = Maximum groundwater concentration of the COI (mg/L)
Q = Groundwater flow rate (m^3/s)
CF = Conversion factors: 1,000 L/m^3; 31,557,600 s/year

The values of the aquifer parameters used for these calculations are provided in Table A.1. The calculated mass discharge rates were then used as inputs for the surface water and sediment partitioning model.

The cross-sectional area for the UA was 613 m^2. The length of the lake through which groundwater flows was estimated to be approximately 670 m. The height of the UA was approximately 0.91 m (Ramboll, 2021).

The hydraulic gradient was 0.008 m/m, based on the average horizontal hydraulic gradient determined for the UA (Ramboll, 2021).

The hydraulic conductivity was 0.002 cm/s, based on the geometric mean horizontal hydraulic conductivity measured for the UA (Ramboll, 2021).

Surface Water and Sediment Concentration

Groundwater flowing into the lake will be diluted in the surface water flow. Constituents transported by groundwater into the surface water migrate into the water column and the bed sediments. The surface water model Gradient used to estimate the surface water and sediment concentrations is a steady-state model described in US EPA's indirect exposure assessment methodology (US EPA, 1998), and also used in US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014). This model describes the partitioning of constituents between surface water, suspended sediments, and benthic sediments based on equilibrium partition coefficients. It estimates the concentrations of constituents in surface water, suspended sediments, and benthic sediments at steady-state equilibrium at a theoretical location downstream of the discharge point after complete mixing of the water column. In the analysis, Gradient used the partitioning coefficients given in Table J-1 of the US EPA CCR Risk Assessment for all COIs (US EPA, 2014). These coefficients are presented in Table A.2.

To be conservative, Gradient assumed that the constituents were not affected by dissipation or degradation once they entered the water body. The total water body concentration of the COI was calculated as (US EPA, 1998):

$$C_{wtot} = \frac{m_c}{V_f \times f_{water}}$$

where:

C_{wtot}	=	Total water body concentration of the constituent (mg/L)
m_c	=	Mass discharge rate of the COI (mg/year)
V_f	=	Water body annual flow (L/year)
f_{water}	=	Fraction of COI in the water column (unitless)

There are no flow records available for the eastern branch of Coffeen Lake. The flow rate was assumed to be the same as that estimated for the unnamed tributary (*i.e.*, 90 cfs) (Golder Associates Inc., 2020), which flows from north to south into the eastern branch of the lake. The surface water parameters are presented in Table A.3.

The fraction of COI in the water column was calculated for each COI using the sediment/water and suspended solids/water partition coefficients (US EPA, 2014, Table J-1). The fraction of COI in the water column is defined as (US EPA, 2014):

$$f_{water} = \frac{(1 + [K_{dsw} \times TSS \times 0.000001]) \times \frac{d_w}{d_z}}{\left([1 + (K_{dsw} \times TSS \times 0.000001)] \times \frac{d_w}{d_z}\right) + ([bsp + K_{dbs} \times bsc] \times \frac{d_b}{d_z})}$$

where:

f_{water}	=	Fraction of COI in the water column (unitless)
K_{dsw}	=	Suspended sediment-water partition coefficient (mL/g)
K_{dbs}	=	Sediment-water partition coefficient (mL/g)
TSS	=	Total suspended solids in the surface water body (mg/L), set equal to the average Coffeen Lake concentration of 3.2 mg/L (Hanson Professional Services, Inc., 2020 222-4807)
0.000001	=	Units conversion factor
d_w	=	Depth of the water column (m). The depth of the water column was estimated as 5.7 m (Austen *et al*., 1993).
d_b	=	Depth of the upper benthic layer (m), set equal to 0.03 m (US EPA, 2014)
$d_z = d_w + d_b$	=	Depth of the water body (m) = 5.73 m
bsp	=	Bed sediment porosity (unitless), set equal to 0.6 (US EPA, 2014)
bsc	=	Bed sediment particle concentration (g/cm^3), set equal to 1.0 g/cm^3 (US EPA, 2014)

The fraction of COIs dissolved in the water column (f_d) is calculated as (US EPA 2014):

$$f_d = \frac{1}{1 + K_{dsw} \times TSS \times 0.000001}$$

The values of the fraction of COIs in the water column and other calculated parameters are presented in Table A.4.

The total water column concentration (C_{wcTot}) of the COIs, comprising both the dissolved and suspended sediment phases, is then calculated as (US EPA, 2014):

$$C_{wcTot} = C_{wtot} \times f_{water} \times \frac{d_z}{d_w}$$

Finally, the dissolved water column concentration (C_{dw}) for the COIs is calculated as (US EPA, 2014):

$$C_{dw} = f_d \times C_{wcTot}$$

The dissolved water column concentration was then used to calculate the concentration of COIs sorbed to suspended solids in the water column (US EPA, 1998):

$$C_{sw} = C_{dw} \times K_{dsw}$$

where:

C_{sw}	=	Concentration sorbed to suspended solids (mg/kg)

C_{dw} = Concentration dissolved in the water column (mg/L)
K_{dsw} = Suspended solids/water partition coefficient (mL/g)

In the same way, using the total water body concentration and the fraction of COIs in the benthic sediments, the model derives the total concentration in benthic sediments (US EPA, 2014, Table J-1-12):

$$C_{bstot} = f_{benth} \times C_{wtot} \times \frac{d_z}{d_b}$$

where:

C_{bstot} = Total concentration in bed sediment (mg/L or g/m^3)
C_{wtot} = Total water body concentration of the constituent (mg/L)
f_{benth} = Fraction of constituent in benthic sediments (unitless)
d_b = Depth of the upper benthic layer (m)
$d_z = d_w + d_b$ = Depth of the water body (m)

This value can be used to calculate dry weight sediment concentration as follows:

$$C_{sed-dw} = \frac{C_{bstot}}{bsc}$$

where:

C_{sed-dw} = Dry weight sediment concentration (mg/kg)
C_{bstot} = Total sediment concentration (mg/L)
bsc = Bed sediment bulk density (default value of 1 g/cm^3 from US EPA, 2014)

The total sediment concentration is composed of the concentration dissolved in the bed sediment pore water (equal to the concentration dissolved in the water column) and the concentration sorbed to benthic sediments (US EPA, 1998).

The concentration sorbed to benthic sediments was calculated from (US EPA, 1998):

$$C_{sb} = C_{dbs} \times K_{dbs}$$

where:

C_{sb} = Concentration sorbed to bottom sediments (mg/kg)
C_{dbs} = Concentration dissolved in the sediment pore water (mg/L)
K_{dbs} = Sediments/water partition coefficient (mL/kg)

For each COI, the modeled total water column concentration, the modeled dry weight sediment concentration, and the modeled concentration sorbed to sediment are presented in Table A.5.

Table A.1 Parameters Used to Estimate Groundwater Discharge to Surface Water

Groundwater Unit	Parameter	Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	613	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.008	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.002	cm/s

Note:
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).

Table A.2 Partition Coefficients

Constituent	Sediment-Water, Mean, K_{dbs}		Suspended Sediment-Water, Mean, K_{dsw}	
	Value (log_{10}) (mL/g)	Value (mL/g)	Value (log_{10}) (mL/g)	Value (mL/g)
Metals				
Arsenic	2.4	2.51E+02	3.9	7.94E+03
Boron	0.8	6.31E+00	3.9	7.94E+03
Cadmium	3.3	2.00E+03	4.9	7.94E+04
Chromium	4.9	7.94E+04	5.1	1.26E+05
Cobalt	3.1	1.26E+03	4.8	6.31E+04
Lead	4.6	3.98E+04	5.7	5.01E+05
Lithium	-	-	-	-
Mercury	4.9	7.94E+04	5.3	2.00E+05
Radionuclides				
Radium-226+228	-	7.40E+03	-	7.40E+03
Other				
Sulfate	-	-	-	-

Notes:
Source: US EPA (2014).
Lithium and sulfate do not readily sorb to soils and sediments. Consequently, sediment concentrations were not modeled for these constituents (K_d was assumed to be 0).

Table A.3 Surface Water Parameters

Parameter	Name	Value	Unit
TSS	Total Suspended Solids	6	mg/L
V_{fx}	Surface Water Flow Rate	8.04×10^{10}	L/yr
d_b	Depth of Upper Benthic Layer (default)	0.03	m
d_w	Depth of Water Column	5.70	m
d_z	Depth of Water Body	5.73	m
bsc	Bed Sediment Bulk Density (default)	1	g/cm^3
bsp	Bed Sediment Porosity (default)	0.6	-
M_{TSS}	TSS Mass Per Unit Area[a]	0.0342	kg/m^2
M_S	Sediment Mass Per Unit Area[b]	30	kg/m^2

Notes:
Source of default values: US EPA (2014).
(a) Determined by multiplying total suspended solids, TSS by the depth of water column, d_w.
(b) Determined by multiplying depth of upper benthic layer, d_b, with sediment bed particle concentration of 1 g/cc.

Table A.4 Calculated Parameters

COI	Fraction of Constituent in the Water Column f_{water}	Fraction of Constituent in the Benthic Sediments $f_{benthic}$	Fraction of Constituent Dissolved in the Water Column $f_{dissolved}$
Arsenic	0.442	0.558	0.955
Boron	0.9665	0.0335	0.9545
Cadmium	0.1232	0.8768	0.6772
Chromium	0.0042	0.9958	0.5697
Cobalt	0.172	0.828	0.725
Lead	0.019	0.981	0.250
Lithium	0.997	0.003	
Mercury	0.005	0.995	0.455
Radionuclides			
Radium-226+228	0.026	0.974	0.957

Note:
COI = Constituent of Interest.

Table A.5 Surface Water and Sediment Modeling Results

COI	Groundwater Concentration (mg/L or pCi/L)	Mass Discharge Rate (mg/year or pCi/year)	Total Water Column Concentration (mg/L or pCi/L)	Concentration Sorbed to Bottom Sediments (mg/kg or pCi/kg)
Total Metals				
Arsenic	4.1E-02	1.3E+05	1.6E-06	3.8E-04
Boron	7.5E+00	2.3E+07	2.9E-04	1.8E-03
Cadmium	2.7E-02	8.4E+04	1.0E-06	1.4E-03
Chromium	1.1E-01	3.4E+05	4.3E-06	1.9E-01
Cobalt	3.4E-02	1.1E+05	1.3E-06	1.2E-03
Lead	6.8E-02	2.1E+05	2.6E-06	2.6E-02
Lithium	1.0E-01	3.1E+05	3.9E-06	(a)
Mercury	1.3E-03	4.0E+03	5.0E-08	1.8E-03
Radionuclides				
Radium-226+228	1.8E+01	5.4E+07	6.8E-04	4.8E+00
Other				
Sulfate	2.4E+03	7.4E+09	9.3E-02	(a)

Notes:
pCi/kg = PicoCuries Per Kilogram; pCi/L = PicoCuries Per Liter.
(a) Lithium, chloride, and sulfate do not readily sorb to soil or sediment particles; a K_d value of 0 was used for the modeling.

Appendix A References

Austen, DJ; Peterson, JT; Newman, B; Sobaski, ST; Bayley, PB. [Illinois Natural History Survey]. 1993. "Compendium of 143 Illinois Lakes: Bathymetry, Physico-chemical Features, and Habitats. Volume 2 - Lakes in Regions 4 and 5 (Final)." Report to Illinois Dept. of Conservation, Division of Fisheries, Center for Aquatic Ecology. Aquatic Ecology Technical Report 93/9 (2); F-69-R(4-6) 273p., June.

Golder Associates Inc. 2020. "Construction Completion Report, Unnamed Tributary Relocation at the Illinois Power Generating Company Coffeen Site." Report to Illinois Power Generating Co., 161p., November.

Hanson Professional Services Inc. 2020. "Antidegradation Assessment for Discharge of Gypsum Management Facility Waters to Coffeen Lake, Coffeen Power Plant, Illinois Power Generating Company, NPDES Permit No. IL000108." Report to Illinois Power Generating Co., Collinsville, IL. 37p., July 20.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois (Final)." Report to Illinois Power Generating Co. 700p., October 25.

US EPA. 1998. "Methodology for assessing health risks associated with multiple pathways of exposure to combustor emissions." National Center for Environmental Assessment (NCEA), EPA 600/R-98/137, December. Accessed at http://www.epa.gov/nceawww1/combust.htm.

US EPA. 2014. "Human and Ecological Risk Assessment of Coal Combustion Residuals (Final)." Office of Solid Waste and Emergency Response (OSWER), Office of Resource Conservation and Recovery, December. Accessed at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-RCRA-2009-0640-11993.

Appendix B

Screening Benchmarks

Table B.1 Calculated Water Quality Standards Protective of Incidental Ingestion and Fish Consumption

Human Health COI	BCF[a] (L/kg-tissue)	Basis	MCL (mg/L)	RfD (mg/kg-day)	ADI[b] (mg/day)	Human Threshold Criteria		
						Water & Fish (mg/L)	Water Only (mg/L)	Fish Only (mg/L)
Arsenic	44	NRWQC (2002)	0.010	0.00030	0.020	0.022	2.0	0.023
Boron	1	(c)	NC	0.20	14	467	1,400	700
Cadmium	270	US EPA, 2014	0.0050	0.00050	0.010	0.0018	1.0	0.0019
Chromium	16	NRWQC (2002)	0.10	1.5	0.20	0.61	20	0.63
Cobalt	300	ORNL (2020)	NC	0.00030	0.021	0.0035	2.1	0.0035
Lead	46	US EPA (2014)	0.015	NC	0.030	0.015	0.015	0.015
Lithium	1	(c)	NC	0.002	0.14	4.7	14	7.0
Human Health COI	**BAF (L/kg-tissue)**		**MCL (pCi/L)**	**ADI (pCi/day)**	**Food Ingestion Slope Factor[d] (risk/pCi)**	**Human Threshold Criteria**		
	SW-Fish	**Basis**				**Water & Fish (pCi/L)**	**Water Only (pCi/L)**	**Fish Only (pCi/L)**
Radium-226+228	4.0	ORNL (2020)	5	10	1.43E-09	1,000	1,000	87,413

Notes:

ADI = Acceptable Daily Intake; BAF = Bioaccumulation Factor; BCF = Bioconcentration Factor; MCL = Maximum Contaminant Level; NC = No Criterion Available; NRWQC = National Recommended Water Quality Criteria; ORNL = Oak Ridge National Laboratory; pCi = picocurie; Ra = Radium; RAIS = Risk Assessment Information System; RfD = Reference Dose; US EPA = United States Environmental Protection Agency.

(a) BCFs from the following hierarchy of sources:

NRWQC (US EPA, 2002). National Recommended Water Quality Criteria: 2002. Human Health Criteria Calculation Matrix.

US EPA (2014). Human and Ecological Risk Assessment of Coal Combustion Residuals.

ORNL RAIS (ORNL, 2020). Risk Assessment Information System (RAIS) Toxicity Values and Chemical Parameters.

(b) ADI based on the MCL is calculated as the MCL (mg/L) multiplied by a water ingestion rate of 2 L/day. In the absence of an MCL, the ADI was calculated as the RfD (mg/kg-day) multiplied by the body weight (70 kg).

(c) BCF of 1 was used as a conservative assumption, due to lack of published BCF.

(d) Food ingestion slope factors for Ra-226+D and Ra-228+D were compared and the higher factor (Ra-228+D) was selected. The "+D" indicates that the risks from "associated short-lived radioactive decay products are also included" (US EPA, 2001).

Equations from IEPA (2019):

Consumption of Water and Fish

$$HTC = \frac{ADI}{W + (F \times BCF)}$$

Incidental Consumption of Water Only

$$HTC = \frac{ADI}{W}$$

Consumption of Fish Only

$$HTC = \frac{ADI}{F \times BCF}$$

Where:

Human Threshold Criteria (HTC)	Chemical-specific	mg/L
Acceptable Daily Intake (ADI)	Chemical-specific	mg/day
Fish Consumption Rate (F)	0.02	kg/day
Bioconcentration Factor (BCF)/ Bioaccumulation Factor (BAF)	Chemical-specific	L/kg-tissue
Water Consumption Rate (W)	0.01	L/day
Body Weight	70	kg
Target Cancer Risk (TCR)	1.0E-05	

Radium-226+228

$$HTC = \frac{TCR}{(SF \times BAF \times F)}$$

Table B.2 Recreator Exposure to Sediment

COI	Relative Bioavailability (unitless)	Dermal Absorption Fraction (unitless)	Cancer TRV CSF (mg/kg-day)$^{-1}$	Cancer TRV Dermal CSF (mg/kg-day)$^{-1}$	Cancer Child + Adult Incidental Ingestion SL (mg/kg)	Cancer Child + Adult Dermal Contact SL (mg/kg)	Cancer SL (mg/kg)	Non-Cancer TRV RfD (mg/kg-day)	Non-Cancer TRV Dermal RfD (mg/kg-day)	Non-Cancer Child Incidental Ingestion SL (mg/kg)	Non-Cancer Child Dermal Contact SL (mg/kg)	Non-Cancer Adult Incidental Ingestion SL (mg/kg)	Non-Cancer Adult Dermal Contact SL (mg/kg)	Non-Cancer SL (mg/kg) Child	Non-Cancer SL (mg/kg) Adult	Recreator RSL Sediment (mg/kg)	Basis[a]
Total Metals																	
Arsenic	1	3.0E-02	1.5E+00	1.5E+00	8.1E+01	4.1E+02	6.8E+01	3.0E-04	3.0E-04	4.1E+02	4.4E+03	4.4E+03	8.0E+03	3.8E+02	2.8E+03	6.8E+01	c
Boron	1	NA	NC	NC	NC	NC	NC	2.0E-01	2.0E-01	2.7E+05	NA	2.9E+06	NA	2.7E+05	2.9E+06	2.7E+05	nc
Cadmium	1	1.0E-03	NC	NC	NC	NC	NC	1.0E-04	2.5E-06	1.4E+02	1.1E+03	1.5E+03	2.0E+03	1.2E+02	8.5E+02	1.22E+02	nc
Chromium	1	NA	NC	NC	NC	NC	NC	1.5E+00	2.0E-02	2.1E+06	NA	2.2E+07	NA	2.1E+06	2.2E+07	2.1E+06	nc
Cobalt	1	NA	NC	NC	NC	NC	NC	3.0E-04	3.0E-04	4.1E+02	NA	4.4E+03	NA	4.1E+02	4.4E+03	4.1E+02	nc
Lead	1	NA	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	4.0E+02	L
Lithium	1	NA	NC	NC	NC	NC	NC	2.0E-03	2.0E-03	2.7E+03	NA	2.9E+04	NA	2.7E+03	2.9E+04	2.7E+03	nc
Radionuclides																**Total Soil PRG (pCi/kg)**	
Radium-226+228																7.9E+03	

Notes:

ABS = Dermal Absorption Fraction; COI = Constituent of Interest; CSF = Cancer Slope Factor; NC = No Criterion Available; pCi = PicoCurie; PRG = Preliminary Remediation Goal; RfD = Reference Dose; RSL = Regional Screening Level; SL = Screening Level; TRV = Toxicity Reference Value; US EPA = United States Environmental Protection Agency.

(a) Screening benchmark defined as the lower of the Screening Levels for cancer and non-cancer. The basis of the benchmark presented as c = based on cancer endpoint, nc = based on non-cancer endpoint, or L = based on blood lead levels.

Equations for Screening Benchmark and Screening Levels:

$$\text{Screening Benchmark} = \frac{1}{\frac{1}{SL_{ing}} + \frac{1}{SL_{derm}}}$$

$$\text{Non-cancer } SL_{ing} = \frac{THQ * RfD}{Intake} \qquad \text{Cancer } SL_{ing} = \frac{TR}{Intake * CSF}$$

$$\text{Non-cancer } SL_{derm} = \frac{THQ * RfD}{Intake * ABS} \qquad \text{Cancer } SL_{derm} = \frac{TR}{Intake * ABS * CSF}$$

Where:

Target Risk (TR)	1E-05	
Target Hazard Quotient (THQ)	1	
Reference Dose (RfD)	Chemical-specific	mg/kg-day
Dermal Absorption Fraction (ABS)	Chemical-specific	
Cancer Slope Factor (CSF)	Chemical-specific	mg/kg
Incidental Ingestions Screening Level (SL_{ing})	Chemical-specific	mg/kg
Dermal Contact Screening Level (SL_{derm})	Chemical-specific	mg/kg

Sediment – Ingestion (Chemical)

Intake Factor (IF) = $\frac{IR \times EF \times ED \times CF}{BW \times AT}$		=	Non-Cancer 7.3E-07 Child	Non-Cancer 6.8E-08 Adult	Cancer 6.3E-08 Child	Cancer 2.0E-08 Adult	Basis
IR	Ingestion Rate (mg/day)		67	33	67	33	One-third of US EPA residential soil ingestion rate (Professional Judgment)
EF	Sediment Exposure Frequency (days/year)		60	60	60	60	2 days/week between April and October when air temperature > 70°F (Professional Judgment)
ED	Exposure Duration (years)		6	20	6	20	Default value for Resident (US EPA, 2021b)
CF	Conversion Factor (kg/mg)		0.000001	0.000001	0.000001	0.000001	
BW	Body Weight (kg)		15	80	15	80	Default value for Resident (US EPA, 2021b)
AT	Averaging Time (days)		2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2021b)

Sediment – Dermal Contact (Chemical)

Intake Factor (IF) = $\frac{SA \times AF \times EF \times ED \times CF}{BW \times AT}$		=	Non-Cancer 2.2E-06 Child	Non-Cancer 1.2E-06 Adult	Cancer 1.9E-07 Child	Cancer 3.6E-07 Adult	Basis
SA	Surface Area Exposed to Sediment (cm^2/day)		1,026	3,026	1,026	3,026	Age weighted SA for lower legs and feet (US EPA, 2011b)
AF	Sediment Skin Adherence Factor (mg/cm^2)		0.2	0.2	0.2	0.2	Age weighted AF for children exposed to sediment (US EPA, 2011b)
EF	Sediment Exposure Frequency (days/year)		60	60	60	60	2 days/week between April and October when air temperature > 70°F (Professional Judgment)
ED	Exposure Duration (years)		6	20	6	20	Default value for Resident (US EPA, 2021b)
CF	Conversion Factor (kg/mg)		0.000001	0.000001	0.000001	0.000001	
BW	Body Weight (kg)		15	80	15	80	Default value for Resident (US EPA, 2021b)
AT	Averaging Time (days)		2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2021b)

Table B.3.1 Recreator PRGs for Soil, input values

Variable	Recreator Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.8653
B (PEF Dispersion Constant)	18.7762	18.7848
City (Climate Zone)	Default	Chicago, IL (7)
C (PEF Dispersion Constant)	216.108	215.0624
Cover layer thickness for GSF (gamma shielding factor) cm	0 cm	0 cm
$CF_{rec\text{-}fowl}$ (fowl contaminated fraction) unitless	1	1
$CF_{rec\text{-}game}$ (game contaminated fraction) unitless	1	1
ED_{rec} (exposure duration - recreator) yr		26
EF_{rec} (exposure frequency - recreator) day/yr		60
$f_{p\text{-}fowl}$ (fowl on-site fraction) unitless	1	1
$f_{p\text{-}game}$ (land game on-site fraction) unitless	1	1
$f_{s\text{-}fowl}$ (fraction of year fowl is on site) unitless	1	1
$f_{s\text{-}game}$ (fraction of year land game is on site) unitless	1	1
$MLF_{pasture}$ (pasture plant mass loading factor) unitless	0.25	0.25
t_{rec} (time - recreator) yr		26
TR (target risk) unitless	0.000001	0.000001
F(x) (function dependent on U_m/U_t) unitless	0.194	0.182
PEF (particulate emission factor) m^3/kg	1,359,344,438	1,560,521,177
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	98.431
A_s (acres)	0.5	0.5
Site area for ACF (area correction factor) m^2	1,000,000 m^2	1,000 m^2
ED_{rec} (exposure duration - recreator) yr		26
$ED_{rec\text{-}a}$ (exposure duration - recreator adult) yr		20
$ED_{resc\text{-}c}$ (exposure duration - recreator child) yr		6
EF_{rec} (exposure frequency - recreator) day/yr		60
$EF_{rec\text{-}a}$ (exposure frequency - recreator adult) day/yr		60
$EF_{rec\text{-}c}$ (exposure frequency - recreator child) day/yr		60
ET_{rec} (exposure time - recreator) hr/day		8
$ET_{rec\text{-}a}$ (exposure time - recreator) hr/day		8
$ET_{rec\text{-}c}$ (exposure time - recreator) hr/day		8
$IFA_{rec\text{-}adj}$ (age-adjusted inhalation rate - recreator) m^3		9,200
$IFS_{rec\text{-}adj}$ (age-adjusted soil intake rate - recreator) mg		63,720
$IRA_{rec\text{-}a}$ (inhalation rate - recreator adult) m^3/day	20	20
$IRA_{rec\text{-}c}$ (inhalation rate - recreator child) m^3/day	10	10
$IRS_{rec\text{-}a}$ (soil intake rate - recreator adult) mg/day	100	33
$IRS_{rec\text{-}c}$ (soil intake rate - recreator child) mg/day	200	67
t_{rec} (time - recreator) yr		26
TR (target risk) unitless	0.000001	0.000001
U_m (mean annual wind speed) m/s	4.69	4.65
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Notes:

IL = Illinois; PRG = Preliminary Remediation Goal; yr = year.

Table B.3.2 Recreator PRGs for Soil, Ra-226

Isotope	ICRP Lung Absorption Type	Soil Ingestion Slope Factor (risk/pCi)	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Food Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1,000 m^2 Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Particulate Emission Factor (m^3/kg)	Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	Beef Transfer Factor (pCi/kg per pCi/d)	Poultry Transfer Factor (pCi/kg per pCi/d)	Ingestion PRG TR=1.0E-06 (pCi/g)	Inhalation PRG TR=1.0E-06 (pCi/g)	External Exposure PRG TR=1.0E-06 (pCi/g)	Total PRG TR=1.0E-06 (pCi/g)	Total PRG TR=1.0E-06 (mg/kg)	Total PRG TR=1.0E-06 (pCi/kg)
Ra-226	S	6.77E-10	2.82E-08	2.50E-08	5.14E-10	4.33E-04	1.60E+03	6.85E-01	1.00E+00	1.56E+09	1.95E-02	1.70E-03	-	2.32E+01	6.02E+03	4.10E+01	1.48E+01	1.50E-05	1.48E+04

Notes:
d = Day; ICRP = International Commission on Radiological Protection; Ra = Radium; S = Slow; pCi = Picocurie; PRG = Preliminary Remediation Goal; TR = Target Risk; yr = Year.

Table B.3.3 Recreator PRGs for Soil, Ra-228

Isotope	ICRP Lung Absorption Type	Soil Ingestion Slope Factor (risk/pCi)	Inhalation Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/g)	Food Ingestion Slope Factor (risk/pCi)	Lambda (1/yr)	Half-life (yr)	1,000 m^2 Soil Volume Area Correction Factor	0 cm Soil Volume Gamma Shielding Factor	Particulate Emission Factor (m^3/kg)	Dry Soil-to-plant transfer factor (pCi/g-fresh plant per pCi/g-dry soil)	Beef Transfer Factor (pCi/kg per pCi/d)	Poultry Transfer Factor (pCi/kg per pCi/d)	Ingestion PRG TR=1.0E-06 (pCi/g)	Inhalation PRG TR=1.0E-06 (pCi/g)	External Exposure PRG TR=1.0E-06 (pCi/g)	Total PRG TR=1.0E-06 (pCi/g)	Total PRG TR=1.0E-06 (mg/kg)	Total PRG TR=1.0E-06 (pCi/kg)
Ra-228	S	1.98E-09	4.37E-08	3.43E-11	1.42E-09	1.21E-01	5.75E+00	1.00E+00	1.00E+00	1.56E+09	1.95E-02	1.70E-03	-	7.93E+00	3.89E+03	2.04E+04	7.91E+00	2.90E-08	7.91E+03

Notes:

d = Day; ICRP = International Commission on Radiological Protection; Ra= Radium; S = Slow; pCi = Picocurie; PRG = Preliminary Remediation Goal; TR = Target Risk; yr = Year.

Appendix B

Corrective Action Alternative Analysis – Supporting Information Report

Intended for
Illinois Power Generating Company
134 Cips Lane
Coffeen, Illinois 62017

Date
June 10, 2025

Project No.
1940110241-001

CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT

ASH POND NO. 1
COFFEEN POWER PLANT
IEPA ID NO. W1350150004-01

RAMBOLL Bright ideas. Sustainable change.

CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT IEPA ID NO. W1350150004-01

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940110241-001**
Recipient	**Illinois Power Generating Company**
Document type	**Supporting Information Report**
Revision	**FINAL**
Date	**June 10, 2025**
Prepared by	**Katlyn Nohr, Sarah Slagle-Garrett**
Checked by	**J. Austin Bond, PE**
Approved by	**Brian G. Hennings, PG**
Description	**Corrective Action Alternatives Analysis Supporting Information Report**

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I, J. Austin Bond, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this report has been prepared in accordance with the accepted practice of engineering. 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.

J. Austin Bond, PE
Qualified Professional Engineer

062-075181	IL	11/30/2025
License Number	**State**	**Exp. Date**

Affix Seal

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Table B	Feasibility-Level Implementation Schedule – Alternative 2 Source Control with GWE

APPENDICES

Appendix A	Feasibility-Level Design Drawing for Alternative 2 Remedy
Appendix B1	Groundwater Modeling Technical Memorandum
Appendix B2	Groundwater Modeling Report (2022)
Appendix C	Material Quantity, Labor, and Mileage Estimates for Alternative 2 Remedy

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
AP1	Ash Pond No. 1 ("the site")
AP2	Ash Pond No. 2
bgs	below ground surface
BMP	best management practices
CAAA	Corrective Action Alternatives Analysis
CAAA-SIR	Corrective Action Alternatives Analysis Supporting Information Report
CAP	Corrective Action Plan
CBR	closure-by-removal
CCR	coal combustion residuals
CCR Rule	40 C.F.R. § 257 Subpart D
CIP	closure-in-place
CMA	Corrective Measures Assessment
COC	constituent of concern
COF	Coffeen Power Station
CPP	Coffeen Power Plant
CY	cubic yards
GMF	Gypsum Management Facility
Gradient	Gradient Corporation
GSP	Gypsum Stack Pond
GWE	groundwater extraction
GWET	groundwater extraction trench
GWP	groundwater polishing
GWPS	groundwater protection standard(s)
HDPE	high-density polyethylene
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
Kd	soil adsorption coefficient
mL/g	milliliters per gram
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RP	Recycle Pond
RS Means	RS Means Heavy Construction Cost Data
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency

1. INTRODUCTION AND BACKGROUND

1.1 Plant and Site Information

Illinois Power Generating Company (IPGC) is the owner of the inactive coal-fired Coffeen Power Plant (CPP), also referred to as the Coffeen Power Station (COF), in Coffeen, Montgomery County, Illinois. IPGC intends to complete groundwater corrective action at the coal combustion residuals (CCR) surface impoundment (SI) Ash Pond number (No.) 1 (AP1), which is identified by Illinois Environmental Protection Agency (IEPA) identification (ID) No. W1350150004-01, CCR Unit ID 101, and National Inventory of Dams (NID) No. IL50722. Groundwater corrective action for COF AP1 will be performed under the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments [1] and the requirements of Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257, herein referred to as the Federal CCR Rule [2].

1.2 CAAA-SIR Background and Scope

35 I.A.C. § 845 requires a Corrective Action Alternatives Analysis (CAAA) to be completed as part of remedy selection, pursuant to the requirements of 35 I.A.C. § 845.670(e). The CAAA for COF AP1 was prepared by Gradient Corporation (Gradient). Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Corrective Action Alternatives Analysis Supporting Information Report (CAAA-SIR) to provide information requested by Gradient to support the CAAA for COF AP1.

This CAAA-SIR is a feasibility-level assessment utilized to evaluate multiple groundwater corrective action alternatives. The remedy that is ultimately selected within the CAAA, to which this CAAA-SIR is attached, was then further developed into a permit-level remedy within the Corrective Action Plan (CAP), to which the CAAA is attached. Therefore, there may be minor differences in information presented for the selected remedy between this CAAA-SIR and the CAP. Information that may be different includes, but is not limited to, groundwater quality data, groundwater modeling inputs and results, implementation schedules, time to reach GWPS, the physical dimensions and scope of the remedy, and engineering design parameters. These differences are due to the further remedy refinement that is inherent with advancing the selected alternative into the permit-level remedy that is included within the CAP.

1.2.1 Identified Corrective Action Alternatives

Corrective action remedies selected for evaluation within this CAAA-SIR were identified as potentially feasible for COF AP1 in the Corrective Measures Assessment (CMA), prepared by Ramboll and attached to the CAAA prepared by Gradient. The remedies identified as potentially feasible included:

- Alternative 1: Source control with groundwater polishing (GWP); and
- Alternative 2: Source control with groundwater extraction (GWE).

Other remedies, including source control groundwater cutoff wall and source control with in-situ treatment (permeable reactive barrier or chemical treatment), were determined to be infeasible for the site during the CMA process.

1.2.2 Scope of CAAA-SIR

Ramboll completed the following tasks and documented the tasks within this CAAA-SIR, for each of the corrective action alternative remedies listed in **Section 1.2.1**:

- Feasibility-level design drawings (**Appendix A**) were developed to show the approximate extents and typical sections/details of the Alternative 2 remedy (source control with GWE). Drawings were not prepared for the Alternative 1 remedy as it does not involve construction at the site.
- Narratives describing the implementation of each remedy were developed, including the pre-design, design, construction, operations and maintenance (O&M), and closeout phases.
- Feasibility-level schedules providing the estimated time to implement the remedy were developed, including design, permitting, construction, and post-construction O&M.
- Feasibility-level plans for the management of extracted groundwater were developed for alternatives where groundwater extraction is a component of the potential corrective action.
- Information required to evaluate specific portions of 35 I.A.C. § 845.670(e) requirements were prepared, as requested by Gradient, including 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3).
- Estimates of implementation-based equipment mileage, vehicle delivery mileage, labor hour, and labor commuting mileage, were developed for each remedy alternative where physical construction and/or O&M activities are expected to occur.

All remedies presented within this CAAA-SIR assume that the source control presented in the Final Closure Plan [3] for COF AP1 would also be implemented. Source control is the primary corrective action for COF AP1 and will include removing free liquids from the CCR and completing a hybrid closure-in-place (CIP) by consolidating approximately 436,000 cubic yards (CY) of CCR in the current COF AP1 footprint from 26 acres down to 10.4 acres (the CIP area) and installing a geomembrane final cover system.

Updated groundwater modeling (**Appendix B**) estimates that source control alone would result in GWPS being achieved approximately 40 years after closure completion without implementing other forms of corrective action. The potential remedies evaluated in this CAAA-SIR are intended to work in conjunction with the primary remedy, which is source control.

1.2.3 Criterion for Estimating Time to Achieve GWPS

Times to achieve GWPS for each of the remedial alternative remedies were estimated for the wells within the existing AP1 compliance monitoring system. This approach was utilized to provide a consistent comparison of the estimated the time to reach GWPS for each remedy, as required by 35 I.A.C. § 845.670(e)(f).

1.3 Report Contents

The following information is included within this report:

- **Section 1** includes the introduction and background;
- **Section 2** includes information for the Alternative 1 remedy: source control with GWP;
- **Section 3** includes information for the Alternative 2 remedy: source control with GWE;

- **Section 4** includes information used to develop estimates of material quantities, labor hours, and mileage; and
- **Section 5** includes reference documents used in the development of this CAAA-SIR.

2. ALTERNATIVE 1 REMEDY: SOURCE CONTROL WITH GROUNDWATER POLISHING

The Alternative 1 remedy, source control with GWP, would include a consolidate-and-cap approach for source control, after which GWP would be implemented. GWP is a remedial alternative that relies on natural geochemical processes and can be an appropriate remedy, as recognized by the United States Environmental Protection Agency (USEPA) in a final policy directive for groundwater remediation [4].

2.1 Supporting Groundwater Modeling and Time to Reach GWPS

The constituents of concern (COCs) exceeding the GWPS at compliance groundwater monitoring wells as of the 2024 Annual Report [5] are boron, sulfate, and TDS. Sulfate was selected for modeling source control as presented in the Final Closure Plan and was identified as a surrogate for the exceedances[1] of boron and TDS, as described in the Groundwater Modeling Report [6]. For modeling purposes, it was assumed that sulfate would not significantly sorb or chemically react with aquifer solids (soil adsorption coefficient [Kd] was set to 0 milliliters per gram [mL/g]) which is a conservative estimate for predicting contaminant transport times in the model. Sulfate transport is likely to be affected by both chemical and physical attenuation mechanisms (*i.e.,* adsorption and/or precipitation reactions as well as dilution and dispersion) [6]. Physical attenuation (dilution and dispersion) of contaminants in groundwater is simulated in the groundwater computer models. Chemical attenuation mechanisms and their effect on modeled times for exceedances to reach the GWPS are discussed in the Groundwater Polishing Evaluation Report [7] and discussed herein.

Groundwater modeling for the Alternative 1 remedy, performed to support the closure plan for AP1 and further refined in 2024 (**Appendix B**) estimated that GWPS would be met in 40 years after the implementation of source control for all wells within the existing AP1 monitoring well network.

2.2 Remedy Implementation

Implementation of this portion of the remedy would be initiated after source control (*e.g.,* final closure of AP1) is completed. Implementation would include performing corrective action groundwater monitoring, enacting an adaptive management strategy, and, after GWPS have been met, performing corrective action closure and completion activities. Information associated with each of these activities is described below.

- Corrective Action Groundwater Monitoring
  - Regular corrective action groundwater monitoring would be conducted utilizing a corrective action groundwater monitoring network designed in accordance with 35 I.A.C. § 845.680(c), which specifies that wells must be installed in the plume of contamination that lies beyond the waste boundary.

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPSs as described in the proposed groundwater monitoring program, which was submitted to the IEPA on October 25, 2021 as part of IPGC's operating permit application for COF AP1. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, IPGC has not identified any actual exceedances

    - Samples would be collected for COCs required by 35 I.A.C. § 845.600(a)(1). Samples would be collected on a quarterly basis initially and potentially reduced to a semiannual basis once five years of monitoring have occurred, in accordance with 35 I.A.C. § 845.650(b)(4).
    - Monitoring results would be submitted to IEPA for each monitoring event, in addition to an annual groundwater monitoring and corrective action report, in accordance with 35 I.A.C. § 845.610(e).
    - Routine maintenance of the monitoring well network would occur during the monitoring period. This would include inspecting the wells, making repairs to the wells (as and if needed), and rehabilitating and/or replacing wells to improve performance (as and if needed).
- Adaptive Management during Monitoring
  - Groundwater monitoring results would be evaluated and documented in in the monitoring reports submitted to IEPA, in accordance with 35 I.A.C. § 845.610(e).
  - If remedy progress does not correspond with expectations, additional methods or techniques to achieve compliance with GWPS would be evaluated and, if feasible, implemented in accordance with 35 I.A.C. § 845.680(b).
- Corrective Action Confirmation Modeling and Completion
  - After GWPS have been met for all corrective action monitoring wells, corrective action confirmation groundwater monitoring would be implemented. This would include monitoring each well for three additional years to confirm that GWPS have been achieved, in accordance 35 I.A.C. § 845.680(c).
    - It should be noted that post-closure care groundwater monitoring required for a 30-year period by 35 I.A.C. § 845.780(c) would continue to occur after corrective action groundwater monitoring is expected to be completed.
  - After completion of the corrective action confirmation monitoring period, a Corrective Action Completion Report and Certification would be prepared and submitted to IEPA, in accordance with 35 I.A.C. § 845.680(e).

2.2.1 Remedy Implementation Schedule

A feasibility-level implementation schedule for the Alternative 1 source control with GWP remedy is provided in **Table A** below.

Table A. Feasibility-Level Implementation Schedule – Alternative 1: Source Control with GWP

Implementation Phase	Implementation Task	Timeframe* (Preliminary Estimates)
Corrective Action Implementation	Corrective Action Monitoring (Time to Meet GWPS)	480 months (40 years)
	Corrective Action Confirmation Monitoring	36 months
	Corrective Action Completion	6 months
	Timeframe to Complete Corrective Action Implementation	522 months (44 years)
	Total Timeline to Complete Corrective Action (after completion of source control)	522 months (44 years)

*All timeframes are assumed to start after source control (*e.g.,* final closure of the SI) is complete and a corrective action permit has been issued by IEPA, whichever is later.

2.2.2 Management of Extracted Groundwater

No groundwater extraction would occur under this remedy.

2.2.3 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) Information

As requested by Gradient, the following information required by 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) has been developed for the remedy. The information was developed based on preliminary-level information contained within the CMA for AP1 and then refined based on additional feasibility-level design activities performed as part of the development of this CAAA-SIR.

- Potential Need for Replacement of the Remedy – 35 I.A.C. § 845.670(e)(1)(H)
  - No replacement of the remedy would be required for source control with GWP, as a physical remedy would not be constructed.
- Degree of Difficulty Associated with Constructing the Remedy – 35 I.A.C. § 845.670(e)(3)(A)
  - No construction would be required with the source control with GWP remedy; therefore, there is no difficulty in construction of the remedy.
- Expected Operational Reliability of the Remedy - 35 I.A.C. § 845.670(e)(3)(B)
  - As documented in the Groundwater Polishing Evaluation Report [7], groundwater geochemical processes anticipated to occur as downgradient groundwater approaches ambient background conditions are not expected to alter the chemical mechanisms of GWP and are not expected to delay the modeled time to achieve GWPS compliance.
  - GWP would begin once source control has been completed without delays and continuously function during the corrective action period.
- Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies - 35 I.A.C. § 845.670(e)(3)(C)
  - No permits from other agencies would be required outside of permits issued by IEPA for source control (Closure Plan and Construction Permit Application, submitted to IEPA in 2022 [8]).
- Availability of Necessary Equipment and Specialists - 35 I.A.C. § 845.670(e)(3)(D)

  - Equipment and specialists for field data collection and groundwater sampling are required for the GWP alternative. Laboratory equipment and specialists would also be required to assess groundwater concentrations of site constituents. Groundwater professionals (*i.e.,* geologists, hydrogeologists, statisticians, geochemists) would be required to perform statistical analysis and other assessments to confirm that GWP is functioning as-intended and prepare corrective-action related groundwater monitoring and progress reports.
  - The equipment and specialists required for site groundwater monitoring and analysis are currently performing this work as part of the routine groundwater monitoring program in accordance with 35 I.A.C. § 845.220(c)(4). Therefore, no new equipment or specialists are required for groundwater monitoring for this alternative.

- Available Capacity and Location of Needed Treatment, Storage, and Disposal Services – 35 I.A.C. § 845.670(e)(3)(E)
  - No treatment, storage, or disposal services would be required with the source control with GWP remedy, as GWP would not generate any appreciable volume of waste or wastewater.

3. ALTERNATIVE 2 REMEDY: SOURCE CONTROL WITH GWE

The Alternative 2 remedy, source control with GWE, would include the construction of a downgradient groundwater extraction trench (GWET) that would be located adjacent to both the CIP and closure-by-removal (CBR) areas along the northern side of AP1. The trench would extend from grade surface down to approximately 38 feet below ground surface (bgs) (approximate elevation 602 to 604 feet[2]) and would be terminated just below the bottom of the uppermost aquifer (UA). The total length of the GWET would be approximately 1,600 feet, extending along the relatively flat area between AP1 and the former CPP cooling water discharge flume. The constructed width of the trench is expected to be on the order of 3 feet. The purpose of the GWET would be to provide active removal of the impacted groundwater to accelerate achieving GWPS.

The GWET would be constructed by excavating existing subgrade soils, installing a collection pipe in the trench, backfilling with clean granular fill, and placing a compacted clay cap over the trench to reduce surface water infiltration. The collection pipe would drain to sumps spaced throughout the trench with an extraction pump within each sump. Extracted groundwater would be collected and routed via pneumatic pumps and air compressors to a new on-site lined settling pond and discharged through either a new or existing outfall, where it would be managed in accordance with site National Pollutant Discharge Elimination System (NPDES) permits.

A feasibility-level drawing of the source control with GWE remedy is provided as **Figure 1** in **Appendix A.**

3.1 Remedy Scoping and Groundwater Modeling Results

The location of the GWET was selected by reviewing physical constraints around AP1 and designating locations on IPGC property where the trench could feasibly be constructed with limited impacts to other site features. The location was additionally selected to avoid sensitive areas such as wetlands and floodplains [9, 10], while limiting adverse impacts or conflicts with the AP1 final closure construction.

Assessment of physical constraints resulted in the GWET being located within the footprint of the CBR area of AP1, along the northern perimeter, which is not within regulatory floodplains or known wetlands, provides generally straight and level alignment for the construction of the GWET, and would reduce conflicts with the AP1 final closure. The location of the GWET is generally perpendicular to existing groundwater flow patterns between AP1 and the former CPP cooling water discharge flume, which lies between AP1 and Ash Pond No. 2 (AP2). The depth of the GWET wall was selected based on interception with the existing groundwater table and the base of the UA. The surface elevation at the base of the AP1 CBR berm (approximately 640 feet) results in trench depth to approximately 36 to 38 feet bgs to terminate at the bottom of the UA (approximate elevation 602 to 604 feet).

Groundwater modeling for the Alternative 2 remedy (**Appendix B**) estimated that the time to achieve GWPS compliance in the AP1 monitoring wells is 40 years under both remedy

[2] All elevations in this report are referenced to North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

alternatives, suggesting that installation and operation of the GWET under Alternative 2 remedy will not improve the overall time to achieve sulfate GWPS.

3.2 Remedy Implementation

Implementation of the Alternative 2 source control with GWE is expected to include multiple tasks spread out over three phases, including pre-construction activities (Phase 1), corrective action construction (Phase 2), and corrective action operations, maintenance, and closeout (Phase 3). Information for each phase is described in this section.

3.2.1 Phase 1: Pre-Construction Activities

Pre-construction activities would include further pre-design investigation, obtaining permits from other agencies, completing the final design of the remedy, and selecting a remedy implementation contractor via a bidding process. Information associated with each of these activities is described below.

- Completing pre-design investigation, final design and bid activities, including:
  - Completion of final pre-design subsurface investigations, laboratory soil testing, engineering calculations, design drawings, specifications, and a construction quality assurance plan.
  - Bidding and selection of a GWET construction contractor.
- Obtaining permits from other agencies including:
  - A general stormwater permit for construction site activities through IEPA, including construction stormwater controls and other best management practices (BMPs) such as silt fences and other measures.
  - An amendment to the submitted AP1 Closure Plan and Construction Permit Application to allow for the disposal of GWET spoils beneath the AP1 final cover system.
  - An Illinois Department of Natural Resources (IDNR) Office of Water Resources, Dam Safety modification permit may need to be obtained for construction of the GWET in the vicinity of the embankment.
  - A modification to the site's NPDES permit would be obtained to accept discharge of extracted groundwater for the operational lifetime of the GWET.

3.2.2 Phase 2: Corrective Action Construction

Corrective action construction would be initiated after pre-construction activities are complete. It would include mobilizing construction equipment to the site, preparing the site for construction activities, construction of the GWET (the trench and associated mechanical elements and piping installation), construction of a settling pond, and performing post-construction and site restoration activities. GWET construction is assumed to occur concurrently with AP1 closure construction; this is to allow all spoils generated during GWET construction to be disposed of beneath the final cover system in the AP1 closure, rather than disposing of them in another onsite location or in an offsite landfill.

Information associated with each of these activities is described below.

- The contractor would mobilize equipment and materials to the site, install stormwater BMPs around the construction area, construct a staging and laydown area, and construct a level working platform and/or temporary construction access roads along the GWET alignment.
- Construction of the working platform would include removing, relocating, or modifying existing site infrastructure and utilities that may conflict with the construction of the GWET, grading to ensure a level working platform, and placing a granular fill working pad to support trench installation equipment.
- The 1,600-foot GWET would be installed into the UA. For the purposes of this CAAA-SIR, the trench was assumed to be installed using one-pass technology, although other installation methods may be evaluated during a later phase of design.
  - The trench would be installed in two 800-foot-long segments, beginning by setting the sump vertically at the east end of the trench, and trenching 800 feet to the center of the trench. A second 800-foot section would then be installed from the center of the trench to the west end. Two sumps are expected to be utilized within the trench. The trench would be on the order of 3 feet wide.
  - Perforated 6-inch-diameter high-density polyethylene (HDPE) collection pipe would be installed approximately 8 inches from the bottom of the trench at a very slight grade (approximately 0.5 to 2 percent) towards the sumps.
  - Simultaneously with pipe installation, in-situ soils would be removed, and the trench would be backfilled with granular material consisting of premixed sand and gravel.
  - Excavated soils (*e.g.,* spoils) would be placed into off-road dump trucks and hauled to AP1 for use as contouring (*i.e.,* subgrade) fill beneath the final cover system. The material would be moisture-conditioned by spreading it in thin lifts and compacting in accordance with the subgrade fill specifications for AP1 final closure.
  - A clay cap would be placed in a thin layer overlying the backfilled granular mix and compacted, to reduce surface water infiltration into the trench.
- An approximately 1-acre settling pond for management of extracted groundwater was assumed to be constructed using conventional construction equipment. However, other groundwater treatment and management technologies may be evaluated during a later phase of design. The temporary wastewater treatment plant that is being constructed on-site to treat existing CCR-contact water within the Gypsum Management Facility (GMF) Gypsum Stack Pond (GSP), adjacent GMF Recycle Pond (RP), and AP1 prior to discharge, is not expected to operate post-closure, and therefore was assumed to be unavailable for treating groundwater extracted from the GWET.
  - The location of the settling pond would be sited to limit adverse impacts or conflicts with the AP1 final closure construction, future solar redevelopment, and other existing and future site infrastructure. The precise location of the settling pond would be evaluated during later phases of design.
  - The settling pond would be approximately 1-acre in size and 2 feet deep. Soils would be mechanically excavated from the settling pond and used to create 10-foot-wide berms

around the perimeter of the settling pond to contain extracted groundwater. All excavated soils from the settling pond would be managed within the settling pond footprint.

  - A geomembrane liner system would be installed in the settling pond to reduce the potential for releases of extracted groundwater.
  - Underground trenches with HDPE piping would be excavated to convey extracted groundwater from the GWET to the settling pond and from the settling pond to the appropriate NPDES outfall. This would include the installation of electrical, mechanical, and pneumatic infrastructure to operate the conveyance piping system.

- Site restoration would be completed following the installation of the GWET. This would include repairing site infrastructure that was relocated or damaged during construction and minor regrading and seeding of disturbed areas.
  - Temporary BMPs would be installed during the site restoration period, if required, in accordance with site land disturbance permits. The BMPs would be removed once vegetation is established.

3.2.3 Phase 3: Corrective Action Operations, Maintenance, and Closeout

Corrective action operations, maintenance, and closure would be initiated after corrective action construction is completed. It would include performing corrective action groundwater monitoring, and, after GWPS have been met, performing corrective action closeout and completion activities. Information associated with each of these activities is described below.

- Corrective Action O&M
  - Continued operation of the GWET system would require routine scheduled inspections and associated maintenance including, but not limited to, totalizer data collection, filter system maintenance (if needed), and maintenance of extraction pumps, as well as other system components.
  - Non-routine maintenance that may occur during extended operation of the GWET may include tasks such as repair or replacement of the extraction pumps, repair or replacement of the system air compressor, and flushing or jetting of water conveyance lines in the event organic or inorganic solids accumulate on the interior walls.
  - Routine monitoring and compliance activities associated with the treatment and discharge of extracted water via the site's NPDES permit.
- Corrective Action Monitoring
  - Regular corrective action groundwater monitoring would be conducted using a corrective action groundwater monitoring well network designed in accordance with 35 I.A.C. § 845.680(c), which specifies that wells must be installed within the plume of contamination that lies beyond the waste boundary.
    - Samples would be collected for major ions for evaluating groundwater chemistry and COCs. Samples would be collected on a quarterly basis initially and potentially reduced to a semiannual basis once five years of monitoring have occurred, in accordance with 35 I.A.C. § 845.650(b)(4).
    - Monitoring results would be submitted to IEPA after each monitoring event, in addition to an annual groundwater monitoring and corrective action report, in accordance with

35 I.A.C. § 845.640(e). The annual corrective action report would include an evaluation of the actual performance of the remedy relative to the remedy's expected performance.

    - Routine maintenance of the monitoring well network would be conducted during the monitoring period. This would include inspecting the wells, making repairs to the wells (as and if needed), and rehabilitation and/or replacing the wells to improve performance (as and if needed).

  - If the remedy does not achieve its expected performance, additional methods or techniques to achieve compliance with GWPS would be evaluated and, if feasible, implemented in accordance with 35 I.A.C. § 845.680(b).

- Adaptive Management during Monitoring
  - Groundwater monitoring results would be evaluated and documented in in the monitoring reports submitted to IEPA, in accordance with 35 I.A.C. § 845.610(e).
  - Remedy progress evaluation as part of adaptive site management may include additional investigation to inform updates to the conceptual site, groundwater, and geochemical models.
  - If remedy progress does not correspond with expectations, additional methods or techniques to achieve compliance with GWPS would be evaluated and, if feasible, implemented in accordance with 35 I.A.C. § 845.680(b).
- Corrective Action Completion
  - After GWPS have been met for all compliance wells for a period of three years, corrective action would be considered complete, per 35 I.A.C. § 845.680(c).
    - It should be noted that post-closure care groundwater monitoring required for a 30-year period by 35 I.A.C. § 845.780(c) would continue to occur after corrective action groundwater monitoring is expected to be completed.
  - After completion of the corrective action confirmation monitoring period, a Corrective Action Completion Report and Certification would then be submitted to IEPA, in accordance with 35 I.A.C. § 845.680(e).

3.2.4 Remedy Implementation Schedule

A feasibility-level implementation schedule for the Alternative 2 source control with GWE remedy is provided in **Table B** below.

Table B. Feasibility-Level Implementation Schedule – Alternative 2: Source Control with GWE

Implementation Phase	Implementation Task	Timeframe (Preliminary Estimates)
1: Pre-Construction Activities	Agency Coordination, Approvals, and Permitting	18 to 24 months
	Final Design and Bid Process	24 to 36 months
	Timeframe to Complete Corrective Pre-Construction Activities	42 to 60 months after CAP Approval
2: Corrective Action Construction	Corrective Action Construction	6 to 12 months
	Timeframe to Complete Corrective Action Construction	6 to 12 months after completion of pre-construction activities.
3: Corrective Action O&M and Closeout	Corrective Action Monitoring (Time to Meet GWPS)	480 months* (40 years)
	Corrective Action Confirmation Monitoring	36 months*
	Corrective Action Completion	6 months*
	Timeframe to Complete Corrective Action O&M and Closeout	522 months* (43.5 years) after completion of O&M and closeout activities.
	Total Timeline to Complete Corrective Action	570 to 594 months (48 to 50 years)
Timeline to Complete Corrective Action (after completion of source control)		522 months* (43.5 years*)

*Denotes a timeframe that is assumed to start after source control (*e.g.,* final closure of the SI) is complete and a corrective action construction permit application has been issued by IEPA, whichever is longer.

It should be noted that Phases 1 and 2 were assumed to occur concurrently with closure construction, to allow spoils to be disposed of beneath the AP1 final cover system. Therefore, the start of Phase 3 (Corrective Action O&M and closeout) was assumed to begin at the completion of source control (final closure of AP1). In the event that Phases 1 and 2 could not be completed concurrently with source control due to a delay in receiving permits or construction-related conflicts, the total schedule would likely increase.

3.2.5 Management of Extracted Groundwater

Extracted groundwater from the GWET was assumed to be managed and treated by a newly constructed on-site settling pond, although other treatment technologies may be evaluated at a later phase of design. The settling pond would need to be sited to avoid conflict with planned solar redevelopment, other site infrastructure, and closure activities related to AP1 and other SIs at CPP. A settling pond approximately 1 acre in size was assumed to be sufficient to allow sediments to settle from extracted groundwater prior to discharge. Groundwater collected from the extraction well network would be sent to the settling pond via the pneumatic extraction pumps and transfer piping. Treated water would be discharged via a NDPES outfall, in accordance with site-specific NPDES permit requirements [11].

3.2.6 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) Information

As requested by Gradient, the following information required by 35 I.A.C. § 845.670(e)(1)(H) and 35 I.A.C. § 845.670(e)(3) has been developed for the remedy. The information was

developed based on preliminary-level information contained within the CMA for COF AP1 and then refined based on additional feasibility-level design activities performed as part of the development of this CAAA-SIR.

- Potential Need for Replacement of the Remedy – 35 I.A.C. § 845.670(e)(1)(H)
  - No replacement of the remedy is expected to be required, although the remedy requires ongoing monitoring and maintenance to retain its effectiveness.
- Degree of Difficulty Associated with Constructing the Remedy – 35 I.A.C. § 845.670(e)(3)(A)
  - The remedy would require use of specialized contractors and equipment (*i.e.,* one-pass trenching contractor and equipment) for the installation of the trench, in addition to general construction equipment (*i.e.,* excavation and grading equipment).
- Expected Operational Reliability of the Remedy - 35 I.A.C. § 845.670(e)(3)(B)
  - The GWET is expected to have high operational reliability if it is constructed in accordance with the design and specifications.
  - The GWET system is a mechanical system that would require routine maintenance to reliably operate, as outlined in **Section 3.2.3**.
- Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies - 35 I.A.C. § 845.670(e)(3)(C)
  - Agency permits would need to be obtained from IEPA for discharge of extracted groundwater, construction stormwater controls and BMPs, and potentially an IDNR Dam Safety modification permit. These permits typically take 18 to 24 months to obtain, with the NPDES permit modification taking longer to obtain than the other permits.
    - While some of these permits may also be obtained for the AP1 final closure, it is uncertain at this time of the schedule for approval of both the final closure plan and the eventual CAP; therefore, it has been assumed that separate permit applications for both the closure and corrective action construction would be submitted.
- Availability of Necessary Equipment and Specialists - 35 I.A.C. § 845.670(e)(3)(D)
  - Construction of the GWET would require a specialized contractor experienced with construction of similar types of trenches in similar geologic environments. Relatively few construction contractors with this experience, particularly using one-pass equipment, are available. The contractor would likely need specialized and often custom-built equipment.
  - Specialists in one-pass trenching methods would also need to be utilized during the design and construction phase. The specialists would include design engineers, construction managers, and contractor staff experienced with trench construction and equipment operation.
  - Geotechnical specialists would be needed to design the working platform and monitor the AP1 embankment for signs of distress during one-pass trench installation.
  - These types of equipment and specialists have been utilized in the past for other similar types of GWET design and construction projects. However, there may be backlogs associated with the equipment and specialists, due to high existing demand for specialty ground improvement contractors and design specialists who are supporting similar types of

projects in the electric utility, dam/levee, and other market sectors. These backlogs could add additional delay to the project schedule above current assumptions.

- Specialists would be needed to maintain the GWE system during the operational timeframe and are currently being utilized as part of GWE O&M. System components that require maintenance include totalizers, instrumentation, and the extraction and transfer pumps.
  - Additionally, specialists are occasionally needed for non-routine O&M which may include flushing or jetting of the conveyance lines, replacement of faulty system components, replacement of pumps or pump controllers, and replacement of faulty system instrumentation.
  - Specialists and replacement equipment are generally available within proximity (*i.e.*, 100 to 300 miles) of the site but some of the more complex equipment, including the transfer pumps and transfer pump controller, may have extended lead times for replacement or servicing.
- Equipment and specialists for field data collection and groundwater sampling are required for the remedy. Laboratory equipment and specialists would also be required to assess groundwater concentrations of site COCs. Groundwater professionals (*i.e.,* geologists, hydrogeologists, statisticians, geochemists) would be required to perform statistical analysis and other assessments to confirm that the remedy is functioning as intended and prepare corrective action-related groundwater monitoring and progress reports.
  - The equipment and specialists required for site groundwater monitoring and analysis are currently performing this work in accordance with 35 I.A.C. § 845.220(c)(4). Therefore, no new equipment or specialists are required for groundwater monitoring for this alternative.

- Available Capacity and Location of Needed Treatment, Storage, and Disposal Services – 35 I.A.C. § 845.670(e)(3)(E)
  - Wastes generated during GWET construction would be limited to spoils; these would be disposed of onsite in AP1 during closure construction, as compacted contouring fill beneath the final cover system. Completing the GWET construction at the same time as the AP1 closure would provide sufficient on-site capacity for the disposal of generated spoils.
  - The GWET system would send extracted groundwater to an on-site settling pond to settle solids extracted during groundwater recovery via the pneumatic extraction pumps and transfer piping. This settling pond would be new construction that would need to be sited, designed, constructed, and maintained.
    - The settling pond would need to be sited to not conflict with planned solar redevelopment, wetlands, floodplains, or other site infrastructure.
  - Continued NPDES permit renewals may be required, depending on the timeline of corrective action implementation relative to completion of source control activities.

4. MATERIAL QUANTITY, LABOR, AND MILEAGE ESTIMATES

Estimates of material quantities, total labor hours, and mileage were prepared for Alternative 2 source control with GWE, to support Gradient in preparing a CAAA. Estimates were prepared for the construction and O&M of each remedy. Estimates were not prepared for Alternative 1 source control with GWP as the alternative does not require remedial construction or O&M of a physical remedy.

Estimates were prepared utilizing the following approach:

- Major implementation (*e.g.,* construction) components and line items were identified, in accordance with the remedy implementation narratives contained within this CAAA-SIR.
- Construction quantities were estimated based on quantity estimates for volumes, areas, and units, as obtained from the feasibility-level engineering drawings and schedules included within this CAAA-SIR.
- RS Means Heavy Construction Cost Data (RS Means) [12] was utilized to estimate the crew size, equipment description, and daily output associated with each line item.
- For line items where RS Means data was not available, the crew size, equipment description, and daily output were estimated based on Ramboll's experience, information from contractors, and/or information from material suppliers.
- For the Alternative 2 source control with GWE active remedy, daily construction and O&M labor mobilization miles were estimated assuming a weekly mobilization/demobilization from Chicago (500 miles round trip) and a local commute of 40 miles round trip per day. The number of working days and hours per week were estimated from the construction schedule developed for each remedy.
- Estimates of material delivery miles were prepared based on Ramboll's experience.

The detailed material quantity, labor, and mileage estimates are provided in **Appendix C**.

5. REFERENCES

[1] "Illinois Administrative Code, Title 35, Subtitle G, Chapter I, Subchapter J, Part 845: Standards for The Disposal Of Coal Combustion Residuals In Surface Impoundments," effective April 21, 2021.

[2] Code of Federal Regulations, "Title 40, Chapter I, Subchapter I, Part 257, Subpart D, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," April 17, 2015.

[3] Golder Associates USA, Inc., "Final Closure Plan for Ash Pond No. 1," Coffeen, IL, July 28, 2022.

[4] United States Environmental Protection Agency, "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites," OSWER Directive Number 9200.4-17P, April 21, 1999.

[5] Ramboll Americas Engineering Solutions, "2024 35 I.A.C. S 845 Annual Groundwater Monitoring and Corrective Action Report, Ash Pond No. 1, Coffeen Power Station, IEPA ID No. W1350150004-01," Coffeen, IL, 2025.

[6] Ramboll, Groundwater Modeling Report Ash Pond 1, Coffeen, IL, July 28, 2022.

[7] Geosyntec Consultants, Inc., "Groundwater Polishing Evaluation Report Cofeen Power Station - Ash Pond No. 1 (EPA ID No. 101)," Coffeen, IL, 2024.

[8] Golder Associates USA, Inc., Part 845 Construction Permit Application for Ash Pond 1, Coffeen, IL, July 28, 2022.

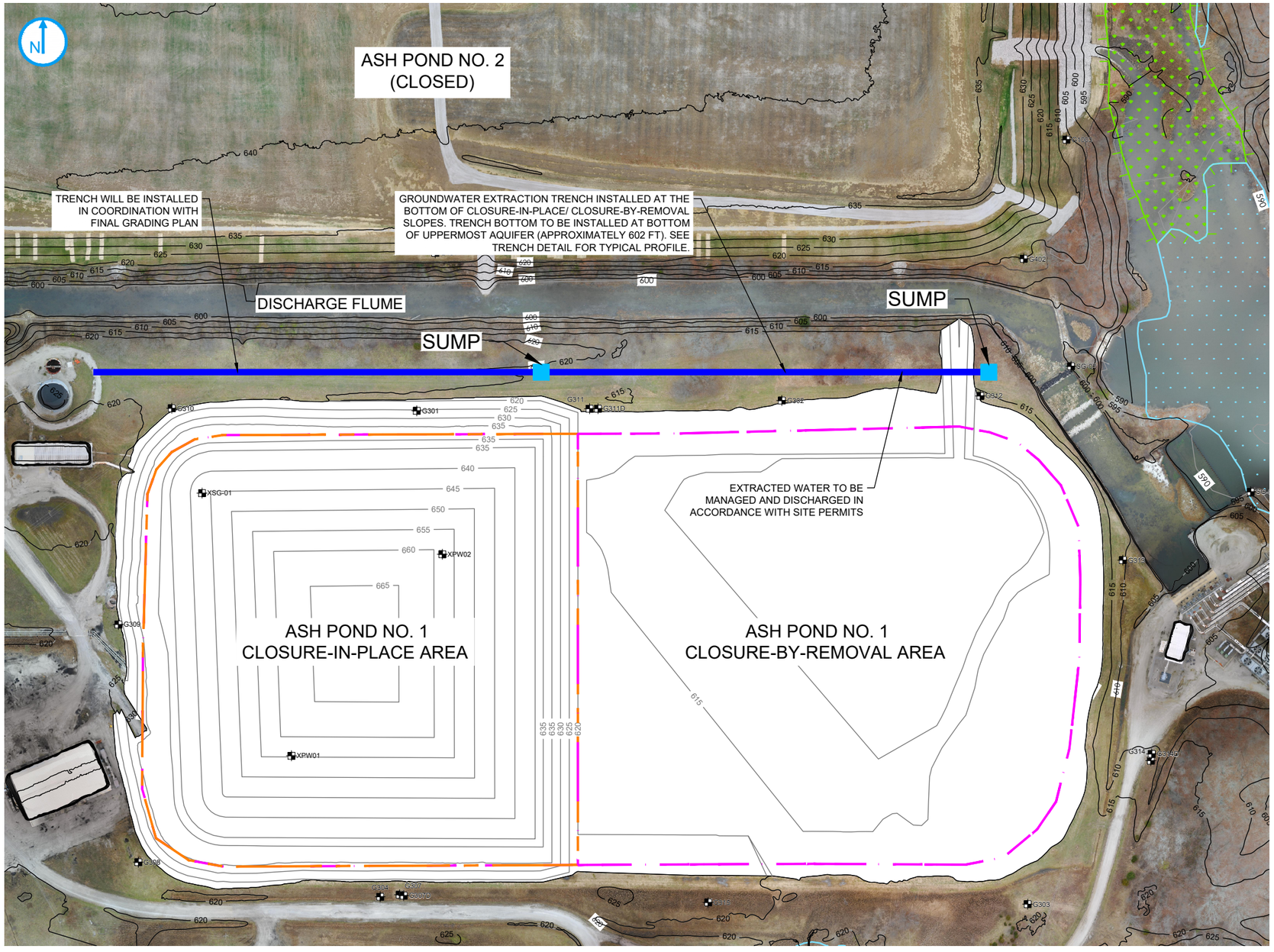
[9] U.S. Fish and Wildlife Service,, "National Wetlands Inventory, Surface Waters and Wetlands," [Online]. Available: https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/.

[10] National Flood Insurance Program, *Flood Hazard Boundary Map, Montgomery County, Illinois, Unincorporated Areas,* Federal Emergency Management Agency, 1981.

[11] Illinois Environmental Protection Agency, "NPDES Permit No. IL0000108," Illinois Environmental Protection Agency, Coffeen, Illinois, 2023.

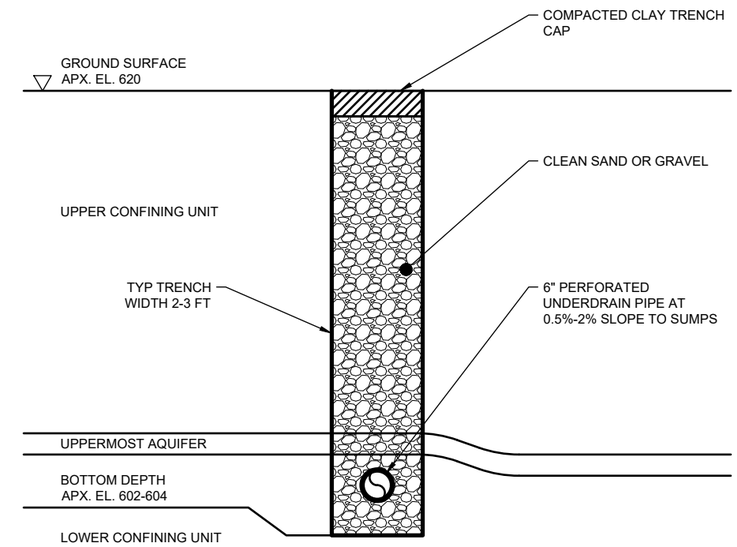
[12] Gordian, RS Means Data version 8.7, Springfield, IL: Gordian, 2023.

APPENDIX A
FEASIBILITY-LEVEL DESIGN DRAWING FOR ALTERNATIVE 2 REMEDY



SITE PLAN

0 200 Feet



TRENCH DETAIL

NOT TO SCALE

NOTE:

1. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 12/3/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 12/3/2020 & 12/4/2020..
2. POST-CLOSURE GRADING REPRESENTED PER COFFEEN POWER PLANT ASH POND NO. 1 CONSTRUCTION PERMIT APPLICATION DRAWINGS COMPLETED BY GOLDER, JULY 2022.
3. WETLANDS REPRESENTED AS PER ILLINOIS NATIONAL WETLANDS INVENTORY.

EXISTING	PROPOSED
MAJOR CONTOUR	MAJOR CONTOUR
WETLANDS BOUNDARY (SEE NOTE 3)	GROUNDWATER EXTRACTION TRENCH
BODY OF WATER	SUMP
	CLOSURE IN PLACE WASTE BOUNDARY
	CLOSURE BY REMOVAL BOUNDARY

GROUNDWATER EXTRACTION TRENCH
FEASABILITY-LEVEL DESIGN

ASH POND NO. 1
Coffeen Power Plant 134 CIPS Lane Coffeen, IL 62017

FIGURE 1

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 1940075591 DATED: 5/21/2025 DESIGNER: LEM/KRM CADD\ACCDocs\Ramboll Gruppen AS\RUS-1940103584-002 Vistra Energy COF\Project Files\4 Delivery\40 WIP\401 Civil\Drawings\03_CAAA-SIR\COF-AP1 CAAA-SIR.dwg

APPENDIX B1
GROUNDWATER MODELING TECHNICAL MEMORANDUM

Intended for
Illinois Power Generating Company

Date
June 10, 2025

Project No.
1940110241-001

GROUNDWATER MODELING TECHNICAL MEMORANDUM

ASH POND NO. 1, COFFEEN POWER PLANT

IEPA ID NO. W1350150004-01

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GROUNDWATER MODELING TECHNICAL MEMORANDUM ASH POND NO. 1, COFFEEN POWER PLANT IEPA ID NO. W1350150004-01

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940110241-001**
Recipient	**Illinois Power Generating Company**
Document type	**Technical Memorandum**
Revision	**FINAL**
Date	**June 10, 2025**
Prepared by	**Jinjun Wang, PhD**
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Table 1 Summary of Surface Water Elevations in Discharge Flume
Table 2 Simulated Time to Achieve Sulfate GWPS in AP1 Monitoring Wells

TABLES (IN TEXT)

Table A Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells

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Figure 1 Monitoring Well Location Map
Figure 2 Simulated Sulfate Concentrations in AP1 Monitoring Wells – Alternative 1 Remedy
Figure 3 Proposed Groundwater Extraction Trench Location – Alternative 2 Remedy
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APPENDICES

Appendix A MODFLOW and MT3DMS Model Files (Electronic Only)

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
AP1	Ash Pond No. 1
CAAA	Corrective Action Alternatives Analysis
CAP	Corrective Action Plan
CCR	coal combustion residual(s)
CBR	closure-by-removal
CIP	closure-in-place
COC	constituent of concern
CPP	Coffeen Power Plant
ft	foot/feet
Geosyntec	Geosyntec Consultants, Inc.
gpm	gallons per minute
GPR	Groundwater Polishing Evaluation Report
GMF GSP	Gypsum Management Facility Gypsum Stack Pond
GMF RP	Gypsum Management Facility Recycle Pond
Golder	Golder Associates USA, Inc.
GPR	Groundwater Polishing Evaluation Report
GWE	groundwater extraction
GWET	groundwater extraction trench
GWPS	groundwater protection standard(s)
ID	identification
IEPA	Illinois Environmental Protection Agency
LCU	lower confining unit
mg/L	milligrams per liter
mL/g	milliliters per gram
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
Ramboll	Ramboll Americas Engineering Solutions, Inc.
UA	uppermost aquifer

EXECUTIVE SUMMARY

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Modeling Technical Memorandum on behalf of the Coffeen Power Plant (CPP), operated by Illinois Power Generating Company, in accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845. This document presents the results of predictive groundwater modeling simulations in support of potential Corrective Action Plan (CAP) remedial alternatives identified in the Corrective Action Alternatives Analysis (CAAA) required by 35 I.A.C. § 845,670(e), for Ash Pond No. 1 (AP1) in Coffeen, Illinois, identified by Illinois Environmental Protection Agency (IEPA) identification (ID) number (No.) W1350150004-01 and National Inventory of Dams (NID) No. 50722. Two potential remedial alternatives were evaluated, including (1) Alternative 1: source control with groundwater polishing, and (2) Alternative 2: source control with groundwater extraction (GWE). Each remedial alternative simulation was based on the closure-in-place (CIP) scenario that was selected as the closure alternative for AP1 (Golder Associates USA, Inc. [Golder], 2022a) and simulated in the Groundwater Modeling Report (Ramboll, 2022).

The groundwater modeling efforts described in this Groundwater Modeling Technical Memorandum include groundwater flow modeling using MODFLOW-NWT (Niswonger et al., 2011) and contaminant fate and transport modeling using MT3DMS (Zheng and Wang, 1999) to evaluate how each corrective action will achieve compliance with the applicable groundwater protection standards (GWPSs); and describe fate and transport of contaminants in accordance with 35 I.A.C. § 845.220 (c)(2). The effectiveness of each corrective action alternative was assessed based on the time for simulated sulfate concentrations to decrease below the GWPS in groundwater monitoring wells in the vicinity of AP1 (**Figure 1**).

Alternative 1 remedy consists of source control with groundwater polishing, which represents the selected closure alternative for AP1 (Golder, 2022a). Alternative 2 remedy consists of installation and operation of a groundwater extraction trench (GWET) installed to the bottom of the uppermost aquifer (UA) starting at completion of closure.

Groundwater modeling results for both the Alternative 1 and Alternative 2 remedies indicate the simulated sulfate concentrations would achieve the applicable GWPS of 400 milligrams per liter (mg/L) in each of the monitoring wells within 40 years.

1. INTRODUCTION

1.1 Background

This Groundwater Modeling Technical Memorandum is prepared to evaluate how potential CAP remedial alternatives would achieve compliance with the applicable GWPSs, and to describe fate and transport of contaminants in accordance with 35 I.A.C. § 845.220 (c)(2). The groundwater modeling efforts consist of predictive groundwater modeling to assess the long-term effectiveness and time to achieve GWPS for sulfate for the following remedial alternatives: (1) Alternative 1: source control with groundwater polishing, and (2) Alternative 2: source control with GWE. In both remedial alternatives, source control is the CIP that had been selected as the closure alternative for AP1 (Golder, 2022a) and modeled in the Groundwater Modeling Report (Ramboll, 2022).

1.2 Previous Groundwater Modeling Reports

In accordance with requirements of 35 I.A.C. § 845, Ramboll developed groundwater flow and transport models for AP1 in 2022. The groundwater flow model was built using MODFLOW-2005 (Harbaugh, 2005), and the contaminant fate and transport model was built using MT3DMS. The groundwater models were used to evaluate two closure scenarios, including consolidation of the coal combustion residuals (CCR) and CIP, and closure-by-removal (CBR). The modeling exercises and results were summarized in the Groundwater Modeling Report (Ramboll, 2022), which was submitted as an attachment to the Construction Permit Application for Coffeen AP1 (Golder, 2022a).

The groundwater modeling efforts presented in this Groundwater Modeling Technical Memorandum are based on the Ramboll (2022) groundwater modeling simulations and evaluations, as detailed in **Section 2**.

2. ALTERNATIVE 1 SIMULATION

The Groundwater Modeling Report (Ramboll, 2022) simulates the CIP closure of AP1 as presented in the Construction Permit Application (Golder, 2022a). The closure of AP1 consists of removal of CCR from the eastern portion of AP1, consolidation into the western portion of AP1, and construction of a cover system over the remaining CCR. These activities constitute Alternative 1 remedy: source control with groundwater polishing.

2.1 Model Description

Modeling activities conducted to simulate the CIP closure of AP1 (*i.e.*, Alternative 1 remedy) included:

- A steady state groundwater flow model was constructed using MODFLOW-2005 and calibrated to match mean groundwater elevations observed between 2015 to 2021. The calibrated flow model was used to simulate the mean groundwater flow conditions at the site.
- Transient flow and transport models were constructed based off of the calibrated steady state model using MODFLOW-2005 and MT3DMS, respectively. These models simulate groundwater flow and transport for 42 years with changes in site conditions through time and match observed sulfate concentrations in groundwater.
- Prediction simulations began with a 2-year dewatering period simulated in MODFLOW-2005 and MT3DMS where heads were reduced within the CCR unit and concentrations were removed from CCR removal areas.
- Prediction simulations resumed for CIP following the 2-year dewatering period using MODFLOW-2005 and MT3DMS. A predictive simulation was conducted to estimate the time for sulfate concentrations to meet the GWPS in groundwater monitoring wells at AP1.

For the contaminant fate and transport simulations, sulfate was selected as the constituent to evaluate the effectiveness of the closure scenario. Of the analytes which exceed GWPS in site groundwater, sulfate was detected in AP1 groundwater at the highest concentrations relative to its GWPS and it will likely take the longest time to meet the GWPS. It is not necessary to model all constituents that exceed GWPS or have been detected at lower concentrations relative to their GWPSs, because those constituents will likely achieve their GWPSs more quickly (Gradient, 2024).

2.2 Model Updates

For the purpose of evaluating the potential groundwater remedial alternatives, the groundwater flow modeling program associated with the prediction simulations, including the 2-year dewatering simulation and the 100-year CIP simulation, was updated from MODFLOW-2005 to MODFLOW-NWT. The input and output files, as well as the model executables, are provided in **Appendix A**. MODFLOW-NWT is a modeling program designed to solve nonlinear groundwater flow problems due to unconfined aquifer conditions and is superior in solving problems involving drying and rewetting of unconfined aquifers (Niswonger et al., 2011), which were expected for the selected remedial alternatives. In addition, the layer types associated with model Layers 2 through 4 in the prediction models were updated from “confined” to “unconfined (T Varies)” to accommodate the drying and rewetting conditions. MT3DMS remained as the fate and transport modeling program.

A stream gauge present within the discharge flume located to the south of AP2 monitors the surface water elevation in the flume. Historical surface water elevations collected at the stream gauge are summarized in **Table 1**. As shown in the table, the surface water elevation varied from 598.34 ft[1] to 599.36 ft between March 2021 and July 2024, with an average of 598.67 ft. Accordingly, in the 100-year CIP prediction model, the discharge flume was simulated as a drain, with a drain stage set to 598.7 ft to represent the average surface water elevation within the flume.

In addition, the drain boundaries simulating the GMF GSP and GMF RP in the 100-year CIP prediction model were updated to reflect the final closure design associated with these two SI units (Golder, 2022b and 2022c).

The updated simulation results for Alternative 1 remedy are discussed in **Section 2.3**. The simulated groundwater elevations and sulfate concentrations at the end of the 2-year dewatering period also served as the initial conditions for the following remedial alternative simulations described in **Section 3**.

2.3 Simulation Results

The simulated sulfate concentrations in groundwater monitoring wells versus time are shown in **Figure 2**. The simulated time to achieve sulfate GWPS in the monitoring wells is summarized in **Table 2**. According to the simulation results, monitoring well G301 has the longest time to achieve compliance among all the monitoring wells, which is 40 years. For the remaining monitoring wells, it takes less than 17 years for the sulfate concentrations to decrease below GWPS.

[1] All elevations in this report are referenced to North American Vertical Datum of 1988 (NAVD88) unless otherwise noted.

3. ALTERNATIVE 2 SIMULATION

The source control with CIP (*i.e.*, Alternative 1 remedy) simulation described in **Section 2** was modified to simulate the Alternative 2 remedy (source control with GWE).

3.1 Alternative 2 Remedy – Source Control with GWE

3.1.1 Overview

Alternative 2 remedy consists of the installation and operation of a GWET downgradient of AP1 (**Figure 3**). The extraction trench is proposed to be installed down to the bottom of the UA. According to the simulated groundwater flow pattern under CIP, the groundwater flow direction in the UA within AP1 is to the north/northeast. The goal of Alternative 2 remedy is to increase the hydraulic gradient towards the extraction trench by lowering the heads in the extraction trench. A greater hydraulic gradient will induce higher groundwater flow velocity, which may increase the speed of residual dissolved phase mass removal from beneath AP1.

3.1.2 Model Approach

The 100-year CIP prediction model described in **Section 2** was modified to simulate the proposed GWET. The input and output files, as well as the model executables, are provided in **Appendix A**. The proposed GWET was simulated as a drain located at the bottom of the UA, which was simulated as Layer 3 in the model (**Figure 3**). The GWET was assumed to be 3-foot thick, and the backfill material for the GWET was assumed to be sand with a hydraulic conductivity of 62.4 ft/day. Therefore, the hydraulic conductivities in model cells within and above the drain were adjusted to 10 ft/day, both vertically and horizontally, to match the permeability of fill material in the extraction trench.

3.1.3 Simulation Results

Simulation of Alternative 2 remedy assumed operation of the GWET for 100 years. The simulated sulfate concentrations in AP1's groundwater monitoring wells versus time for Alternative 2 remedy are shown in **Figure 4**. The simulated time to achieve sulfate GWPS in the monitoring wells is summarized in **Table 2**. According to the simulation results, monitoring well G301 is the last well to reach GWPS, in 40 years under Alternative 2 remedy. Comparison of the simulated time to achieve GWPS in **Table 2** indicate that installation and operation of the GWET will not improve the overall time to achieve sulfate GWPS in the monitoring wells as compared to Alternative 1.

4. ASSESSMENT OF GEOCHEMICAL PROCESSES

This groundwater flow and transport model estimates the time for sulfate to reach the GWPS under different potential corrective actions based on physical components of groundwater polishing. As described in the Groundwater Modeling Report submitted with the construction permit, it was assumed that sulfate would not significantly sorb or chemically react with aquifer solids (distribution coefficient [K_d] was set to 0 milliliters per gram [mL/g]), which is a conservative estimate for estimating contaminant transport times.

A Groundwater Polishing Evaluation Report (GPR) (Geosyntec Consultants, Inc. [Geosyntec], 2025) was attached to the Corrective Actions Alternative Analysis (CAAA). The geochemical modeling effort presented in the GPR supports the assessment of groundwater polishing as a component of the proposed corrective action by evaluating the potential for chemical attenuation of constituents of concern (COCs) before and after source control as a means of contextualizing the times estimated in the flow and transport model. The GPR also provides an initial foundation for understanding groundwater chemistry to inform adaptive site management as a key component of the Corrective Action Groundwater Monitoring Program.

In their report, Geosyntec evaluated the potential for natural groundwater polishing processes, which involve both physical and chemical mechanisms, to attenuate sulfate and boron and evaluate the potential for previously attenuated sulfate and boron to be remobilized into groundwater as concentrations return to background levels. The groundwater polishing evaluation determined that geochemical conditions demonstrate chemical attenuation of boron and sulfate via sorption to aquifer solids, particularly iron and aluminum oxides and (applicable to sulfate only) precipitation of barite. Mobilization of currently attenuated sulfate and boron is unlikely to affect the modeled time to reach the GWPS under future conditions. In other words, the impact of groundwater polishing through chemical attenuation mechanisms has only a minimal effect on the estimated time it takes for sulfate concentrations to reach the GWPS of 400 mg/L, as modeled by the flow and transport model.

5. CONCLUSIONS

The groundwater modeling efforts in this Groundwater Modeling Technical Memorandum consist of flow and transport modeling using MODFLOW-NWT and MT3DMS to assess the time to achieve GWPS for sulfate for two CAP remedy alternatives: Alternative 1 remedy (source control with groundwater polishing), and Alternative 2 remedy (source control with GWE). Both alternatives incorporate the primary corrective action, which is the CIP of AP1 source control efforts (Golder, 2022a).

A summary of predicted time for sulfate concentrations to meet the GWPS in monitoring wells is provided in **Table 2**. The percentage of impacted monitoring wells attaining the GWPS over time is summarized below in **Table A**.

Table A. Estimated Timeframes to Attain GWPS in Groundwater Monitoring Wells

Alternative	Impacted Wells	Percentage of Wells Predicted to Attain GWPS†					
		2 Years‡	5 Years‡	10 Years‡	20 Years‡	30 Years‡	40 Years‡
1	13	8%	15%	23%	92%	92%	100%
2	13	8%	8%	31%	92%	92%	100%

†: Estimated timeframes per the number of impacted wells (wells with estimated times to achieve the GWPS) shown in Table 2
‡: Years counted starting from completion of corrective action

Simulation results indicate that, under both CAP remedy alternatives, monitoring well G301 is the last monitoring location to achieve GWPS for sulfate. The time to achieve GWPS compliance in the AP1 monitoring wells is 40 years under both remedy alternatives, indicating that installation and operation of the GWET under Alternative 2 remedy will not improve the overall time to achieve sulfate GWPS.

6. REFERENCES

Geosyntec Consultants, Inc., 2025. Groundwater Polishing Evaluation Report, Coffeen Power Plant - Ash Pond No. 1 Unit. June.

Golder Associates USA, Inc., 2022a. Part 845 Construction Permit Application for Ash Pond 1, Coffeen, IL. July 28.

Golder Associates USA, Inc., 2022b. Part 845 Construction Permit Application for Gypsum Management Facility Gypsum Stack Pond, Coffeen Power Plant. July 28.

Golder Associates USA, Inc., 2022c. Part 845 Construction Permit Application for Gypsum Management Facility Recycle Pond, Coffeen Power Plant. July 28.

Gradient, 2024. Closure Alternatives Analysis Groundwater Modeling Review at the Coffeen Power Plant, Edwards Power Plant, Newton Power Plant, and Hennepin Power Plant, Expert Report of Andrew Bittner, P.E.

Harbaugh, A.W., 2005. MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model - the Ground-Water Flow Process: U.S. Geological Survey Techniques and Methods 6-A16.

Illinois Administrative Code, Title 35, Subtitle G, Chapter I, Subchapter J, Part 845: Standards for The Disposal of Coal Combustion Residuals in Surface Impoundments, effective April 21, 2021.

Niswonger, R.G., Panday, Sorab, and Ibaraki, Motomu, 2011. MODFLOW-NWT, A Newton formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6–A37, 44 p.

Ramboll Americas Engineering Solutions, Inc (Ramboll), 2022. Groundwater Modeling Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois.

Zheng C., and P. Wang, 1999. MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems: Documentation and User’s Guide.

TABLES

TABLE 1. SUMMARY OF SURFACE WATER ELEVATIONS IN DISCHARGE FLUME

GROUNDWATER MODELING TECHNICAL MEMORANDUM

COFFEEN POWER PLANT

ASH POND NO. 1

COFFEEN, ILLINOIS

Date	Surface Water Elevation (ft amsl)
03/29/2021	598.75
04/20/2021	598.56
05/03/2021	598.74
05/17/2021	598.56
06/09/2021	598.37
06/23/2021	598.34
07/12/2021	598.75
07/26/2021	598.44
08/16/2021	598.39
10/25/2021	598.59
02/07/2022	598.52
05/09/2022	598.52
08/23/2022	598.42
02/13/2023	598.62
05/30/2023	598.40
10/24/2023	598.38
11/13/2023	598.51
12/18/2023	598.56
01/12/2024	599.17
02/12/2024	598.82
03/29/2024	599.00
04/29/2024	599.36
05/29/2024	599.18
06/29/2024	598.84
07/30/2024	598.91
Minimum	598.34
Maximum	599.36
Average	598.67

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TABLE 2. SIMULATED TIME TO ACHIEVE SULFATE GWPS IN AP1 MONITORING WELLS

GROUNDWATER MODELING TECHNICAL MEMORANDUM

COFFEEN POWER PLANT

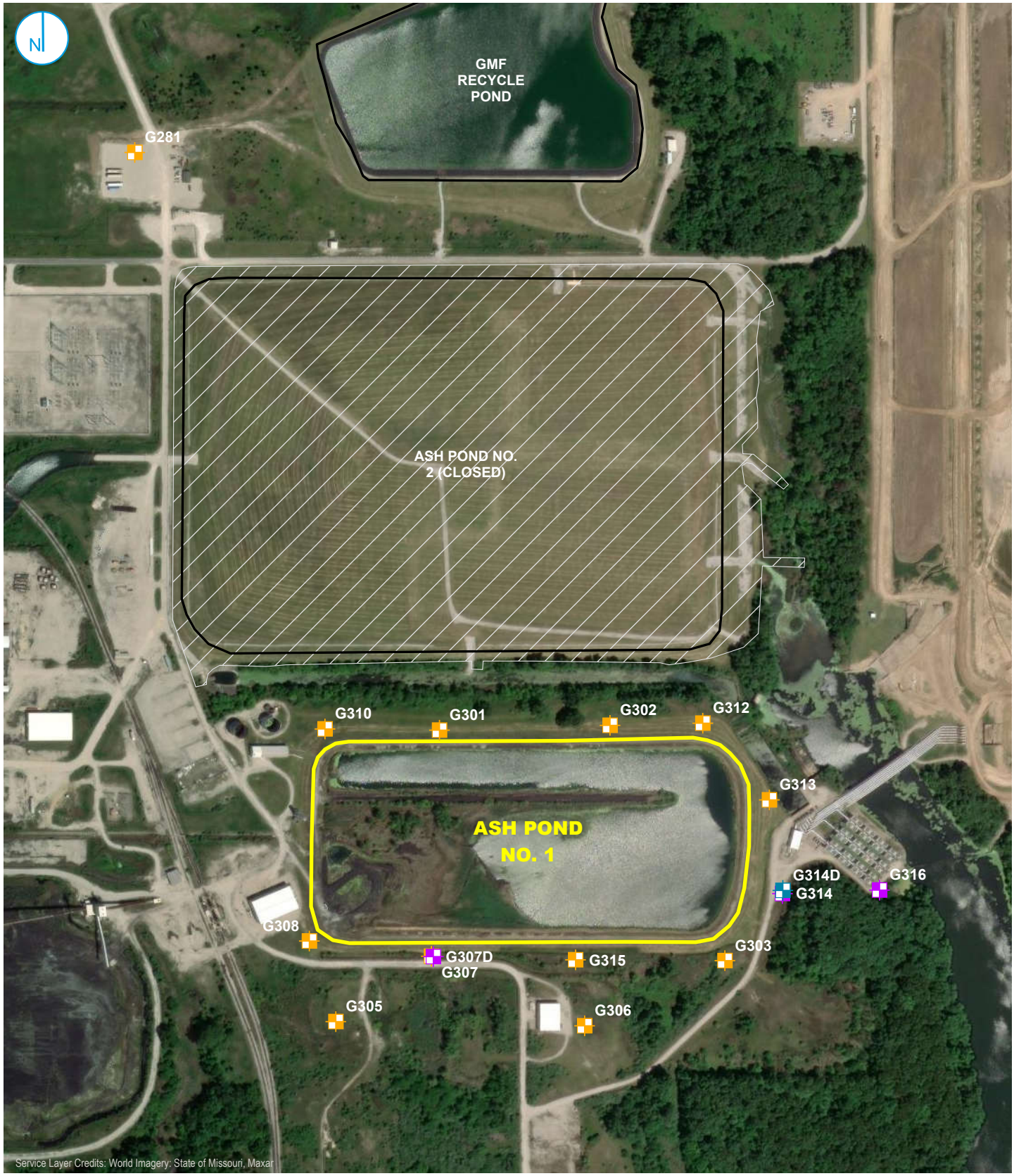
ASH POND NO. 1

COFFEEN, ILLINOIS

Monitoring Well	Time to Achieve GWPS in Monitoring Well (Year)	
	Alternative 1 Remedy (Source Control with Groundwater Polishing)	Alternative 2 Remedy (Source Control with Groundwater Extraction)
G281	0	0
G301	40	40
G302	7	7
G303	10	9
G305	0	0
G306	0	0
G307	4	4
G307D	17	16
G308	13	13
G309	13	12
G310	14	13
G312	1	6
G313	10	10
G314	14	14
G314D	0	0
G315	14	13
G316	11	11
G317	0	0
Minimum	0	0
Maximum	40	40
Average	9	9

RAMBOLL

FIGURES



Y:\Mapping\Projects\22\2285\MXD\Model_Figures\Coffeen\AP1\CAAA-SIR\COF_101_CAAA.aprx\Figure 1. Monitoring Well Location Map

PROJECT: 169000XXXX | DATED: 3/21/2024 | DESIGNER: GALARNMC

UA MONITORING WELL

LCU (VANDALIA MEMBER) MONITORING WELL

LCU (SMITHBORO TILL) MONITORING WELL

REGULATED UNIT (SUBJECT UNIT)

SITE FEATURE

LIMITS OF FINAL COVER

0 250 500 Feet

MONITORING WELL LOCATION MAP

ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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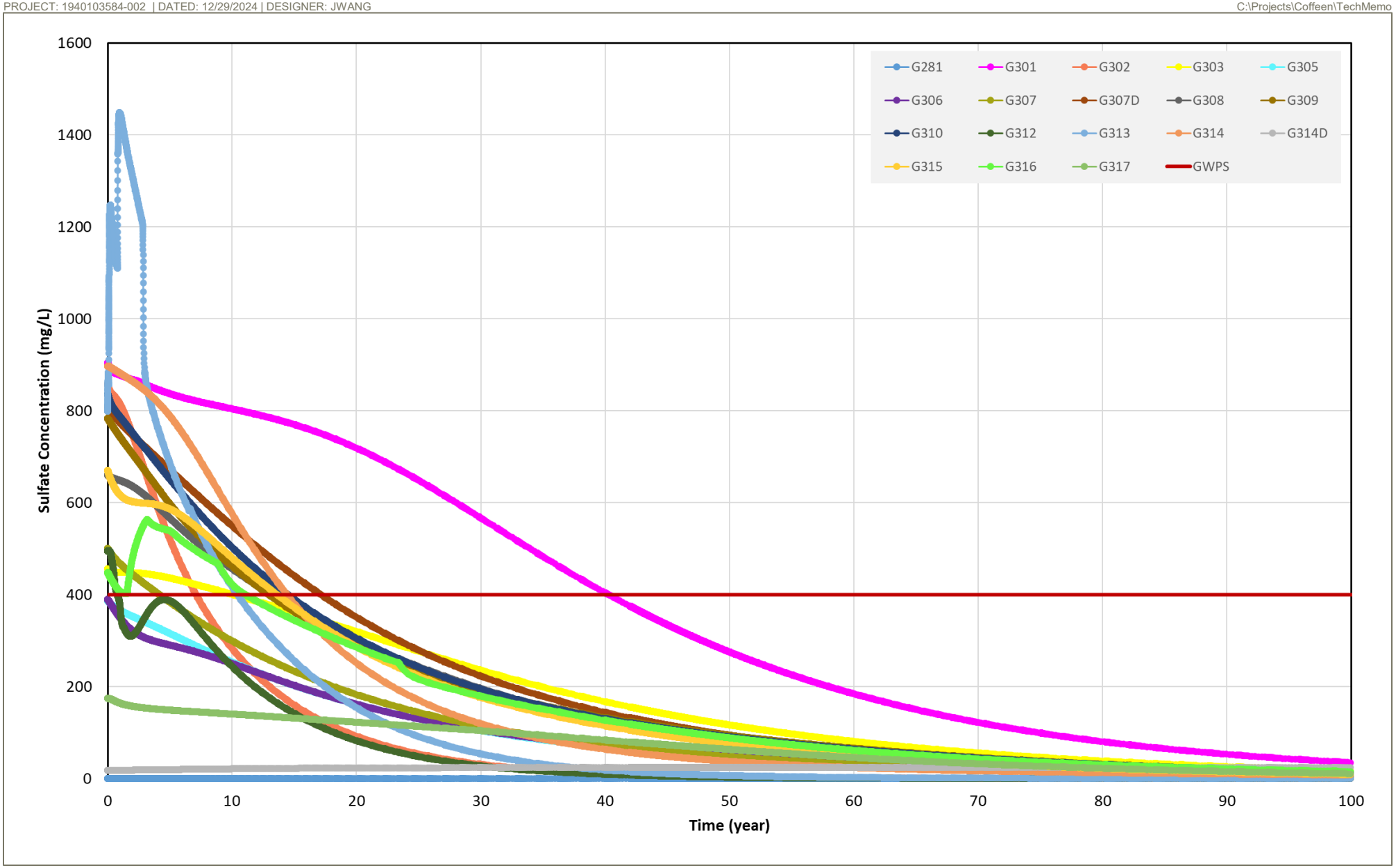

SIMULATED SULFATE CONCENTRATIONS IN AP1 MONITORING WELLS - ALTERNATIVE 1 REMEDY

ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

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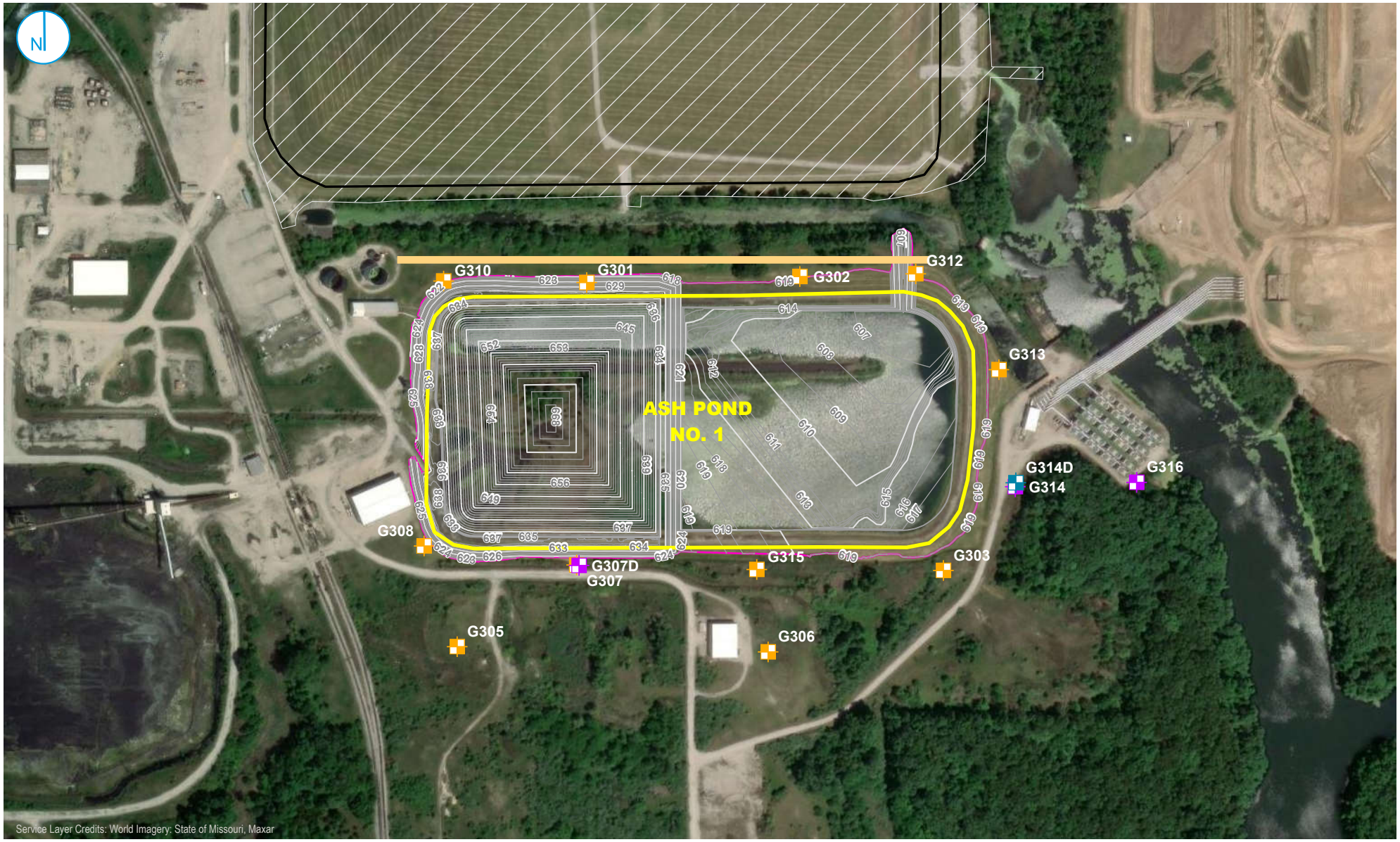

UA MONITORING WELL
LCU (VANDALIA MEMBER) MONITORING WELL
LCU (SMITHBORO TILL) MONITORING WELL
PROPOSED EXTRACTION TRENCH LOCATION

PROPOSED CLOSURE GRADES
5FT ELEVATION CONTOUR
1FT ELEVATION CONTOUR
PROPOSED CLOSURE GRADES BOUNDARY
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER

0 200 400 Feet

PROPOSED GROUNDWATER EXTRACTION TRENCH LOCATION - ALTERNATIVE 2 REMEDY

ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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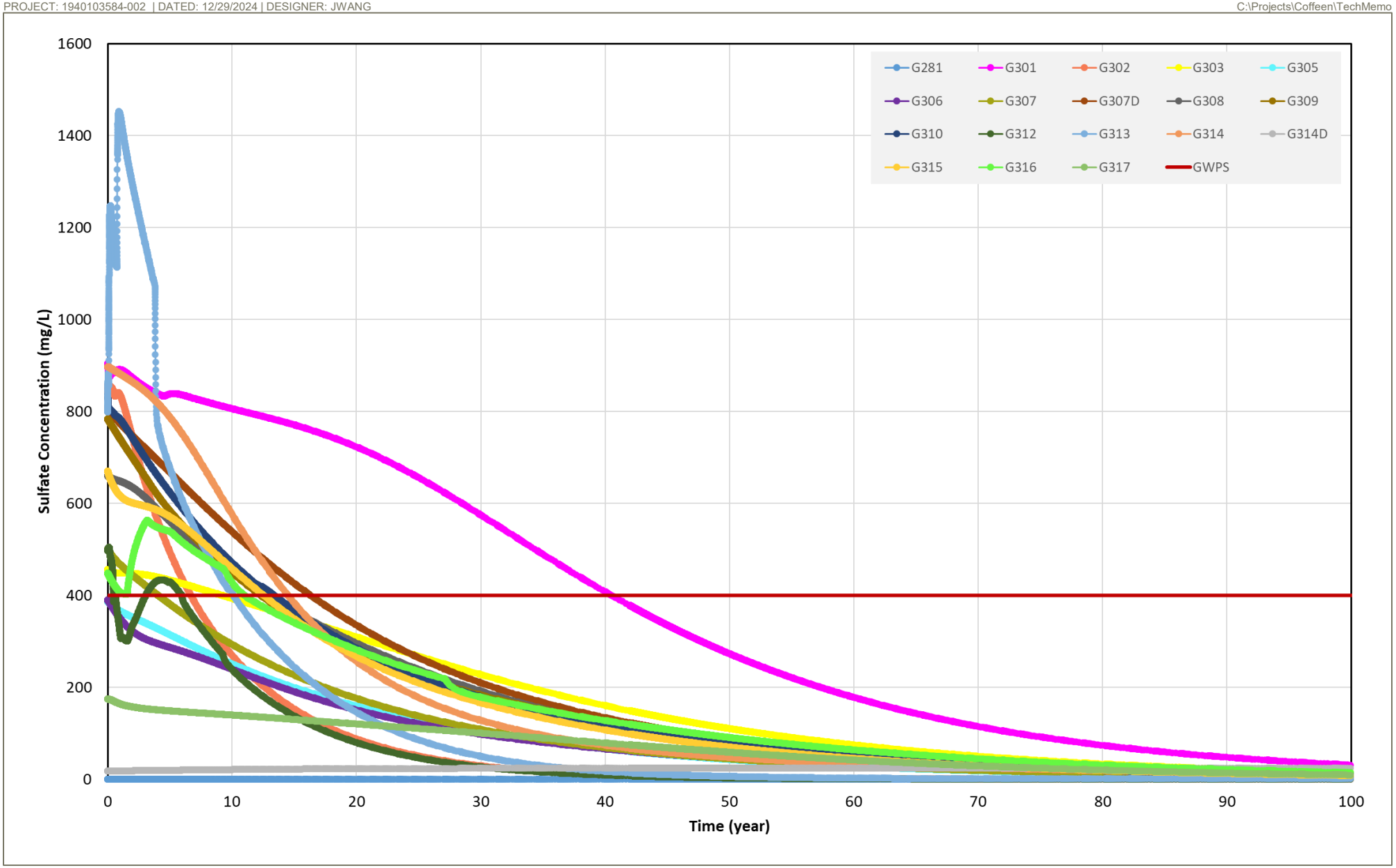

SIMULATED SULFATE CONCENTRATIONS IN AP1 MONITORING WELLS - ALTERNATIVE 2 REMEDY

ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.
A RAMBOLL COMPANY

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APPENDIX A
MODFLOW AND MT3DMS MODELING FILES

(ELECTRONIC ONLY)

APPENDIX B2
GROUNDWATER MODELING REPORT (2022)

Intended for
Illinois Power Generating Company

Date
July 28, 2022

Project No.
1940101010-008

GROUNDWATER MODELING REPORT

ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT ASH POND NO. 1

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940101010-008**
Recipient	**Illinois Power Generating Company**
Document type	**Groundwater Model Report**
Revision	**FINAL**
Date	**July 28, 2022**

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ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
bgs	below ground surface
CBR	closure by removal
CCR	coal combustion residual(s)
CIP	closure in place
cm/s	centimeter per second
CPP	Coffeen Power Plant
CSM	conceptual site model
DA	deep aquifer
DCU	deep confining unit
DEM	Digital Elevation Model
ft^2	square feet
ft/d	feet per day
ft/ft	feet per foot
Geosyntec	Geosyntec Consultants, Inc.
GHB	general head boundary conditions
GMF GSP	Gypsum Management Facility Gypsum Stack Pond
GMF RP	Gypsum Management Facility Recycle Pond
GMP	Groundwater Monitoring Plan
GMR	Groundwater Modeling Report
GWPS	groundwater protection standard(s)
Hanson	Hanson Professional Services, Inc.
HCR	Hydrogeologic Site Characterization Report
HDPE	high density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
HFB	horizontal flow barrier
HUC	Hydrologic Unit Code
ID	identification
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company - IPGC
ISGS	Illinois State Geological Survey
K_D	linear isotherm
K_{eff}	effective hydraulic conductivity
K_F	Freundlich isotherm
K_L	Langmuir isotherm
Kd	distribution coefficient
Kh/Kv	anisotropy ratio
LCU	lower confining unit
LF	Landfill
L/kg	liters per kilogram
m	meter
mg/L	milligrams per liter

mil	one thousandth of an inch
mL/g	milliliters per gram
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
NRT	Natural Resources Technology, Inc.
Part 845	35 I.A.C. § 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments
R2	correlation coefficient
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment(s)
SSR	sum of squared residuals
TDS	total dissolved solids
TR	transient model
TVD	total-variation-diminishing
UA	uppermost aquifer
UCU	upper confining unit
USDA/NRCS	United States Department of Agriculture/Natural Resources Conservation Service
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Modeling Report (GMR) on behalf of the Coffeen Power Plant (CPP), operated by Illinois Power Generating Company - IPGC (IPGC), in accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) (Illinois Environmental Protection Agency [IEPA], 2021). This document presents the results of predictive groundwater modeling simulations for proposed closure scenarios for the coal combustion residuals (CCR) management unit Ash Pond Number (No.) 1 (AP1 [(Vistra Identification [ID] No. 101, IEPA ID No. W1350150004-01, and National Inventory of Dams [NID] No. IL50722]). AP1 is a 23-acre, unlined surface impoundment (SI) used to manage CCR and non-CCR waste streams at the CPP. Its total storage capacity is approximately 300 acre-feet.

The CPP is located in Montgomery County, in central Illinois between the two lobes of Coffeen Lake (**Figure 1-1**), which was formed in 1963 by damming the McDavid Branch of the East Fork of Shoal Creek. Coffeen Lake encompasses approximately 1,100 acres and was created to provide a source of cooling water for the CPP. Coffeen Lake borders the CPP to the west, east, and south, and agricultural land is located to the north. Historically coal mines were operated at depth below the site. Mine shafts, processing facilities, and historic coal storage were located on the southern extent of the CPP, south of AP1. The CPP operated as a coal-fired power plant from 1964 until November 2019 and has five CCR management units, with AP1 being the subject of this GMR. Unlithified material present above the bedrock in the vicinity of the CPP was categorized into hydrostratigraphic units as part of the 2021 Hydrogeologic Site Characterization Reports (HCR; Ramboll, 2021a). In addition to the CCR, the hydrostratigraphic units occur in the following order (from ground surface downward) and include:

- **Upper Confining Unit (UCU):** Consists of the Loess Unit and the upper clayey portion of the Hagarstown Member which has generally lower vertical permeability. The UCU has been eroded east of AP1, near the Unnamed Tributary.
- **Uppermost Aquifer (UA):** The UA is the sandy portion of the Hagarstown Member which is classified as primarily sandy to gravelly silts and clays with thin beds of sands. Similar to the Loess Unit, the Hagarstown is absent in some locations near the Unnamed Tributary.
- **Lower Confining Unit (LCU):** Comprised of the Vandalia Member, Mulberry Grove Member, and Smithboro Member. These units include a sandy to silty till with thin, discontinuous sand lenses, a discontinuous and limited extent sandy silt which has infilled prior erosional features, and silty to clayey diamicton, respectively.
- **Deep Aquifer (DA):** Sand and sandy silt/clay units of the Yarmouth Soil, which include accretionary deposits of fine sediment and organic materials, typically less than five feet thick and discontinuous across the CPP.
- **Deep Confining Unit (DCU):** Comprised of the Banner Formation and generally clays, silts, and sands. The Lierle Clay Member is the upper layer of the Banner Formation which was encountered at the CPP.

Flow of groundwater from central portions of the CPP to Coffeen Lake or the Unnamed Tributary through the UA are the primary pathways for contaminant migration. Groundwater elevations are

primarily controlled by surface topography, geologic unit topography, and water levels within Coffeen Lake and the Unnamed Tributary. A groundwater divide trending north-south is observed running through the approximate center of the CPP. Phreatic surfaces or water elevations within the SI are generally consistent and have not been observed to fluctuate with groundwater elevations, indicating limited hydraulic connection with the SI.

The conceptual site model (CSM) for modeling the groundwater at the CPP is as follows:

- Most hydrostratigraphic layers are laterally continuous across the area. The flat to gently rolling uplands are dissected by deeply incised streams (into the materials of the UCU, UA, and LCU) that are tributaries to river systems in the area. Coffeen Lake was created by damming one of these tributary streams for use by the CPP.
- The UA is separated from the bottom of the AP1 by a minimum of 10 feet of low-permeability glacial till that comprises the UCU. Erosion caused by incised streams has occurred along the northeast corner of AP1 which likely results in ash being in contact with the UA.
- Surface recharge and groundwater migrate vertically through the low permeability sediments of the UCU. Groundwater migrates horizontally through the higher permeability sediments of the UA.
- Groundwater elevations and lake elevations indicates groundwater flows into Coffeen Lake from the UA.
- AP1 is constructed such that the earthen berm and base are in contact with the UCU with exception of limited areas in the northeast of the SI where the UCU and UA have been eroded and the berm and base are in contact with the LCU.
- The stage within AP1 is managed with minimal (less than 3 feet) variability throughout the year.

A review and summary of data collected from 2015 through 2021 for parameters with groundwater protection standards (GWPS) listed in 35 I.A.C. § 845.600 is provided in the HCR (Ramboll, 2021a). Concentration results presented in the HCR and summarized in the History of Potential Exceedances (Ramboll, 2021b) are considered potential exceedances because the methodology used to determine them is proposed in the Statistical Analysis Plan (Appendix A to the Groundwater Monitoring Plant [GMP], Ramboll 2021c), which has not been reviewed or approved by IEPA at the time of submittal of the Part 845 operating permit application. The following constituents with potential exceedances of the GWPS listed in 35 I.A.C. § 845.600 were identified: boron, cobalt, pH, sulfate, and total dissolved solids (TDS) (Ramboll, 2021b) at AP1.

A Technical Memorandum (**Attachment A**) was prepared by Geosyntec Consultants, Inc. (Geosyntec, 2022a), *Evaluation of Potential Groundwater Protection Standard Exceedances, Coffeen Ash Pond No.1, Coffeen Illinois*, to further evaluate potential GWPS exceedances. The results of the evaluation demonstrated that the potential GWPS exceedances of cobalt in well G314 and pH in well G312 are not related to AP1 based on several lines of evidence presented in the Technical Memorandum.

Statistically significant correlations between sulfate concentrations and concentrations of TDS identified as potential exceedances of the GWPS indicate sulfate is an acceptable surrogate for TDS in the groundwater model. Concentrations of TDS are expected to change along with model predicted sulfate concentrations. A potential exceedance of boron was observed at one

monitoring well, G313, which also has potential exceedances of both sulfate and TDS. Similar source and behavior in the groundwater system would be expected among boron, sulfate, and TDS at UA monitoring well G313, and boron concentrations are expected to change along with model predicted sulfate concentrations.

It was assumed that sulfate would not significantly sorb or chemically react with aquifer solids (distribution coefficient [Kd] was set to 0 milliliters per gram [mL/g]) which is a conservative estimate for predicting contaminant transport times in the model. Boron, sulfate, and TDS transport is likely to be affected by both chemical and physical attenuation mechanisms (*i.e.,* adsorption and/or precipitation reactions as well as dilution and dispersion).

All available hydrological information were used to construct a CSM and numerical model of the CPP. A steady state, 5-layer numerical model, based on a previous groundwater model of the area, was constructed to characterize the long-term groundwater flow conditions at the site. The hydrostratigraphic units included in the model were the UCU, UA, and LCU. The DA and DCU were not included in the model. Calibration of the model focused on simulating mean groundwater elevations for 95 wells at the site by modifying hydraulic parameters for the different hydrostratigraphic units, alongside river and general head boundary conductance. The calibrated model represents a reasonable match to the observed head and sulfate concentration data.

The calibrated model was used to predict the sulfate concentration for two closure scenarios using information provided in the Final Closure Plan for AP1 (Golder Associates [Golder], 2022a) including:

- **Scenario 1:** closure in place (CIP) including removal of CCR from the eastern portion of AP1, consolidation into the western portion of AP1, and construction of a cover system over the remaining CCR, and;
- **Scenario 2:** closure by removal (CBR) including removal of all CCR and regrading of the removal area.

Prior to the simulation of these scenarios, a dewatering simulation was included, which simulated the removal of free liquids from AP1 prior to the implementation of the two closure scenarios.

Scenario 1 (CIP) was predicted to reduce total flux in and out of the Fill Unit (CCR) by approximately 99.9%, when simulated post-construction heads in the groundwater monitoring wells are predicted to stabilize. Additionally, the base of consolidated CCR was compared to the simulated steady-state groundwater elevations which indicate between 3.2 and 10 feet of separation will be present between the base of CCR and groundwater.

Differences exist in the timeframes to reach the GWPS for most monitoring wells between CIP and CBR. In general, the simulated groundwater concentrations in the monitoring wells within the UA will achieve the GWPS in 15 years and 18 years respectively for the CIP and CBR closure scenarios, with the exception of well G301 in the CIP scenario. The predicted delayed reduction in concentration at well G301, 59 years to reach the GWPS, is a result of the well being located along the flow path of the residual sulfate concentrations released into native geologic materials prior to closure. Reduced percolation rates through the consolidation area at the northwest corner of AP1 in the CIP scenario means that the residual sulfate concentrations in this limited area require a longer time period to migrate through native geologic materials.

1. INTRODUCTION

1.1 Overview

In accordance with the requirements of Part 845 (IEPA, 2021), Ramboll has prepared this GMR on behalf of the CPP, operated by IPGC. This report will apply specifically to the CCR unit referred to as AP1 (**Figure 1-1**). However, information gathered to evaluate other CCR units at the CPP regarding geology, hydrogeology, and groundwater quality is included, where appropriate. AP1 is a 23-acre, unlined SI used to manage CCR and non-CCR waste streams at the CPP. Its total storage capacity is approximately 300 acre-feet. This GMR presents and evaluates the results of predictive groundwater modeling simulations for two proposed closure scenarios, including CCR consolidation and CIP, and CBR scenarios summarized below.

- **Scenario 1:** CIP including removal of CCR from the eastern portion of AP1, consolidation into the western portion of AP1, and construction of a cover system over the remaining CCR.
- **Scenario 2:** CBR including removal of all CCR and regrading of the removal area.

1.2 Previous Groundwater Modeling Reports

Several reports containing groundwater modeling have been completed at the CPP. The information presented in this GMR includes data collected in support of the previous groundwater models as well as data collected as part of a 2021 field investigation to support development of a HCR (Ramboll, 2021a). The HCR was provided as an attachment to the initial operating permit application required by 35 I.A.C. § 845.230. Previous groundwater modeling reports completed for the various CCR units located at the CPP include, but are not limited to, the following (recent to oldest):

- ***Natural Resources Technology, Inc. (NRT), January 24, 2017. Hydrostatic Modeling Report. Coffeen Power Station, Coffeen, Illinois.***
  Utilized the Hydrologic Evaluation of Landfill Performance (HELP) model to predict percolation from Ash Pond No. 2 (AP2) and evaluate AP2 hydrostatic conditions in response to the proposed cover system as described in the Revised 30% Closure Design Package.
- ***NRT, January 24, 2017. Groundwater Modeling Report. Coffeen Power Station, Coffeen, Illinois.***
  Included simulations of the site hydrology, the extent of CCR leachate impacts on groundwater, and the effect of pond closure on groundwater quality.

1.3 Site Location and Background

The CPP is located in Montgomery County, in central Illinois, within Section 11 Township 7 North and Range 7 East (**Figure 1-1**). The CPP is approximately two miles south of the city of Coffeen and about eight miles southeast of the city of Hillsboro, Illinois. AP1 is located between the two lobes of Coffeen Lake (identified as "Coffeen Lake" and "Unnamed Tributary" on **Figure 1-1** and **Figure 1-2**) to the west, east, and south, and is bordered by agricultural land to the north. The approximately 1,100-acre Coffeen Lake was built by damming the McDavid Branch of the East Fork of Shoal Creek in 1963 for use as an artificial cooling lake for the CPP. Historically, several coal mines were operated at depth in the vicinity of the CPP as well as the US Minerals processing facility located to the north. **Figure 1-2** is a site map showing the location of AP1 (Part 845 regulated CCR unit and subject of this GMR), AP2, Gypsum Management Facility Recycle Pond

(GMF RP), Gypsum Management Facility Gypsum Stack Pond (GMF GSP), and Landfill (LF). A surface water pond southwest of the LF collects overflow from the LF, this feature does not contain CCR. The area near AP1 will hereinafter be referred to as the Site.

1.4 Site History and CCR Units

The CPP was a coal-fired electrical generating plant that began operation in 1964. The plant initially burned bituminous coal from Illinois and CCR from the coal fired units was disposed of in AP1. AP2 was also utilized in the early 1970's and AP1 was reconstructed in 1978. Both of these units were used until the mid-1980's. Beginning in 2010, CCR material was placed in the LF and GMF units (*i.e.,* GMF RP and GMF GSP). All approximate dates of construction of each successive stage of the CCR units at the CPP are included in the groundwater model and described here.

AP1: This SI (also known as the Bottom Ash/Recycle Pond) is a reclaimed ash pond that was reconstructed utilizing the existing earthen berms with reinforcement, as provided by Water Pollution Control Permit 1978-EA-389 issued by the IEPA on May 26, 1978. AP1 (existing unlined SI) covers an area of approximately 23 acres, has berms up to 41 feet above the surrounding land surface, and a volume of 300 acre-feet. It primarily received bottom ash and low volume wastes from floor drains in the main power block building. Several years ago, air heater wash and boiler chemical cleaning wastes were directed to AP1, but this practice was discontinued. The bottom ash was periodically removed for beneficial uses by a third-party contractor. Sluicing of waste to AP1 ceased prior to November 4, 2019.

AP2: AP2 is a closed (IEPA approved) SI with a surface area of approximately 60 acres and berms 47 feet higher than the surrounding land surface. AP2 was originally removed from service and capped in the mid 1980's. A clay and soil cap was placed on the surface of the pond with contouring and drainage provided to direct storm water to four engineered revetment down drain structures. Prior to capping, this pond was identified as Outfall 004 in the facility National Pollutant Discharge Elimination System (NPDES) operating permit, IL0000108. Additional closure activities include the construction of a geomembrane cover system that began in July 2019 and was completed on November 17, 2020. The construction was completed in accordance with the Closure and Post Closure Care Plan approved by the IEPA on January 30, 2018.

GMF GSP: The 77-acre GMF GSP received blowdown from the air emission scrubbers and was put into operation in 2010. Construction of the GMF GSP was in accordance with Water Pollution Control Permit 2008-EA-4661 and features a composite 60- one thousandth of an inch (mil) high-density polyethylene (HDPE) liner with 3 feet of recompacted soil with a hydraulic conductivity of 1×10^{-7} centimeters per second (cm/s) with internal piping and drains to collect contact water. Construction of the unit required excavation to approximately 603 feet North American Vertical Datum of 1988 (NAVD88), removal of the sands and silts of the UA prior to construction of the liner, and installation of a groundwater underdrain system to eliminate inward pressure on the liner prior to placement of CCR. The GMF GSP underdrain was actively pumped during construction but is no longer actively pumped. IPGC ceased receipt of waste to the GMF GSP prior to April 11, 2021.

GMF RP: The 17-acre GMF RP received blowdown from the air emission scrubbers and was put into operation in 2010. Construction of the GMF RP was in accordance with Water Pollution Control Permit 2008-EA-4661 and features a composite 60-mil HDPE liner with 3 feet of recompacted soil with a hydraulic conductivity of 1×10^{-7} cm/s with internal piping and drains to collect contact water. Construction of the unit required excavation to approximately 601 feet

NAVD88, removal of the sands and silts of the UA prior to construction of the liner, and installation of a groundwater underdrain system to eliminate inward pressure on the liner prior to placement of CCR. The GMF RP underdrain is a passive, gravity drained system. IPGC ceased receipt of waste to the GMF RP prior to April 11, 2021.

LF: Fly ash was managed in a permitted composite lined landfill constructed in 2010. The LF has an active groundwater underdrain system that is currently being pumped. Additionally, the ash landfill leachate collection system is restricted by rule to no more than one foot of leachate on the composite liner. An IEPA groundwater monitoring program is in effect for the GMF GSP and GMF RP (under Bureau of Water), and LF (under Bureau of Land).

2. SITE GEOLOGY AND HYDROGEOLOGY

2.1 Stratigraphy

The geology and hydrogeology of AP1 are described in detail in the HCR (Ramboll, 2021a) and summarized below.

The unlithified stratigraphy within and immediately surrounding AP1 consists of the following in descending order: fill material and CCR; clays and silts (Loess Unit); gravelly clay till and sandy materials, absent in some locations (Hagarstown Member); a weathered till zone and sandy, silt, or clay till (Vandalia Member); silt and sandy silt/clay unit (Mulberry Grove Member); silty clay diamicton (Smithboro Member); sand and sandy silt/clay, absent in some locations (Yarmouth Soil); and clay and silt with some sand (Lierle Clay Member). The unlithified units overlay Pennsylvanian-age limestone, sandstone, and minor coal beds (Bond Formation). The Bond Formation bedrock was not encountered in any borings advanced at the CPP, so site-specific information is not available.

CCR consisting of bottom ash and other non-CCR waste is present within AP1 at a thickness of up to 18 feet, as estimated from borings advanced within AP1, and an average thickness of 10 feet. However, CCR materials may be thicker near former drainage features in localized areas eroded through the loess and clay (Ramboll, 2021a). One such former drainage feature is located in the northeast corner of AP1 and ash fill may be in contact with the sandy portion of the Hagarstown Member similar to features observed at AP2. Non-CCR fill material consisting of silty clay, sandy lean clay, or lean clay with sand, with trace amounts of fine gravel comprises the berms surrounding AP1.

The Loess Unit is the uppermost unlithified unit identified at the CPP. This unit is comprised of the combined Roxana and Peoria Silt and extends from beneath the topsoil, derived from the loess, to the top of the Hagarstown Member. The loess has been classified as silt or clayey silt, with minor amounts of sand. The Loess Unit ranges in thickness from 0 feet (absent) to 16 feet, and was generally 8 to 14 feet thick, where present near AP1. The Loess Unit is generally considered unsaturated, and the UA is recharged by precipitation that percolates through this unit.

The Hagarstown Member (also referred to as Hagarstown Beds) exhibits two units: the first unit consisting of the gravelly clay till and the second consisting of sandy material overlying the Vandalia Member. The clay till portion had varying thicknesses ranging from approximately 2 to 6 feet as observed adjacent to AP1 (Ramboll, 2021a). The sandy portion of the Hagarstown, where present, was typically encountered between 9 and 34 feet below ground surface (bgs) near AP1, and is generally 1 to 5 feet thick, although thicknesses up to 7 feet have been observed north of the LF (Ramboll, 2021d; Ramboll, 2021e). The composition of the sandy portion of the Hagarstown unit varies across the CPP and has been classified as gravelly till, poorly sorted gravel, well sorted gravel, sand, and silty sand. Based on historic topography, the Hagarstown Member is not present in former drainage features present along the banks of Coffeen Lake and the Unnamed Tributary. During construction of the LF, GMF GSP, and the GMF RP, the Loess Unit and portions of the Hagarstown Member were excavated to facilitate construction.

The Vandalia (*i.e.,* till) Member is a sandy/silty till with thin, discontinuous lenses of silt, sand, and gravel. The Vandalia Member was encountered between 1.5 and 34 feet bgs in all borings

advanced at the CPP. The Vandalia Member typically ranged in thickness from 11.7 feet in the northern portion of the CPP, to 31.0 feet between the GMF GSP and the GMF RP. Similar to the observed top elevation of the Hagarstown Member, the top of the Vandalia Member declines in elevation near Coffeen Lake and topographic drainage features. This unit is relatively thick throughout the CPP, with an average thickness of over 15 feet (Hanson Professional Services, Inc. [Hanson], 2009).

The Mulberry Grove (*i.e.,* silt) Member typically consists of a thin, lenticular unit of gray sandy silt (Willman et al., 1975). It represents the interval between the retreat of the glacier that deposited the Smithboro Member and the advance of the glacier that deposited the Vandalia Member. At the CPP, the Mulberry Grove Member is represented by gray sandy silt layers deposited in depressions found in the surface of the underlying Smithboro Member. This unit was absent in many borings through the central portion of the CPP from south to north, and is generally less than 2 feet thick, but was measured at up to 4.9 feet thick near the GMF GSP (Hanson, 2009).

The Smithboro (*i.e.,* till) Member is described as a gray, compact, silty, clayey diamicton that ranges in thickness from 6.7 to 21.2 feet northwest of the LF.

The Yarmouth Soil is described as the weathered zone on the Kansan drift, but in some places, it consists of accretionary deposits of fine sediment and organic material that accumulated in poorly drained areas on the surface of the Kansan deposits. Historical borings in the northern portion of the CPP which encountered the Yarmouth were summarized previously by Hanson (2009) as ranging in thickness from 0 feet (absent) to 5.1 feet.

The Lierle Clay Member is the uppermost member of the Kansan Stage Banner Formation. It is described as an accretion gley with clay, silt, and some sand. It was encountered by Hanson (2009) in all but a few borings on site. During the 2021 investigation, the top of the Lierle Clay was observed between 54 and 57 feet bgs. No borings advanced at the CPP penetrated the full thickness of the Banner Formation.

Pennsylvanian-age Bond Formation bedrock was not encountered in any borings advanced at the CPP, so site-specific information is not available.

2.2 Hydrogeology

Regionally, the water table conforms to the topographic features of the land surface. Recharge occurs in the uplands and flows towards drainage features. Moderate thicknesses of unconsolidated materials fill shallow valleys or are present on the uplands bordering the main valleys. These materials contain thin and discontinuous deposits of sand and gravel.

2.2.1 Groundwater Flow

Monitoring well locations are illustrated in **Figure 2-1**. Monitoring well locations and construction details are summarized in **Table 2-1**. Overall groundwater flow within the UA is divided towards the two lobes of Coffeen Lake. Groundwater generally flows from the center of the CPP west towards Coffeen Lake, and east towards the Unnamed Tributary, the eastern lobe of Coffeen Lake, and the discharge flume, resulting in a groundwater divide (high) running through the middle of the CPP (**Figure 2-2** and **Figure 2-3**). Groundwater flows north to northeast across AP1 toward the former discharge structure and Unnamed Tributary. Although elevations vary

seasonally, the groundwater flow direction in the UA is consistent and likely controlled by the proximity and hydraulic connection to Coffeen Lake.

2.2.2 Hydraulic Properties

Over 100 monitoring wells have been installed since 2006 to monitor groundwater conditions around the five CCR units at the CPP for both State and Federal groundwater compliance programs. Six hydrostratigraphic units were described in detail in the HCR (Ramboll, 2021a) and are summarized as follows:

- **CCR**: This unit is composed of CCR, consisting primarily of bottom ash. This also includes earthen fill deposits of predominantly silt and clay materials from on-site excavations that were used to construct berms and roads surrounding the various impoundments across the CPP. Laboratory testing of one CCR (ash) sample from AP1 had a vertical hydraulic conductivity of 8.8×10^{-5} cm/s.
- **UCU**: Consists of the Loess Unit and the upper clayey portion of the Hagarstown Member which has generally lower vertical permeability and generally greater than 60 percent fines (Ramboll, 2021a). This unit was encountered across most of the CPP, with the exception of the eastern edges of AP1 near the Unnamed Tributary where the unit was eroded following deposition or locations where it has been excavated for construction. Vertical hydraulic conductivities based on laboratory testing ranged from 1.3×10^{-8} to 5.0×10^{-7} cm/s.
- **UA** This unit consists primarily of sand and sandy silts and clays at the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member. This unit is absent in several locations due to weathering and in others due to excavation during construction of CCR Units. Field hydraulic conductivity tests indicated hydraulic conductivities ranged from 1.7×10^{-5} to 9.1×10^{-3} cm/s near AP1. Laboratory testing of one UA sample, collected near the GMF RP, had a vertical hydraulic conductivity of 1.6×10^{-4} cm/s (Ramboll, 2021a).
- **LCU**: This unit is composed of the sandy clay till of the Vandalia Member, the silt of the Mulberry Grove Formation, and the compacted clay till of the Smithboro Member. The unit underlies the UA and was encountered in all boring locations on the CPP. Results from laboratory tests completed for vertical hydraulic conductivity indicate the Vandalia Member has a very low vertical hydraulic conductivity. Field hydraulic conductivity tests indicated hydraulic conductivities from 4.0×10^{-8} to 3.4×10^{-5} cm/s; however, these likely reflect the isolated and discontinuous sandy lenses. Vertical hydraulic conductivities based on laboratory testing were from 1.3×10^{-8} to 5.0×10^{-7} cm/s.
- **DA**: This unit consists primarily of sandy silt and sands of the Yarmouth Soil, which are thin (less than 5 feet) and discontinuous across the CPP. Field hydraulic conductivity tests indicated hydraulic conductivities from 8.7×10^{-5} to 1.7×10^{-3} cm/s within the DA.
- **DCU**: This unit underlies the DA and is composed of the Banner Formation, of which the thick Lierle Clay is the first encountered unit. No boring penetrated the full thickness of this formation.

2.2.3 Groundwater Elevation Data

During the 2021 Part 845 investigation, groundwater elevations in the UA ranged from approximately 591 to 625 feet NAVD88 across the CPP. Groundwater elevations were typically

highest towards the northern extent of the CPP, near the GMF GSP and GMF RP, except monitoring well G307 south of AP1, which consistently had the highest groundwater elevation. Groundwater elevations were lowest near the Unnamed Tributary and east of AP1 towards Coffeen Lake. Groundwater elevations in the vicinity of AP1 were typically from 591 to 621 feet NAVD88, with the exception of G307 as noted above, which was typically around 624 feet NAVD88 (**Figure 2-2** and **Figure 2-3**).

No seasonal variation has been observed in the UA monitoring wells, and any seasonal responses may be muted by the proximity and hydraulic connection to Coffeen Lake.

2.2.4 Mining Activity

Several coal mines, both strip and underground types, previously operated in Montgomery County, Illinois. Three mines - the Hillsboro Mine (Illinois State Geological Survey [ISGS] Mine No. 871), the Clover Leaf No. 4 Mine (ISGS Mine No. 442), and the Clover Leaf No. 1 Mine (ISGS Mine No. 3001) – were operated as room and pillar mines in the vicinity of the site beginning as early as 1889. The mines extracted coal from the Herrin (No. 6) Coal at depths of approximately 500 to 535 feet bgs (ISGS, 2019). All nearby mining operations ceased in 1983.

The Hillsboro Mine showed indications of small-scale faulting, roof stability issues, and floor heaving. Mine shafts, processing facilities, and some historic coal storage associated with these historic mines were located south of AP1. AP1 directly overlies the Hillsboro Mine. AP1 is outside of the buffer zone of the Clover Leaf No. 4 and Clover Leaf No. 1 mines (Ramboll, 2021a).

3. GROUNDWATER QUALITY

3.1 Groundwater Classification

Per 35 I.A.C. § 620.210, groundwater within the UA at AP1 meets the definition of Class I - Potable Resource Groundwater based on the following criteria:

- Groundwater in the UA is located 10 feet or more below the land surface and
- Within a geologic material which is capable of a hydraulic conductivity of 1 x 10^{-4} cm/s or greater using a slug test.

Field hydraulic conductivity tests performed in the UA near AP1 in 2021 had a geometric mean of 2.0 x 10^{-3} cm/s (Ramboll, 2021a). Based on this information, groundwater is classified as Class I – Potable Resource Groundwater.

However, background (upgradient) groundwater originates from areas southwest of AP1 that have historically been used for coal storage and present a potential alternate source for groundwater impacts.

3.2 Potential Groundwater Exceedances

A review and summary of data collected from 2015 through 2021 for parameters with GWPSs listed in 35 I.A.C. § 845.600 is provided in the HCR (Ramboll, 2021a). Concentration results presented in the HCR were compared directly to 35 I.A.C. § 845.600 GWPSs to determine potential exceedances. The results are considered potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or utilize the statistical methodologies proposed in the GMP (Ramboll, 2021c) attached to the operating permit application.

Groundwater concentrations from 2015 to 2021 are summarized in the History of Potential Exceedances (Ramboll, 2021b) (attached to the operating permit application) and are considered potential exceedances because the methodology used to determine them is proposed in the Statistical Analysis Plan (Appendix A to the GMP, Ramboll 2021c), which has not been reviewed or approved by IEPA at the time of submittal of the Part 845 operating permit application.

The History of Potential Exceedances attached to the operating permit application summarizes all potential groundwater exceedances following the proposed Statistical Analysis Plan. The following potential exceedances were identified:

- Boron – determined at well G313.
- Cobalt - determined at well G314.
- pH (lower limit) - determined at well G312.
- Sulfate - determined at wells G301, G303, G304/G307, G305, G307D, G308, G309, G310, G311, G312, G313, G314, G314D, G315, and G317.
- TDS - determined at wells G303, G304/G307, G305, G307D, G308, G309, G310, G311, G312, G313, G314, G315, and G317.

A Technical Memorandum (**Attachment A**) was prepared by Geosyntec Consultants, Inc. (Geosyntec, 2022a), *Evaluation of Potential Groundwater Protection Standard Exceedances, Coffeen Ash Pond No.1, Coffeen Illinois*, to further evaluate potential GWPS exceedances. The

results of the evaluation demonstrated that the potential GWPS exceedances of cobalt in well G314 and pH in well G312 are not related to AP1 based on several lines of evidence presented in the Technical Memorandum. Since potential GWPS exceedances for cobalt and pH are not related to AP1, these parameters will not be discussed further in this GMR.

4. GROUNDWATER MODEL

4.1 Overview

Data collected at the Site from 2015 to the 2021 field investigation were used to update an existing groundwater model of the CPP (NRT, 2017b). The updated model was then used to evaluate the results of predictive groundwater modeling simulations for two proposed closure scenarios, including CCR consolidation and CIP, and CBR. The modeling results are summarized and evaluated in this GMR. The associated model files are included as **Appendix B**.

4.2 Description of Existing Model

The NRT (2017b) contaminant fate and transport model simulated boron and was performed to support closure of AP2 using MODFLOW and MT3DMS. AP1, GMF GSP, GMF RP, and LF were present within the previous model domain.

The NRT (2017b) modeling consisted of the following:

- Steady-state MODFLOW model was developed to represent site conditions for 2016. This model was calibrated to a set of groundwater elevation data collected during November 2016.
- The hydraulic properties from the steady-state model were used in the calibration of the transient MODFLOW and MT3DMS models which simulated groundwater flow and transport at the AP2 from 1970 to 2017. Boron concentrations collected in August 2016 were used to calibrate the transport model.
- Predictive simulations to estimate future boron concentrations for a baseline (no action) and capping closure scenario for AP2 were completed. Closure action was modeled over a period of 1,500 years, beginning in January 2018.
- Predicted boron concentrations were simulated to reach compliance for CIP at AP2 after 101 years (NRT, 2017b). These modeling results were part of the closure plan approved by IEPA on January 30, 2018.

4.3 Conceptual Model

The HCR (Ramboll, 2021a) forms the foundation of the AP1 hydrogeological setting. The AP1 overlies the recharge area for the underlying transmissive geologic media, which are composed of unlithified deposits.

4.3.1 Hydrogeology

As discussed in **Section 2.2**, groundwater flow in the UA at the CPP is divided towards the two lobes of Coffeen Lake. The loess of the UCU and sands of the UA are hydraulically connected. The groundwater flow in the silts and clays of the UCU and LCU are expected to be primarily vertical. The Hagarstown member is where the majority of the horizontal migration is expected to occur. The hydrogeological CSM consists of the following layers:

- Hagarstown Loess Unit (*i.e.,* UCU) – Loess Unit and the upper clayey portion of the Hagarstown Member.
- Hagarstown Member (*i.e.,* UA) – sand and sandy silts and clays at the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member.

- Vandalia Member/Mulberry Grove Member (*i.e.,* LCU) – unweathered sandy clay till and discontinuous silts.
- Smithboro Till (*i.e.,* LCU) – compacted clay till of the Smithboro Member.

The hydrostratigraphic units included in the model were the UCU, UA, and LCU. The DA and DCU were not included in the model, which includes consistency with the original model (NRT, 2017b). No potential GWPS exceedances have been observed in the DA. This, coupled with the limited groundwater data available for the DA and DCU, meant that these layers were not included in the model. Therefore, the Smithboro Till (*i.e.,* LCU) represents the lower boundary of the CSM.

Surfaces for each of the three major geological units (Loess Unit, Hagarstown Member, Vandalia/Mulberry Grove Member and Smithboro Till Member) were taken from the NRT model (2017b). The NRT model (2017b) used available information from well logs to interpolate the top and base of the UA.

4.3.2 Extent and Boundaries

The United States Geological Survey (USGS) National Map places the CPP within the East Fork Shoal Creek watershed subbasin (Hydrologic Unit Code [HUC] 071402030303).

The CPP CSM extent is bounded by a hydrological catchment (watershed) divide to the east based on watershed data from USGS. Along the north, south, and east, the model boundary has been placed along known waterbodies as much as possible. As such, it is assumed groundwater inflow from adjacent watersheds is negligible through both the UA and LCU.

The Coffeen Lake water levels are managed an average elevation 591.0 feet NAVD88. Coffeen Lake and Unnamed Tributary are the receiving body of water for surface water in the area encompassed by the CSM.

Infiltration of precipitation to the groundwater table is applied as recharge at the site. Groundwater in the UCU migrates downward into the Hagarstown Formation. As discussed in **Section 2.2.1**, the Hagarstown Formation is considered the UA for groundwater adjacent to AP1.

4.3.3 Ash Pond No. 1

AP1 is constructed such that the earthen berm and base are in contact with the UCU with exception of limited areas in the northeast of the SI where the UCU and UA have been eroded and the berm and base of CCR are in contact with the LCU. Findings from the HCR (Ramboll, 2021a) indicate that AP1 does influence the UA flow system, where there is a component of radial flow from AP1. However, this radial flow system appears to be centered around the southwest corner of AP1 resulting in a northerly and easterly component of groundwater flow within the UA.

Sulfate was selected for transport modeling. Sulfate is commonly used as an indicator parameter for contaminant transport modeling for CCR because: (i) it is commonly present in coal ash leachate; and (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater.

4.5 Model Approach

4.5.1 Potential Groundwater Exceedances

A comparison of observed TDS concentrations to sulfate (**Figure A** below) indicates a statistically significant correlation between these parameters in UA wells where these potential exceedances were observed. Observed concentrations were transformed into Log10 concentrations for evaluation. The correlation coefficient (R^2) and p values (indicator of statistical significance) are also provided on **Figure A**. Higher R^2 values (*i.e.,* closer to 1) indicate stronger correlation between parameters. A correlation is considered statistically significant when the p value is lower than 0.05. The correlation has a p value less than the target of 0.05, indicating the correlation is statistically significant. The statistically significant correlation associated with sulfate concentrations indicate sulfate is an acceptable surrogate for TDS in the groundwater model, and concentrations of this parameter are expected to change along with model predicted sulfate concentrations.

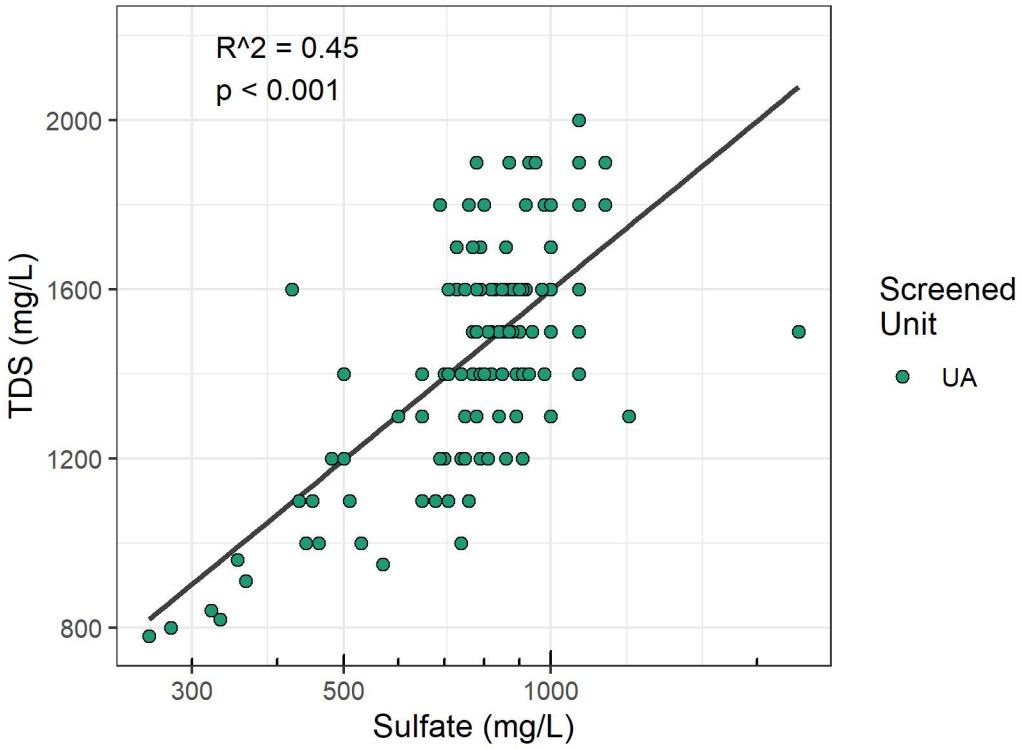

Figure A. Sulfate Correlation with TDS in UA Wells

A potential exceedance of boron was also observed at one monitoring well, G313, in the vicinity of AP1, based on the History of Potential Exceedances (Ramboll, 2021b). Correlations between sulfate and boron for the same AP1 UA wells did not indicate a statistically significant correlation between these constituents. However, UA monitoring well G313 has potential exceedances of both sulfate and TDS along with the potential exceedance of boron (**Section 3.2**). Boron, like sulfate, is a common indicator parameter used for contaminant transport modeling of CCR; and boron is less likely than other constituents to be present in background groundwater from natural or other anthropogenic sources. The only significant source of boron is AP1. With potential

exceedances of boron, sulfate, and TDS present in the same well (G313) and having the same source (AP1), boron concentrations are expected to change along with model predicted sulfate concentrations.

4.5.2 Summary of Modeling Activities

A three-dimensional groundwater flow model was calibrated to represent the conceptual flow system described above. Prediction simulations were performed to evaluate the effects of closure (source control) measures (CCR consolidation and CIP and CBR scenarios) for the CCR units on groundwater quality following initial corrective action measures, which includes removal of free liquids (dewatering). **Figure 4-1** illustrates the calibration and predictive modeling timelines.

Three model codes were used to simulate groundwater flow and contaminant transport:

- Groundwater flow was modeled in three dimensions using MODFLOW 2005.
- Contaminant transport was modeled in three dimensions using MT3DMS.
- Percolation (recharge) was modeled using the results of HELP model.

Modeling steps are a summarized below:

- A steady state model was created in MODFLOW 2005 and used to simulate the mean groundwater flow conditions at the site. The model was calibrated to match mean groundwater elevations observed between 2015 to 2021 (**Table 4-1**).
- Transient flow models based off of the calibrated steady state model were used to simulate groundwater flow and transport for 42 years using MODFLOW 2005 and MT3DMS to simulate changes in site conditions through time and match currently observed concentrations of sulfate in groundwater (**Table 4-1**).
- Prediction simulations began with a 2-year dewatering period simulated in MODFLOW 2005 and MT3DMS where heads were reduced within the CCR unit and concentrations were removed from CCR removal areas.
- Prediction simulations resumed for CIP and CBR following the 2-year dewatering period using the results of HELP modeling as input values for recharge rates in the construction areas.
- The prediction simulations were run using MODFLOW 2005 and MT3DMS to estimate the time for sulfate concentrations to meet the GWPS in the compliance wells and to evaluate the differences between the two closure scenarios.

5. MODEL SETUP AND CALIBRATION

5.1 Model Descriptions

For the construction and calibration of the numerical groundwater flow model for the site, Ramboll selected the model code MODFLOW, a publicly-available groundwater flow simulation program developed by the USGS (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system—given user-supplied inputs of hydraulic conductivity, aquifer/layer thickness, recharge, wells, and boundary conditions. The program also calculates water balance at wells, rivers, and drains.

MODFLOW was developed by USGS (McDonald and Harbaugh, 1988) and has been updated several times since. Major assumptions of the code are: (i) groundwater flow is governed by Darcy's law; (ii) the formation behaves as a continuous porous medium; (iii) flow is not affected by chemical, temperature, or density gradients; and (iv) hydraulic properties are constant within a grid cell. Other assumptions concerning the finite difference equation can be found in McDonald and Harbaugh (1988). MODFLOW 2005 was used for these simulations with Groundwater Vistas 7 software for model pre- and post- processing tasks (Environmental Simulations, Inc., 2017).

MT3DMS (Zheng and Wang, 1998) is an update of MT3D. It calculates concentration distribution for a single dissolved solute as a function of time and space. Concentration is distributed over a three-dimensional, non-uniform, transient flow field. Solute mass may be input at discrete points (wells, drains, river nodes, constant head cells), or distributed evenly or unevenly over the land surface (recharge).

MT3DMS accounts for advection, dispersion, diffusion, first-order decay, and sorption. Sorption can be calculated using linear, Freundlich, or Langmuir isotherms. First-order decay terms may be differentiated for the adsorbed and dissolved phases.

The program uses the standard finite difference method, the particle-tracking-based Eulerian-Lagrangian methods and the higher-order finite-volume total-variation-diminishing (TVD) method for the solution schemes. The finite difference solution has numerical dispersion for low-dispersivity transport scenarios but conserves good mass balance. The particle-tracking method avoids numerical dispersion but was not accurate in conserving mass. The TVD solution is not subject to significant numerical distribution and adequately conserves mass, but is numerically intensive, particularly for long-term models such as developed for this model. The finite difference solution was used for this simulation.

Major assumptions of MT3DMS are: (i) changes in the concentration field do not affect the flow field; (ii) changes in the concentration of one solute do not affect the concentration of another solute; (iii) chemical and hydraulic properties are constant within a grid cell; and (iv) sorption is instantaneous and fully reversible, while decay is not reversible.

The HELP model was developed by the United States Environmental Protection Agency (USEPA). HELP is a one-dimensional hydrologic model of water movement across, into, through, and out of

a landfill or soil column based on precipitation, evapotranspiration, runoff, and the geometry and hydrogeologic properties of a layered soil and waste profile. For this modeling, results of the HELP model, HELP Version 4.0 (Tolaymat and Krause, 2020) completed for the groundwater model were used to estimate the hydraulic flux from closure construction.

5.2 Flow and Transport Model Setup

The 2017 flow and transport models were retained and revised as appropriate to perform simulations for the AP1.

The modeled area was approximately 10,000 feet by 15,025 feet (150,250,000 square feet [ft^2]) centered on the CPP (**Figure 5-1**). The model boundaries along the northern and eastern edges of the model were selected to maintain sufficient distance from the CPP to reduce boundary interference with model calculations, while not extending too far past the extent of available calibration data. The eastern edge of the model also approximates topographic highs, surface water divides, and watershed boundaries.

The steady state MODFLOW model was calibrated to mean groundwater elevation collected from 2015 to 2021 as presented in **Table 4-1**. MT3DMS was run on the transient flow model and model-simulated concentrations were calibrated to observed sulfate concentration values at the monitoring wells from January 2015 to July 2021 as presented in **Table 4-1**. Multiple iterations of MODFLOW and MT3DMS calibration were performed to achieve an acceptable match to observed flow and transport data. For AP1, the calibrated flow and transport models were used in predictive modeling to evaluate the CIP and CBR closure scenarios. Prior to simulation of CIP and CBR, a dewatering phase, which simulated the removal of free liquid from the CCR material in the AP1 was completed. Closure scenarios were simulated by removing saturated ash cells from removal areas and using HELP modeled recharge values to simulate changes proposed in the closure scenarios.

5.2.1 Grid and Boundary Conditions

A five-layer, 326 x 211 node grid was established with a variable grid spacing between 25 and 100 feet (**Figures 5-2 through 5-6**), with a total number of 284,575 active cells.

The main body of Coffeen Lake is immediately adjacent to CPP on the west and south and the Unnamed Tributary borders CPP to the east. These surface water features form the southern, eastern, and western boundaries of the model. The northern boundary of the model domain is a general head boundary. Vertically, the model domain extends from the top of the saturated zone to the base of the Smithboro Member. The thick clays of the Banner Formation are relatively impermeable compared to the overlying unconsolidated sediments and provides a base for the model.

The northern boundaries for layers 3, 4, and 5 are general head boundaries placed to simulate flow in the sandier soils of the Hagarstown Member, Vandalia/Mulberry Grove Member and Smithboro Till composing the UA (layer 3), and LCU (layer 4 and 5). The northern boundary represents the regional flow conditions within these units. The eastern edge is no-flow boundary in all model layers.

Coffeen Lake is represented as a constant head boundary based on an average surface water elevation of 591.0 feet NAVD88. The constant head boundary was simulated with an elevation equal to 591.0 feet. The lake is in hydraulic connection with multiple layers within the model.

The bottom of the model was also a no-flow boundary. The top of the model was a time-dependent specified flux boundary, with specified flux rates equal to the recharge rate. A specified mass flux boundary was used to simulate downward percolation of solute mass from the AP1. This boundary condition assigns a specified concentration to recharge water entering the cells within AP1, and the resulting concentration in the AP1 cells is a function of the relative rate and concentration of recharge water (water percolating from the impoundment) compared to the rate and concentration of other water entering the node.

5.2.2 Flow Model Input Values and Sensitivity

Evaluation of monitoring well data for the CPP has not identified statistically significant seasonal trends in groundwater flow or quality which could affect model applicability for prediction of transport. The MODFLOW model was calibrated to mean groundwater elevations from 2015 to 2021. Multiple iterations of MODFLOW calibration were performed to achieve an acceptable match to observed flow data.

Sensitivity analysis was conducted by changing input values and observing changes in the sum of squared residuals (SSR). Horizontal conductivity, vertical conductivity, and river and general head conductance terms were all varied by one order of magnitude (*i.e.*, between one-tenth and ten times) of the calibrated values. Recharge terms were varied between one-half and two times calibrated values. River stage was obtained from the 10 meter (m) Digital Elevation Model (DEM) from the United States Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS) National Geospatial Center of Excellence (USDA/NRCS, 2022). The vertical error of the 10 m DEM is 0.82 m (2.7 feet); therefore, the stream stage was varied by adding and subtracting 2.7 feet. Where appropriate, drain stage was modified based on the DEM error. Where this was inappropriate, drain stage increased and decreased by 2 feet. General head boundary head terms were varied between 90 and 110 percent of calibrated values. The HFB was varied by increasing the hydraulic conductivity by a factor of 100 and 1,000. When the calibrated model was tested, the SSR was 351. Sensitivity test results were categorized into negligible, low, moderate, moderately high, and high sensitivity based on the change in the SSR as summarized in the notes in **Table 5-1**.

5.2.2.1 Layer Top/Bottom

The top of the saturated zone was used as the top of the model. The elevations for the base of each hydrostratigraphic layer were obtained from the NRT model (2017b) and were imported as grid data into MODFLOW. The upper Loess Unit of the Hagarstown Member (UCU) was divided into two layers to accommodate the explicit inclusion of the CCR in AP1 and AP2. The sand and silts of the Hagarstown Member which form the UA were represented using a single layer. The LCU was represented by two layers, the upper LCU (layer 4) represents the unweathered Vandalia/Mulberry Grove Member and the lower LCU (layer 5) represents the Smithboro Member.

The UCU layer was split into two layers (layers 1 and 2) to simulate the construction of AP1 and AP2. Within AP1 and AP2, layer 1 represents ash fill and layer 2 represents the UCU present below the ash and above the UA. Outside of AP1 and AP2, both layers 1 and 2 represent the UCU. Layer 3 represents the UA and the LCU is present in layers 4 and 5. **Figures 5-7 through 5-11** show the bottom elevations of the five model layers. The resulting model layers represent the distribution and change in thickness of each water-bearing unit across the model domain. **Table A** below provides elevation and thickness information for the model layers and hydrostratigraphic units used in the model.

Table A. Flow Model Layer Descriptions

Layer	Hydrostratigraphic Unit Name	Hydrostratigraphic Unit Used to Determine Layer Thickness	Top Elevation [1]	Bottom Elevation [1]	Thickness (feet)
			Mean (Minimum – Maximum)		
1&2	UCU and CCR	Loess Unit of Hagarstown Member and CCR	640 (-)	607.73 (604.0-614.15)	27.1 (26.0-29.85)
3	UA	Hagarstown Member	607.73 (604.0-614.15)	600.9 (580.0-612.0)	5.2 (2.0-34.0)
4	LCU	Vandalia/Mulberry Grove Member	600.9 (580.0-612.0)	588.5 (578.0-594.0)	18.83 (2.0-30.0)
5	LCU	Base of Coffeen Lake	588.5 (578.0-594.0)	540.0 (-)	48.4 (38.0-51.1)

Notes:
[1] Elevation is measured in feet, referenced to NAVD88.

5.2.2.2 Hydraulic Conductivity

Hydraulic conductivity values and sensitivity results are summarized in **Table 5-1.** The spatial distribution of the hydraulic conductivities within the UCU, UA and LCU were considered homogenous. **Figures 5-12 through 5-16** show the spatial distribution of the hydraulic conductivity zones, AP1 and other units on site for each of the five model layers. Construction of the GMF units removed the sands and silts of the UA prior to construction of the liner, therefore the UA is absent beneath these units and liner hydraulic properties are assigned. Conductivity zones that did not have representative site data (*i.e.,* zones 19 and 21, representing the cells above the river cells and the disturbed sediments between the LF and GMF GSP, respectively) were determined through model calibration.

Where available, hydraulic conductivity values were derived from field measured or laboratory tested values reported in the HCR (Ramboll, 2021a) (**Section 2.2.2**). No horizontal anisotropy was assumed. Vertical anisotropy was applied to conductivity zones to simulate preferential flow in the horizontal direction in these materials, and are presented as anisotropy ratio (Kh/Kv) in **Table 5-1**.

The model was highly sensitive to changes in horizontal and vertical hydraulic conductivity in zones 1 (UCU), 2 (UA), and 3 (LCU - unweathered Vandalia), and moderately sensitive to changes in horizontal and vertical hydraulic conductivity in zones 10 (CCR fill-AP1) and 19 (UCU-fill). The model exhibited a negligible to low sensitivity in the remaining zones for both horizontal and vertical conductivity.

5.2.2.3 Recharge

Recharge rates were determined through calibration of the model to observed groundwater elevations. For the calibration model, recharge was applied to the uppermost active layer and the rates varied based on different units, namely the AP1, AP2, GMF GSP, GMF RP, LF, Surface Water Pond, and Cooling Pond. Model inputs are summarized in **Table 5-1**. The distribution of recharge is shown in **Figure 5-17**. Changes in operational history, such as the addition of AP1 to the site in 1977 and the GMF units in 2010 as illustrated in **Figures 5-18 through 5-21,** have been

incorporated into the transient model simulation (**Table 5-2**). See **Section 5.2.3.1** for additional discussion of time discretization.

The model had a high sensitivity to changes in recharge in zones 1 (UCU) and 7 (CCR fill - AP1). The model had negligible to low sensitivity to changes in recharge in the remaining zones, with the exception of zone 6 (CCR fill - AP2), where the sensitivity was moderate.

5.2.2.1 Storage and Specific Yield

The flow calibration model did not use these terms because it was run at steady state. For the transport model, which was run as a transient simulation, no field data defining these terms were available so published values were used consistent with Fetter (1988). Specific yield was set to equal effective porosity values described in **Section 5.2.3.5**. The spatial distribution of the storage and specific yield zones were consistent with those of the hydraulic conductivity zones. The sensitivity of these parameters was tested by evaluating their effect on the transport model as described in **Section 5.2.3.6**.

5.2.2.2 River Parameters

Five river reaches were included in the model as head dependent flux boundaries that required inputs for elevation of the surface water, bottom of the stream, width, bed thickness, and bed hydraulic conductivity (**Table 5-1**). The five river reaches were the Unnamed Tributary east of the CPP (reach 0 and reach 5), the Unnamed Tributary west of the CPP (reach 1), ponded surface water west of the LF (reach 2), and the condenser cooling water discharge flume (reach 3). The river and drain information is summarized in **Table B** below.

Table B. River and Drain Information

Name	Boundary Type	Length (feet)	Slope (ft/ft)
Unnamed Tributary East	River	8959.0	-0.0031
Unnamed Tributary East – downstream reach	River	1438.3	-0.0026
Unnamed Tributary West	River	3436.5	-0.0098
Ponded Surface Water West	River	-	-
Condenser Cooling Flume	River	-	-
Active Landfill Underdrain	Drain	2147.0	-
Gravity Drain Recycle Pond	Drain	2181.8	-
North Drain	Drain	3032.0	-

Notes:
ft/ft = feet per foot

In the absence of river geometry information, the DEM was used to estimate stream stage at the upstream and downstream limits of the Unnamed Tributary east of the CPP and the Unnamed Tributary west of the CPP. The surface water stages for the ponded surface water west of the LF and the Condenser Cooling Flume were constant (not sloped) and were also obtained from the DEM. For both Unnamed Tributaries (east and west), the slope of the river was then linearly interpolated along the reaches, providing an estimation of stream stage along the length of each reach for each model grid cell though which the river flows. Bed thickness was set at 2 foot and river width was set at 10 feet. The river bottom is set 3 feet below the stage for both the

Unnamed Tributaries. The downstream reach (reach 5) of the Unnamed Tributary is located in layer 5 of the model adjacent to the SI unit AP2, this layer represents the LCU-Smithboro till and has a low hydraulic conductivity. To increase connectivity of the tributary to the overlying layers, the hydraulic conductivity of the streambed was modified during calibration.

The Condenser Cooling flume stage is maintained at 604.0 feet and the ponded surface water west of the LF was maintained at 617.5 feet, and bed thicknesses for these reaches were set to 1 foot. The width of the Cooling Flume (approximately 52 feet) and ponded surface water west of the LF are larger than the grid cell dimensions (25 feet by 25 feet); therefore, the conductance term for both were based on the area of the cells which coincide with the flume and ponded water.

The model had low to moderate sensitivity to changes in river stage. The model had low to moderately high sensitivity to changes in river conductance, with the exceptions of reach 0 (Unnamed Tributary East) and reach 3 (Condenser Cooling Flume) which had high sensitivity.

5.2.2.3 Drain Parameters

The LF has an active underdrain, which is actively pumped to prevent more than 1-foot of groundwater head above the liner. This was estimated to be 603.5 feet. The GMF RP has a passive drain beneath the liner which discharges water towards the Unnamed Tributary east of the unit. This was estimated to be 600.5 feet. Both the active LF drain and passive GMF RP drain were placed in layer 4 (LCU) below the low hydraulic conductivity zones which represent the base of the lined units. A surface water drain in the north of the model was also included; the placement of this northern drain was determined using google earth imagery. The Northern drain appears to be a man-made feature and no hydrological data are available as to its flow conditions. Therefore, its implementation in the model as a drain makes the fewest assumptions of its interaction with the aquifer. This surface water drain is located in layer 1 and has an elevation of 622.0 feet.

The model had low sensitivity to changes in drain stage. The model had negligible to moderate sensitivity to changes in drain conductance, with the exception of reach 0 (Active LF Underdrain) where the model had moderately high sensitivity to changes in drain conductance.

5.2.2.4 GMF Unit Parameters

All GMF units (GMF GSP, GMF RP, and LF) have a similar liner construction (**Table C** below); they were all implemented into the model using horizontal flow barrier (HFB) package to represent the liner system on the sides of the units. The bottom of the liner is implemented by assigning the liner system hydraulic conductance to model layer 3 within the footprint of the pond. The base elevation of layer 3 within the footprint of the GMF units simulates the base elevation of the liner. The thickness of model layer 3 within the footprint of the pond was set to three feet. Removal of the sands and silts below the GMF units (as described in **Sections 1.4** and **2.1**) means that the liner is in direct contact with the Vandalia Member. The groundwater flow dynamics beneath/around the Ash Landfill and GMF Units is affected by several factors, including: removal of the Hagarstown Member from beneath the Units; presence of the construction dewatering systems around the units; and the lateral variability of lithology within the Hagarstown Member (Hanson, 2016). Drains discussed above were used to represent the underdrains associated with the GMF units. The hydraulic properties within the GMF units were set to represent the CCR.

Estimates of the hydraulic properties of each of the components within the liner system were derived using values from the HELP model; see **Section 5-1** for more information about HELP. For flow perpendicular to the layer orientation, as is the case in the liner where the hydraulic gradient is vertical for the base and horizontal for the sides of the pond, the harmonic mean was used to obtain the effective hydraulic conductivity (K_{eff}) (Fetter, 1988). The harmonic mean was determined by:

$$K_{eff} = \frac{\sum b}{\sum \frac{b}{K}}$$

where b is the layer thickness and K is the horizontal hydraulic conductivity.

HFB input parameters are presented in **Table 5-1**. The model had low to moderate sensitivity to changes in the hydraulic conductivity in the HFB.

Table C. Liner System Properties From Top to Bottom for the GMF GSP, GMF RP, and LF

Liner Component	Thickness (feet)	Hydraulic Conductivity (cm/s)	Hydraulic Conductivity (ft/d)
HDPE geomembrane (60 mil)	0.06	2.0×10^{-13}	5.7×10^{-10}
Recompacted Soil	3.0	1.0×10^{-7}	2.8×10^{-4}
Vertical Harmonic Mean of liner system	**NA**	**NA**	***2.89×10^{-8}***

* Estimated based on available information
ft/d = feet per day
NA = not applicable

5.2.2.5 General Head Boundary

General head boundary conditions (GHB) were used along the northern boundary of the model for layer 3 through 5 (**Figures 5-4 through 5-6**). The GHB at the northern limit of the model represents groundwater entering the model domain from upgradient areas. The GHB is present in layers 3 through 5 and was used to simulate groundwater flow into the model via the UA and LCU. The groundwater levels used for the northern boundary of the model in layers 3 through 5 were estimated using the Dupuit equation for steady state flow in an unconfined aquifer with recharge.

The DEM of the site provided estimates of the surface water levels for Coffeen Lake on the west of the model (591 feet), and Rocky Ford Sportsman Club North Lake (604 feet) on the east of the model domain (refer to **Figure 5-1**). The calibrated ambient recharge to the UCU was used in the calculation of the groundwater level distribution at the northern boundary. The hydraulic conductivity value used in the Dupuit equation was estimated during model calibration.

This GHB was only applied to cells along the northern boundary where the base of the cell was below the calculated groundwater head for a given distance from the constant head boundaries, the head was determined by the Dupuit equation. Cell conductance was then calculated using the cells' saturated thickness and cell width, and hydraulic conductivity were based on cell hydraulic conductivities and adjusted if appropriate during calibration.

The GHB elevation for northern boundary in the UA was established during calibration (**Table 5-1**). The distance to the GHB head was set to 1, and the GHB conductivity was

calculated using the cell width, cell thickness, and calibrated hydraulic conductivity from the model.

The sensitivity to changes in specified head was low to moderate, with the exception of reach 3 (Northern Model Boundary in LCU Layer 4) where the model sensitivity was high. The flow calibration model had a negligible sensitivity to changes in conductance.

5.2.3 Transport Model

MT3DMS input values are listed in **Table 5-2** and described below. Sensitivity of the transport model is summarized in **Table 5-3**.

Groundwater transport was calibrated to groundwater sulfate concentration ranges at each well as measured from the monitoring wells between 2015 (where available) and 2021. The transport model calibration targets are summarized in **Table 4-1**.

Sensitivity analysis was conducted by changing input values and observing percent change in sulfate concentration at each well from the calibrated model sulfate concentration. Effective porosity was varied by decreasing and increasing calibrated model values by 0.05. Storage values were multiplied and divided by a factor of 10, and specific yield by a factor of 2. The dispersivity values in the calibrated model were increased by a factor of 5 and 10. The sensitivity of the transport model to changes in the liner conductance was also investigated by increasing and decreasing the hydraulic conductivity of the liner by one order of magnitude (*i.e.*, between one-tenth and ten times).

The transport model had a negligible to moderate sensitivity to changes in storage and specific yield (**Table 5-3**) as discussed in **Section 5.2.3.6**. The transport model ranged from negligible to moderate sensitivity to effective porosity and dispersivity as discussed in **Sections 5.2.3.5** and **5.2.3.7**, respectively. The sensitivity to the liner conductivity was negligible to low as discussed in **Section 5.2.3.2**.

5.2.3.1 Time Discretization and Stress Periods

The evolution of the CPP required changes to the hydraulic properties within the model; this is not possible in a single model where hydraulic properties as assumed to remain constant. As a result, the changes in the site (*e.g.,* inclusion of the GMF units) are simulated in three consecutive numerical models, as summarized in **Table D** below. The simulation length was revised from the existing model to extend to the current time (2022).

Table D. Transient Model Setup and Time Discretization

Date	Model	Stress Period	Operational Change	Previous model
Pre-1970	Steady-State	NA	No CCR units present	Not applicable
1970-2010	Transient (TR-1)	1:1970-1985	AP2 only	Steady State Pre-1970 flow
		2:1985-2010	AP2 and AP1 in operation	
2010-2018	Transient (TR-2)	1:2010-2018.	AP1, GMF GSP and GMF RP in operation.	TR-1 as initial flow and concentrations

2018-2022	Transient (TR-3)	1:2018-2022	Modification to lined units GMF GSP and GMF RP, AP2 capped	TR-2 as initial flow and concentrations

Notes:
TR = transient model

5.2.3.2 GMF Units

Groundwater chemistry data from wells G215 (located adjacent to the GMF GSP), and wells G275 and G279 (located adjacent to the GMF RP), indicate an increase in sulfate concentrations post 2018 when compared with sulfate concentrations in adjacent wells. Sulfate concentrations in G215 have experienced further increases since 2021. Sulfate concentrations around the GMF RP tend to be higher than those around the GMF GSP, with elevated sulfate concentrations observed since 2015 (the earliest sampling date). Elevated sulfate concentrations along the southern boundary of the GMF RP are associated with historic groundwater impacts from AP2. However, wells G275 and G279 are located along the eastern boundary of the pond and have elevated sulfate concentrations. To simulate observed sulfate concentrations at these isolated wells (GMF GSP well G215, and GMF RP wells G275 and G279), the hydraulic conductivity of the liner (simulated using HFB) was increased to allow sulfate migration from the CCR unit in the transient model TR-3, as shown in **Figure B** below and **Table D** above.

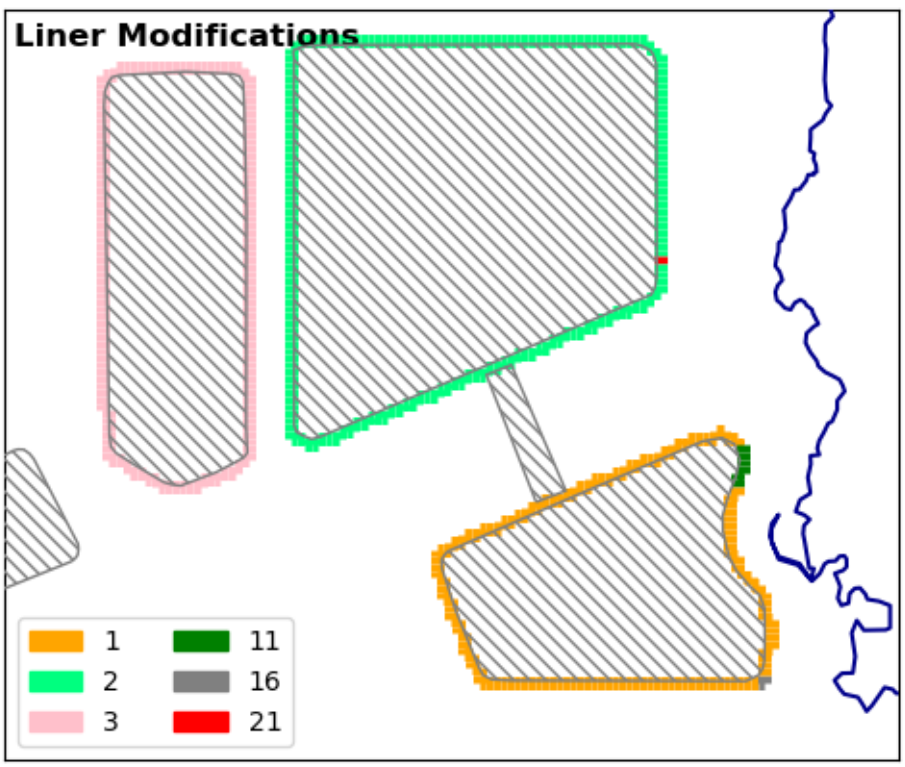

Figure B. Liner Modification Zones

As part of the transport calibration process, the hydraulic conductivity of HFB reaches 11, 16, and 21 were modified to simulate the observed rises in sulfate. The changes are summarized in **Table 5-2**. Model sensitivity near the GMF ponds is discussed in the Groundwater Modeling

Report, *GMF Gypsum Stack Pond and GMF Recycle Pond, Coffeen Power Plant, Coffeen Illinois* (Ramboll, 2022).

The monitoring wells associated with AP1 show negligible to low sensitivity to changes in the GMF liner conductivity (**Table 5-3**). AP1 Is located approximately 2,500 foot south of the GMF SIs, any changes in groundwater flow and transport will be minimal in proximity to AP1.

5.2.3.3 Initial Concentration

No initial concentrations were placed in the steady state flow calibration model. The flow model was run as transient and concentration was added to the model through recharge starting at the same time as the transient flow simulation. Modeling was performed for a sufficient period (42 years) to allow modeled concentrations in the primary transport layer (*i.e.,* UA) to reach recently observed levels.

Modeling was performed over three numerical models which mirror the operational developments at the CPP. **Table 5-2** provides an overview of how the source concentrations and recharge rates change through time.

5.2.3.4 Source Concentration

Five sources in the form of vertical percolation (recharge) and constant concentration cells were simulated in the CCR material for calibration (**Table 5-2**) (in chronological order): (i) percolation through CCR in AP2 (1970-2022), (ii) percolation through CCR in AP1 (1978-2022), (iii) percolation through CCR in GMF RP (2010-2022), (iv) percolation through CCR in GMF GSP (2010-2022), and (v) percolation through CCR in GMF LF (2010-2022). All five sources were simulated by assigning concentration to the recharge input. The CCR sources were also simulated with constant concentration cells placed where CCR was present (**Figures 5-18 through 5-21**) to simulate saturated CCR conditions. From the model perspective, this means that when the simulated water level is above the base of these cells, water that passes through the cell will take on the assigned concentration. All source concentrations were calibrated in the transport model to the sulfate concentration data collected from November 2015 to August 2021. The source concentrations applied to the recharge zones and saturated ash cells immediately below the recharge zones have the same concentration values. **Table 4-1** indicates that the background sulfate concentrations (identified with a "B" for background in the "CCR unit" column) at CPP show considerable variability across the site, from 11 mg/L (G286) to 770.0 mg/L (G288). No background sulfate concentration was applied to recharge beyond the source areas in the model.

Because these are the sources of concentration in the model, the model will be highly sensitive to changes in the input values. For that reason, sensitivity testing was not completed for the source values.

5.2.3.5 Effective Porosity

Effective porosity for each modeled hydraulic conductivity zones were based on the NRT model (2017b), data from the HCR (Ramboll, 2021a), and literature values (Fetter, 2001) and are presented in **Table 5-2**.

The model had a negligible to moderate sensitivity to changes in porosity values (**Table 5-3**). The greatest sensitivity for porosity was moderate for the high porosity sensitivity test at

monitoring locations G305, G306, and G317. Moderate sensitivity at monitoring well G317 was also observed for the low porosity sensitivity test.

5.2.3.6 Storage and Specific Yield

The transport model had a negligible to low sensitivity to changes in storage and specific yield, with the exception of sensitivity at monitoring wells G306, G307, and G317, where sensitivity was moderate (**Table 5-3**).

5.2.3.7 Dispersivity and Diffusion

Physical attenuation (dilution and dispersion) of contaminants is simulated in MT3DMS. Dispersion in porous media refers to the spreading of contaminants over a greater region than would be predicted solely from the average groundwater velocity vectors (Anderson, 1979; Anderson, 1984). Dispersion is caused by both mechanical dispersion, a result of deviations of actual velocity at a microscale from the average groundwater velocity, and molecular diffusion driven by concentration gradients. Molecular diffusion is generally secondary and negligible compared to the effects of mechanical dispersion and only becomes important when groundwater velocity is very low. The sum of mechanical dispersion and molecular diffusion is termed hydrodynamic dispersion, or simply dispersion (Zheng and Wang, 1998).

Longitudinal dispersivity was 10 feet in the UA and 1 foot in the UCU and LCU, with transverse and vertical dispersion coefficients assuming a ratio of 1/10 and 1/100.

The model had a negligible to moderate sensitivity to changes in dispersivity values (**Table 5-3**). The greatest sensitivity for dispersivity was moderate for the highest dispersivity sensitivity test at monitoring well locations G313, G314, G316, and G317. Sensitivity was also moderate for the lower dispersivity sensitivity test at monitoring well locations G313 and G317.

5.2.3.8 Retardation and Decay

It was assumed that sulfate would not significantly sorb or chemically react with aquifer solids (Kd was set to 0 mL/g) which is a conservative estimate for estimating contaminant transport times. Boron, sulfate, and TDS transport is likely to be affected by both chemical and physical attenuation mechanisms (*i.e.,* adsorption and/or precipitation reactions as well as dilution and dispersion). Batch adsorption testing was conducted to generate site specific partition coefficient results for boron and sulfate (Geosyntec, 2022b; **Appendix C**) for locations G311 and G313. Results of the testing are summarized below:

- Boron: The Freundlich isotherm (K_F) fit the data best for G313/SB306 and G313/SB313, yielding K_F values of 0.65 liters per kilogram (L/kg) and 2.03 L/kg, respectively. Though slightly higher at G313/SB313, these values are comparable to boron partition coefficients reported in literature, which range from 0.19 to 1.3 L/kg depending on pH conditions and the amount of sorbent present (EPRI, 2005; Strenge & Peterson, 1989). No partition coefficient was calculated for G311.
- Sulfate: The G311 partition coefficient for sulfate ranged from -624 L/kg for the Langmuir isotherm (K_L) to 10.11 L/kg for the linear isotherm (K_D), but the best-fitting Freundlich isotherm yielded a low K_F value of 9.2×10^{-12} L/kg. None of the isotherms showed a high goodness-of-fit (*i.e.,* R^2) for either G313/SB306 or G313/SB313, with the highest correlation being 0.05, and were associated with erroneously high (1,700 L/kg) and low (-690 L/kg) partition coefficients. An accurate sulfate partition coefficient could therefore not be calculated from any of the data. These results are consistent with the findings of Strenge and Peterson

(1989), who found that partition coefficients for sulfate are 0.0 L/kg, regardless of pH conditions and the amount of sorbent present.

The results from site samples are variable with poor goodness of fit which supports modeling sulfate without retardation. The potential exceedances identified in groundwater (boron, sulfate, and TDS) are affected by natural attenuation processes in multiple ways and to varying degrees. Further assessment of these processes and how they may be applied as a potential groundwater remedy will be completed as part of future remedy selection evaluations, as necessary. For the purposes of this GMR, and as mentioned at the beginning of this section, no retardation was applied to sulfate transport in the model (*i.e.*, Kd was set to 0 mL/g). Sensitivity tests were not run for retardation.

5.3 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions were made while developing this model:

- Leading up to 2022, the groundwater flow system cannot be simulated as steady state.
- Natural recharge is constant over the long term.
- Fluctuations in lake stage do not affect groundwater flow and transport over the long term.
- Hydraulic conductivity is consistent within hydrostratigraphic units.
- The approximate base of ash surface in the AP1, GMF GSP, GMF RP, and LF were developed with Golder using soil borings and historic topographic maps.
- Source concentrations are assumed to remain constant over time.
- Sulfate is not adsorbed and does not decay and mixing and dispersion are the only attenuation mechanisms.

The model is limited by the data used for calibration, which adequately define the local groundwater flow system and the source and extent of the plume. Since data used for calibration are located near the units on site, model predictions of transport distant spatially and temporally from the calibrated conditions at the CCR units will not be as reliable as predictions closer to the CCR units and concentrations observed in 2021.

5.4 Calibration Flow Model

The groundwater model was manually calibrated to best approximate the mean groundwater elevations in 95 wells at the site. The mean elevations used for calibration and locations of wells within the flow model are summarized in **Table 4-1** Well locations are shown in **Figure 2-1**. This involved modifying the hydraulic conductivities of the different hydrostratigraphic units, recharge rate, and conductance of the drains, rivers, and general head boundaries within the model to minimize the difference between the mean observed groundwater elevation and simulated groundwater elevation. Where possible, the range of the parameter values used during calibration were based on observed values (*i.e.,* for the range in hydraulic conductivity estimates from the HCR). Where this was not possible, such as for the drain and general head boundary conductance, the range of parameter values were based on other site information or inferred from knowledge from similar sites. Where data were limited, the parameter values were less constrained during calibration (*e.g.,* parameter values had wider ranges). The SSR was used as a metric to identify the optimal values for the different parameters.

5.5 Calibration Flow and Transport Model Results

Results of the MODFLOW modeling are presented below. The model files accompany this report (**Appendix B**). **Table 5-1** shows the calibrated hydraulic conductivity for the different units shown in **Figures 5-12 through 5-16**.

Groundwater model calibration results are presented in **Figure 5-22** and **Figure 5-23**, which shows the observed and simulated groundwater elevations and the observed groundwater elevations versus residuals. The near-linear relationship between observed and simulated values presented on **Figure 5-22** indicates that the model adequately represents the calibration dataset. The root mean squared error of the groundwater elevation across all wells was 1.92 feet. The mass balance error for the flow model was 0.00 percent and the ratio of the residual standard deviation to the range of heads was 9.0 percent, which is below the desired target value of 10 percent. Another flow model calibration goal is that residuals are evenly distributed such that there is no bias affecting modeled flow. The observed heads are plotted versus the simulated heads in **Figure 5-23** and simulated values are evenly distributed above and below observed values. The residual mean was also near zero with a value of 0.10 feet, indicating a small bias towards underestimating the groundwater elevations in the calibrated model; this is also illustrated in the observed versus residuals plot in **Figure 5-23**.

The simulated groundwater elevations within the UA (layer 3) for the entire site are shown in **Figure 5-24**. **Figure 5-25** shows the simulated groundwater elevations in proximity to AP1. In general, the model is able to simulate the groundwater flow patterns for the UA (**Figure 2-2** and **Figure 2-3**) at AP1 as interpreted from the site well data for April and July 2021, respectively. The simulated groundwater flow pattern also captures the radial flow pattern centered on the southwest area of AP1. Fourteen wells provided calibration targets for the simulated groundwater level around AP1. The simulated groundwater levels for five of these wells are within 1 foot; six wells are within 2 feet. G303 and G312 are underestimated by 2.14 feet and 3.06 feet respectively, and G309 is overestimated by 2.24 feet.

The range of observed sulfate concentrations for transport calibration locations are summarized in **Table 4-1**. The goals of the transport model calibration were to have predicted concentrations fall within the range of observed concentrations, and to have predicted concentrations above and below the GWPS for sulfate (400 mg/L) match observed concentrations above or below the standard at each well. One or both of these goals were achieved at all of the transport calibration location wells, except G317, where concentrations were underpredicted (**Figure 5-26**). Deviations from the observed ranges are discussed below.

The model underpredicts concentrations at G305 and G317. The observed sulfate concentrations range from 710 to 930 mg/L and 780 to 1100 mg/L for G305 and G317, respectively. The predicted concentrations are 424.8 mg/L and 146.8 mg/L for G305 and G317, respectively. G305 is located south of AP1 (**Figure 2-1**) in close proximity to the mine entrance discussed in **Section 2.2.4** and shown in **Figure 1-2**. The disturbance associated with the former mining activity may be associated with the elevated sulfate concentrations in this well. G317 is located southeast of AP1, downgradient of G303 (whose predicted sulfate concentration is within the observed range). Groundwater flow in this area is predominantly towards Coffeen Lake (west to east). There is aerial and topographic evidence supporting the presence of a soil pile related to the mining activities in the area west (upgradient) of G317 (see **Section 2.2.4**). One soil boring completed through the soil pile documents the presence of coal in the boring log, indicating the

soil pile may be another source of sulfate. This soil pile may potentially leach sulfate into the groundwater thereby increasing the sulfate concentration at G317 above that which would be attributed to AP1 alone.

The remaining calibration locations had predicted concentrations that fall within the range of observed concentrations and/or have predicted concentrations above and below the GWPS for sulfate (400 mg/L) matching observed concentrations above or below the standard at each well. In other words, there was a very good match between predicted and observed sulfate concentrations relative to wells with concentrations above and below the GWPS. The transport model has achieved a very good calibration using a sulfate source concentration of 1,000 mg/L, even though some wells have observed concentrations that are greater than the source concentration used. The distribution of sulfate concentrations in the calibrated model are presented on **Figure 5-27**.

6. PREDICTIVE SIMULATIONS

6.1 Overview and Prediction Model Development

Prediction simulations were performed to evaluate the effects of closure (source control measures) for AP1 on groundwater quality. The prediction simulations evaluated changes in groundwater sulfate concentrations from Scenario 1: CIP (removal of CCR from the eastern portion of AP1 and consolidation into the western portion of the AP1) and Scenario 2: CBR (removal of all CCR material from AP1). As discussed in **Section 5.2.3.7** physical attenuation (dilution and dispersion) of contaminants in groundwater is simulated in MT3DMS, which captures the physical process of natural attenuation as part of corrective actions for both closure scenarios simulated. No retardation was applied to sulfate transport in the model (*i.e.,* Kd was set to 0 mL/g) as discussed in **Section 5.2.3.8**.

Closure scenarios were simulated by initially removing free liquids from the CCR material over the course of 2 years by placing drain cells within AP1 with an elevation of 618 feet and applying zero recharge to simulate dewatering of the CCR units.

HELP-calculated percolation rates, based on removal and final soil backfill grading designs provided in the Final Closure Plans for AP1 (Golder, 2022a), GMF GSP (Golder, 2022b), and GMF RP (Golder, 2022c), were applied for the different closure scenarios. HELP modeling input and output values are summarized in **Table 6-1** and described in detail below.

The CIP and CBR scenarios were simulated for a 100-year period. The following simplifying assumptions were made during the simulations:

- Removal of free liquids from CCR takes place prior to the CIP and CBR closure scenarios. Drain cells were placed within the units to simulate the removal of free water within the ponds; and recharge was set to zero.
- In the CIP and CBR closure scenarios, HELP-calculated average annual percolation rates were developed from a 30-year HELP model run. This 30-year HELP-calculated percolation rate remained constant over duration of the closure scenario prediction model runs following CCR dewatering period.
- Changes in recharge resulting from removal of free liquids (decrease calibration model recharge rates to zero) and CCR fill removal/final soil backfill grading (recharge rates are based on HELP-calculated average annual percolation rates) have an instantaneous effect on recharge and percolation through surface materials.
- Sulfate source concentrations were assumed to be negligible (0 mg/L) in CCR removal areas in both the CIP and CBR scenarios. The spatial distribution of CCR concentrations within the consolidation area for the CIP scenario were maintained from the initial transport simulation.
- Cap construction in CIP scenario was assumed to be completed with a cover system consisting of the following (listed from ground surface down): a vegetative cover (6 inches thick), rooting zone (18 inches thick), a 200-mil geocomposite drainage layer and a 40-mil linear HDPE geomembrane.
- The start of each closure prediction simulation was initiated at the end of the calibration model period of 42 years plus 2 years to complete removal of free liquids. For example, the

simulation of Scenario 1: CIP begins at 44 years (42 years for calibration plus 2 years). The prediction modeling timeline for each scenario is illustrated in **Figure 4-1**.

- CCR consolidation/removal areas were assumed to be graded and include proper drainage controls to remove excess water from the surface using the design drawings provided (Golder, 2022a).
- The CIP scenario includes the placement of a stormwater pond within the removal area. The outflow elevation of this stormwater pond is 625 feet, which will discharge into Coffeen Lake adjacent to the AP2. This is represented as a drain in the model whose elevation is equal to the stormwater pond outflow elevation.
- Local fill materials applied to the prediction models have similar hydraulic properties as the UCU materials used in the transport calibration models. However, the local fill materials were assumed to have reduced vertical anisotropy ratios, approaching isotropic, due to reworking of the material as it is placed as backfill (Kh/Kv decreased from measured values of 10 to 1 for reworked material).

6.2 HELP Model Setup and Results

HELP (Version 4.0; Tolaymat and Krause, 2020) was used to estimate percolation through AP1 in areas of CCR removal with soil backfill, and areas of CCR consolidation with final cover system. HELP input and output files are included electronically and attached to this report.

HELP input data and results are provided in **Table 6-1**. All scenarios were modeled for a period of 30 years. Climatic inputs were synthetically generated using default equations developed for Belleville Scott Air Force Base in Belleville, Illinois (the closest weather station included in the HELP database). Precipitation, temperature, and solar radiation was simulated based on the latitude of CPP. Thickness of soil backfill and soil runoff input parameters were developed for the ash fill removal scenarios using data provided in the Final Closure Plans for AP1 (Golder, 2022a), GMF GSP (Golder, 2022b), and GMF RP (Golder, 2022c).

HELP model results (**Table 6-1**) indicated 7.85 inches of percolation per year for AP1 CCR removal and soil backfill area in the CIP scenario and 0.00027 inches of percolation per year through the CCR and final cover system for the CIP scenario. Results indicated 7.85 inches and 6.28 inches of percolation per year for AP1 eastern and western CCR removal and soil backfill area in the CBR scenario, respectively. The differences in HELP model runs for each area included the following parameters: area, soil backfill thickness, slopes, and soil runoff slope length; all other HELP model input parameters were the same for each simulated area. HELP input data and results are provided in **Appendix B.**

Two additional HELP model simulations were completed to support the *Proposed Alternative Final Protective Layer Equivalency Demonstration*, (Geosyntec, 2022c) which is an appendix to the Construction Permit Application to which this report is also attached. Results of these two HELP simulations were not incorporated in the MODFLOW simulations for closure. Simulation inputs and output results are presented in **Appendix D**.

6.3 Simulation of Closure Scenarios

The calibrated model was used to evaluate the effectiveness of the two closure scenarios by defining CCR removal and consolidation areas, reducing head to simulate removal of free liquids, removing source concentrations from the removal areas, adding drain cells and removing

recharge to simulate stormwater management within the removal areas, and applying reduced recharge in the CCR consolidation areas to simulate the effects of the cover system on flow and transport. Removal of source inputs from the ash removal areas was simulated by reducing the sulfate concentrations associated with recharge in the areas to 0 mg/L and removing constant concentration cells.

Each prediction scenario was simulated as a continuation of the AP1 dewatering simulation which followed the transient calibrated model. The prediction model input values are summarized in **Table 6-2,** and the modifications to the recharge zones and drain placement for the CIP scenario are illustrated in **Figure 6-1**. **Figure 6-2** illustrates the CCR removal area for the CBR at the AP1. The two closure scenarios are discussed in this report based on predicted changes in sulfate concentrations as described below and results are presented in **Figure 6-3 to Figure 6-6**.

6.3.1 Closure in Place Model Results

The design for Scenario 1: CIP includes an initial 2-year dewatering period to remove free liquids followed by CCR removal from AP1, consolidation in the western area of AP1, and construction of a cover system over the remaining CCR (**Figure 6-1**). Stormwater drainage will be present within the eastern area of AP1 with an outflow elevation of 625 feet.

Predicted concentrations start to decline at all monitoring wells with observations above the GWPS for sulfate (400 mg/L) once closure actions are initiated within the prediction model. These declines occur first in the eastern area where CCR is removed and saturated ash cells (constant concentration cells) are reduced in the area of the highest modeled source concentrations. Following removal of CCR in the eastern area, sulfate concentrations are no longer entering the model domain from recharge or from saturated ash cells (constant concentration cells). Dewatering also reduces the head within AP1. These low heads are maintained following completion of closure by the drain cells that simulate storm water management designs within the removal area to the east, and by the greatly reduced infiltration rates (recharge) that result from placement of the cover system over the consolidated CCR in the western end of AP1. As a result of the reduced heads and recharge, downward percolation of solute mass from AP1 is reduced, which decreases the sulfate concentration entering the model domain.

The predictive model indicates that most wells will reach the GWPS (400 mg/L) in under 14.8 years following closure, with one exception. **Figure 6-3** and **Figure 6-4** show the extent of the plume in the UA after 14.8 years and the maximum extent of the plume in the model after 14.8 years, respectively. The predicted delayed reduction in concentration at well G301, 58.8 years, is a result of the well's location along the flow path of the residual sulfate concentrations released into native geologic materials prior to closure. All UA groundwater monitoring wells are below the GWPS within 58.8 years (**Figure 6-5** and **Figure 6-6**). The residual sulfate plume in the UA from the calibrated model remains in close proximity to AP1 as it recedes over time. The predicted footprint of the sulfate plume in the UA after 58.8 years shown in **Figure 6-5** is considerably reduced from that at the end of the transient model simulation (**Figure 5-27**).

The predicted delayed reduction in concentration at well G301 is a result of the well's location along the flow path of the residual sulfate concentrations released into native geologic materials prior to closure. Reduced percolation rates through the consolidation area within AP1 in the CIP scenario means that the residual sulfate concentrations require a longer time period to migrate through native geologic materials.

Evaluations of post-construction water flux through the consolidated and covered Fill Unit (CCR) were completed using data obtained from the Scenario 1 (CIP) prediction model when simulated post-construction heads in the groundwater monitoring wells are predicted to stabilize (once heads stabilized in the model, the post-construction movement of water in and out of the Fill Unit [CCR] were compared to pre-construction conditions). The pre-construction (calibration model) and post-construction Scenario 1 (CIP) prediction model simulated water flux values are summarized in **Appendix E** and discussed below. Data export files used for flux evaluations are found along with model files in **Appendix B**.

Scenario 1 (CIP) was predicted to reduce total flux in and out of the Fill Unit (CCR) by approximately 99.9%, when simulated post-construction heads in the groundwater monitoring wells are predicted to stabilize (approximate hydraulic steady state) as illustrated in **Figure 6-7**. **Figure 6-8** is a plot showing the changes in flux reduction (shown as negative percentage) over time starting from implementation of Scenario 1 (CIP) through approximate hydraulic steady state conditions. Following implementation of Scenario 1 (CIP), influx into the CCR unit decreases rapidly as illustrated in **Figure 6-8**. Following removal of free-liquids, the consolidated CCR is no longer in contact with groundwater. Thus, the modeling indicates consolidation and closure with the proposed cover system result in 99.9% reduction in outflux after 10 days (**Figure 6-8**). The outflux from the CCR unit remains relatively constant throughout the CIP simulation.

Further, the base of consolidated CCR was compared to the simulated steady-state groundwater elevations which indicate between 3.2 and 10 feet of separation will be present between the base of CCR and groundwater (**Figure 6-9**).

6.3.2 Closure by Removal Model Results

The design for Scenario 2: CBR includes an initial 2-year dewatering period followed by CCR removal from AP1 (**Figure 6-2**). Stormwater drainage is present within AP1 with an outflow elevation of 625 feet.

For most wells, predicted concentrations for CBR start to decline at monitoring wells with observations above the standard GWPS for sulfate (400 mg/L) once the closure actions are initiated within the prediction model. The concentration of sulfate in some wells (most notably G315, G307 and G308) show short term fluctuations (less than 5 years) following the removal of concentration during the dewatering phase, such that sulfate concentrations decline and are followed by a short rise before the impacts of the CBR are clearly observed. The general decline in sulfate concentration occur as the CCR is removed from AP1 and saturated ash cells (constant concentration cells) are removed. Following removal of CCR, sulfate concentrations are no longer entering the model domain from recharge or from saturated ash cells (constant concentration cells); all source concentrations are removed. Dewatering through removal of free liquids also reduces the head within AP1. These low heads are maintained following completion of closure by the drain cells that simulate storm water management designs within AP1. The removal of the CCR sources leads to the gradual reduction the residual sulfate concentrations released into native geologic materials prior to closure. All monitoring wells with observations above the standard GWPS for sulfate (400 mg/L) are predicted to be below the GWPS 18.1 years after closure implementation (**Figure 6-3**).

The sulfate plume in the CBR prediction model differs from that in the CIP prediction model. Higher recharge rates are present in the western portion of the pond because there is no cover

system. The relatively higher recharge rates maintain components of the radial flow pattern described in **Section 2.2** at AP1. However, the stormwater drainage within the pond does constrain the groundwater elevation beneath AP1. As a result of the radial flow pattern, the prediction model indicates that a portion of the historic plume will remain along the western edge of AP1 as the plume recedes over time. The maximum extent of the plume at 14.8 years is illustrated in **Figure 6-4**. The maximum extent of the plume remains in close proximity to AP1 and is no longer present above the GWPS (400 mg/L) at 58.8 years as illustrated in **Figure 6-6**.

7. CONCLUSIONS

This GMR has been prepared to evaluate how proposed CIP and CBR scenarios will achieve compliance with the applicable groundwater standards at the CPP for AP1. An existing groundwater model was updated to include data collected from the recent 2021 field investigations and used to predict the impacts of the closure scenarios on groundwater quality at the CPP. Statistically significant correlations between sulfate concentrations and concentrations of TDS identified as potential exceedances of the GWPS indicate sulfate is an acceptable surrogate for TDS in the groundwater model. Concentrations of TDS are expected to change along with model predicted sulfate concentrations. A potential exceedance of boron was observed at one monitoring well, G313, which also has potential exceedances of both sulfate and TDS. Similar source and behavior in the groundwater system would be expected among boron, sulfate, and TDS at UA monitoring well G313, and boron concentrations are expected to change along with model predicted sulfate concentrations. It was assumed that sulfate would not significantly sorb or chemically react with aquifer solids (Kd was set to 0 mL/g) which is a conservative estimate for predicting contaminant transport times in the model. The MODFLOW and MT3DMS models were used to evaluate two scenarios using information provided in the Final Closure Plan for AP1 (Golder, 2022a):

- **Scenario 1:** CIP including removal of CCR from the eastern portion of AP1, consolidation into the western portion of AP1, and construction of a cover system over the remaining CCR.
- **Scenario 2:** CBR including removal of all CCR and regrading of the removal area.

Scenario 1 (CIP) was predicted to reduce total flux in and out of the Fill Unit (CCR) by approximately 99.9%, when simulated post-construction heads in the groundwater monitoring wells are predicted to stabilize. Additionally, the base of consolidated CCR was compared to the simulated steady-state groundwater elevations which indicate between 3.2 and 10 feet of separation will be present between the base of CCR and groundwater.

Differences exist in the timeframes to reach the GWPS for most monitoring wells between CIP and CBR. In general, the simulated groundwater concentrations in the monitoring wells within the UA will achieve the GWPS in 15 years and 18 years respectively for the CIP and CBR closure scenarios, with the exception of well G301 in the CIP scenario. The predicted delayed reduction in concentration at well G301, 59 years to reach the GWPS, is a result of the well's location along the flow path of the residual sulfate concentrations released into native geologic materials prior to closure. Reduced percolation rates through the consolidation area at the northwest corner of AP1 in the CIP scenario means that the residual sulfate concentrations in this limited area require a longer time period to migrate through native geologic materials.

8. REFERENCES

Anderson, M.P. 1979. *Using models to simulate the movement of contaminants through groundwater flow systems*. CRC Critical Rev. Environ. Control., 9(2), p. 97-156.

Anderson, M.P. 1984. *Movement of contaminants in groundwater: groundwater transport -- advection and dispersion*. Groundwater Contamination. National Academy Press, Washington, D.C. p. 37-45.

Environmental Simulations, Inc., 2017. *Groundwater Vistas 7 Software*.

Electric Power Research Institute (EPRI), 2005. *Chemical constituents in coal combustion product leachate: boron. Final Report 1005258.*

EPRI, 2005. *Chemical constituents in coal combustion product leachate: boron*. Final Report 1005258.

Fetter, C.W., 1988. *Applied Hydrogeology*. Merrill Publishing Company, Columbus, Ohio.

Fetter, C.W., 2001. *Applied Hydrogeology*. 4th Edition, Prentice Hall, Upper Saddle River, p. 79.

Geosyntec Consultants, Inc. (Geosyntec), 2022a. *Technical Memorandum: Evaluation of Potential GWPS Exceedances, Coffeen Ash Pond 1, Coffeen Power Plant*.

Geosyntec Consultants, Inc. (Geosyntec), 2022b. *Technical Memorandum: Evaluation of Partition Coefficient Results, Coffeen Ash Pond No. 1, CCR Unit 101, Coffeen Power Plant, Coffeen Illinois*.

Geosyntec Consultants, Inc. (Geosyntec), 2022c. *Technical Memorandum: Proposed Alternative Final Protective Layer Equivalency Demonstration, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois*.

Golder Associates (Golder), 2022a. *Final Closure Plan for Ash Pond No. 1*, attached to the Construction Permit Application to which this report is also attached, July 2022.

Golder Associates (Golder), 2022b. *Final Closure Plan for the Gypsum Management Facility Gypsum Stack Pond, Coffeen Power Plant, Coffeen, Illinois*, July 2022.

Golder Associates (Golder), 2022c. *Final Closure Plan for the Gypsum Management Facility Recycle Pond, Coffeen Power Plant, Coffeen*, July 2022.

Haley & Aldrich, Inc., October 1, 2018. *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*.

Hanson Professional Services, Inc. (Hanson), 2009. *Section 3: Hydrogeologic Investigation. Initial Facility Report*. Hanson Professional Services, Inc. August 2009.

Hanson Professional Services, Inc. (Hanson), 2016. 40 CFR 257.60 *Uppermost Aquifer Considerations, Gypsum Pond*, Illinois Power Holdings LLC, Coffeen Energy Center, Montgomery County, Illinois, April 2016.

Illinois Environmental Protection Agency (IEPA), 2021. *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 Illinois Administration Code 845, Addendum*. April 15, 2021.

Illinois State Geological Survey (ISGS), 2019. *Directory of Coal Mines in Illinois, Christian County*. Accessed from URL: https://wikiimage.isgs.illinois.edu/ilmines/webfiles/mines-series/mines-directories/pdf-files/mines-directory-christian.pdf. August 2019.

McDonald, M.G., and A.W. Harbaugh, 1988. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: Techniques of Water-Resources Investigations, Techniques of Water-Resources of the United States Geological Survey*. Book 6, Chapter A1.

Natural Resource Technology, Inc. (NRT), 2017a. *Hydrogeologic Site Characterization Report. Ash Pond 2, Coffeen Power Station, Coffeen, Illinois*. Illinois Power Generating Company. January 24, 2017.

Natural Resource Technology, Inc. (NRT), 2017b. *Groundwater Model Report. Ash Pond 2, Coffeen Power Station, Coffeen, Illinois*. Illinois Power Generating Company. January 24, 2017.

Nelson, W. John, 1995. *Structural Features in Illinois*. Illinois State Geological Survey, Bulletin 100, 144 p.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021a. *Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen, Illinois*. Illinois Power Generating Company. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021b. *History of Potential Exceedances, Ash Pond No. 1, Coffeen, Illinois*. Illinois Power Generating Company. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021c. *Groundwater Monitoring Plan. Coffeen Power Plant, Ash Pond No. 1, Coffeen, Illinois*. Illinois Power Generating Company. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021d. *Hydrogeologic Site Characterization Report, GMF Recycle Pond, Coffeen, Illinois*. Illinois Power Generating Company. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021e. *Hydrogeologic Site Characterization Report, GMF Gypsum Stack Pond, Coffeen, Illinois*. Illinois Power Generating Company. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2022. *Groundwater Modeling Report, GMF Gypsum Stack Pond and GMF Recycle Pond, Coffeen Power Plant, Coffeen Illinois*.

Strenge, D. and Peterson, S. 1989. *Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS) (No. PNL-7145)*. Pacific Northwest Lab., Richland, WA (USA).

Tolaymat, T. and Krause, M, 2020. *Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual*. United States Environmental Protection Agency, Washington, DC, EPA/600/B 20/219.

United States Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS), 2022. National Geospatial Center of Excellence, Digital Elevation Model.

United States Geological Survey (USGS), 2021. *National Map*. Accessed from URL: https://apps.nationalmap.gov/viewer/

Willman, H.B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J.A. Simon, 1975. *Handbook of Illinois Stratigraphy.* Illinois State Geological Survey, Bulletin 95, 261 p.

Zheng, Z., and P.P. Wang, 1998. MT3DMS, a Modular Three-Dimensional Multispecies Transport Model, Model documentation and user's guide prepared by the University of Alabama Hydrogeology Group for the US Army Corps of Engineers.

TABLES

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (feet)	Measuring Point Elevation (feet)	Measuring Point Description	Ground Elevation (feet)	Screen Top Depth (feet bgs)	Screen Bottom Depth (feet bgs)	Screen Top Elevation (feet)	Screen Bottom Elevation (feet)	Well Depth (feet bgs)	Bottom of Boring Elevation (feet)	Screen Length (feet)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G045D	LCU	08/17/2016	623.81	623.81	Top of PVC	620.94	31.88	41.52	589.06	579.42	41.92	578.90	9.6	2	39.064349	-89.396281
G046D	LCU	08/19/2017	625.24	625.24	Top of PVC	621.91	41.61	51.26	580.30	570.65	51.65	569.90	9.7	2	39.060305	-89.398524
G101	UA	02/02/2010	--	627.60	Top of Disk	625.27	15.68	20.32	609.59	604.95	20.89	603.40	4.6	2	39.071386	-89.400107
G102	UA	04/28/2006	--	629.04	Top of Disk	626.18	12.02	16.78	614.16	609.40	17.15	609.00	4.8	2	39.071387	-89.398991
G103	UA	02/15/2010	--	633.80	Top of Disk	627.94	15.88	20.67	612.06	607.27	21.09	606.90	4.8	2	39.070412	-89.399107
G104	UA	02/15/2010	--	632.94	Top of Disk	627.96	14.91	19.61	613.05	608.35	20.08	605.80	4.7	2	39.069451	-89.399104
G105	UA	02/16/2010	--	632.08	Top of Disk	626.86	16.11	20.90	610.75	605.96	21.37	604.40	4.8	2	39.068491	-89.3991
G106	UA	02/16/2010	--	631.15	Top of Disk	625.96	14.37	18.96	611.59	607.00	19.44	605.50	4.6	2	39.06753	-89.399097
G107	UA	02/17/2010	630.22	630.22	Top of Disk	628.20	13.87	18.50	614.33	609.70	19.00	607.50	4.6	2	39.067106	-89.399646
G108	UA	02/12/2010	--	630.22	Top of Disk	625.58	16.82	21.50	608.76	604.08	22.00	603.60	4.7	2	39.066984	-89.400035
G109	UA	02/11/2010	--	629.76	Top of Disk	624.79	15.39	19.93	609.40	604.86	20.50	604.30	4.5	2	39.067045	-89.400423
G110	UA	02/11/2010	--	629.65	Top of Disk	624.81	15.05	19.59	609.76	605.22	20.16	604.70	4.5	2	39.067172	-89.400704
G111	UA	02/11/2010	--	629.90	Top of Disk	625.28	14.61	19.15	610.67	606.13	19.72	605.60	4.5	2	39.067292	-89.40097
G119	UA	02/09/2010	--	631.55	Top of Disk	626.57	17.29	21.83	609.28	604.74	22.38	604.20	4.5	2	39.068986	-89.401213
G120	UA	02/08/2010	--	631.87	Top of Disk	627.21	15.10	19.62	612.11	607.59	20.21	605.10	4.5	2	39.069479	-89.401214
G121	UA	02/04/2010	--	632.83	Top of Disk	627.94	16.79	21.47	611.15	606.47	21.95	603.80	4.7	2	39.069781	-89.401216
G122	UA	02/04/2010	--	632.69	Top of Disk	628.05	16.51	21.05	611.54	607.00	21.66	606.20	4.5	2	39.070098	-89.401218
G123	UA	02/04/2010	--	632.96	Top of Disk	628.12	20.94	25.46	607.18	602.66	26.07	602.10	4.5	2	39.070399	-89.401219
G124	UA	02/03/2010	--	633.39	Top of Disk	628.70	15.98	20.51	612.72	608.19	21.06	606.70	4.5	2	39.070715	-89.40122
G125	UA	02/03/2010	--	633.51	Top of Disk	628.85	17.03	21.56	611.82	607.29	22.04	606.80	4.5	2	39.071003	-89.401221
G126	UA	02/10/2010	--	625.39	Top of Disk	622.96	12.89	17.43	610.07	605.53	18.00	605.00	4.5	2	39.067304	-89.401274
G151	UA	12/19/2011	--	625.93	Top of Disk	622.82	15.34	19.84	607.48	602.98	20.46	602.40	4.5	2	39.0672	-89.40159
G152	UA	12/20/2011	--	626.52	Top of Disk	623.06	13.59	18.09	609.47	604.97	18.57	604.50	4.5	2	39.066275	-89.401289
G153	UA	12/15/2011	626.35	626.40	Top of Disk	623.23	15.90	20.34	607.33	602.89	20.80	602.50	4.4	2	39.065857	-89.402567
G154	UA	12/16/2011	--	626.35	Top of Disk	623.52	14.26	18.76	609.26	604.76	19.10	603.50	4.5	2	39.067089	-89.403574
G155	UA	12/19/2011	--	625.86	Top of Disk	622.89	15.09	19.58	607.80	603.31	23.23	599.70	4.5	2	39.067493	-89.402659
G200	UA	02/25/2008	--	625.94	Top of Disk	623.27	12.19	16.98	611.08	606.29	17.36	605.30	4.8	2	39.075139	-89.395009
G201	UA	02/25/2008	627.15	627.15	Top of Riser	624.19	13.01	17.80	611.18	606.39	18.15	606.00	4.8	2	39.075141	-89.397829
G205	UA	02/21/2008	--	624.34	Top of Disk	622.10	10.04	14.53	612.06	607.57	15.07	606.10	4.5	2	39.068596	-89.394147
G206	UA	10/14/2010	--	632.82	Top of Disk	630.53	17.51	21.92	613.02	608.61	22.42	606.50	4.4	2	39.067399	-89.398548
G206D	DA	01/25/2021	634.14	634.14	Top of PVC	631.41	49.20	59.00	582.21	572.41	59.39	571.41	9.8	2	39.067428	-89.398493
G207	UA	10/08/2010	--	633.21	Top of Disk	630.61	18.24	22.77	612.37	607.84	23.30	606.60	4.5	2	39.067568	-89.397952
G208	UA	10/07/2010	--	633.16	Top of Disk	630.57	17.53	22.06	613.04	608.51	22.60	606.60	4.5	2	39.067743	-89.397402
G209	UA	10/07/2010	--	632.91	Top of Disk	630.57	17.74	22.28	612.83	608.29	22.81	606.60	4.5	2	39.067923	-89.39685
G210	UA	10/06/2010	--	632.99	Top of Disk	630.48	19.39	23.93	611.09	606.55	24.46	605.50	4.5	2	39.068088	-89.396322
G211	UA	10/11/2010	--	632.64	Top of Disk	630.31	17.34	21.88	612.97	608.43	22.41	606.30	4.5	2	39.068263	-89.395792
G212	UA	10/11/2010	--	632.89	Top of Disk	630.59	16.74	21.29	613.85	609.30	21.81	606.60	4.6	2	39.06843	-89.395318
G213	UA	10/12/2010	--	632.81	Top of Disk	630.34	16.75	21.29	613.59	609.05	21.82	606.30	4.5	2	39.068585	-89.394822
G214	UA	10/14/2010	--	632.85	Top of Disk	630.39	17.75	22.14	612.64	608.25	22.65	606.40	4.4	2	39.068919	-89.393982
G215	UA	10/13/2010	--	633.06	Top of Disk	630.48	19.41	23.80	611.07	606.68	24.31	606.20	4.4	2	39.069309	-89.39394

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ASH POND NO. 1

COFFEEN, ILLINOIS

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G216	UA	10/13/2010	--	632.76	Top of Disk	630.28	20.04	24.42	610.24	605.86	24.93	604.30	4.4	2	39.069765	-89.393946
G217	UA	10/12/2010	--	633.10	Top of Disk	630.67	20.49	24.88	610.18	605.79	25.38	604.70	4.4	2	39.07034	-89.393959
G218	UA	10/12/2010	--	633.11	Top of Disk	630.64	20.33	24.77	610.31	605.87	25.27	604.60	4.4	2	39.070876	-89.393956
G270	UA	02/26/2008	--	625.86	Top of Disk	623.73	13.13	17.92	610.60	605.81	18.27	605.50	4.8	2	39.066564	-89.397403
G271	UA	09/10/2009	--	625.57	Top of Disk	622.89	9.96	14.31	612.93	608.58	14.79	606.90	4.4	2	39.065007	-89.395587
G272	UA	09/10/2009	--	623.81	Top of Disk	620.72	9.11	13.98	611.61	606.74	14.32	606.40	4.9	2	39.064989	-89.394785
G273	UA	09/10/2009	--	623.02	Top of Disk	620.17	9.08	14.56	611.09	605.61	15.10	604.20	5.5	2	39.064985	-89.393973
G274	UA	09/16/2009	--	624.04	Top of Disk	621.67	12.90	17.67	608.77	604.00	18.06	603.60	4.8	2	39.064991	-89.393198
G275	UA	09/16/2009	--	618.26	Top of Disk	616.14	8.22	12.62	607.92	603.52	13.19	603.00	4.4	2	39.065151	-89.392561
G275D	DA	01/14/2021	620.31	620.31	Top of PVC	617.52	49.76	59.55	567.76	557.97	59.89	517.80	9.8	2	39.065121	-89.392595
G276	UA	09/16/2009	--	632.00	Top of Disk	629.14	22.41	27.22	606.73	601.92	27.65	601.10	4.8	2	39.065534	-89.392617
G277	UA	09/14/2009	--	623.08	Top of Disk	620.79	14.29	18.77	606.50	602.02	19.24	600.80	4.5	2	39.065927	-89.392572
G278	UA	09/11/2009	631.19	631.17	Top of Disk	628.85	18.93	23.70	609.92	605.15	24.06	604.80	4.8	2	39.066737	-89.393161
G279	UA	09/10/2009	--	632.04	Top of Disk	629.19	22.40	26.79	606.79	602.40	27.30	601.20	4.4	2	39.067156	-89.392998
G280	UA	02/26/2008	625.35	625.35	Top of Riser	623.11	12.79	17.63	610.32	605.48	17.98	605.10	4.8	2	39.067216	-89.394992
G281	UA	09/08/2015	--	626.36	Top of Disk	623.82	15.51	20.16	608.31	603.66	20.30	603.50	4.7	2	39.065405	-89.399322
G283	LCU	01/14/2021	610.75	610.75	Top of PVC	608.30	8.39	18.17	599.91	590.13	18.36	589.90	9.8	2	39.064645	-89.392119
G284	UA	02/03/2021	618.42	618.42	Top of PVC	615.33	8.08	12.85	607.25	602.48	13.23	601.30	4.8	2	39.065487	-89.390631
G285	LCU	01/25/2021	613.52	613.52	Top of PVC	610.54	13.68	23.45	596.86	587.09	23.83	584.50	9.8	2	39.066513	-89.391474
G286	UA	01/18/2021	613.13	613.13	Top of PVC	609.97	3.37	8.16	606.60	601.81	8.50	600.00	4.8	2	39.067277	-89.391883
G287	UA	01/20/2021	617.45	617.45	Top of PVC	614.34	5.43	10.25	608.91	604.09	10.59	602.50	4.8	2	39.068297	-89.392388
G288	UA	01/19/2021	620.07	620.07	Top of PVC	617.08	7.59	12.26	609.49	604.82	12.75	603.10	4.7	2	39.067834	-89.390082
G301	UA	09/04/2015	--	622.65	Top of Disk	620.88	11.31	15.96	608.96	604.31	16.21	604.10	4.7	2	39.05951	-89.395415
G302	UA	09/04/2015	--	620.04	Top of Disk	618.52	13.21	17.86	604.74	600.09	18.39	599.60	4.7	2	39.059544	-89.393192
G303	UA	08/26/2010	--	622.02	Top of Disk	619.33	10.00	20.00	609.07	599.07	20.40	598.70	10	2	39.057144	-89.391721
G304	UA	08/26/2010	--	626.72	Top of Disk	623.32	10.00	20.00	613.32	603.32	20.40	602.90	10	2	39.057205	-89.395663
G305	UA	05/03/2016	625.67	625.67	Top of PVC	623.23	13.44	18.27	609.10	604.27	18.50	604.10	4.8	2	39.056558	-89.396798
G306	UA	05/03/2016	625.91	625.91	Top of PVC	623.57	13.07	17.68	609.77	605.16	17.90	604.80	4.6	2	39.056494	-89.393556
G307	UA	07/27/2016	624.60	624.60	Top of PVC	624.73	12.96	17.80	609.12	604.28	18.22	603.90	4.8	2	39.057214	-89.395545
G307D	LCU	01/19/2021	624.88	624.88	Top of PVC	622.51	48.98	58.75	573.53	563.76	59.60	562.50	9.8	2	39.05721	-89.39552
G308	UA	01/18/2021	624.59	624.59	Top of PVC	621.59	10.10	14.89	611.49	606.70	15.24	605.80	4.8	2	39.057379	-89.397134
G309	UA	01/21/2021	625.88	625.88	Top of PVC	622.77	12.97	17.75	609.80	605.02	18.10	604.70	4.8	2	39.058508	-89.397243
G310	UA	02/09/2021	622.87	622.87	Top of PVC	619.89	10.24	15.03	609.65	604.86	15.38	604.00	4.8	2	39.059532	-89.396907
G311	UA	01/13/2021	621.04	621.04	Top of PVC	618.32	9.27	14.04	609.05	604.28	14.40	603.90	4.8	2	39.059513	-89.394363
G311D	LCU	01/12/2021	621.24	621.24	Top of PVC	618.39	50.16	60.10	568.23	558.29	60.58	557.80	9.9	2	39.059513	-89.394312
G312	UA	01/15/2021	619.78	619.78	Top of PVC	616.92	9.79	14.58	607.13	602.34	14.93	601.70	4.8	2	39.059558	-89.391983
G313	UA	02/05/2021	614.30	614.30	Top of PVC	611.51	6.30	11.11	605.21	600.40	11.46	599.50	4.8	2	39.058773	-89.391124
G314	LCU	02/05/2021	613.88	613.88	Top of PVC	611.11	14.56	19.58	596.55	591.53	20.02	591.10	5	2	39.05782	-89.390964
G314D	DA	02/04/2021	613.70	613.70	Top of PVC	610.87	39.34	49.11	571.53	561.76	49.47	510.60	9.8	2	39.057852	-89.390958
G315	UA	01/14/2021	623.52	623.52	Top of PVC	620.94	9.69	14.48	611.25	606.46	14.85	605.00	4.8	2	39.057165	-89.393667

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS

GROUNDWATER MODELING REPORT

COFFEEN POWER PLANT

ASH POND NO. 1

COFFEEN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (feet)	Measuring Point Elevation (feet)	Measuring Point Description	Ground Elevation (feet)	Screen Top Depth (feet bgs)	Screen Bottom Depth (feet bgs)	Screen Top Elevation (feet)	Screen Bottom Elevation (feet)	Well Depth (feet bgs)	Bottom of Boring Elevation (feet)	Screen Length (feet)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G316	LCU	02/26/2021	602.59	602.59	Top of PVC	599.64	10.02	14.82	589.62	584.82	15.16	583.90	4.8	2	39.057847	-89.389698
G317	UA	02/12/2021	641.93	641.93	Top of PVC	638.85	30.14	34.93	608.71	603.92	35.28	602.90	4.8	2	39.056727	-89.390148
G401	UA	09/14/2015	--	625.57	Top of Disk	623.03	14.36	18.79	608.67	604.24	19.29	603.70	4.4	2	39.060259	-89.395295
G402	UA	08/27/2010	--	613.37	Top of Disk	610.36	10.00	20.00	600.36	590.36	20.40	590.00	10	2	39.060207	-89.391712
G403	UA	09/11/2015	--	626.47	Top of Disk	623.81	13.11	17.78	610.70	606.03	18.15	605.70	4.7	2	39.063167	-89.398779
G404	UA	05/01/2007	--	615.67	Top of Disk	613.57	6.42	11.17	607.15	602.40	11.62	601.60	4.8	2	39.064329	-89.392493
G405	UA	05/01/2007	--	623.63	Top of Disk	621.40	9.01	13.76	612.39	607.64	14.21	607.20	4.8	2	39.064345	-89.396234
G406	UA	08/19/2016	625.36	625.36	Top of PVC	621.86	13.56	18.37	608.30	603.49	18.75	603.10	4.8	2	39.060309	-89.398508
G407	UA	08/16/2016	621.32	621.32	Top of PVC	618.35	13.78	18.61	604.57	599.74	19.04	598.40	4.8	2	39.061574	-89.402004
G410	UA	02/23/2018	--	619.79	Top of Disk	617.21	8.89	13.68	608.32	603.53	14.09	603.10	4.8	2	39.061572	-89.403763
G411	UA	02/22/2018	--	623.25	Top of Disk	620.49	11.21	16.07	609.28	604.42	16.47	604.00	4.9	2	39.063979	-89.404033
MW01D	DA	05/03/2006	609.02	609.02	Top of PVC	607.08	33.29	38.05	573.79	569.03	38.41	567.10	4.8	2	39.067068	-89.402747
MW02S	UA	05/05/2006	627.12	627.12	Top of PVC	624.16	10.34	15.12	613.82	609.04	15.51	608.70	4.8	2	39.071017	-89.403648
MW02D	LCU	05/05/2006	626.99	626.99	Top of PVC	624.14	22.03	26.83	602.11	597.31	27.22	596.90	4.8	2	39.071031	-89.403649
MW03D	DA	04/27/2006	629.01	629.01	Top of PVC	625.86	52.29	57.06	573.57	568.80	57.40	567.90	4.8	2	39.071386	-89.398976
MW04S	UA	05/11/2006	625.89	625.89	Top of PVC	622.63	9.83	14.26	612.80	608.37	14.77	607.90	4.4	2	39.075356	-89.399232
MW05S	UA	05/17/2006	625.95	625.95	Top of PVC	622.65	12.66	17.41	609.99	605.24	17.71	604.90	4.8	2	39.075866	-89.40333
MW05D	DA	05/17/2006	625.91	625.91	Top of PVC	622.65	45.57	50.33	577.08	572.32	50.72	568.70	4.8	2	39.075863	-89.403313
MW06S	UA	05/04/2006	626.15	626.15	Top of PVC	623.37	11.04	15.62	612.33	607.75	16.08	607.30	4.6	2	39.078189	-89.403644
MW07S	UA	05/09/2006	627.60	627.60	Top of PVC	624.90	9.91	13.79	614.99	611.11	14.39	610.50	3.9	2	39.0786	-89.399383
MW08S	UA	05/10/2006	628.01	628.01	Top of PVC	625.09	11.51	16.00	613.58	609.09	16.60	608.00	4.5	2	39.080234	-89.399079
MW09S	UA	05/03/2006	627.62	627.62	Top of PVC	624.70	11.21	15.62	613.49	609.08	16.20	608.50	4.4	2	39.079954	-89.394899
MW09D	LCU	05/03/2006	627.61	627.61	Top of PVC	624.68	45.81	50.57	578.87	574.11	51.00	570.70	4.8	2	39.07994	-89.394899
MW10S	UA	05/02/2006	624.45	624.45	Top of PVC	621.43	11.28	15.76	610.15	605.67	16.30	605.10	4.5	2	39.07601	-89.394068
MW10D	LCU	05/01/2006	624.47	624.47	Top of PVC	621.33	41.74	46.57	579.59	574.76	47.02	572.60	4.8	2	39.075995	-89.39407
MW11S	UA	04/28/2006	625.27	625.27	Top of PVC	622.04	8.89	13.63	613.15	608.41	14.08	608.00	4.7	2	39.071888	-89.393913
MW11D	LCU	04/28/2006	625.52	625.52	Top of PVC	622.19	28.31	33.04	593.88	589.15	33.50	585.90	4.7	2	39.071888	-89.393894
MW12S	UA	05/10/2006	625.31	625.31	Top of PVC	622.24	10.61	15.18	611.63	607.06	15.61	606.60	4.6	2	39.068514	-89.394199
MW12D	DA	05/10/2006	625.21	625.21	Top of PVC	622.24	42.46	46.99	579.78	575.25	47.47	572.20	4.5	2	39.068501	-89.394199
MW13S	UA	05/09/2006	625.96	625.96	Top of PVC	622.80	11.43	16.23	611.37	606.57	16.62	606.20	4.8	2	39.066297	-89.40118
MW13D	DA	05/09/2006	625.86	625.86	Top of PVC	622.85	49.81	54.60	573.04	568.25	55.00	567.90	4.8	2	39.066293	-89.401163
MW14S	UA	05/02/2006	626.88	626.88	Top of PVC	624.62	12.26	17.02	612.36	607.60	17.38	607.20	4.8	2	39.069153	-89.400442
MW15S	UA	04/25/2006	626.66	626.66	Top of PVC	623.83	14.41	19.16	609.42	604.67	19.62	604.20	4.8	2	39.069772	-89.397088
MW15D	LCU	04/25/2006	626.44	626.44	Top of PVC	623.83	33.68	38.45	590.15	585.38	38.80	585.00	4.8	2	39.06977	-89.397073
MW16S	UA	04/25/2006	629.47	629.47	Top of PVC	626.32	14.59	19.41	611.73	606.91	19.76	606.40	4.8	2	39.073571	-89.397006
MW16D	DA	04/25/2006	629.38	629.38	Top of PVC	626.37	45.90	50.34	580.47	576.03	50.78	575.40	4.4	2	39.073571	-89.397036
MW17S	UA	05/04/2006	630.56	630.56	Top of PVC	627.28	14.02	23.56	613.26	603.72	24.11	603.20	9.5	2	39.07715	-89.396978
MW17D	DA	05/04/2006	630.29	630.29	Top of PVC	627.47	48.82	53.32	578.65	574.15	53.87	573.60	4.5	2	39.077151	-89.396958
MW18S	UA	05/11/2006	628.66	628.66	Top of PVC	625.69	11.31	15.79	614.38	609.90	16.40	609.30	4.5	2	39.077033	-89.401698
MW20S	UA	05/01/2007	622.90	622.90	Top of PVC	620.26	8.41	13.22	611.85	607.04	13.67	604.30	4.8	2	39.064968	-89.394322

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (feet)	Measuring Point Elevation (feet)	Measuring Point Description	Ground Elevation (feet)	Screen Top Depth (feet bgs)	Screen Bottom Depth (feet bgs)	Screen Top Elevation (feet)	Screen Bottom Elevation (feet)	Well Depth (feet bgs)	Bottom of Boring Elevation (feet)	Screen Length (feet)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
R104	UA	10/08/2010	--	632.84	Top of Disk	629.03	14.59	19.32	614.44	609.71	19.85	609.20	4.7	2	39.069474	-89.399109
R201	UA	10/08/2010	--	626.34	Top of Disk	624.02	14.59	19.32	609.43	604.70	19.85	604.20	4.7	2	39.075142	-89.397855
R205	UA	03/20/2017	--	624.52	Top of Disk	621.91	11.32	16.01	610.59	605.90	16.42	605.50	4.7	2	39.068593	-89.394164
T127	UA	02/10/2010	--	630.96	Top of Disk	625.53	17.53	22.07	608.00	603.46	22.64	602.90	4.5	2	39.068119	-89.40121
T128	UA	02/09/2010	631.03	630.93	Top of Disk	626.27	16.53	21.04	609.74	605.23	21.64	602.20	4.5	2	39.068532	-89.401211
T202	UA	10/15/2010	--	628.63	Top of Disk	626.22	12.27	16.65	613.95	609.57	17.21	608.20	4.4	2	39.071776	-89.397705
T408	LCU	08/17/2016	624.08	624.08	Top of PVC	621.09	20.66	25.49	600.43	595.60	25.92	595.20	4.8	2	39.064353	-89.396307
T409	LCU	08/19/2016	625.01	625.01	Top of PVC	621.85	21.79	26.59	600.06	595.26	26.99	594.90	4.8	2	39.0603	-89.398538
TA31	UA	10/28/2014	626.55	626.55	Top of PVC	623.89	15.09	19.57	608.80	604.32	20.19	603.70	4.5	2	39.071368	-89.401366
TA32	UA	10/27/2014	621.42	621.42	Top of PVC	618.93	11.31	15.68	607.62	603.25	16.47	602.50	4.4	2	39.074093	-89.402223
TA33	UA	06/02/2015	625.27	625.27	Top of PVC	622.51	12.23	16.89	610.28	605.62	17.44	605.10	4.7	2	39.071556	-89.403506
TA34	UA	06/03/2015	626.52	626.52	Top of PVC	624.10	10.92	15.41	613.18	608.69	16.10	608.00	4.5	2	39.069631	-89.402759
TR32	UA	07/02/2021	621.68	621.68	Top of PVC	619.28	11.00	15.68	608.28	603.60	16.17	603.11	4.68	2	39.074064	-89.397758
X201	S	--	--	618.47	--	--	--	--	--	--	--	--	--	--	39.065278	-89.3925
SG-02	SW	--	--	605.87	Top of Prot Casing	605.87	--	--	--	--	--	--	--	--	39.059695	-89.391429
SG-03	SW	--	--	594.94	Top of Prot Casing	594.94	--	--	--	--	--	--	--	--	39.059092	-89.390342
SG-04	SW	--	--	599.52	Top of Prot Casing	599.52	--	--	--	--	--	--	--	--	39.064146	-89.390504

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
bgs = below ground surface
DA = deep aquifer
ft = foot or feet
HSU = hydrostratigraphic Unit
LCU = lower confining unit
PVC = polyvinyl chloride
S = source water
SW = surface water
UA = uppermost aquifer
generated 10/05/2021, 2:15:37 PM CDT

TABLE 4-1. FLOW AND TRANSPORT MODEL CALIBRATION TARGETS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

					Flow Targets								Transport Targets							
Well Name	Easting	Northing	HSU	CCR Unit	Number of Samples	mean GWL[1] (feet)	std GWL[1] (feet)	min GWL[1] (feet)	max GWL[1] (feet)	Earliest Sample Date	Latest Sample Date	Flow Calibration Wells	Number of Samples	mean Sulfate (mg/L)	std Sulfate (mg/L)	min Sulfate (mg/L)	max Sulfate (mg/L)	Earliest Sample Date	Latest Sample Date	Transport Calibraiton Well
G101	2514214.26	876551.76	UA	LF	20	617.989	2.504194166	612.95	623.65	15/01/2019	16/11/2015	Yes	-	-	-	-	-	-	-	-
G102	2514531.1	876554.8	UA	GSP	25	622.8612	1.751842649	618.96	627.12	15/01/2019	16/11/2015	Yes	19	90.6	29.7	49	140	04/08/2015	01/26/2021	Yes
G103	2514501.17	876199.41	UA	GSP	19	622.0884211	1.754825927	617.95	624.93	15/01/2019	11/12/2016	Yes	3	66.3	11.2	54	76	04/08/2015	10/06/2015	Yes
G105	2514509.06	875499.78	UA	GSP	19	622.0884211	2.178504235	613.96	624	15/01/2019	11/12/2016	Yes	3	116.7	11.5	110	130	04/08/2015	10/06/2015	Yes
G106	2514512.87	875149.77	UA	GSP	20	620.763	1.194844628	617.46	622.6	15/01/2019	16/11/2015	Yes	19	66.1	23.3	36	140	04/08/2015	01/26/2021	Yes
G107	2514358.3	874994.03	UA	LF	19	619.1036842	1.658802147	615.46	622.33	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G108	2514248.22	874948.67	UA	LF	19	619.4994737	1.31911786	616.24	622.22	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G109	2514137.87	874969.96	UA	LF	19	618.7294737	1.25543031	615.7	620.84	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G110	2514057.7	875015.54	UA	LF	20	618.104	1.590105591	613.27	620.65	15/01/2019	16/11/2015	Yes	-	-	-	-	-	-	-	-
G111	2513981.81	875058.61	UA	LF	19	616.9310526	1.267626368	613.16	618.53	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G119	2513907.62	875675	UA	LF	19	615.9689474	1.16332328	612.24	617.45	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G120	2513905.82	875854.56	UA	LF	19	614.3242105	1.834418817	612.13	617.69	15/01/2019	16/11/2015	Yes	-	-	-	-	-	-	-	-
G121	2513904.33	875964.54	UA	LF	18	614.6861111	2.034979806	611.93	618.73	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G122	2513902.79	876080	UA	LF	18	615.3283333	2.095957594	612.94	620.41	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G123	2513901.58	876189.62	UA	LF	18	614.5494444	3.842648401	610.31	622.79	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G124	2513900.33	876304.71	UA	LF	19	617.8857895	2.128430083	615.09	622.86	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G125	2513899.16	876409.6	UA	LF	20	619.676	2.365809976	614.6	622.96	15/01/2019	16/11/2015	Yes	-	-	-	-	-	-	-	-
G126	2513895.46	875062.25	UA	LF	19	614.87	1.340053896	612.28	616.87	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G151	2513806.06	875023.62	UA	LF	16	614.468125	0.894980214	612.13	615.49	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G152	2513894.35	874687.44	UA	SW	16	615.421875	1.122949799	612.77	617.44	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G153	2513532.77	874532.15	UA	SW	16	614.5425	1.204416871	612.37	616.3	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G154	2513243.08	874978.46	UA	SW	16	614.16	1.731546515	610.33	618.28	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G155	2513501.64	875127.78	UA	SW	16	613.686875	1.278998143	609.91	615.99	15/01/2019	11/12/2016	Yes	-	-	-	-	-	-	-	-
G200	2515650.03	877930.9	UA	B	26	621.4965385	1.461968378	618.16	623.29	15/01/2019	16/11/2015	Yes	25	101.2	8.3	87	120	01/20/2015	07/28/2021	-
G205	2515915	875549.93	UA	GSP	8	619.71	1.482912193	616.33	621.45	02/04/2017	11/12/2016	Yes	-	-	-	-	-	-	-	-
G206	2514669.15	875103.38	UA	GSP	25	621.286	1.444036588	616.61	622.76	15/01/2019	16/11/2015	Yes	20	119.4	24.7	32	150	01/21/2015	01/27/2021	Yes
G207	2514837.85	875166.36	UA	GSP	19	621.9526316	1.135658605	619.41	623.39	15/01/2019	11/12/2016	Yes	4	44.5	30.1	16	72	01/21/2015	10/07/2015	Yes
G208	2514993.46	875231.42	UA	GSP	19	622.0989474	1.175154339	618.97	624.07	15/01/2019	11/12/2016	Yes	4	53.5	37.7	33	110	01/21/2015	10/07/2015	Yes
G209	2515149.64	875298.3	UA	GSP	25	621.6212	1.211081885	617.76	623.18	15/01/2019	16/11/2015	Yes	20	248.8	51.6	95	310	01/21/2015	01/27/2021	Yes
G210	2515299.04	875359.67	UA	GSP	19	620.8747368	1.372254303	616.82	622.5	15/01/2019	11/12/2016	Yes	4	90.3	6.5	84	99	01/21/2015	10/07/2015	Yes
G211	2515448.98	875424.68	UA	GSP	19	621.1094737	1.148145721	618.14	622.45	15/01/2019	11/12/2016	Yes	4	79.8	5.4	74	87	01/21/2015	10/07/2015	Yes
G212	2515583.04	875486.65	UA	GSP	25	620.7644	1.197814259	617.19	622.12	15/01/2019	16/11/2015	Yes	20	55.9	4.2	49	66	01/21/2015	01/26/2021	Yes
G213	2515723.38	875544.3	UA	GSP	19	620.6210526	0.889262458	618.62	621.72	15/01/2019	11/12/2016	Yes	4	53.3	3.3	50	57	01/21/2015	10/07/2015	Yes
G214	2515960.85	875667.97	UA	GSP	19	617.8473684	1.193332598	614.52	619.39	15/01/2019	11/12/2016	Yes	4	71.3	3.9	68	76	01/21/2015	10/07/2015	Yes
G215	2515971.56	875810.11	UA	GSP	25	617.9504	1.033285537	615.48	619.51	15/01/2019	16/11/2015	Yes	21	167.1	109.9	100	490	01/21/2015	06/29/2021	Yes
G216	2515968.45	875976.18	UA	GSP	19	617.8368421	1.365349172	614.37	619.86	15/01/2019	11/12/2016	Yes	4	217.5	9.6	210	230	01/21/2015	10/07/2015	Yes
G217	2515962.98	876185.57	UA	GSP	19	617.5063158	1.127668246	614.32	619.13	15/01/2019	11/12/2016	Yes	4	132.5	5.0	130	140	01/21/2015	10/07/2015	Yes
G218	2515962.17	876380.8	UA	GSP	25	618.3172	1.25211328	614.46	620.1	01/15/2019	11/16/2015	Yes	20	135.8	34.0	94	220	01/21/2015	01/26/2021	Yes
G270	2514996.81	874802.01	UA	RP	26	620.3503846	2.547542315	614.45	623.38	01/15/2019	11/16/2015	Yes	21	69.8	25.8	49	140	01/20/2015	03/30/2021	Yes
G271	2515517.24	874239.3	UA	RP	25	615.7952	1.212807075	613.31	617.95	01/15/2019	11/16/2015	Yes	6	455.0	89.6	340	610	08/10/2018	02/01/2021	Yes
G272	2515745.01	874234.68	UA	RP	19	614.3836842	1.271854335	611.45	616.88	01/15/2019	12/11/2016	Yes	4	332.5	45.7	270	380	01/21/2015	10/08/2015	Yes

TABLE 4-1. FLOW AND TRANSPORT MODEL CALIBRATION TARGETS

GROUNDWATER MODELING REPORT

COFFEEN POWER PLANT

ASH POND NO. 1

COFFEEN, ILLINOIS

					Flow Targets								Transport Targets							
Well Name	Easting	Northing	HSU	CCR Unit	Number of Samples	mean GWL[1] (feet)	std GWL[1] (feet)	min GWL[1] (feet)	max GWL[1] (feet)	Earliest Sample Date	Latest Sample Date	Flow Calibration Wells	Number of Samples	mean Sulfate (mg/L)	std Sulfate (mg/L)	min Sulfate (mg/L)	max Sulfate (mg/L)	Earliest Sample Date	Latest Sample Date	Transport Calibraiton Well
G273	2515975.58	874235.18	UA	RP	25	611.5884	1.339299195	608.82	614.2	01/15/2019	11/16/2015	Yes	20	475.0	89.5	360	690	01/21/2015	02/01/2021	Yes
G274	2516195.61	874239.23	UA	RP	19	610.4968421	1.009549144	607.79	612	01/15/2019	12/11/2016	Yes	4	322.5	53.2	260	390	01/21/2015	10/08/2015	Yes
G275	2516375.98	874299.05	UA	RP	19	604.7021053	0.833210517	602.97	605.97	01/15/2019	12/11/2016	Yes	3	780.0	147.3	650	940	01/21/2015	07/23/2015	Yes
G276	2516358.89	874438.41	UA	RP	24	604.3108333	0.781508667	603.11	606.6	01/15/2019	11/16/2015	Yes	19	223.6	59.6	19	310	01/21/2015	06/28/2021	Yes
G277	2516370.45	874581.65	UA	RP	15	602.6546667	0.949126415	601.23	603.79	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
G278	2516200.7	874875.24	UA	RP	19	605.7357895	1.268819731	604.29	608.15	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
G279	2516245.69	875028.24	UA	RP	24	607.4420833	2.205378759	599.69	611.08	01/15/2019	11/16/2015	Yes	20	569.0	336.3	170	1600	01/21/2015	01/28/2021	Yes
G280	2515679.35	875045.28	UA	RP	26	618.8873077	1.884508546	614.47	622.33	01/15/2019	11/16/2015	Yes	27	78.1	12.2	52	94	01/21/2015	07/27/2021	Yes
G281	2514455.52	874375.28	UA	B	27	619.6537037	1.162395233	616.41	621.68	01/15/2019	11/16/2015	Yes	24	296.3	34.2	250	380	11/20/2015	07/27/2021	-
G283	2516503.05	874115.82	LCU	AP2	9	605.86	1.027898341	604.56	607.8	03/29/2021	08/16/2021	Yes	8	242.5	7.1	230	250	03/31/2021	07/27/2021	Yes
G284	2516922.93	874426.1	UA	B	9	607.9777778	1.492646792	606.17	611.14	03/29/2021	08/16/2021	Yes	8	69.5	10.8	60	95	03/30/2021	07/27/2021	-
G285	2516680.39	874797.74	LCU	B	9	606.5866667	1.509014579	604.33	608.62	03/29/2021	08/16/2021	Yes	8	570.0	40.0	490	620	03/30/2021	07/27/2021	-
G286	2516561.89	875075	UA	B	6	606.6166667	1.448346183	604.68	609.08	03/29/2021	12/07/2021	Yes	8	13.5	2.1	11	16	03/31/2021	07/27/2021	-
G287	2516415.34	875445.28	UA	B	7	608.9657143	1.217249045	607.59	610.83	03/29/2021	08/16/2021	Yes	8	44.4	2.7	41	50	03/29/2021	07/27/2021	-
G288	2517071.51	875282.23	UA	B	9	613.6466667	1.259801572	611.9	616.32	03/29/2021	08/16/2021	Yes	8	200.5	302.5	29	770	03/30/2021	07/27/2021	-
G301	2515583.06	872237.64	UA	AP1	25	615.0272	1.602722995	610.39	618.07	01/15/2019	11/16/2015	Yes	16	742.5	79.8	570	860	11/20/2015	01/27/2021	Yes
G302	2516214.19	872255.38	UA	AP1	25	609.8508	2.621329052	604.64	615.41	01/15/2019	11/16/2015	Yes	16	414.4	86.0	260	530	11/20/2015	01/27/2021	Yes
G303	2516639.34	871384.83	UA	AP1	25	615.7748	1.750197894	611.18	618.05	01/15/2019	11/16/2015	Yes	16	770.0	76.2	600	870	11/20/2015	01/26/2021	Yes
G304	2515519.76	871397.53	UA	AP1	2	623.99	0.113137085	623.91	624.07	08/02/2016	09/05/2016	Yes	3	1033.3	57.7	1000	1100	11/20/2015	05/20/2016	-
G305	2515199.45	871159.15	UA	AP1	23	618.0413043	1.084004798	615.3	620.49	01/15/2019	12/11/2016	Yes	5	864.0	87.6	710	930	05/19/2016	11/17/2016	Yes
G306	2516120.28	871143.66	UA	AP1	26	618.9373077	1.290400117	616.12	621.73	01/15/2019	12/11/2016	Yes	24	284.0	113.3	5.9	700	05/19/2016	07/27/2021	Yes
G307	2515553.24	871401.09	UA	AP1	17	624.0317647	1.239890294	619.33	624.6	01/15/2019	12/11/2016	Yes	13	1029.2	113.1	850	1300	08/16/2016	01/27/2021	Yes
G308	2515101.51	871457.36	UA	AP1	11	619.7218182	0.671190259	618.54	621.03	03/29/2021	08/16/2021	Yes	8	1125.0	46.3	1100	1200	03/29/2021	07/27/2021	Yes
G309	2515067.07	871868.3	UA	AP1	11	618.9445455	0.814350829	617.89	621.09	03/29/2021	08/16/2021	Yes	8	787.5	38.8	740	840	03/29/2021	07/27/2021	Yes
G310	2515159.33	872242.06	UA	AP1	11	614.4509091	1.049528032	613.2	617.27	03/29/2021	08/16/2021	Yes	8	990.0	552.5	420	2300	03/29/2021	07/28/2021	Yes
G311	2515881.77	872241.27	UA	AP1	11	613.6636364	1.07212194	612.45	616.54	03/29/2021	08/16/2021	Yes	8	811.3	35.6	750	860	03/30/2021	07/27/2021	Yes
G312	2516557.45	872263.4	UA	AP1	11	608.9363636	1.307511168	606.99	612.19	03/29/2021	08/16/2021	Yes	8	838.8	143.6	600	1000	03/30/2021	07/27/2021	Yes
G314	2516852.2	871632.87	UA	AP1	10	605.13	3.49532386	596.4	608.6	03/29/2021	08/16/2021	Yes	8	1953.8	473.9	830	2400	03/30/2021	07/27/2021	Yes
G315	2516086.68	871387.77	UA	AP1	10	620.529	0.69468538	619.17	621.24	03/29/2021	08/16/2021	Yes	8	908.8	81.1	850	1100	03/30/2021	07/28/2021	Yes
G316	2517211.619	871645.77	UA	AP1	10	590.022	3.016792999	581.54	591.63	03/29/2021	08/16/2021	-	8	691.3	156.1	330	840	03/30/2021	07/27/2021	Yes
G317	2517087.319	871236.76	UA	AP1	10	609.619	1.740890258	606.57	611.75	03/29/2021	08/16/2021	-	8	952.5	93.6	780	1100	03/30/2021	07/28/2021	Yes
G401	2515614.82	872510.72	UA	AP2	18	607.6811111	1.846264556	603.94	609.8	01/15/2019	11/16/2015	Yes	-	-	-	-	-	-	-	-
G402	2516632.39	872500.43	UA	AP2	20	603.743	1.213286533	600.77	605.36	01/15/2019	11/16/2015	Yes	-	-	-	-	-	-	-	-
G403	2514616.58	873561.48	UA	AP2	20	621.055	1.263622612	618.36	622.45	01/15/2019	11/16/2015	Yes	-	-	-	-	-	-	-	-
G404	2516397.84	873999.83	UA	AP2	20	610.838	1.183783408	607.58	612.14	01/15/2019	11/16/2015	Yes	-	-	-	-	-	-	-	-
G405	2515335.58	873996.63	UA	AP2	20	617.8585	1.158348529	614.47	619.28	01/15/2019	11/16/2015	Yes	-	-	-	-	-	-	-	-
G406	2514702.32	872521.21	UA	AP2	16	615.141875	1.675395351	611.27	617.52	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
G407	2513705.74	872973.57	UA	B	16	613.60625	0.84114109	612.11	614.86	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
MW04S	2514450.47	877999.78	UA	B	19	618.2110526	2.142835335	613.88	621.62	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
MW05S	2513285.52	878175.73	UA	B	19	617.8810526	1.843543975	613.32	620.92	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
MW10S	2515914.48	878250.4	UA	B	18	617.255	1.690963004	614.36	620.43	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-

RAMBOLL

TABLE 4-1. FLOW AND TRANSPORT MODEL CALIBRATION TARGETS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

					Flow Targets								Transport Targets							
Well Name	**Easting**	**Northing**	**HSU**	**CCR Unit**	**Number of Samples**	**mean GWL[1] (feet)**	**std GWL[1] (feet)**	**min GWL[1] (feet)**	**max GWL[1] (feet)**	**Earliest Sample Date**	**Latest Sample Date**	**Flow Calibration Wells**	**Number of Samples**	**mean Sulfate (mg/L)**	**std Sulfate (mg/L)**	**min Sulfate (mg/L)**	**max Sulfate (mg/L)**	**Earliest Sample Date**	**Latest Sample Date**	**Transport Calibraiton Well**
MW11S	2515971.24	876749.49	UA	GSP	24	620.7020833	1.218373753	617.19	622.19	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
MW12S	2515900.49	875519.94	UA	GSP	24	617.9708333	2.049907562	611.42	620.48	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
MW16S	2515087.93	877355.01	UA	B	24	622.0208333	2.003932908	618.34	625.59	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
MW20S	2515876.54	874228.14	UA	B	19	612.0194737	1.76501959	607.74	615.4	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
R104	2514503.48	875857.78	UA	B	20	623.479	1.640654234	619.38	625.92	01/15/2019	11/16/2015	Yes	7	74.4	2.2	72	77	04/08/2015	08/03/2016	-
R201	2514842.05	877925.14	UA	B	26	621.8242308	1.348306117	618.3	623.52	01/15/2019	11/16/2015	Yes	28	211.0	55.8	89	370	01/20/2015	07/28/2021	-
T127	2513911.13	875359.24	UA	B	20	615.954	1.042297058	612.33	617.05	01/15/2019	11/16/2015	Yes	-	-	-	-	-	-	-	-
T128	2513909.58	875509.65	UA	B	19	615.1989474	1.45420805	611.33	617.25	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
T202	2514895.01	876699.56	UA	GSP	19	620.5410526	2.211231167	615.31	624.22	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
T408	2515314.82	873999.37	UA	B	16	617.25875	1.507615667	614.45	619.46	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
T409	2514693.83	872517.86	UA	B	16	615.403125	1.232908316	612.16	617.16	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
TA31	2513856.87	876542.19	UA	B	19	619.7289474	2.10867756	614.89	622.93	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
TA32	2513605.22	877532.63	UA	B	10	615.309	1.097172629	612.42	616.3	01/20/2020	12/11/2016	Yes	-	-	-	-	-	-	-	-
TA33	2513248.73	876605.56	UA	B	19	617.2257895	1.90237663	612.91	620.35	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-
TA34	2513466.7	875906.23	UA	B	19	617.0926316	1.535020239	613.48	619.58	01/15/2019	12/11/2016	Yes	-	-	-	-	-	-	-	-

Notes:

[O: SLN 04/20/22; C: EGP 4/29/22]

[1] GWL = Groundwater Elevation
AP1 = Ash Pond No. 1
AP2 = Ash Pond No. 2
B = Background
GSP = Gypsum Management Facility Gypsum Stack Pond
LF = Landfill
max=maximum
mg/l = milligrams per liter
min=minimum
RP = Gypsum Management Facility Recycle Pond
std=standard deviation from the mean

HSU = Hydrostratigraphic Unit
CCR = coal combustion residuals
UA = uppermost aquifer
LCU = lower confining unit

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Zone	Hydrostratigraphic Unit	Materials	ft/d	cm/s	Kh/Kv	Value Source	Sensitivity[1]
Horizontal Hydraulic Conductivity			**Calibration Model**				
1	UCU	loess and clay	0.51	1.80E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	High
2	UA	sand and sandy silt	4.04	1.43E-03	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	High
3	LCU (unweathered Vandalia)	sand clay till	0.83	2.93E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	High
4	LCU (Smithboro Formation)	sand clay till	0.0014	4.94E-07	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Low
5	SW Pond	NA	2.89E-09	1.02E-12	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
6	LF-CCR	CCR	13.6	4.80E-03	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
7	GSP-CCR	CCR	13.6	4.80E-03	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
8	RP-CCR	CCR	13.6	4.80E-03	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
9	AP2	CCR	13.6	4.80E-03	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
10	AP1	CCR	13.6	4.80E-03	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Moderate
11	Cooling Pond	clay and silt	0.51	1.80E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Low
12	GSP-RP connector	lined channel within UCU	0.51	1.80E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
13	AP2 -berm	loess and clay	0.51	1.80E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
14	AP1-berm	loess and clay	0.51	1.80E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
15	Pond (west)	loess and clay	0.51	1.80E-04	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
16	GSP-liner	liner	2.89E-08	1.02E-11	NA	Harmonic mean of liner layers	Negligible
17	RP-liner	liner	2.89E-08	1.02E-11	NA	Harmonic mean of liner layers	Negligible
18	LF-liner	liner	2.89E-08	1.02E-11	NA	Harmonic mean of liner layers	Negligible
19	UCU- fill (drain/river)	NA	10	3.53E-03	NA	Calibrated - Conductivity Value to Allow Groundwater Flow from UCU to River and Drain Boundary Conditions	Moderate
21	LF-GSP shared embankment	reworked silts and clays	0.01	3.53E-06	NA	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
Vertical Hydraulic Conductivity			**Calibration Model**				
1	UCU	loess and clay	0.0510	1.80E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	High
2	UA	sand and sandy silt	0.4040	1.43E-04	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	High
3	LCU (unweathered Vandalia)	sand clay till	0.0830	2.93E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	High
4	LCU (Smithboro Formation)	sand clay till	0.0001	4.94E-08	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Low
5	SW Pond	lined	2.89E-09	1.02E-12	1	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
6	LF-CCR	CCR	0.2500	8.82E-05	54	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
7	GSP-CCR	CCR	0.2500	8.82E-05	54	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
8	RP-CCR	CCR	0.2500	8.82E-05	54	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
9	AP2	CCR	0.2500	8.82E-05	54	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
10	AP1	CCR	0.2500	8.82E-05	54	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Moderate
11	Cooling Pond	clay and silt	0.0510	1.80E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Low
12	GSP-RP connector	lined channel within UCU	0.0510	1.80E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
13	AP2 -berm	loess and clay	0.0510	1.80E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
14	AP1-berm	loess and clay	0.0510	1.80E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
15	Pond (west)	loess and clay	0.0510	1.80E-05	10	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
16	GSP-liner	liner	2.89E-08	1.02E-11	1	Harmonic mean of liner layers	Negligible
17	RP-liner	liner	2.89E-08	1.02E-11	1	Harmonic mean of liner layers	Negligible
18	LF-liner	liner	2.89E-08	1.02E-11	1	Harmonic mean of liner layers	Negligible
19	UCU- fill (drain/river)	NA	10.0000	3.53E-03	1	Calibrated - Conductivity Value to Allow Groundwater Flow from UCU to River and Drain Boundary Conditions	Moderate

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Zone	Hydrostratigraphic Unit	Materials	ft/d	cm/s	Kh/Kv	Value Source	Sensitivity[1]
Vertical Hydraulic Conductivity (Continued)			**Calibration Model**				
21	LF-GSP shared embankment	reworked silts and clays	0.0100	3.53E-06	1	Calibrated - Within Range of Field Test Results (Ramboll, 2021a)	Negligible
Zone	**Hydrostratigraphic Unit**	**Materials**	**ft/d**	**in/yr**	**Kh/Kv**	**Value Source**	**Sensitivity[1]**
Recharge			**Calibration Model**				
1	UCU	clay and silt	0.00055	2.41	NA	Calibrated	High
2	SW Pond	clay and silt	1.50E-08	6.57E-05	NA	Calibrated	Negligible
3	LF	CCR	8.00E-08	3.50E-04	NA	Calibrated	Negligible
4	GSP	CCR	8.00E-08	3.50E-04	NA	Calibrated	Negligible
5	RP	CCR	8.00E-08	3.50E-04	NA	Calibrated	Negligible
6	AP2	CCR	0.0005	2.19	NA	Calibrated	Moderate
7	AP1	CCR	0.0024	10.51	NA	Calibrated	High
8	Cooling pond	clay and silt	1.40E-05	0.06	NA	Calibrated	Negligible
9	GSP-RP connector	clay and silt	0.00055	2.41	NA	Calibrated	Low
10	AP2-Berm	clay and silt	0.00055	2.41	NA	Calibrated	Negligible
11	AP1-Berm	clay and silt	0.00055	2.41	NA	Calibrated	Negligible
12	Pond (west)	clay and silt	5.50E-04	2.41	NA	Calibrated	Negligible
Storage							
1	UCU	loess and clay	*Not used in steady-state calibration model*				
2	UA	sand and sandy silt					
3	LCU (unweathered Vandalia)	sand clay till					
4	LCU (Smithboro Formation)	sand clay till					
5	SW Pond	lined					
6	LF-CCR	CCR					
7	GSP-CCR	CCR					
8	RP-CCR	CCR					
9	AP2	CCR					
10	AP1	CCR					
11	Cooling Pond	clay and silt					
12	GSP-RP connector	lined channel within UCU					
13	AP2 -berm	loess and clay					
14	AP1-berm	loess and clay					
15	Pond (west)	loess and clay					
16	GSP-liner	liner					
17	RP-liner	liner					
18	LF-liner	liner					
19	UCU- fill (drain/river)	NA					
21	LF-GSP shared embankment	reworked silts and clays					

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

River Parameters							
	Relative Location	**River Width (feet)**	**River depth (feet)**	**Bed Thickness (feet)**	**Hydraulic Conductivity (ft/d)**	**Head (feet)**	**River Boundary Conductance (ft^2/d)**
Reach 0	Unnamed Tributary East Coffeen Lake	10	3	2	4.00E-02	594.7-621.84	0.08-20.4
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Moderate	High
Reach 5	Unnamed Tributary East Coffeen Lake - downstream in layer 5	10	3	2	4.00E-01	591.0-594.7	1.5-109.2
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Moderate	Low
Reach 1	Unnamed Tributary West Coffeen Lake	10	3	2	4.80E-02	591.0-622.45	0.04-12.3
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Low	Moderately High
Reach 2	Pond (west)	cell dimensions	3	1	3.20E-03	617.50	4.0
Sensitivity[1]	NA	- - -		- - -		Low	Low
Reach 3	Condenser Cooling Flume	cell dimensions	4	1	5.00	604.00	5.00
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Moderate	High
Value Source	NA	Calibrated	Calibrated	Calibrated	Calibrated	Estimated based on DEM	Calibrated
Drain Parameters							
	Name	**Drain Width (feet)**	**Drain depth (feet)**	**Bed Thickness (feet)**	**Hydraulic Conductivity (ft/d)**	**Stage (feet)**	**Drain Conductance (ft^2/d)**
Reach 0	Active LF Underdrain	2	2	1.5	2.40E-02	603.5	6.6e-5-0.47
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Low	Moderately High
Reach 1	Gravity Driven GRP Drain	cell dimensions	2	1.5	2.50E-02	600.5	9.7e-5-0.51
Sensitivity[1]		- - -	- - -	- - -	- - -	Low	Moderate
Reach 2	Northern Drain	cell dimensions	2	1.5	2.00E+00	622	5.1-135.46
Sensitivity[1]		- - -	- - -	- - -	- - -	Low	Negligible
Value Source	NA	Calibrated	Calibrated	Calibrated	Calibrated	Estimated based on DEM	Calibrated
General Head Parameters							
	Relative Location	**Width of General Head Boundary Cell (feet)**	**Distance to General Head Boundary Head (feet)**	**Saturated Thickness of Cell (feet)**	**Hydraulic Conductivity (ft/d)**	**Head (feet)**	**General Head Boundary Conductance (ft^2/d)**
Reach 2	Northern Model Boundary in UA	*variable*	1	variable	4.54	591-610.66	1.4-7032.9
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Moderate	Negligible
Reach 3	Northern Model Boundary in LCU ayer 4	*variable*	1	variable	0.83	591-610.66	166-1812.6
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	High	Negligible
Reach 4	Northern Model Boundary in LCU ayer 5	*variable*	1	variable	0.0014	591-610.66	1.61-6.0
Sensitivity[1]	NA	- - -	- - -	- - -	- - -	Low	Negligible
Value Source	NA	Calibrated	Calibrated	Calibrated	Calibrated	Estimated based on Groundwater Elevation Targets in UA around the GSP/GRP/LF	Calibrated

TABLE 5-1. FLOW MODEL INPUT AND SENSITIVITY ANALYSIS RESULTS
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Hydraulic Flow Boundary Parameters					
	Relative Location	**Width of HFB (feet)[2]**	**Hydraulic Conductivity (feet)**		
Reach 1	GSP	1	2.89E-08		
Sensitivity[1]	NA	- - -	Low		
Reach 2	RP	1	2.89E-08		
Sensitivity[1]	NA	- - -	Moderate		
Reach 3	LF	1	2.89E-08		
Sensitivity[1]	NA	- - -	Low		
Value Source	NA	Calibrated	Harmonic mean of construction material		

Notes:

[O: SLN 04/01/22; C: EGP 4/29/22]

[1] Sensitivity Explanation:
Negligible - SSR changed by less than 1%
Low - SSR change between 1% and 10%
Moderate - SSR change between 10% and 50%
Moderately High - SSR change between 50% and 100%
High - SSR change greater than 100%
[2] Liner thickness accounted for in harmonic mean calculation
SSR = sum of squared residuals
- - - = not tested
AP1 = Ash Pond No. 1
AP2 = Ash Pond No. 2
CCR = coal combustion residuals
cm/s = centimeters per second
ft/d = feet per day
ft^2/day = feet squared per day
GSP = Gypsum Management Facility Gypsum Stack Pond
in/yr = inches per year
Kh/Kv = anisotropy ratio
LF = Landfill
NA = not applicable
RP = Gypsum Management Facility Recycle Pond
SW = Surface Water

Hydrostratigraphic Unit
UCU = upper confining unit
UA = uppermost aquifer
LCU = lower confining unit

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Zone	Hydrostratigraphic Unit	Materials	Calibration Model									
			Recharge (ft/d)				Sulfate Concentration (mg/L)				Value Source	Sensitivity
Initial Concentration												
Entire Domain	NA	NA	0.00055				0				NA	- - -
Source Concentration (recharge and constant concentration cells)												
			Pre-GMF		**Post-GMF**		**Pre-GMF**		**Post-GMF**			
	Model Name and Stress Period		**TR1 - STP 1**	**TR1 - STP 2**	**TR2 - STP 1**	**TR3 - STP 1**	**TR1 - STP 1**	**TR1 - STP 2**	**TR2 - STP 1**	**TR3 - STP 1**		
	Time Period		**1970-1984**	**1985-2009**	**2010-2017**	**2018-2022**	**1970-1984**	**1985-2009**	**2010-2017**	**2018-2022**		
6	AP2	CCR	0.0005	0.0005	0.0005	0.00027	1,600	1,600	1,600	0	Leachate sulfate concentrations	- - -
13	AP2 Northwest seep area	-	0.002	0.002	0.002	0.00055	1,600	1,600	1,600	0	Based on previous model	- - -
14	AP2 East and Southwest seep area	-	0.01	0.01	0.01	0.00055	300	300	300	0	Based on previous model	- - -
13	AP2 closure structures	-									Based on previous model	- - -
7	AP1	CCR	0.00055	0.00240	0.00240	0.00240	0	1,000	1,000	1,000	Calibrated	- - -
5	RP	CCR	NA	NA	8.00E-08	8.00E-08	NA	NA	15,000	15,000	Leachate sulfate concentrations	- - -
4	GSP	CCR	NA	NA	8.00E-08	8.00E-08	NA	NA	11,000	11,000	Leachate sulfate concentrations	- - -
3	LF	CCR	NA	NA	8.00E-08	8.00E-08	NA	NA	7,500	7,500	Leachate sulfate concentrations	- - -
GMF Units liner modification (HFB)												
		Well Data	**Hydraulic Conductivity (ft/d)**									
			Pre-GMF		**Post-GMF**							
	Model Name and Stress Period		**TR1 - STP 1**	**TR1 - STP 2**	**TR2 - STP 1**	**TR3 - STP 1**						
	Time Period		**1970-1984**	**1985-2009**	**2010-2017**	**2018-2022**						
1	RP		NA	NA	2.89E-08	2.89E-08					Harmonic Mean	see Table 5-3
11	RP-northeast	G279	NA	NA	2.89E-08	3.00E-04					Calibrated	see Table 5-3
16	RP-southeast	G275	NA	NA	2.89E-08	6.54E-04					Calibrated	see Table 5-3
2	GSP		NA	NA	2.89E-08	2.89E-08					Harmonic Mean	see Table 5-3
21	GSP-east	G215	NA	NA	2.89E-08	6.00E-04					Calibrated	see Table 5-3
3	LF		NA	NA	2.89E-08	2.89E-08					Harmonic Mean	see Table 5-3
Storage, Specific Yield and Effective Porosity				**Calibration Model**								
Zone	**Hydrostratigraphic Unit**	**Materials**	**Storage**	**Specific Yield**	**Effective Porosity**						**Value Source**	**Sensitivity**
1	UCU	loess and clay	0.0034	0.35	0.35						Ramboll (2021a) HCR	see Table 5-3
2	UA	sand and sany silt	0.0034	0.16	0.16						Ramboll (2021a) HCR	see Table 5-3
3	LCU (unweathered Vandalia)	sand clay till	0.0034	0.19	0.19						Ramboll (2021a) HCR	see Table 5-3
4	LCU (Smithboro Formation)	sand clay till	0.0034	0.28	0.28						Ramboll (2021a) HCR	see Table 5-3
5	SW Pond	NA	0.0034	0.35	0.35						Ramboll (2021a) HCR	see Table 5-3
6	LF-CCR	CCR	0.0034	0.19	0.19			NA			Ramboll (2021a) HCR	see Table 5-3
7	GSP-CCR	CCR	0.0034	0.19	0.19						Ramboll (2021a) HCR	see Table 5-3
8	RP-CCR	CCR	0.0034	0.19	0.19						Ramboll (2021a) HCR	see Table 5-3
9	AP2	CCR	0.0034	0.19	0.19						Ramboll (2021a) HCR	see Table 5-3
10	AP1	CCR	0.0034	0.19	0.19						Ramboll (2021a) HCR	see Table 5-3
11	Cooling Pond	clay and silt	0.0034	0.35	0.35						Ramboll (2021a) HCR	see Table 5-3
12	GSP-RP connector	lined channel within UCU	0.0034	0.35	0.35						Ramboll (2021a) HCR	see Table 5-3
13	AP2 -berm	loess and clay	0.0034	0.35	0.35						Ramboll (2021a) HCR	see Table 5-3

TABLE 5-2. TRANSPORT MODEL INPUT VALUES (CALIBRATION)
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Storage, Specific Yield and Effective Porosity				**Calibration Model**				
Zone	**Hydrostratigraphic Unit**	**Materials**	**Storage**	**Specific Yield**	**Effective Porosity**		**Value Source**	**Sensitivity**
14	AP1-berm	loess and clay	0.0034	0.35	0.35	NA	Ramboll (2021a) HCR	see Table 5-3
15	Pond (west)	loess and clay	0.0034	0.35	0.35		Ramboll (2021a) HCR	see Table 5-3
16	GSP-liner	liner	0.0034	0.16	0.16		Ramboll (2021a) HCR	see Table 5-3
17	RP-liner	liner	0.0034	0.16	0.16		Ramboll (2021a) HCR	see Table 5-3
18	LF-liner	liner	0.0034	0.16	0.16		Ramboll (2021a) HCR	see Table 5-3
19	UCU- fill (drain/river)	NA	0.0034	0.5	0.5		Calibrated	see Table 5-3
21	LF-GSP shared embankment	reworked silts and clays	0.0034	0.16	0.16		Calibrated	see Table 5-3
Dispersivity								
Applicable Region	**Hydrostratigraphic Unit**	**Materials**	**Longitudinal (feet)**	**Transverse (feet)**	**Vertical (feet)**		**Value Source**	**Sensitivity**
1	UCU	loess and clay	1	0.1	0.01	NA	calibrated	see Table 5-3
2	UA	sand and sany silt	10	1	0.1		calibrated	see Table 5-3
3	LCU (unweathered Vandalia)	sand clay till	1	0.1	0.01		calibrated	see Table 5-3
4	LCU (Smithboro Formation)	sand clay till	1	0.1	0.01		calibrated	see Table 5-3

[O: SLN 04/01/22; C: EGP 04/29/22]

Notes:
- - - = not tested
AP1 = Ash Pond No. 1
AP2 = Ash Pond No. 2
CCR = coal combustion residuals
ft/d = feet per day
GMF = Gypsum Management Facility
GSP = Gypsum Management Facility Gypsum Stack Pond
LF = Landfill
mg/L = milligrams per liter
NA = not applicable
RP = Gypsum Management Facility Recycle Pond
SS = Steady State model
STP = Stress Period
SW = Surface Water
TR = Transient model

Hydrostratigraphic Unit
UCU = upper confining unit
UA = uppermost aquifer
LCU = lower confining unit

TABLE 5-3. TRANSPORT MODEL INPUT SENSITIVITY (CALIBRATION)
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

			Storage and Specific Yield				Effective Porosity			
Well ID	**SI**	**Calibration on Sulfate Concentration (mg/L)**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**
G301	AP1	961.2	961.3	Negligible	958.1	Negligible	964.1	Negligible	954.2	Negligible
G302	AP1	954.3	951.2	Negligible	937.3	Low	954.8	Negligible	950.7	Negligible
G303	AP1	626.7	613.2	Low	572.0	Low	643.3	Low	598.3	Low
G305	AP1	426.0	408.8	Low	442.1	Low	451.3	Low	379.3	Moderate
G306	AP1	427.0	371.0	Moderate	400.9	Low	463.5	Low	375.8	Moderate
G307	AP1	779.7	762.4	Low	911.7	Moderate	786.0	Negligible	768.6	Low
G308	AP1	880.0	868.7	Low	813.0	Low	883.2	Negligible	872.2	Negligible
G309	AP1	922.0	901.3	Low	867.1	Low	924.2	Negligible	916.0	Negligible
G310	AP1	921.9	925.6	Negligible	916.5	Negligible	926.7	Negligible	915.6	Negligible
G311	AP1	966.6	965.5	Negligible	956.7	Low	967.0	Negligible	964.8	Negligible
G312	AP1	934.7	940.5	Negligible	924.4	Low	936.7	Negligible	933.5	Negligible
G313	AP1	908.8	908.3	Negligible	903.2	Negligible	909.3	Negligible	907.0	Negligible
G314	AP1	848.0	845.7	Negligible	838.1	Low	850.8	Negligible	841.8	Negligible
G315	AP1	786.7	737.7	Low	791.7	Negligible	789.6	Negligible	776.3	Low
G316	AP1	507.5	509.6	Negligible	494.8	Low	532.8	Low	469.7	Low
G317	AP1	146.9	149.8	Low	116.4	Moderate	202.9	Moderate	93.4	Moderate
			S*0.1 Sy*0.5		S*10 Sy*2		Porosity-0.05		Porosity+0.05	

TABLE 5-3. TRANSPORT MODEL INPUT SENSITIVITY (CALIBRATION)
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

		Dispersivity				HFB (GMF GSP and GMF RP Liner)			
Well ID	**SI**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**	**Sulfate Concentration (mg/L)**	**Sensitivity [1]**
G301	AP1	931.7	Low	909.6	Low	959.2	Negligible	937.3	Low
G302	AP1	914.3	Low	887.2	Low	953.4	Negligible	956.9	Negligible
G303	AP1	620.4	Negligible	589.4	Low	626.1	Negligible	622.1	Negligible
G305	AP1	415.1	Low	387.9	Low	425.8	Negligible	425.0	Negligible
G306	AP1	420.1	Low	390.5	Low	426.9	Negligible	426.2	Negligible
G307	AP1	756.7	Low	720.4	Low	779.6	Negligible	779.1	Negligible
G308	AP1	843.3	Low	800.4	Low	879.4	Negligible	879.2	Negligible
G309	AP1	892.9	Low	858.2	Low	922.8	Negligible	916.7	Negligible
G310	AP1	882.3	Low	853.6	Low	922.3	Negligible	915.6	Negligible
G311	AP1	943.7	Low	926.1	Low	965.1	Negligible	963.6	Negligible
G312	AP1	900.6	Low	869.2	Low	934.9	Negligible	933.7	Negligible
G313	AP1	774.1	Moderate	693.3	Moderate	908.4	Negligible	908.6	Negligible
G314	AP1	799.7	Low	756.2	Moderate	848.5	Negligible	848.5	Negligible
G315	AP1	764.9	Low	722.5	Low	785.7	Negligible	786.4	Negligible
G316	AP1	461.4	Low	426.2	Moderate	507.4	Negligible	507.5	Negligible
G317	AP1	123.6	Moderate	124.2	Moderate	146.9	Negligible	146.9	Negligible
		Disp*5		Disp*10		HFB*0.1		HFB*10	

[O: SLN 04/10/22; C: EGP 5/5/22]

Notes:

[1] Sensitivity Explanation:
Negligible = concentration changed by less than 1%
Low = concentration change between 1% and 10%
Moderate = concentration change between 10% and 50%
Moderately High = concentration change between 50% and 100%
High = concentration change greater than 100%

[2] sensitivity test used transient transport

AP1 = Ash Pond No. 1
AP2 = Ash Pond No. 2
Disp = dispersivity
GSP = Gypsum Management Facility Gypsum Stack Pond
HFB = Horizontal Flow Boundary
ID = identification
mg/L = milligrams per liter
RP = Gypsum Management Facility Recycle Pond
S = storativity
Sy = specific yield

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Closure Scenario Number (Drainage Length)	Ash Pond 1 - CIP Consolidation and Cover System Area	Ash Pond 1 - CIP Removal Area (1 foot) - CBR East Side (1 foot)	Ash Pond 1 - CBR West Side (3 feet)	Notes
Input Parameter				
Climate-General				
City	Coffeen, Illinois	Coffeen, Illinois	Coffeen, Illinois	Nearby city to the Site within HELP database
Latitude	39.06	39.06	39.06	Site latitude
Evaporative Zone Depth	18	12	18	Estimated based on geographic location (Illinois) and uppermost soil type (Tolaymat, T. and Krause, M., 2020)
Maximum Leaf Area Index	4.5	4.5	4.5	Maximum for geographic location (Illinois) (Tolaymat, T. and Krause, M., 2020)
Growing Season Period, Average Wind Speed, and Quarterly Relative Humidity	Belleville Scott Air Force Base Belleville, Illinois	Belleville Scott Air Force Base Belleville, Illinois	Belleville Scott Air Force Base Belleville, Illinois	Nearby city to the Coffeen Power Plant within HELP database
Number of Years for Synthetic Data Generation	30	30	30	
Temperature, Evapotranspiration, and Precipitation	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 39.06/-89.39	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 39.06/-89.39	Precipitation, temperature, and solar radiation was simulated based on HELP V4 weather simulation for: Lat/Long: 39.06/-89.39	
Soils-General				
% where runoff possible	100	100	100	
Area (acres)	10	13	10	CBR - Removal Area based on HCR (Ramboll, 2021); CIP - Consolidation and Cover System Area based on construction drawing for Ash Pond No. 1; CIP -Removal Area equals the difference
Specify Initial Moisture Content	No	No	No	
Surface Water/Snow	Model Calculated	Model Calculated	Model Calculated	
Soils-Layers				
1	Vegetative Soil Layer (HELP Final Cover Soil [topmost layer])	Protective Cover Layer (HELP Final Cover Soil [topmost layer])	Protective Cover Layer (HELP Final Cover Soil [topmost layer])	Layers details for CBR, CIP, and Landfill areas based on grading plans, construction drawings, and cover system design for Ash Pond No. 1
2	Protective Soil Layer (HELP Vertical Percolation Layer)	--	--	
3	Nonwoven Geotextile (HELP Custom Layer)	--	--	
4	Geomembrane Liner	--	--	
5	Unsaturated CCR Material (HELP Waste)	--	--	
6	HELP Vertical Percolation Layer	--	--	
7	--	--	--	

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Closure Scenario Number (Drainage Length)	Ash Pond 1 - CIP Consolidation and Cover System Area	Ash Pond 1 - CIP Removal Area (1 foot) - CBR East Side (1 foot)	Ash Pond 1 - CBR West Side (3 feet)	Notes
Soil Parameters--Layer 1				
Type	1	1	1	Vertical Percolation Layer (Cover Soil)
Thickness (in)	6	12	36	For CBR and CIP removal areas, layer 1 thickness is the average thickness of unsaturated backfill material placed after removal
Texture	12	14	14	Defaults used
Description	Silty Clay Loam	Silty Clay	Silty Clay	
Saturated Hydraulic Conductivity (cm/s)	4.20E-05	2.50E-05	2.50E-05	Defaults used
Soil Parameters--Layer 2				
Type	1	--	--	Vertical Percolation Layer
Thickness (in)	18	--	--	design thickness
Texture	14	--	--	Defaults used
Description	Silty Clay	--	--	
Saturated Hydraulic Conductivity (cm/s)	2.50E-05	--	--	Defaults used
Soil Parameters--Layer 3				
Type	2	--	--	Lateral Drainage Layer
Thickness (in)	0.11	--	--	design thickness
Texture	123	--	--	Defaults used
Description	10 oz Nonwoven Geotextile	--	--	
Saturated Hydraulic Conductivity (cm/s)	3.00E-01	--	--	Defaults used
Soil Parameters--Layer 4				
Type	4	--	--	Flexible Membrane Liner
Thickness (in)	0.04	--	--	design thickness
Texture	36	--	--	Defaults used
Description	LDPE Membrane	--	--	
Saturated Hydraulic Conductivity (cm/s)	4.00E -13	--	--	Defaults used
Soil Parameters--Layer 5				
Type	1	--	--	Vertical Percolation Layer (Waste)
Thickness (in)	360	--	--	design thickness
Texture	84	--	--	Defaults used
Description	High-Density Electric Plant Coal Bottom Ash	--	--	
Saturated Hydraulic Conductivity (cm/s)	8.80E-05	--	--	defaults used

TABLE 6-1. HELP MODEL INPUT AND OUTPUT VALUES
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Closure Scenario Number (Drainage Length)	Ash Pond 1 - CIP Consolidation and Cover System Area	Ash Pond 1 - CIP Removal Area (1 foot) - CBR East Side (1 foot)	Ash Pond 1 - CBR West Side (3 feet)	Notes
Soil Parameters--Layer 6				
Type	1	--	--	Background Silty Clay (Ash Pond No. 1)
Thickness (in)	60	--	--	Background clay thickness (Ash Pond No. 1)
Texture	43	--	--	Custom (Ash Pond No. 1) Defaults used (GSP and Landfill)
Description	Loess Unit Silty Clay	--	--	
Saturated Hydraulic Conductivity (cm/s)	3.85E-06	--	--	Average for Loess Unit (Ash Pond No. 1)
Soil Parameters--Layer 7				
Type	--	--	--	Drainage Liner
Thickness (in)	--	--	--	design thickness
Texture	--	--	--	Defaults used
Description	--	--	--	
Saturated Hydraulic Conductivity (cm/s)	--	--	--	Defaults used
Soils--Runoff				
Runoff Curve Number	85.9	88.6	89.2	HELP-computed curve number
Slope	5.00%	0.50%	0.50%	Estimated from construction design drawings
Length (ft)	350	1,000	350	estimated maximum flow path
Vegetation	fair	fair	fair	fair indicating fair stand of grass on surface of soil backfill
Execution Parameters				
Years	30	30	30	
Report Daily	No	No	No	
Report Monthly	No	No	No	
Report Annual	Yes	Yes	Yes	
Output Parameter				
Unsaturated Percolation Rate (in/yr)	**0.00090**	**7.85**	**6.28**	

Notes:
% = percent
CBR = closure by removal
CIP = closure in place
cm/s = centimeters per second
ft = feet
HCR = Hydrogeologic Site Characterization Report
HELP = Hydrologic Evaluation of Landfill Performance
in = inches
in/yr = inches per year
Lat = latitude
Long = longitude

References:
Tolaymat, T. and Krause, M, 2020. Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual . United States Environmental Protection Agency, Washington, DC, EPA/600/B 20/219
Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. Hydrogeologic Site Characterization Report. AP1, GMF GSP, Coffeen Power Plant. Coffeen, Illinois.

TABLE 6-2. PREDICTION MODEL INPUT VALUES
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Hydrostratigraphic Unit/Recharge Area	Notes	Recharge Zone	Sulfate Concentration (mg/L)	Recharge (ft/day)	Recharge (inches/yr)	Constant Concentration Layer	Constant Concentration (mg/L)
Scenario 1: CIP							
AP1 - removal area east	FILL	7	0	1.8E-03	7.85	2&3	130.0
AP1 - consolidation area west	CCR	16	1,000	6.26E-08	2.74E-04	- - -	- - -
Scenario 2: CBR							
AP1 - removal area east	FILL	7	0	1.8E-03	7.85	- - -	- - -
AP1 - removal area west	FILL	16	0	1.4E-03	6.28	- - -	- - -

[O: SLN 04/01/22; C: EGP 04/29/22]

Notes:

- - - = not included
AP1 = Ash Pond No. 1
CCR = coal combustion residuals
ft/day = feet per day
inches/yr = inches per year
mg/L = milligrams per liter

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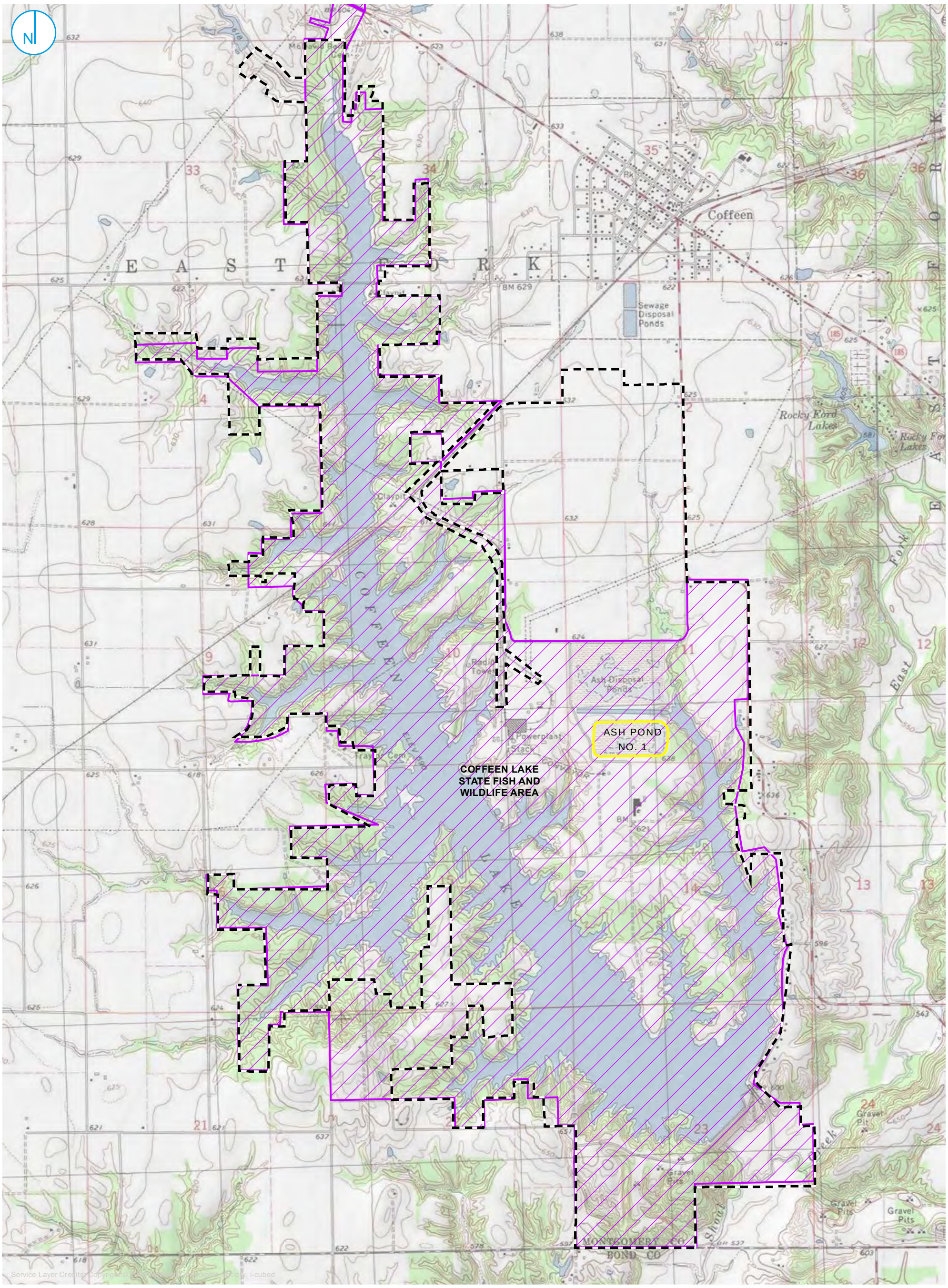
FIGURES



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
COFFEEN LAKE STATE FISH AND WILDLIFE AREA

0 1,000 2,000 Feet

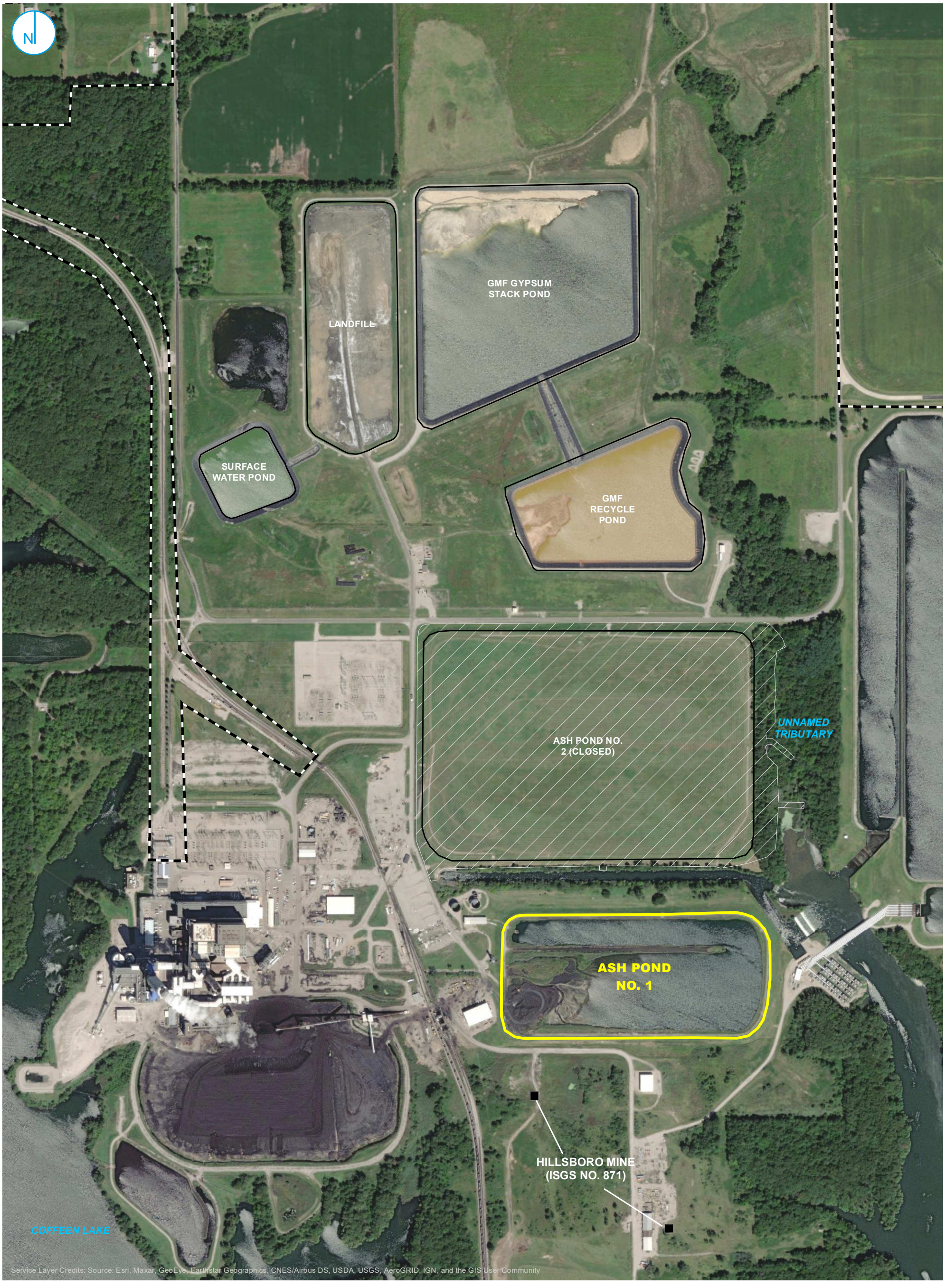
SITE LOCATION MAP

FIGURE 1-1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



- COAL MINE SHAFT
- PART 845 REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 275 550 Feet

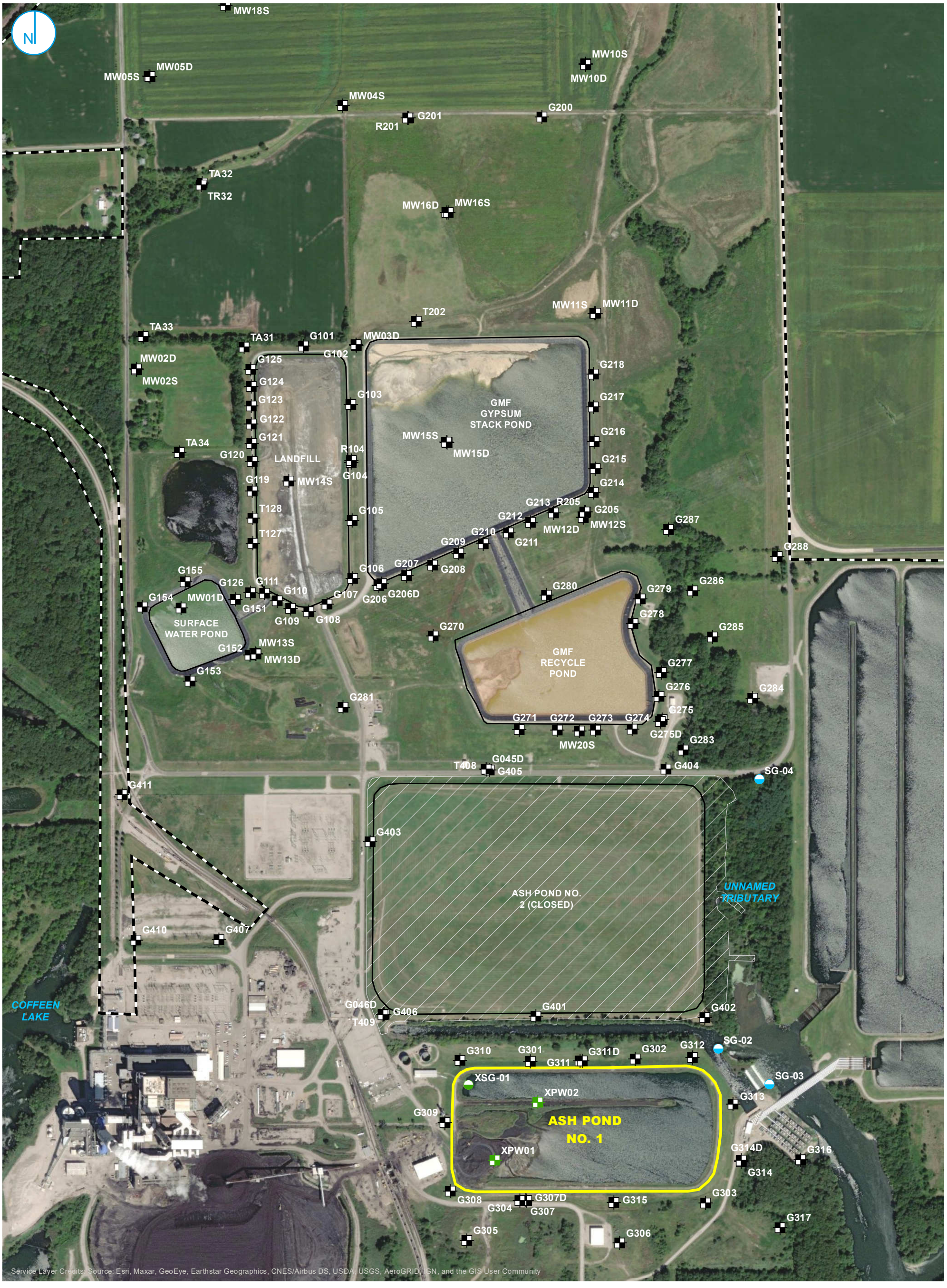
SITE MAP

FIGURE 1-2

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



MONITORING WELL
PORE WATER WELL
STAFF GAGE, RIVER
STAFF GAGE, CCR UNIT
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 275 550 Feet

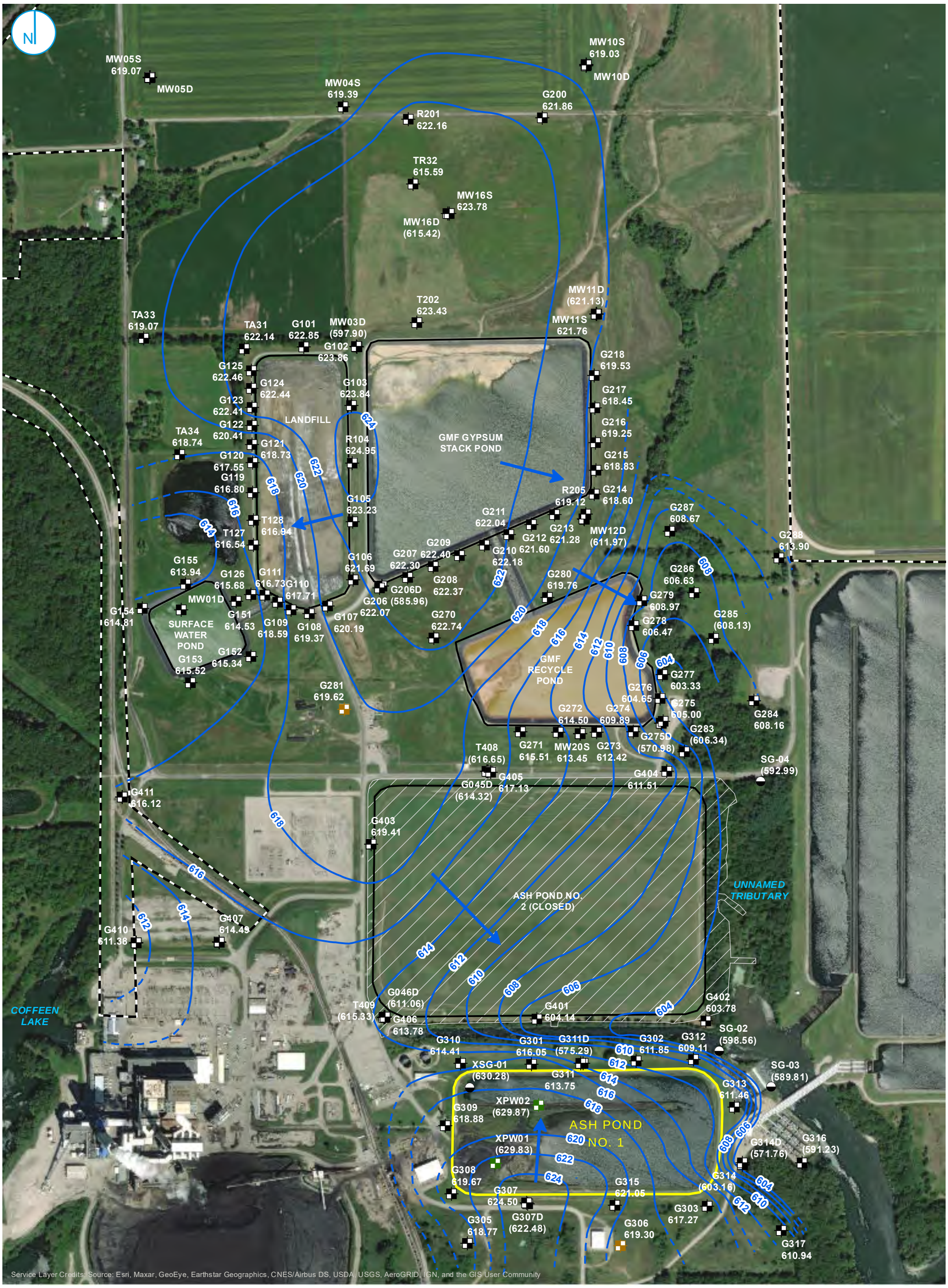
MONITORING WELL LOCATION MAP

FIGURE 2-1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



BACKGROUND WELL
MONITORING WELL
SOURCE SAMPLE LOCATION
STAFF GAGE
GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION

0 275 550 Feet

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP APRIL 20, 2021

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

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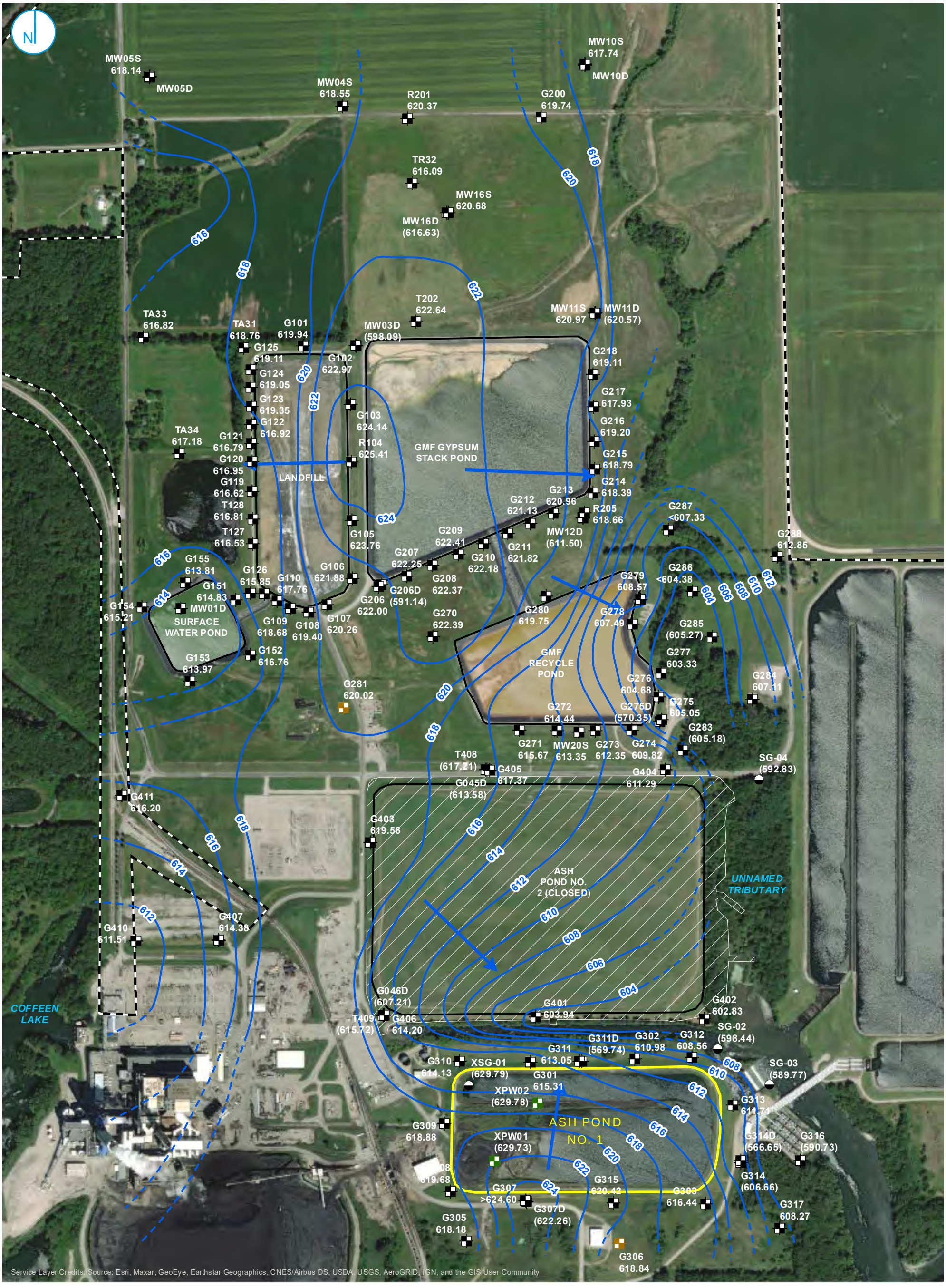


- BACKGROUND WELL
- MONITORING WELL
- SOURCE SAMPLE LOCATION
- STAFF GAGE
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION

0 275 550 Feet

- PART 845 REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

NOTE:
ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP JULY 26, 2021

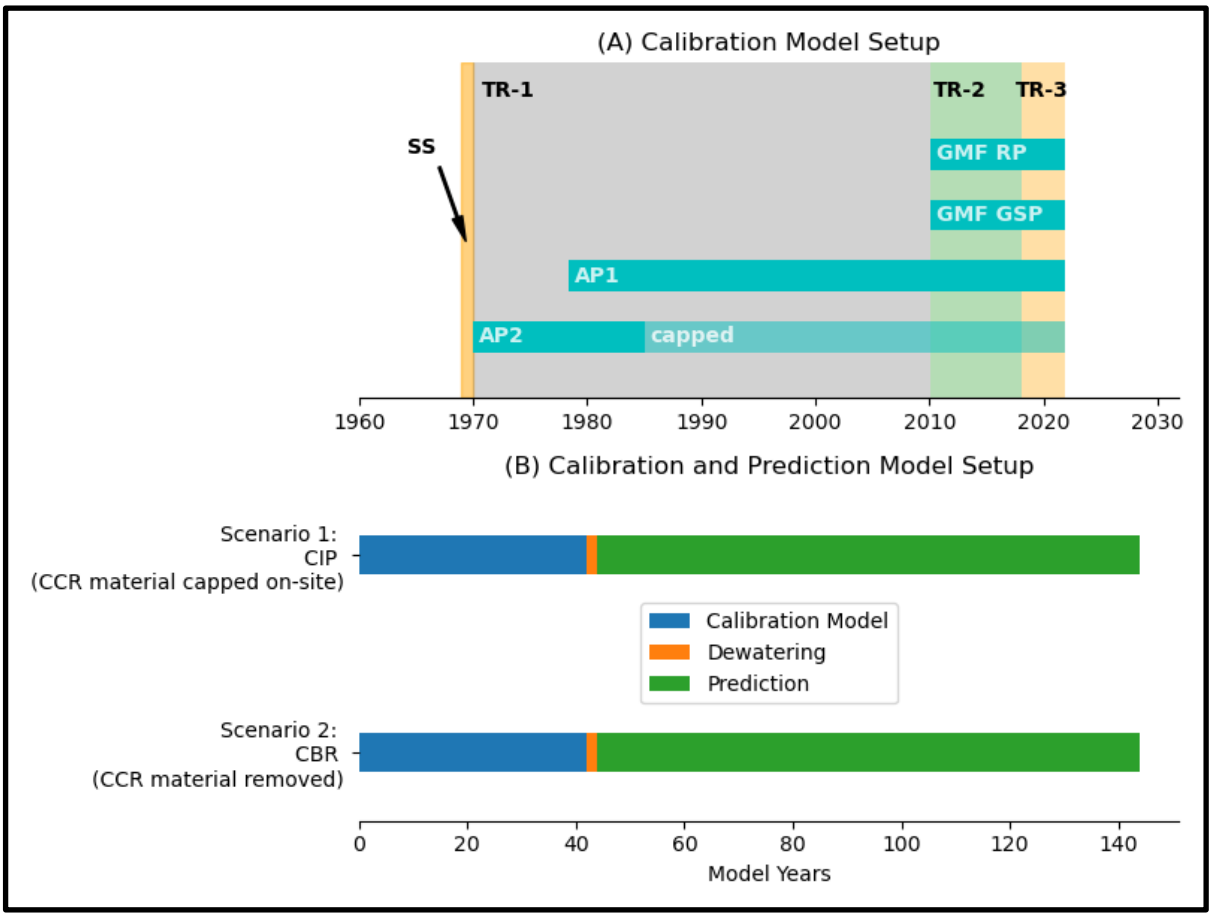
GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-3

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

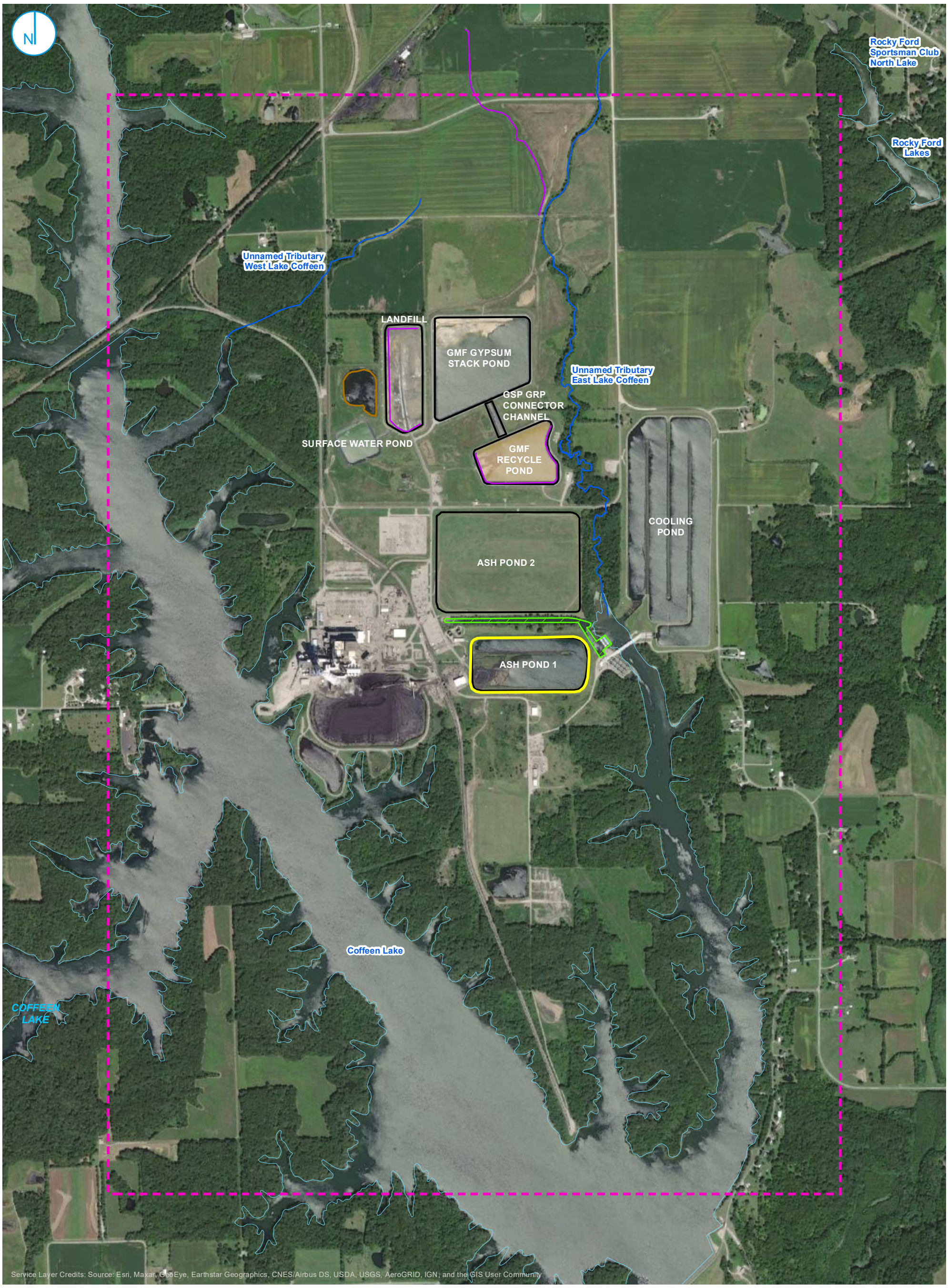
FIGURE 4-1



CALIBRATION AND PREDICTIVE TIMELINE
(SS = STEADY STATE MODEL AND TR = TRANSIENT MODEL)

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL



DRAIN
STREAM
LAKE
COOLING CONDENSER FLUME
SI UNIT
POND
MODEL GRID
PART 845 REGULATED UNIT (SUBJECT UNIT)

0 625 1,250 Feet

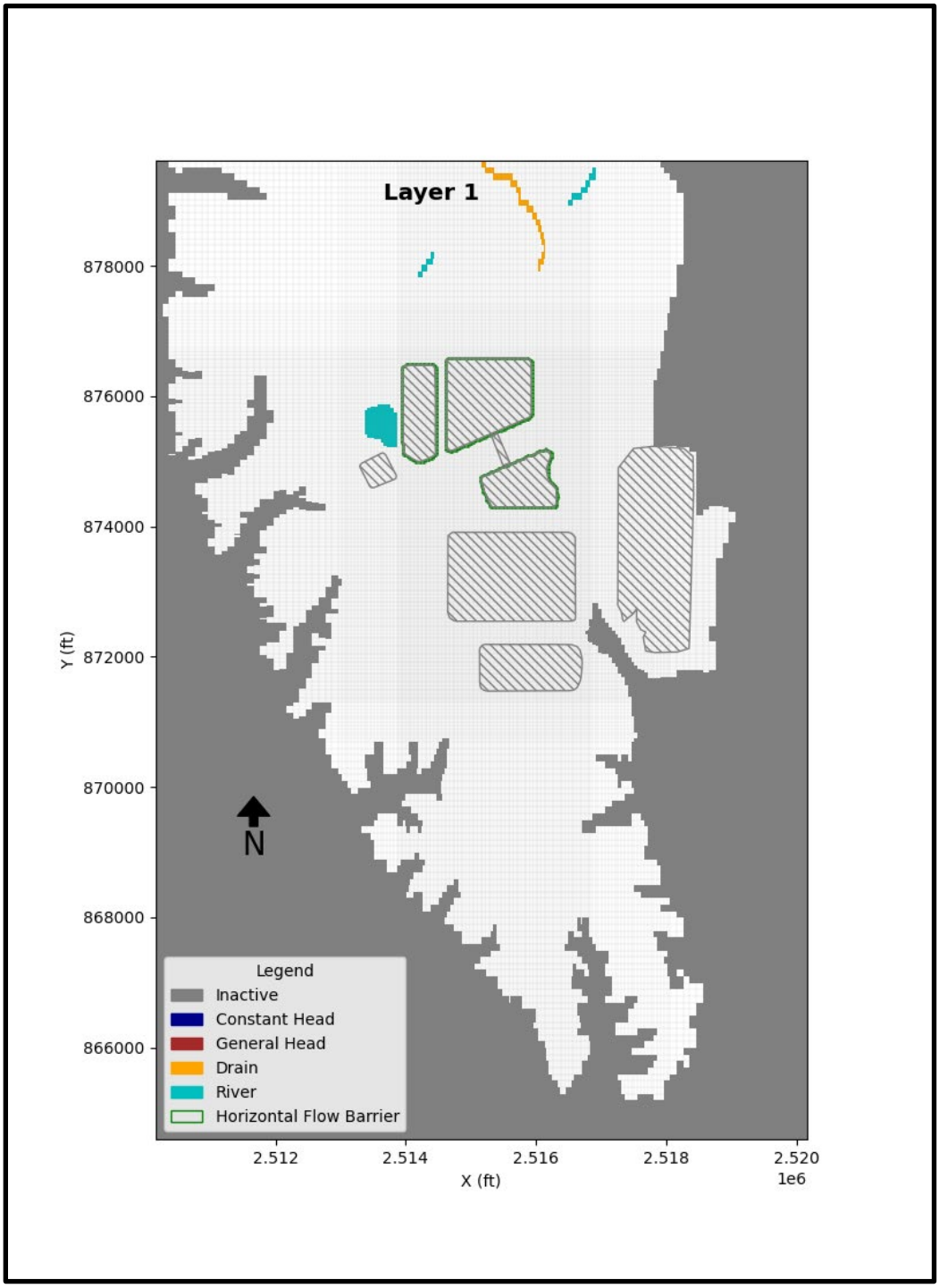
MODEL AREA MAP

FIGURE 5-1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

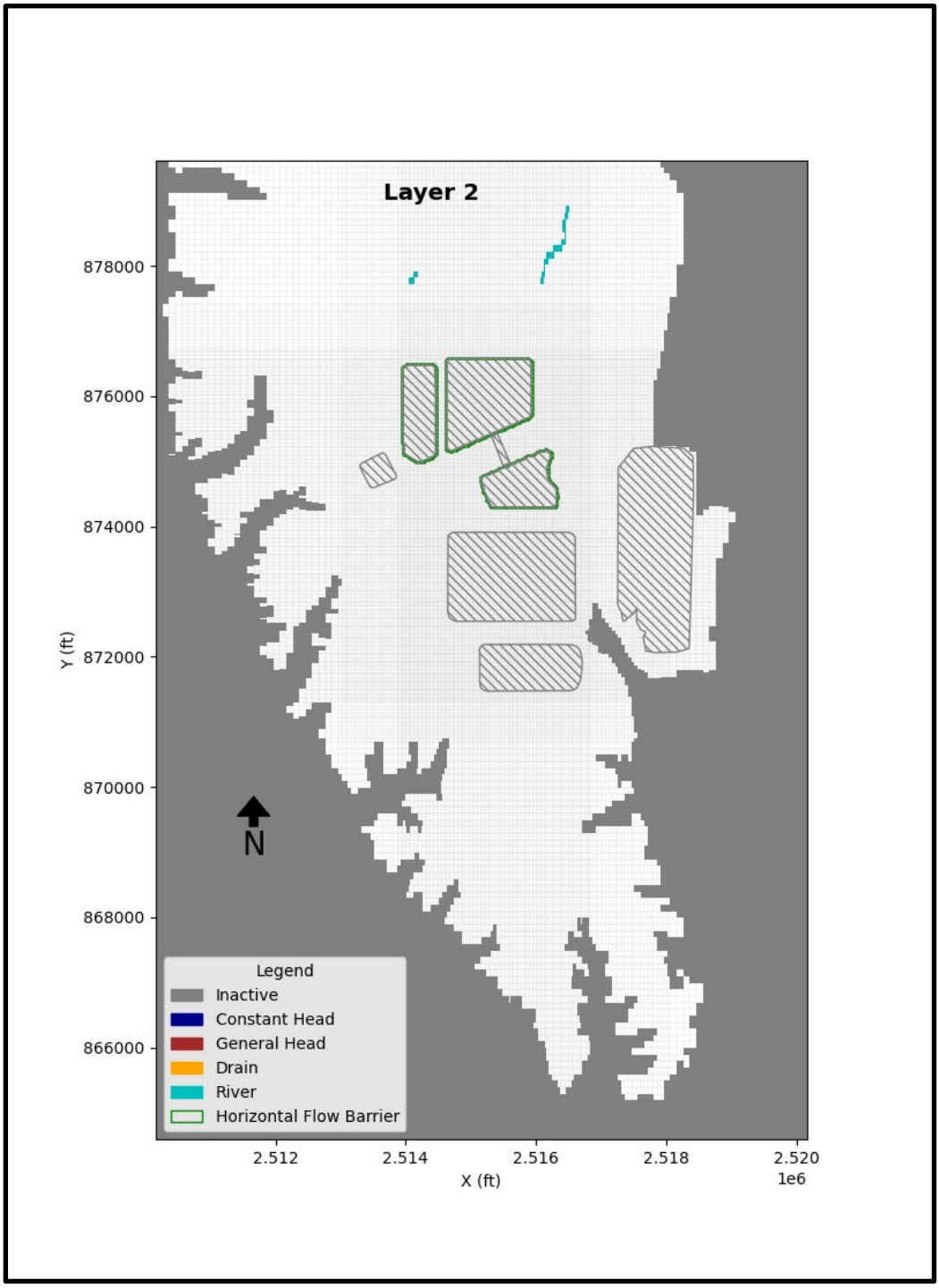
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

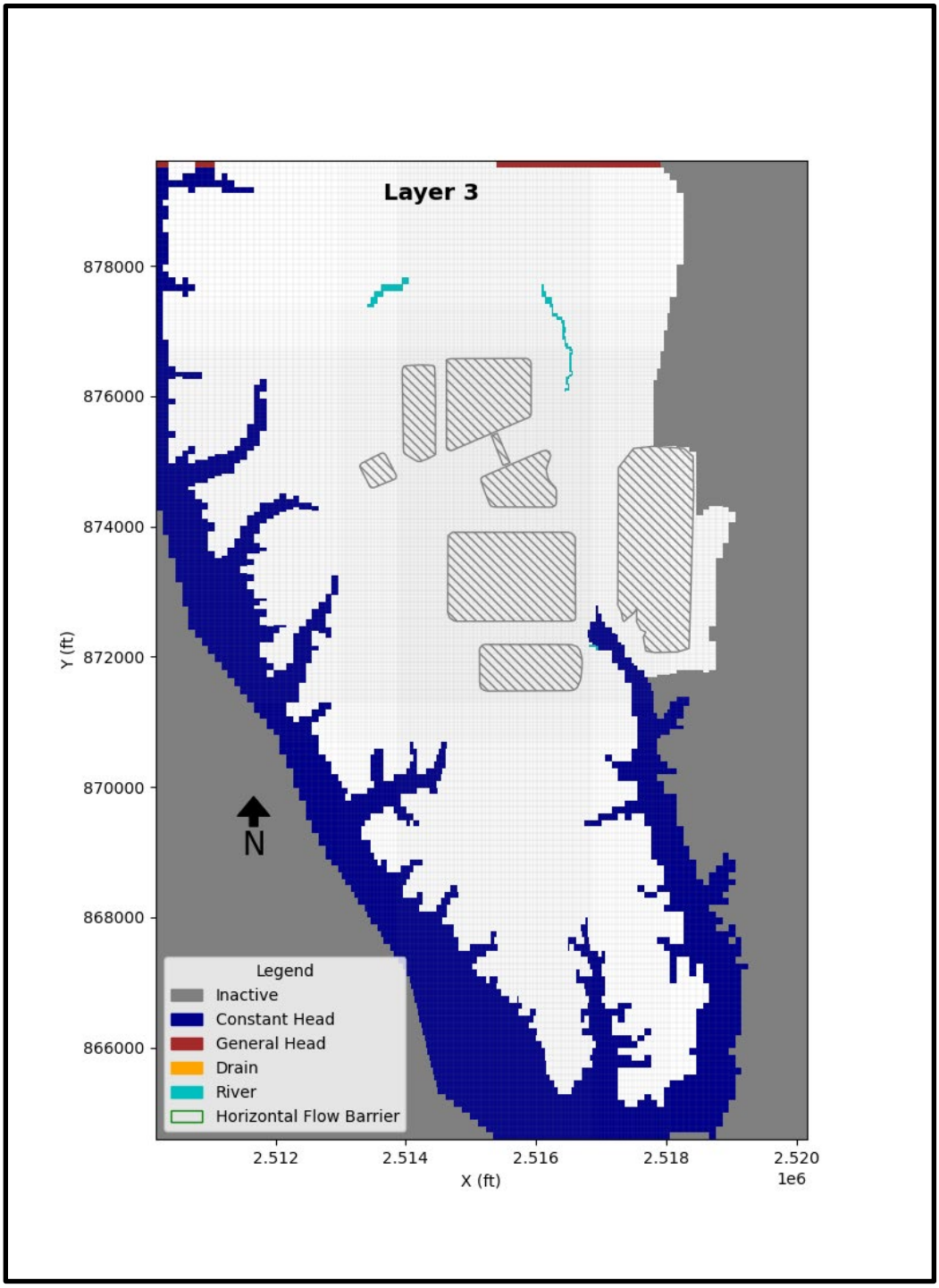
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 2

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

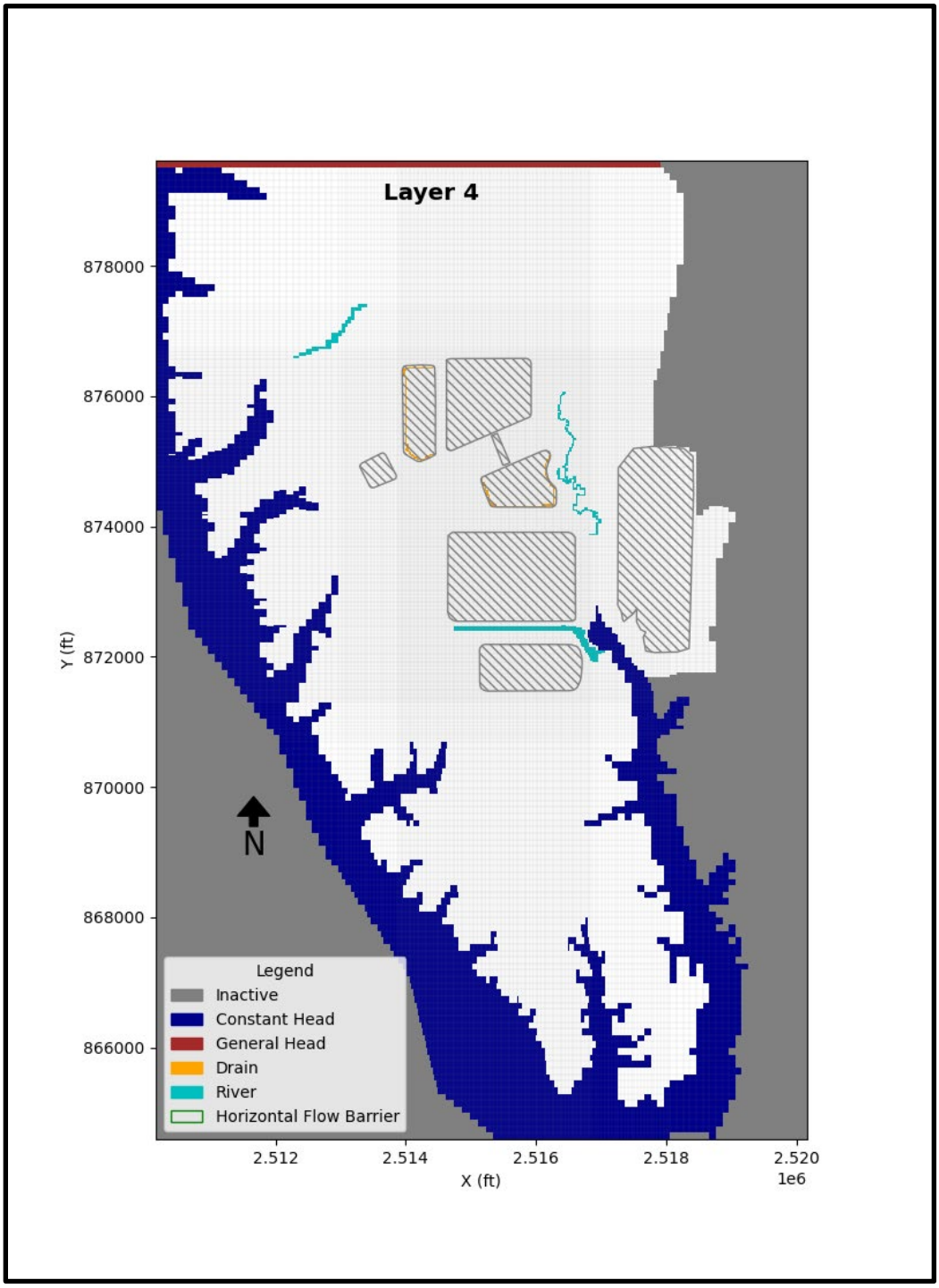
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 3

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

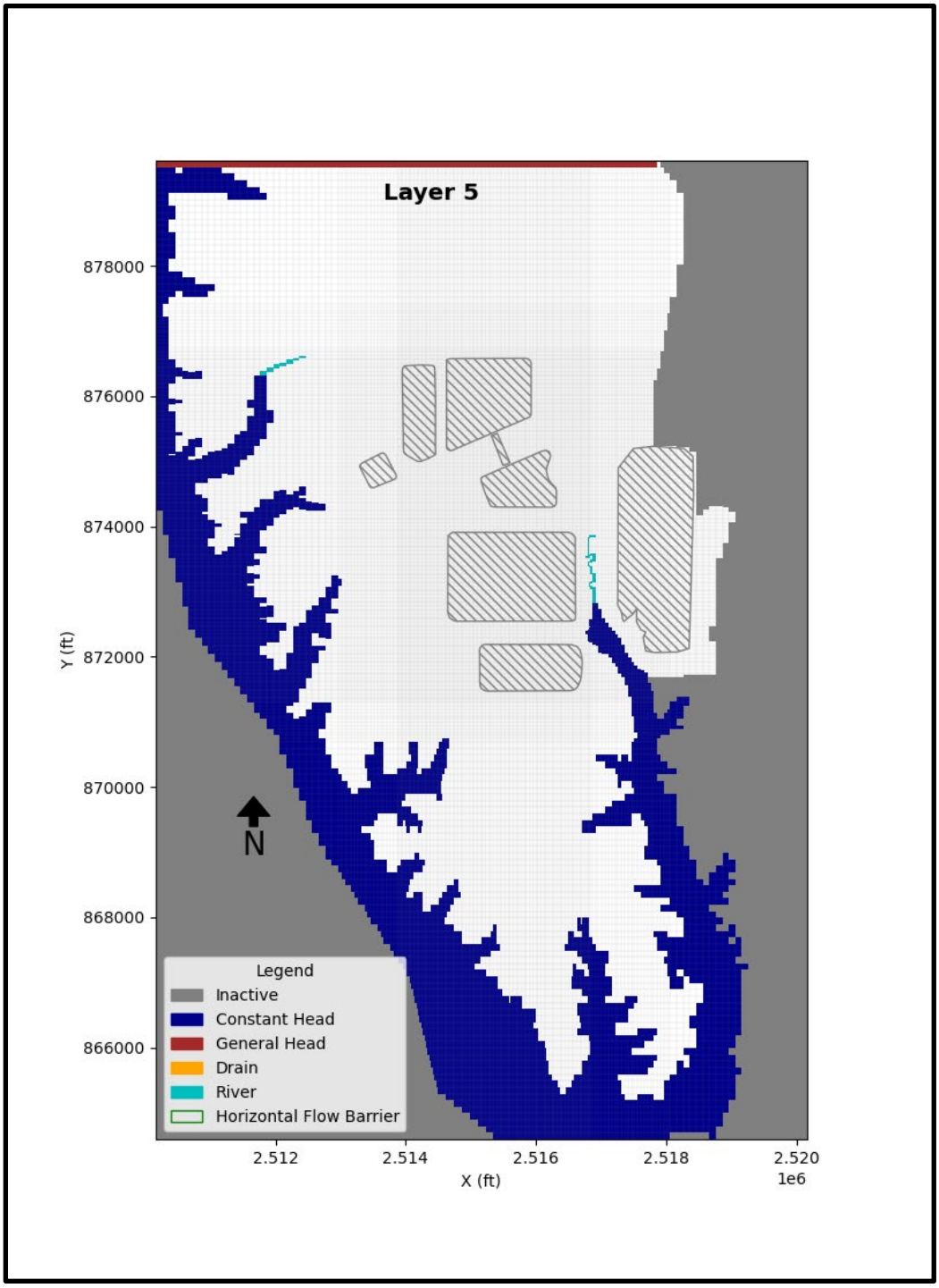
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 4

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

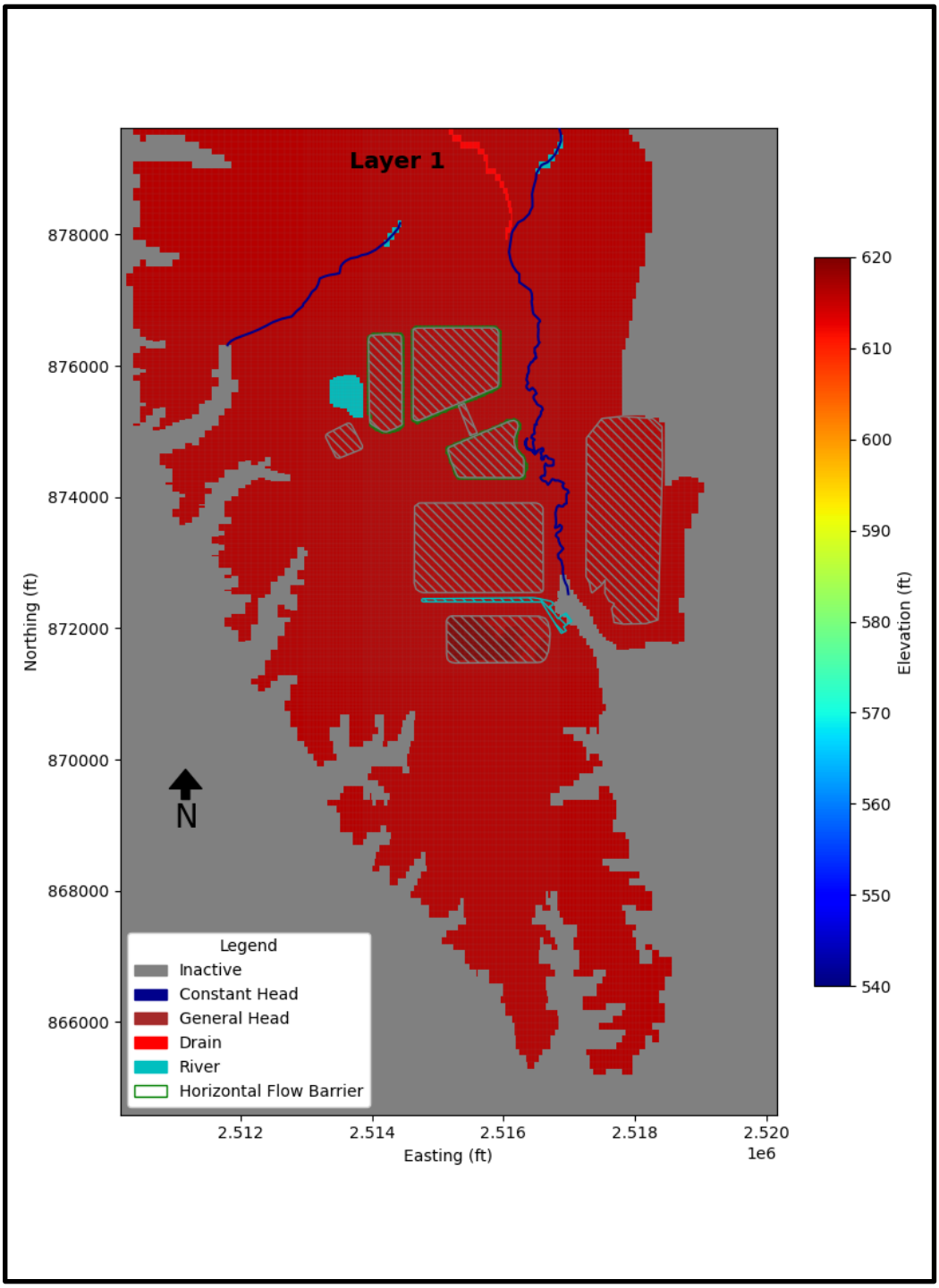
RAMBOLL



BOUNDARY CONDITIONS FOR LAYER 5

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

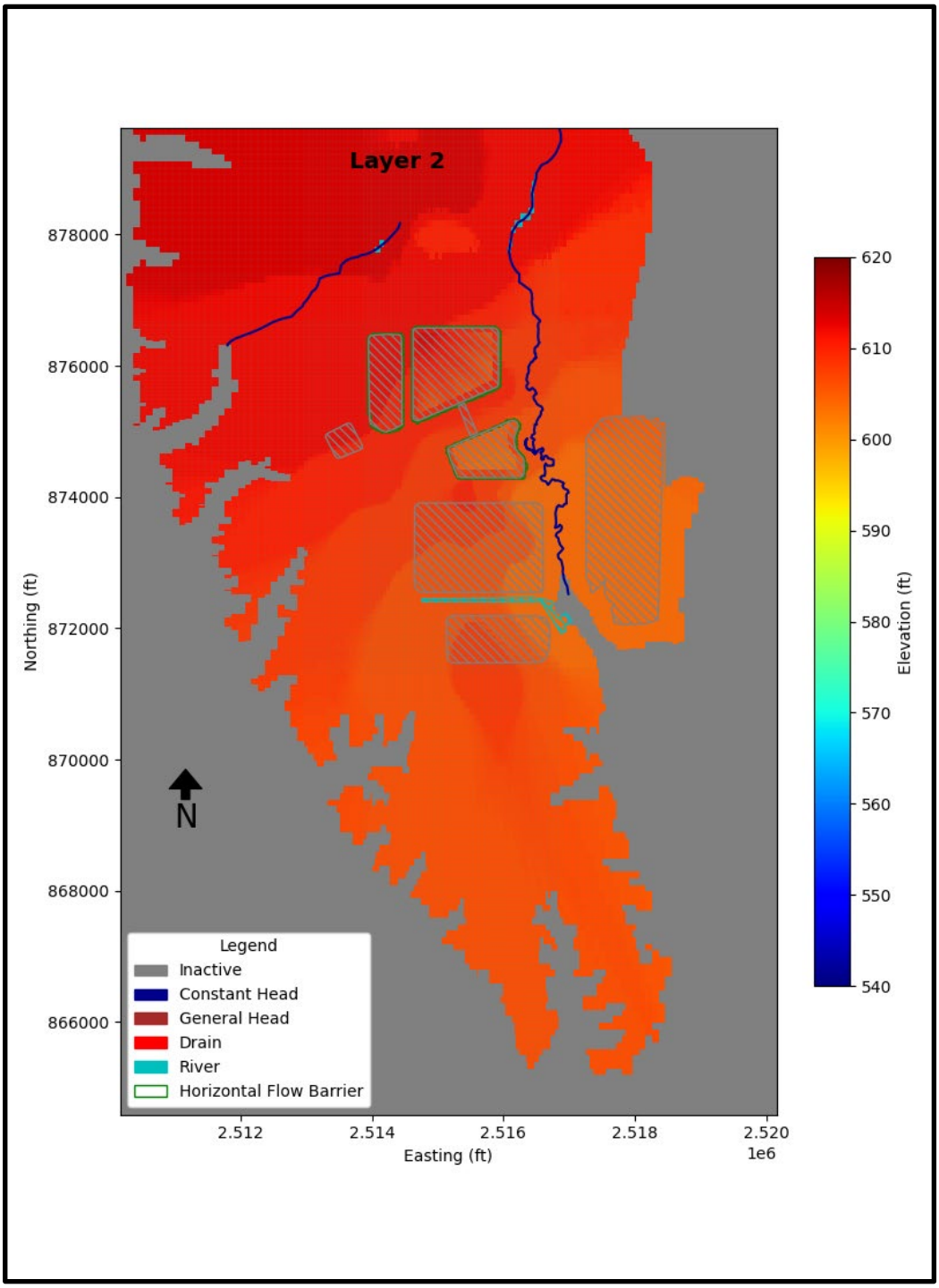
RAMBOLL



BASE OF MODEL FOR LAYER 1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

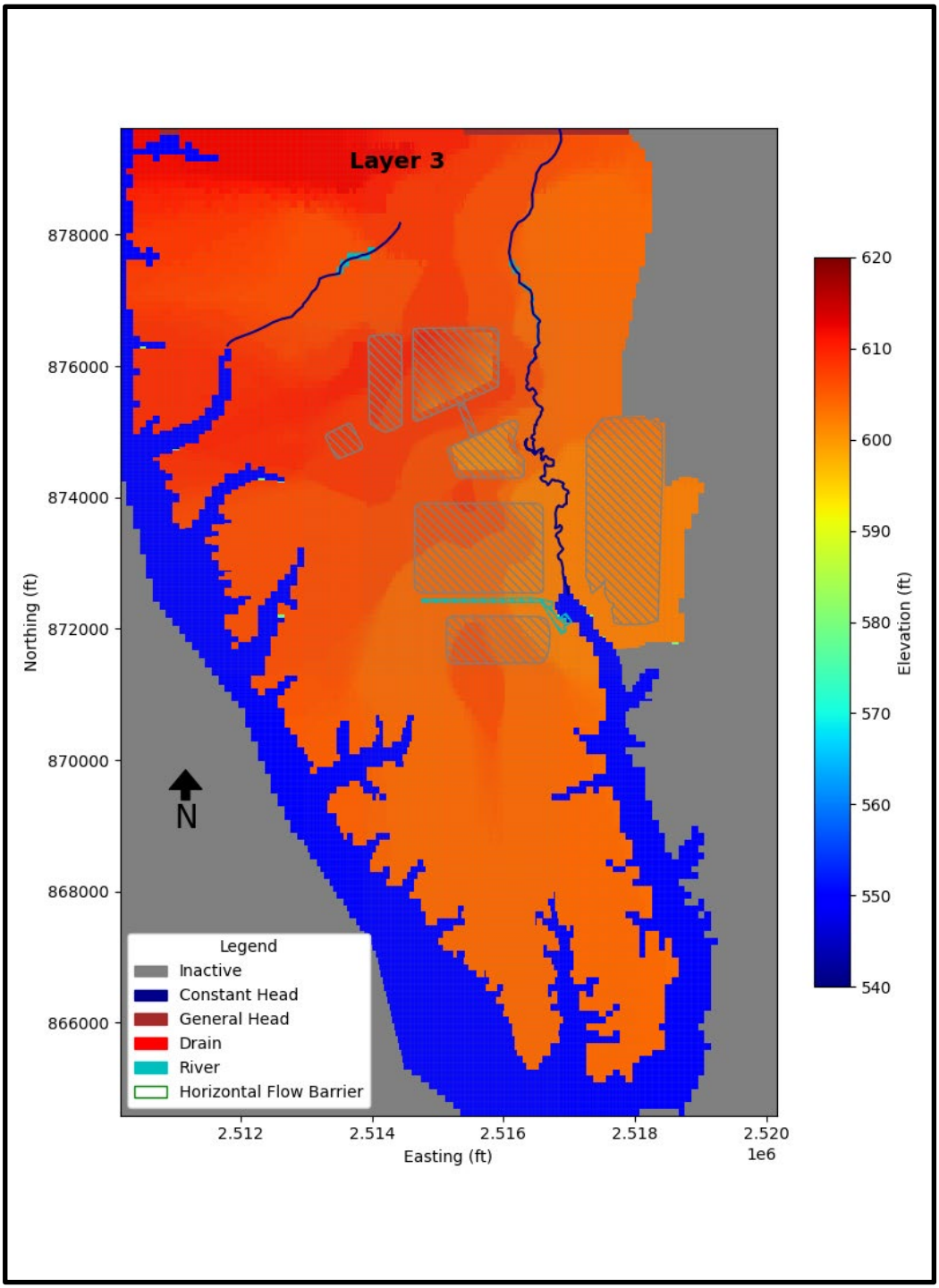
RAMBOLL



BASE OF MODEL FOR LAYER 2

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

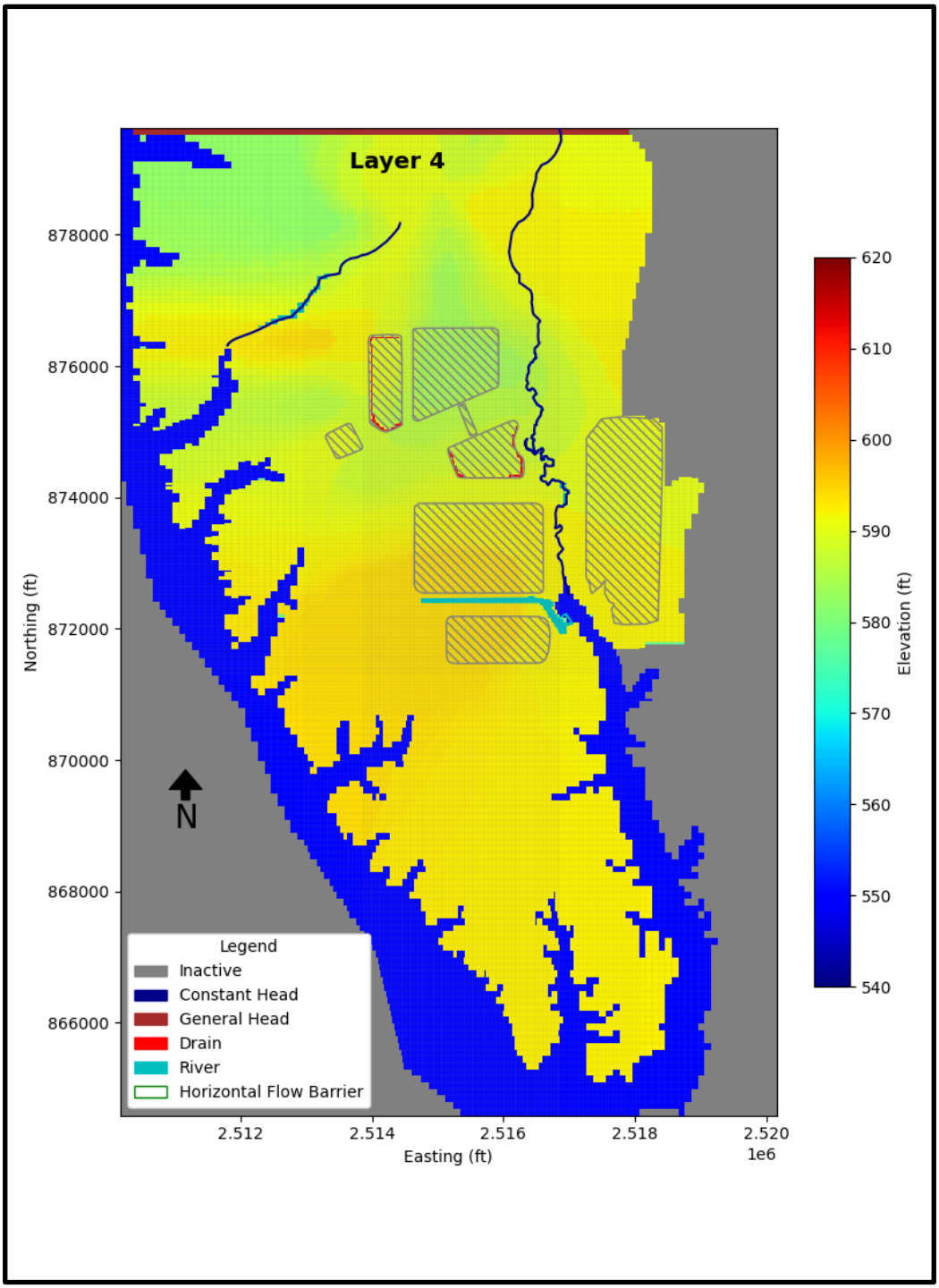
RAMBOLL



BASE OF MODEL FOR LAYER 3

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

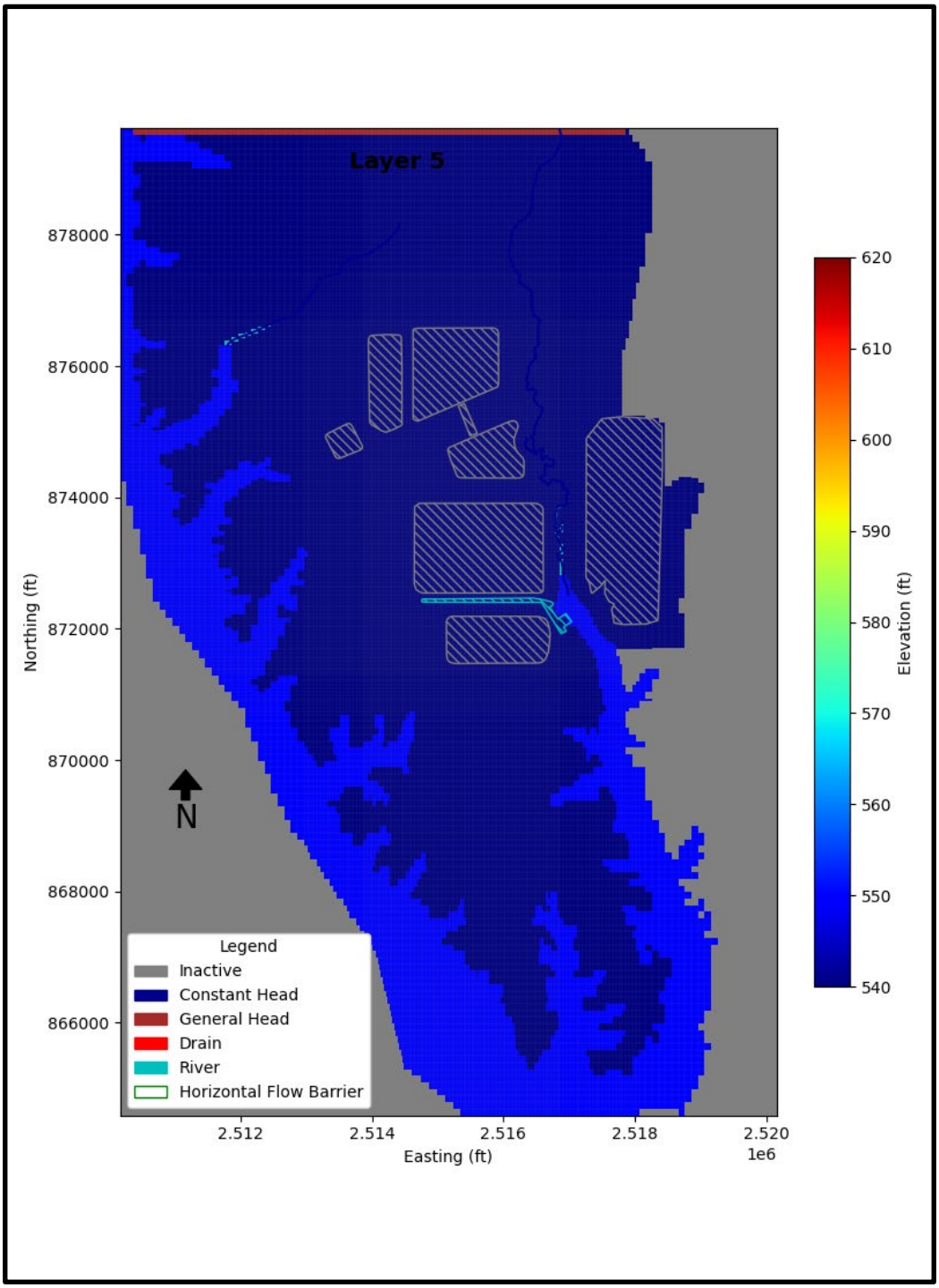
RAMBOLL



BASE OF MODEL FOR LAYER 4

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

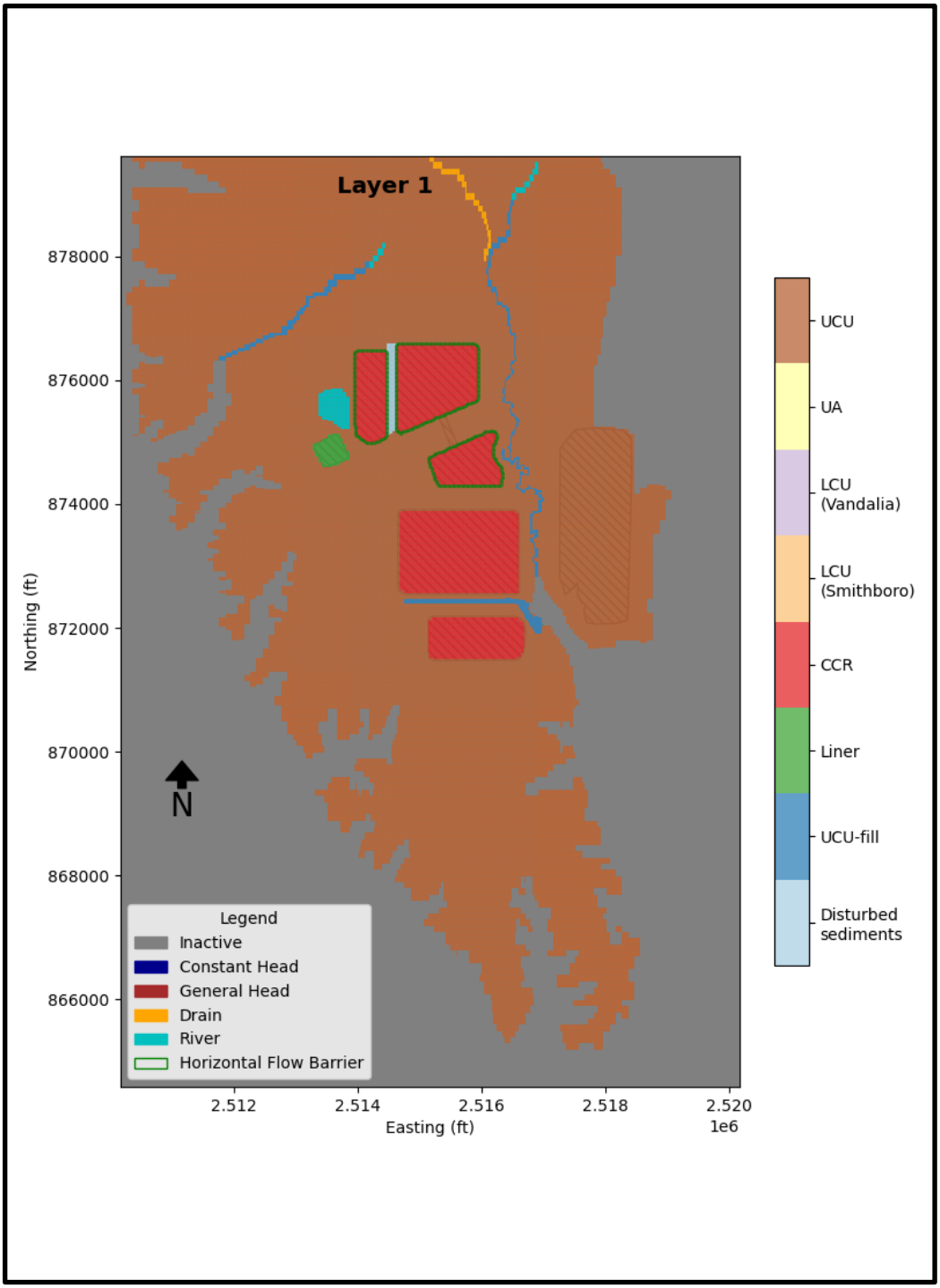
RAMBOLL



BASE OF MODEL FOR LAYER 5

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

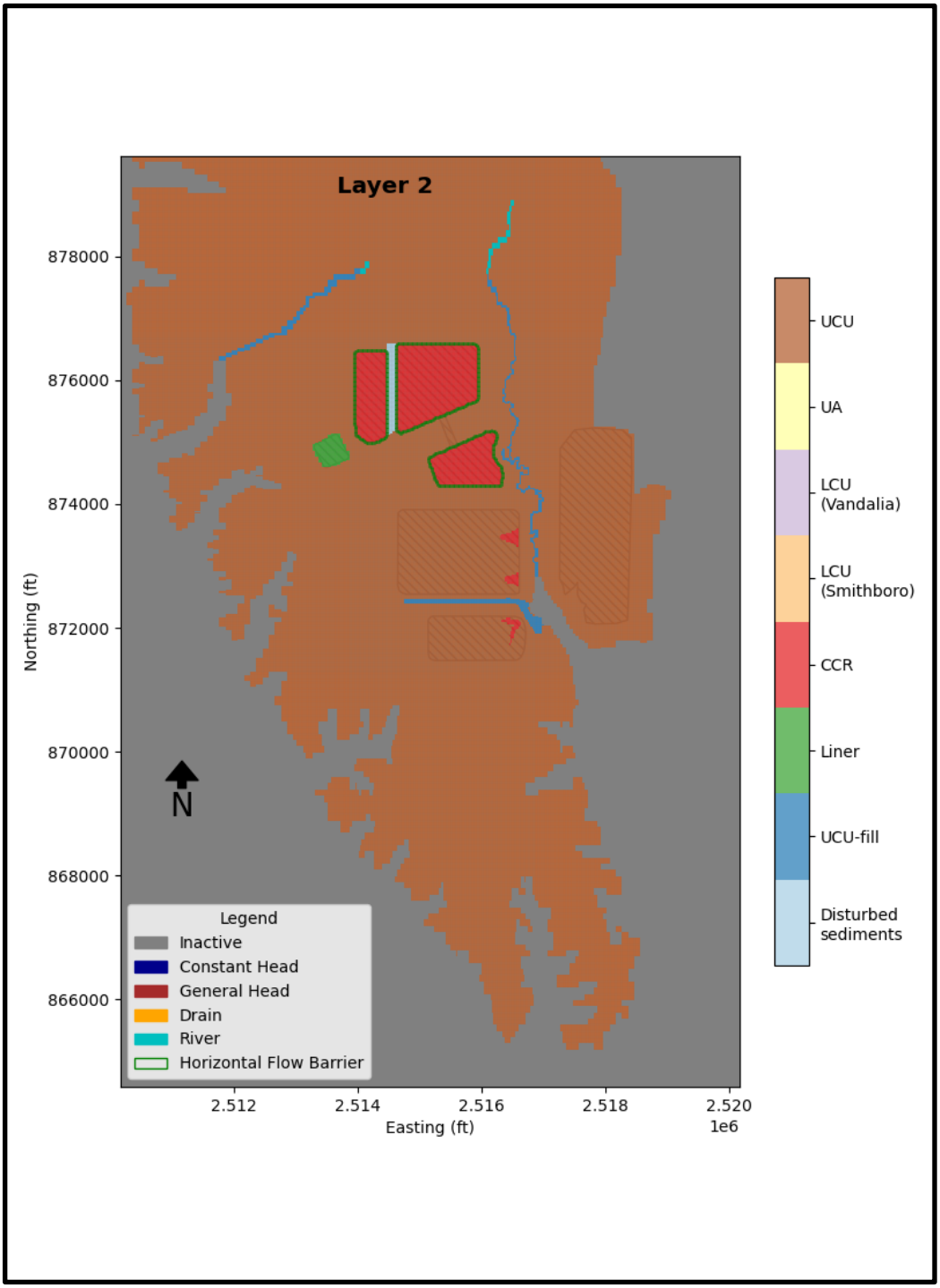
RAMBOLL



HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

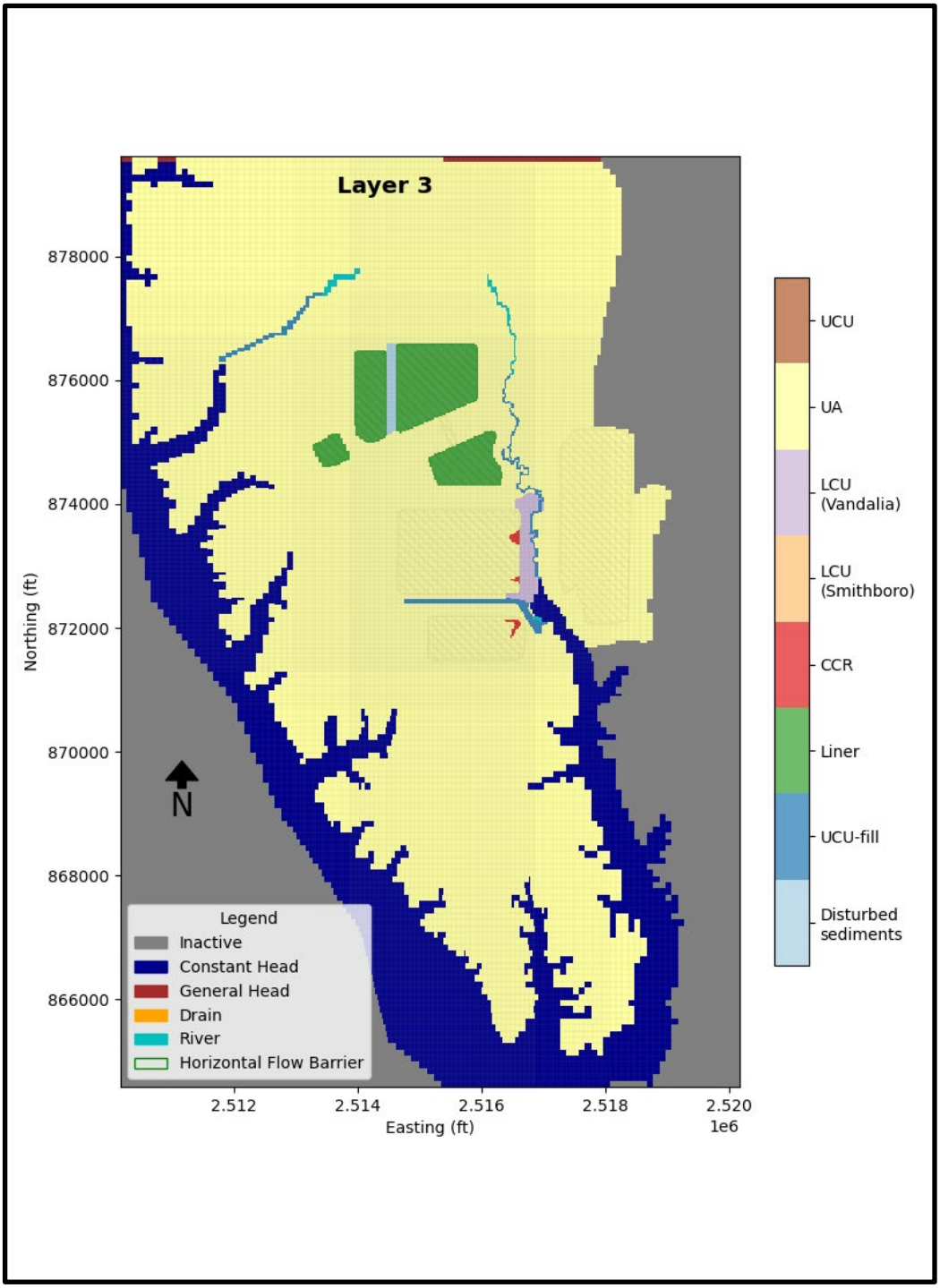
RAMBOLL



HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 2

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

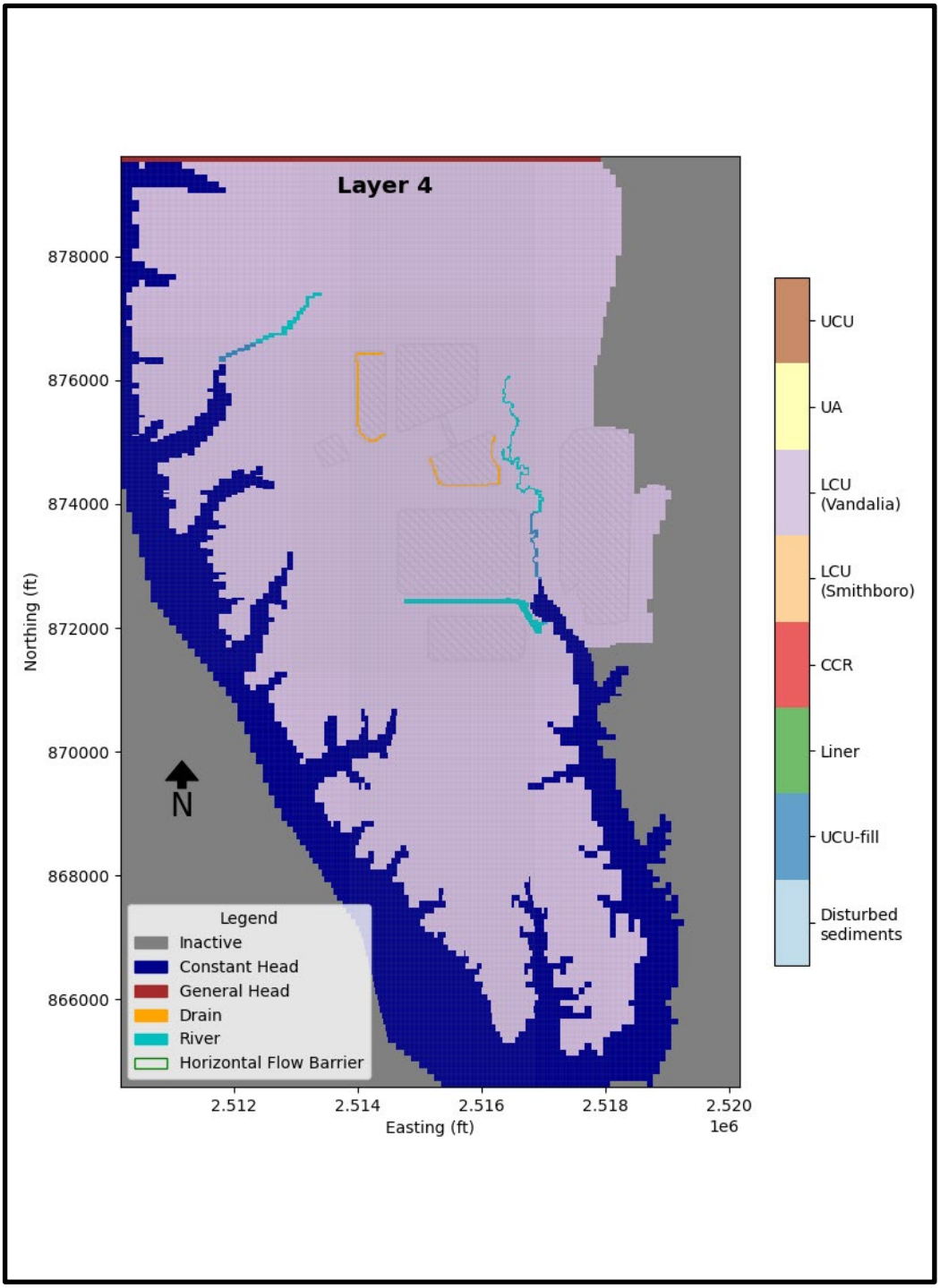
RAMBOLL



HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 3

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

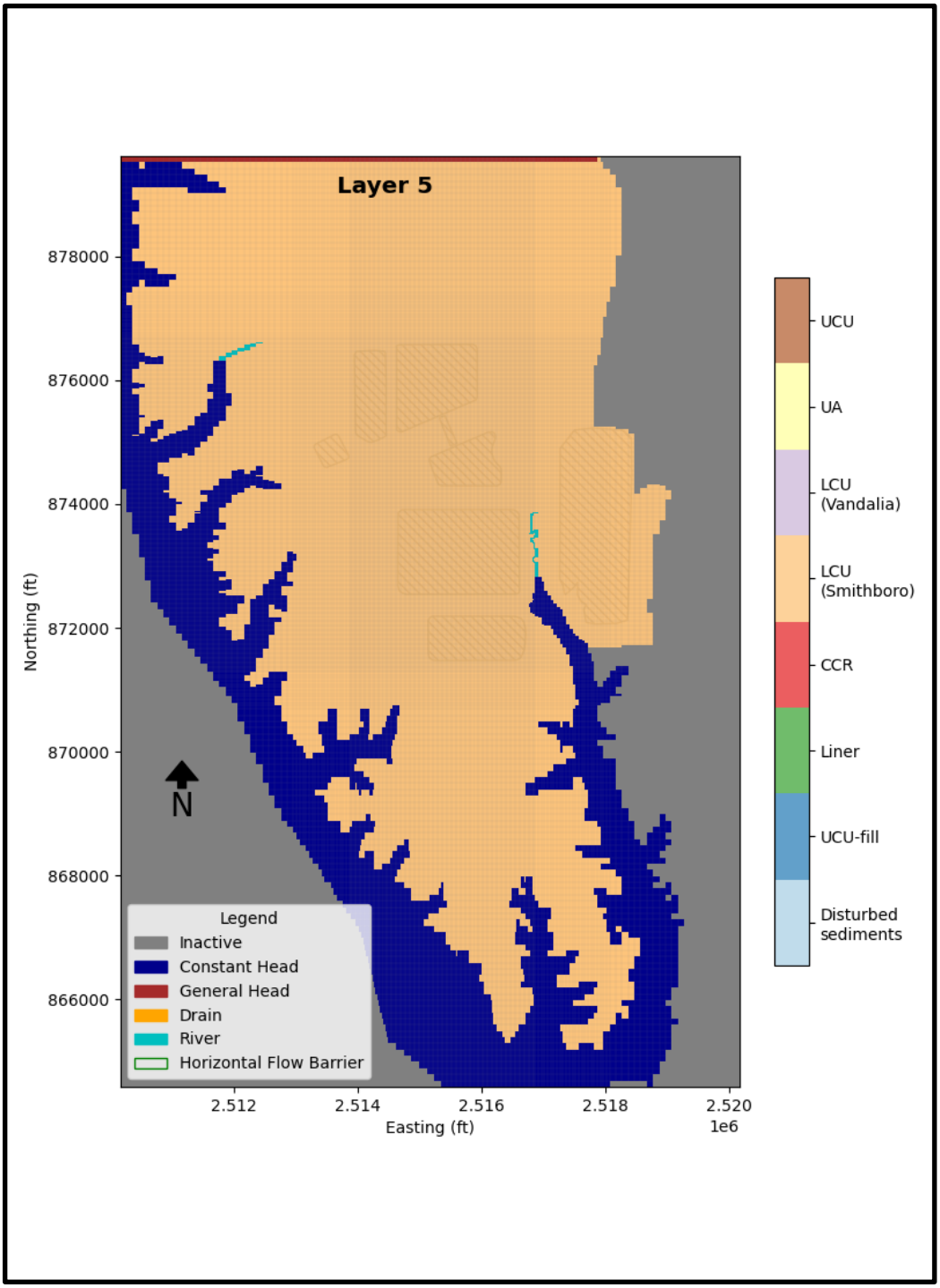
RAMBOLL



HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 4

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

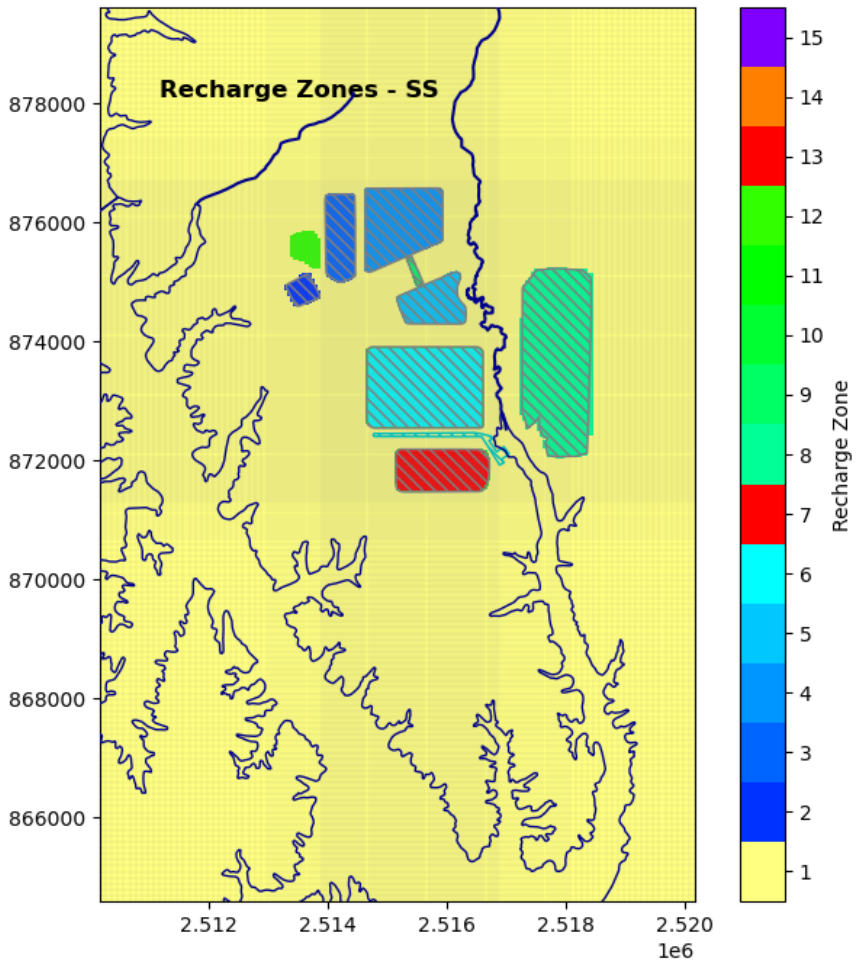
RAMBOLL



HYDRAULIC CONDUCTIVITY ZONES FOR LAYER 5

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

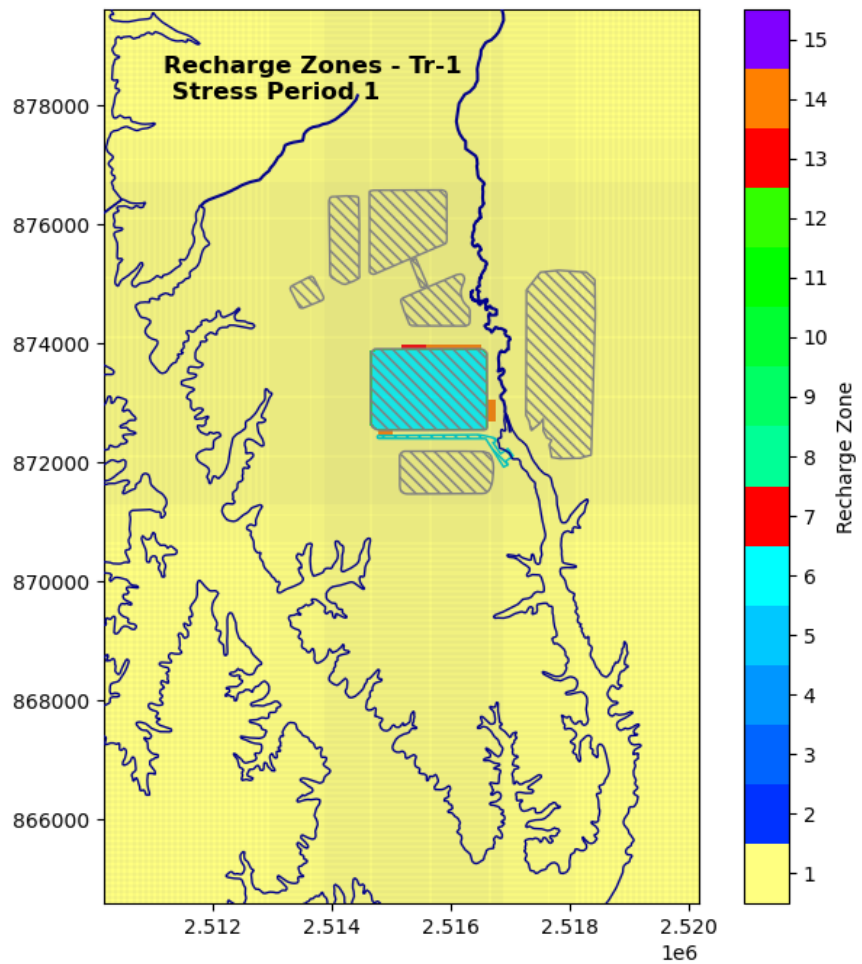
RAMBOLL



MODEL RECHARGE DISTRIBUTION STEADY STATE (SS) MODEL

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

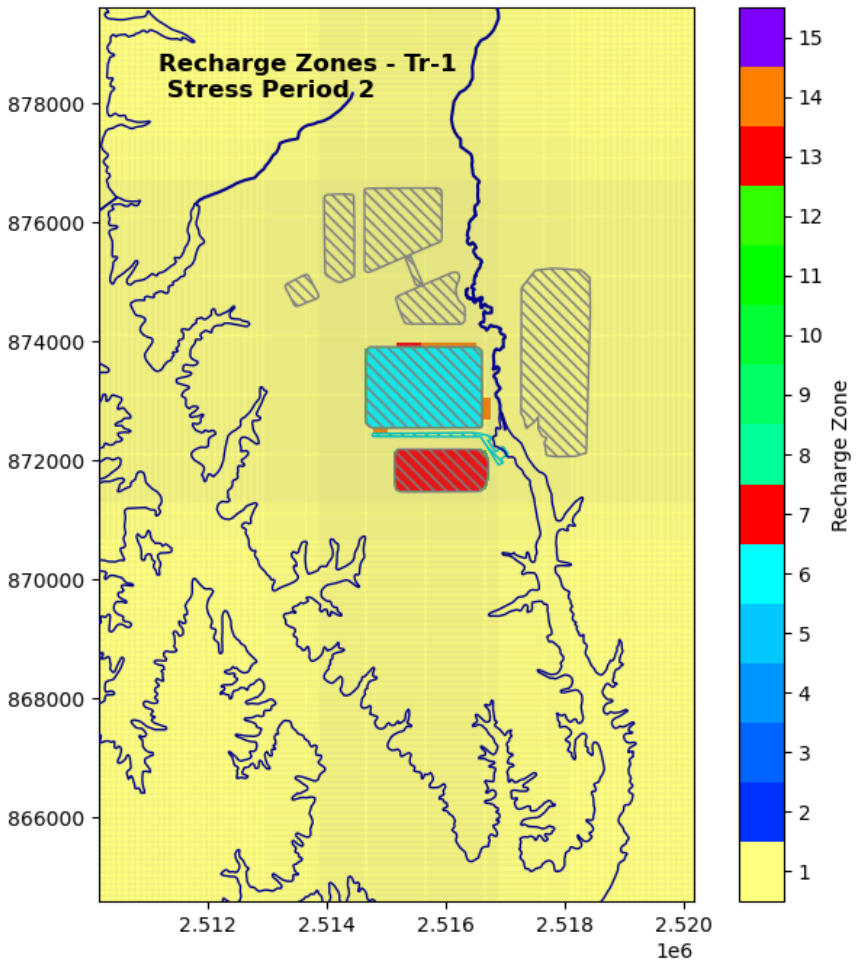
RAMBOLL



MODEL RECHARGE DISTRIBUTION FOR THE TRANSIENT (TR) MODEL TR-1
STRESS PERIOD 1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

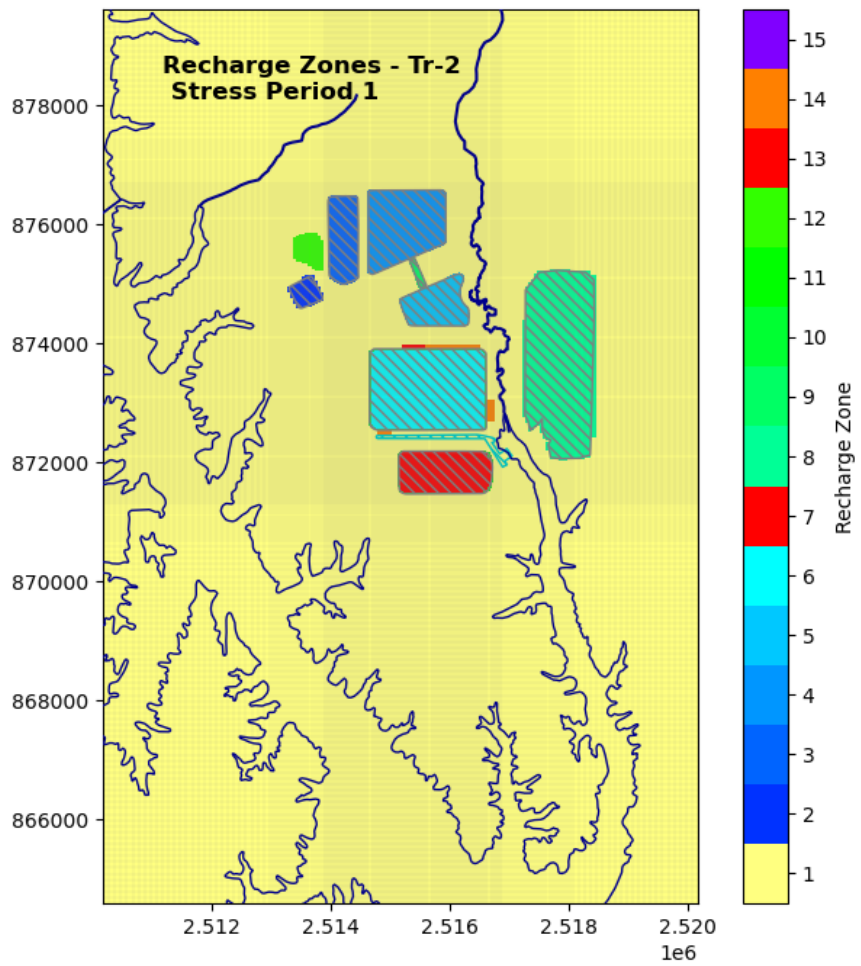
RAMBOLL



MODEL RECHARGE DISTRIBUTION FOR THE TRANSIENT (TR) MODEL TR-1
STRESS PERIOD 2

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

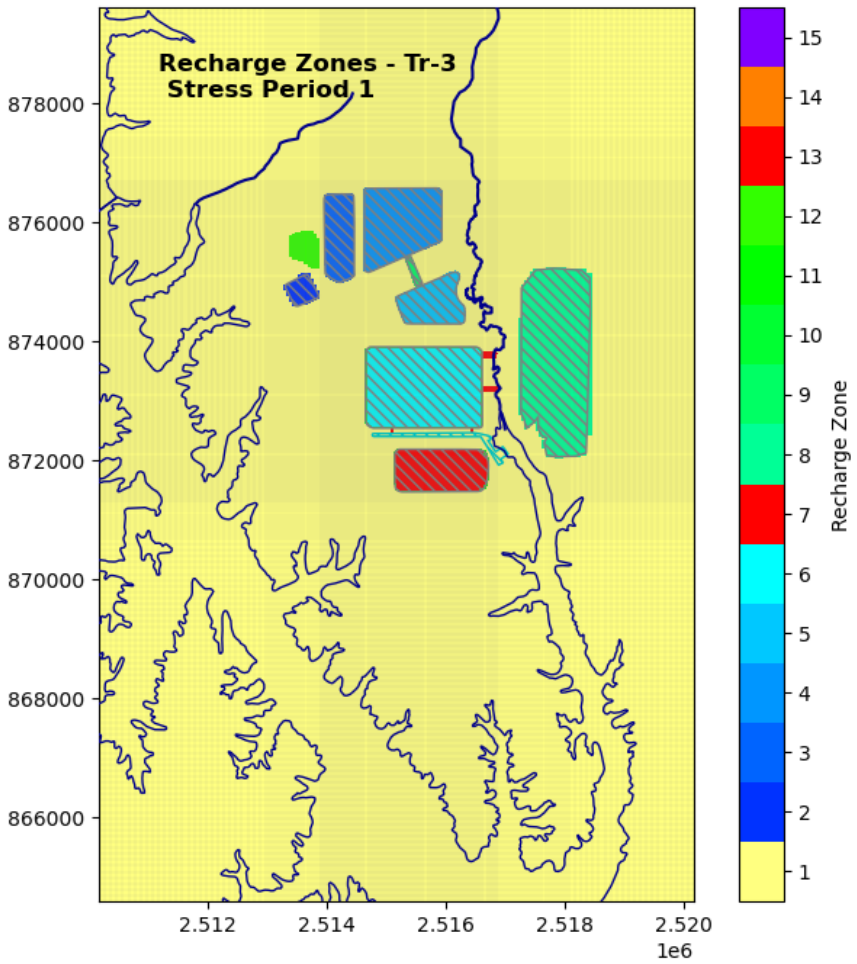
RAMBOLL



MODEL RECHARGE DISTRIBUTION FOR THE TRANSIENT (TR) MODEL TR-2
STRESS PERIOD 1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL

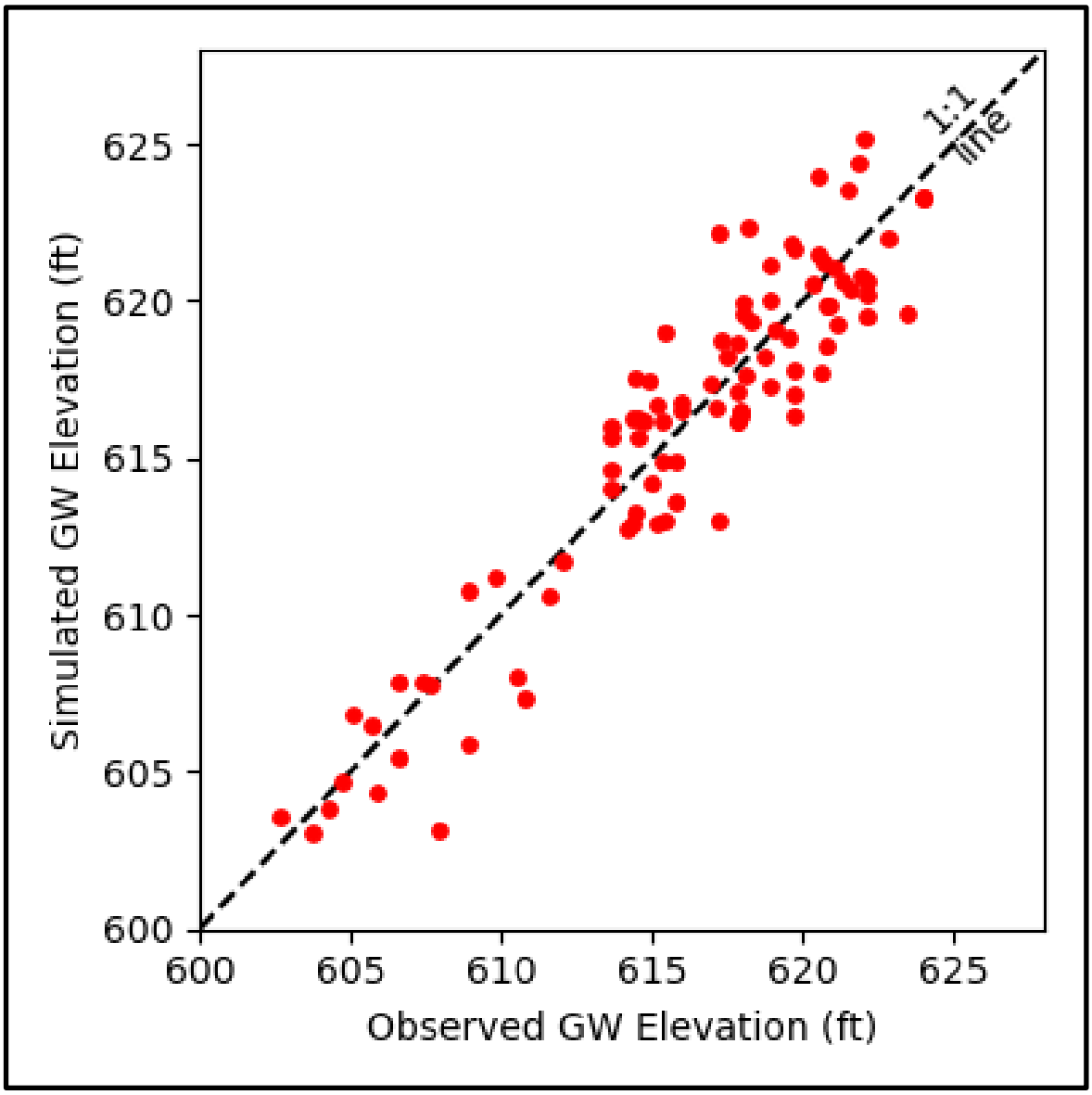


MODEL RECHARGE DISTRIBUTION FOR THE TRANSIENT (TR) MODEL TR-3
STRESS PERIOD 1

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL

FIGURE 5-22

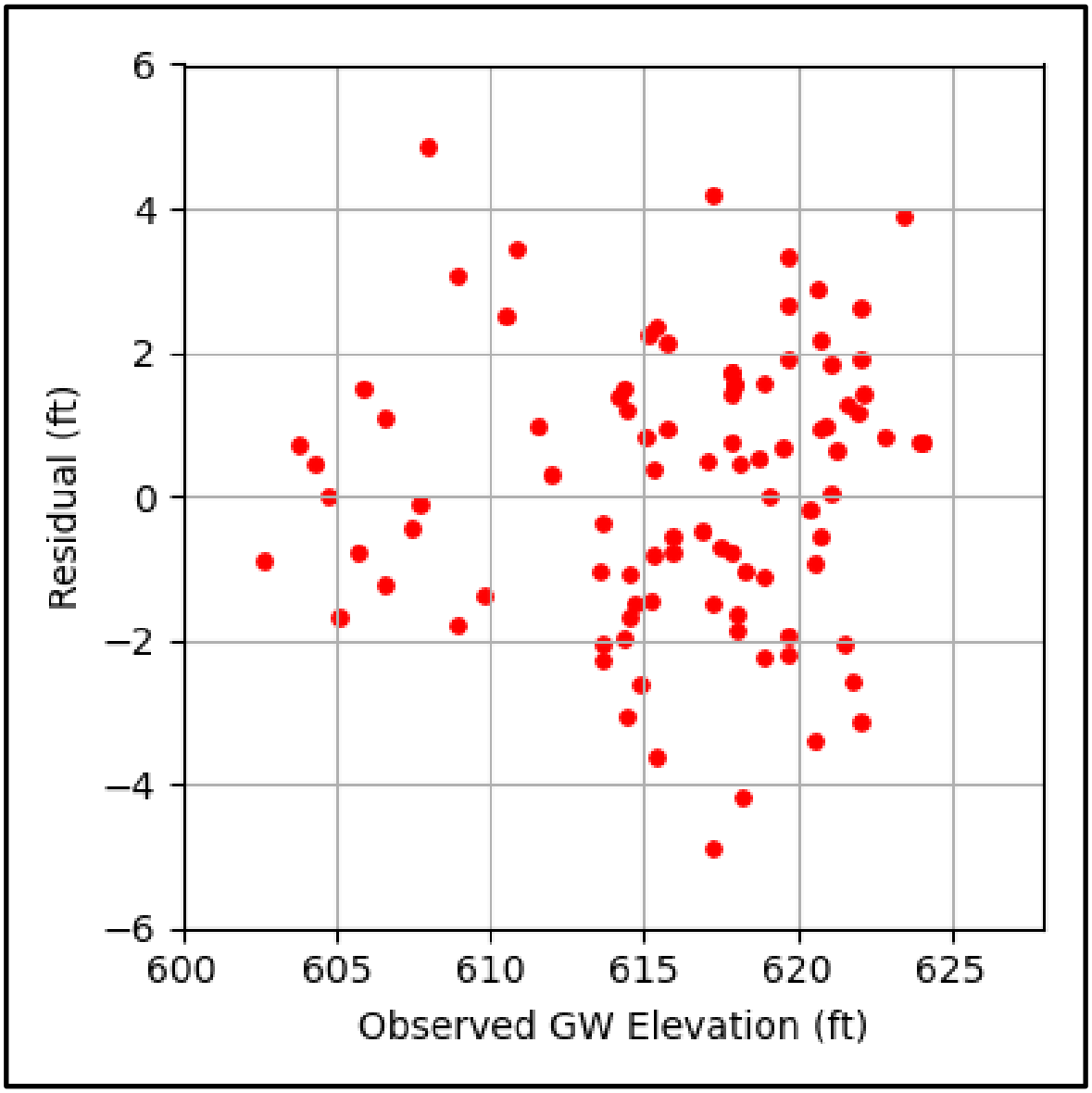


OBSERVED VERSUS SIMULATED STEADY STATE GROUNDWATER LEVELS FROM THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL

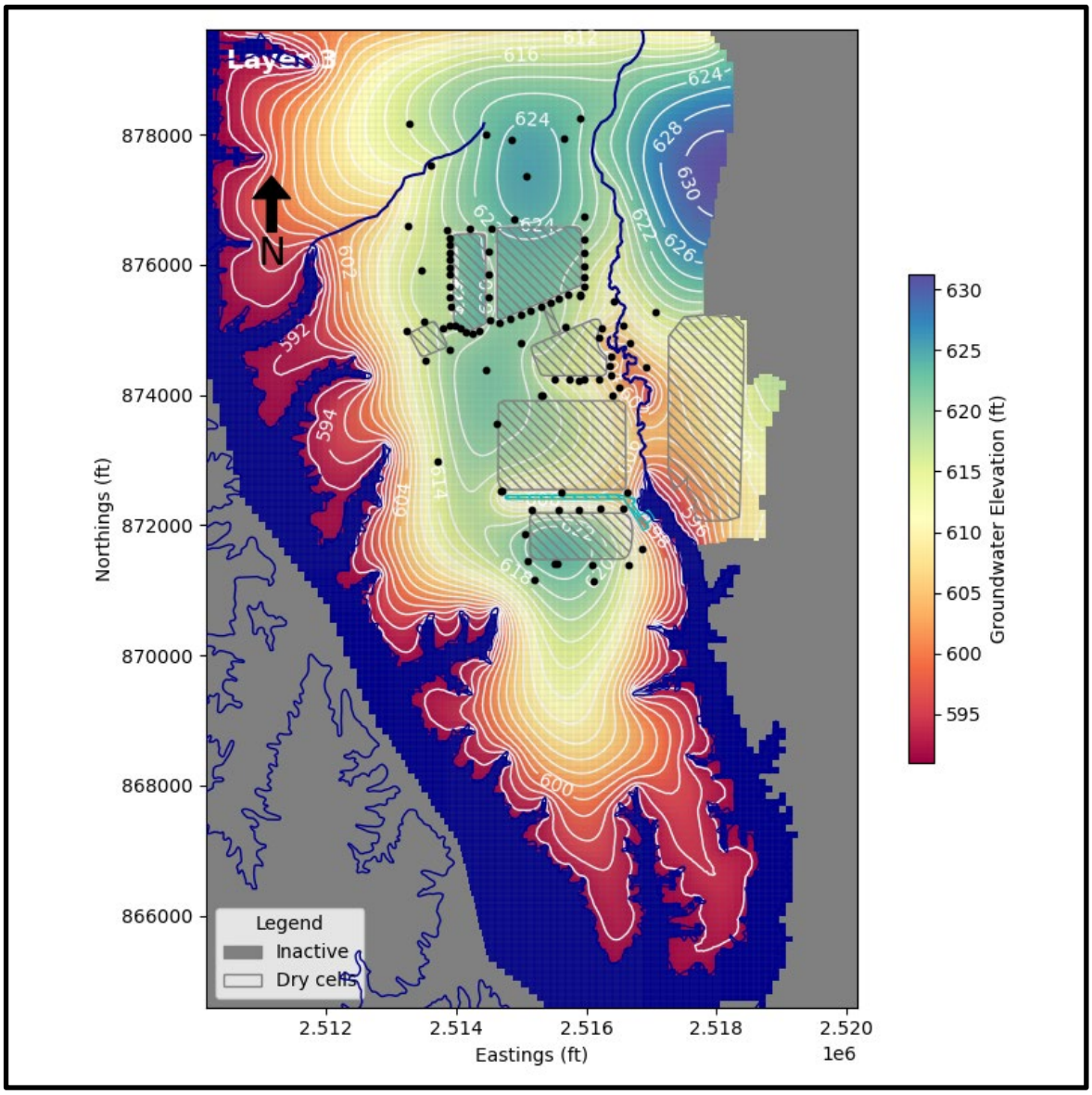
FIGURE 5-23



SIMULATED GROUNDWATER LEVEL RESIDUALS FROM THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

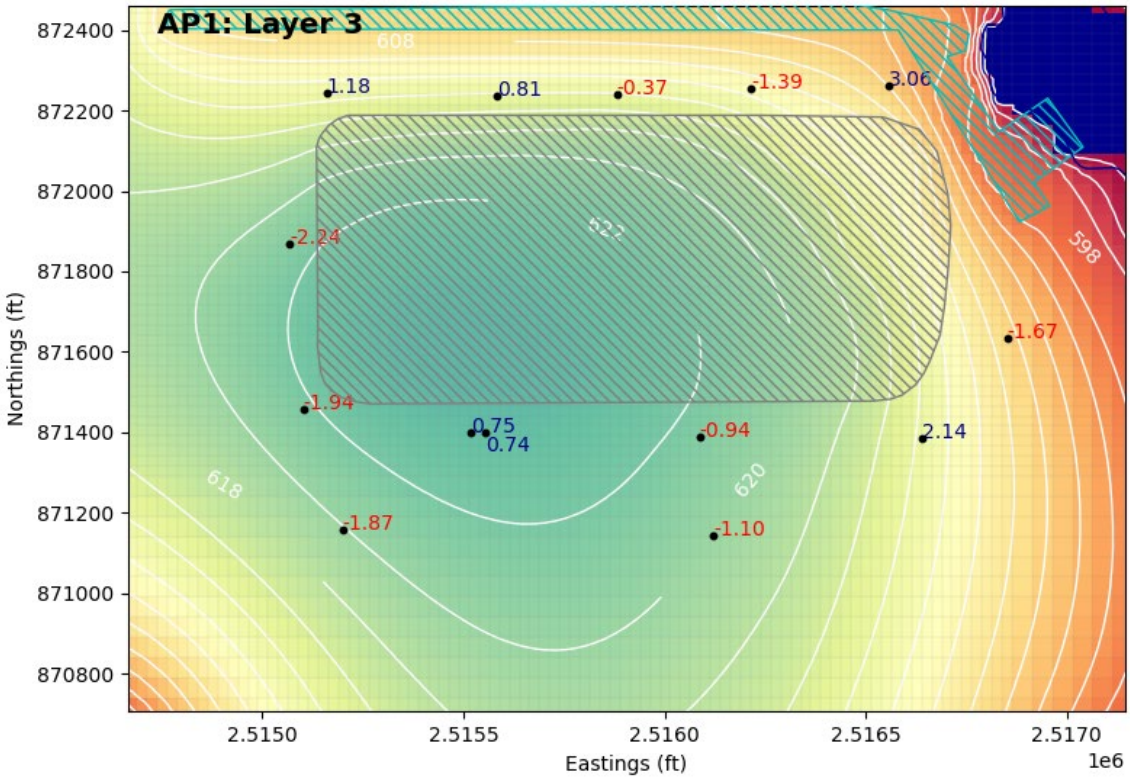
RAMBOLL



SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS FROM UA (LAYER 3) FROM THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

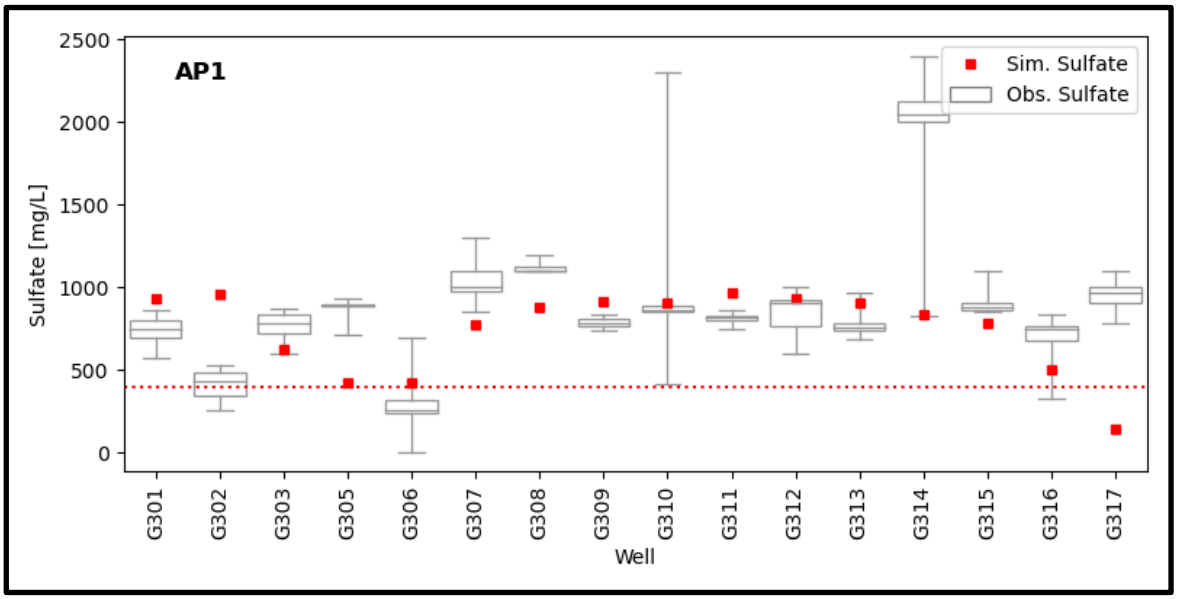
RAMBOLL



SIMULATED STEADY STATE GROUNDWATER LEVEL CONTOURS IN PROXIMITY TO AP1 FROM UA (LAYER 3) FROM THE CALIBRATED MODEL

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

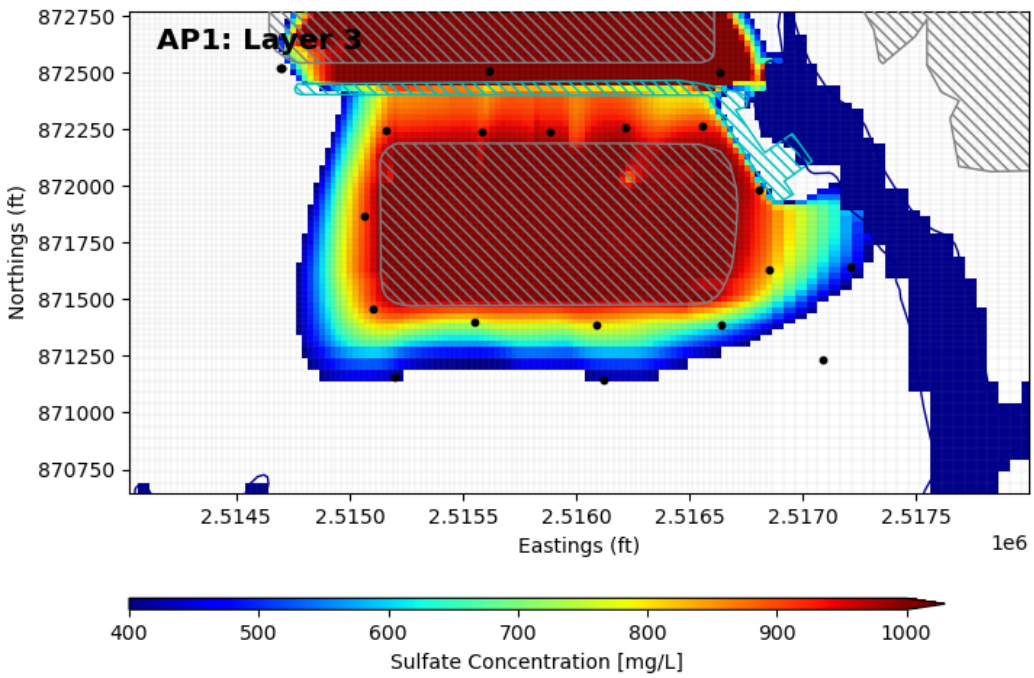
RAMBOLL



OBSERVED VERSUS SIMULATED SULFATE CONCENTRATIONS (mg/L)

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL

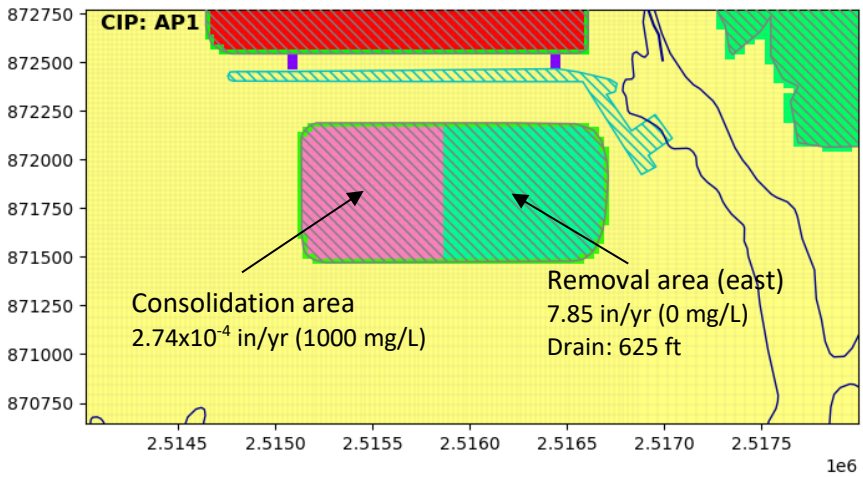


SIMULATED SULFATE PLUME IN THE UA FROM THE TRANSIENT MODEL

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL

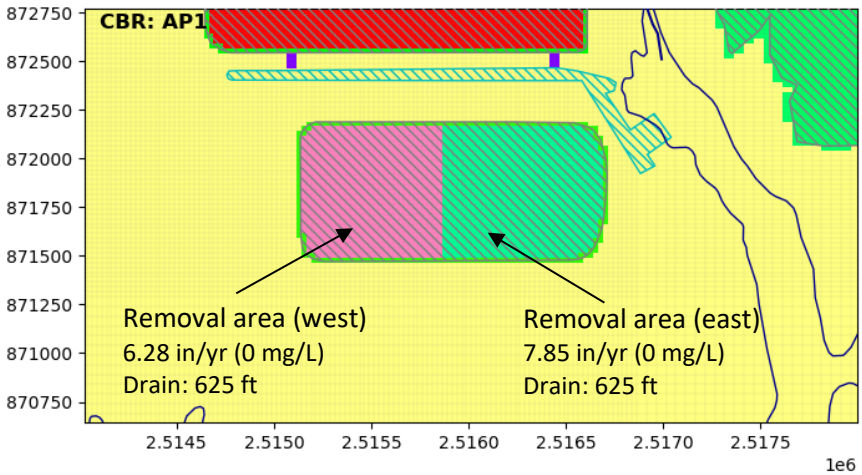
FIGURE 6-1



CIP RECHARGE AND STORMWATER POND MODIFICATIONS

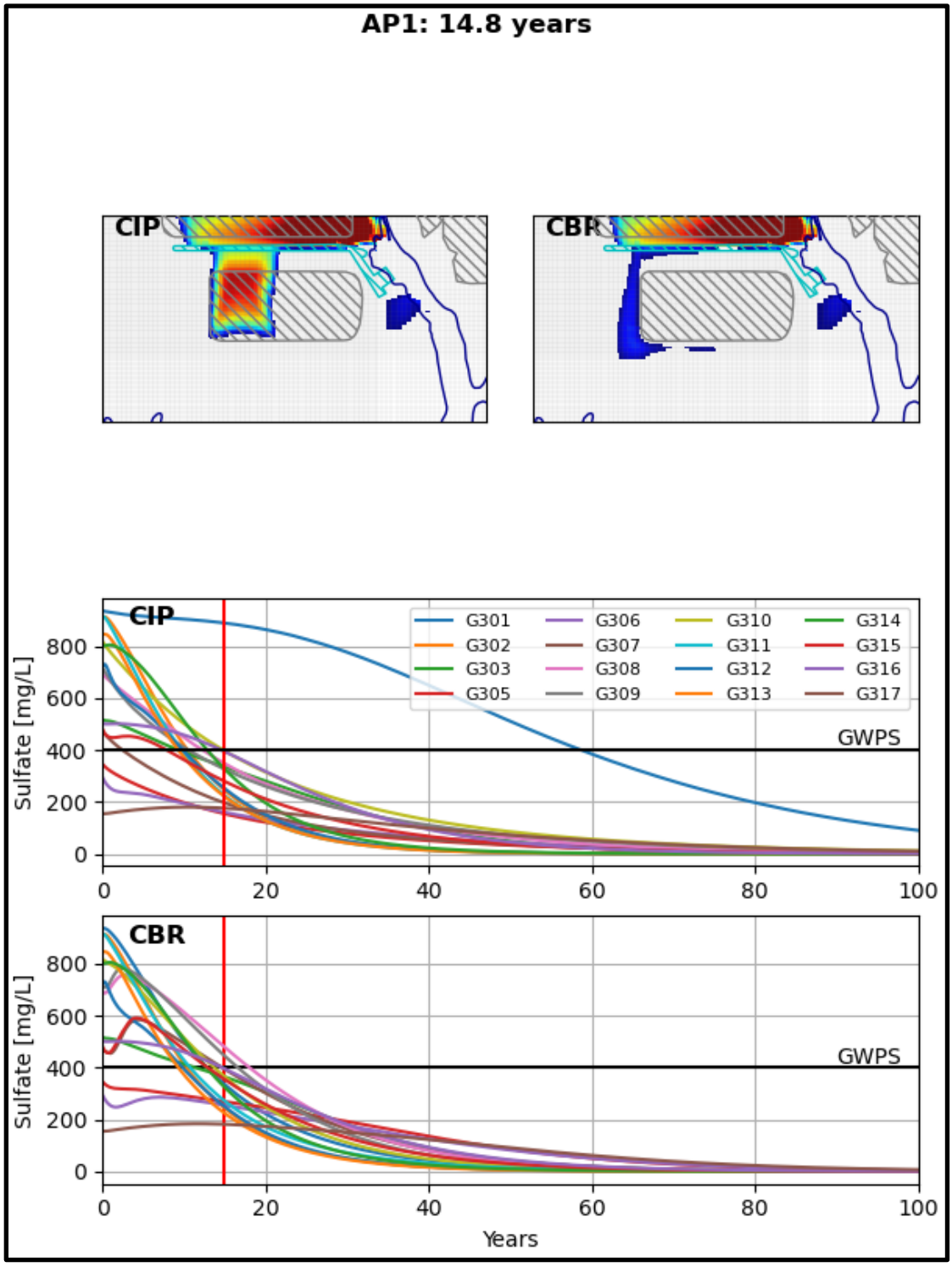
GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL



CBR RECHARGE AND STORMWATER POND MODIFICATIONS

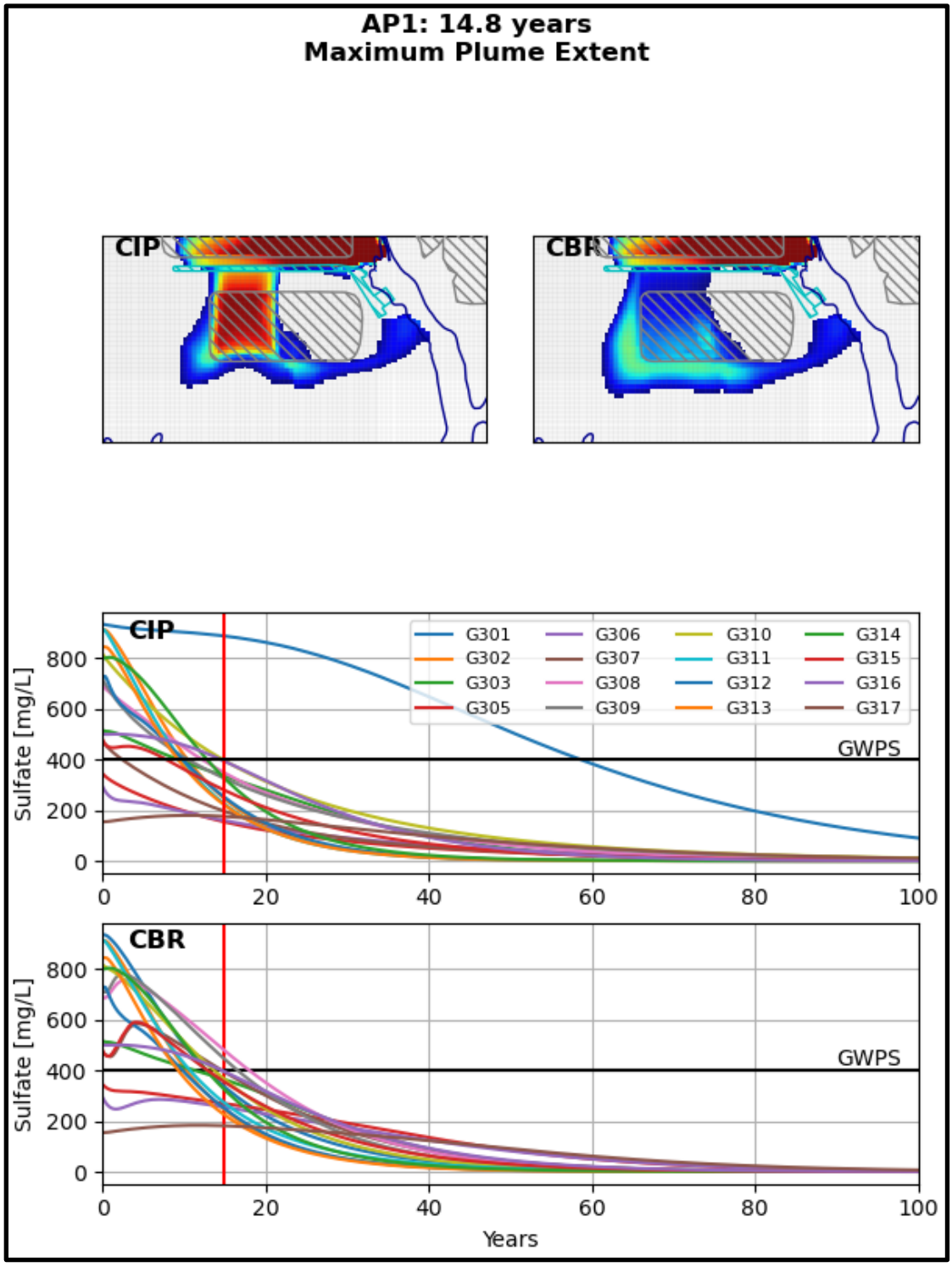
GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS



SIMULATED SULFATE PLUME OF THE UA FOR THE CIP AND CBR SCENARIOS AFTER 14.8 YEARS

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

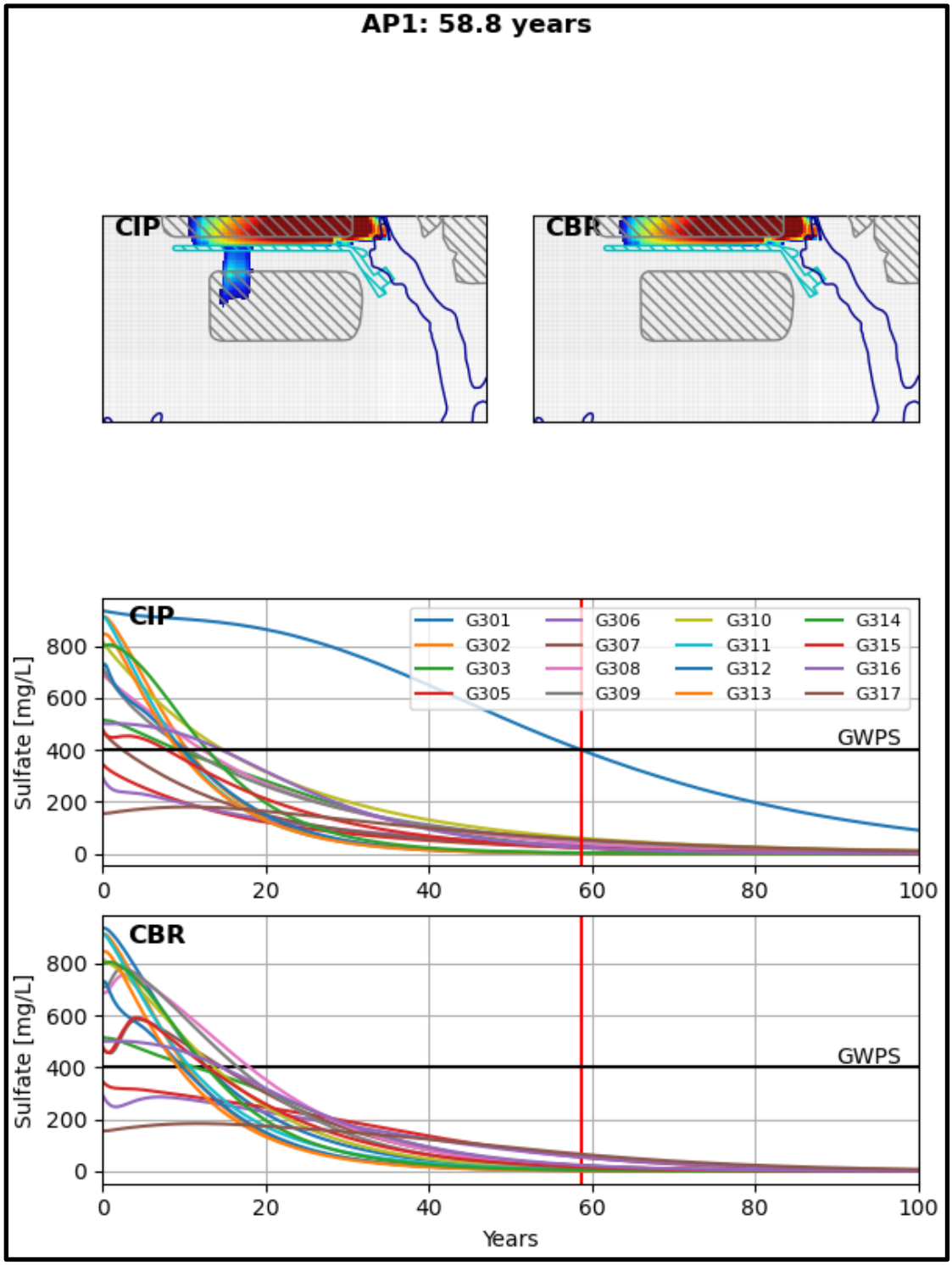
RAMBOLL



SIMULATED MAXIMUM EXTENT OF THE SULFATE PLUME FOR THE CIP AND CBR SCENARIOS AFTER 14.8 YEARS

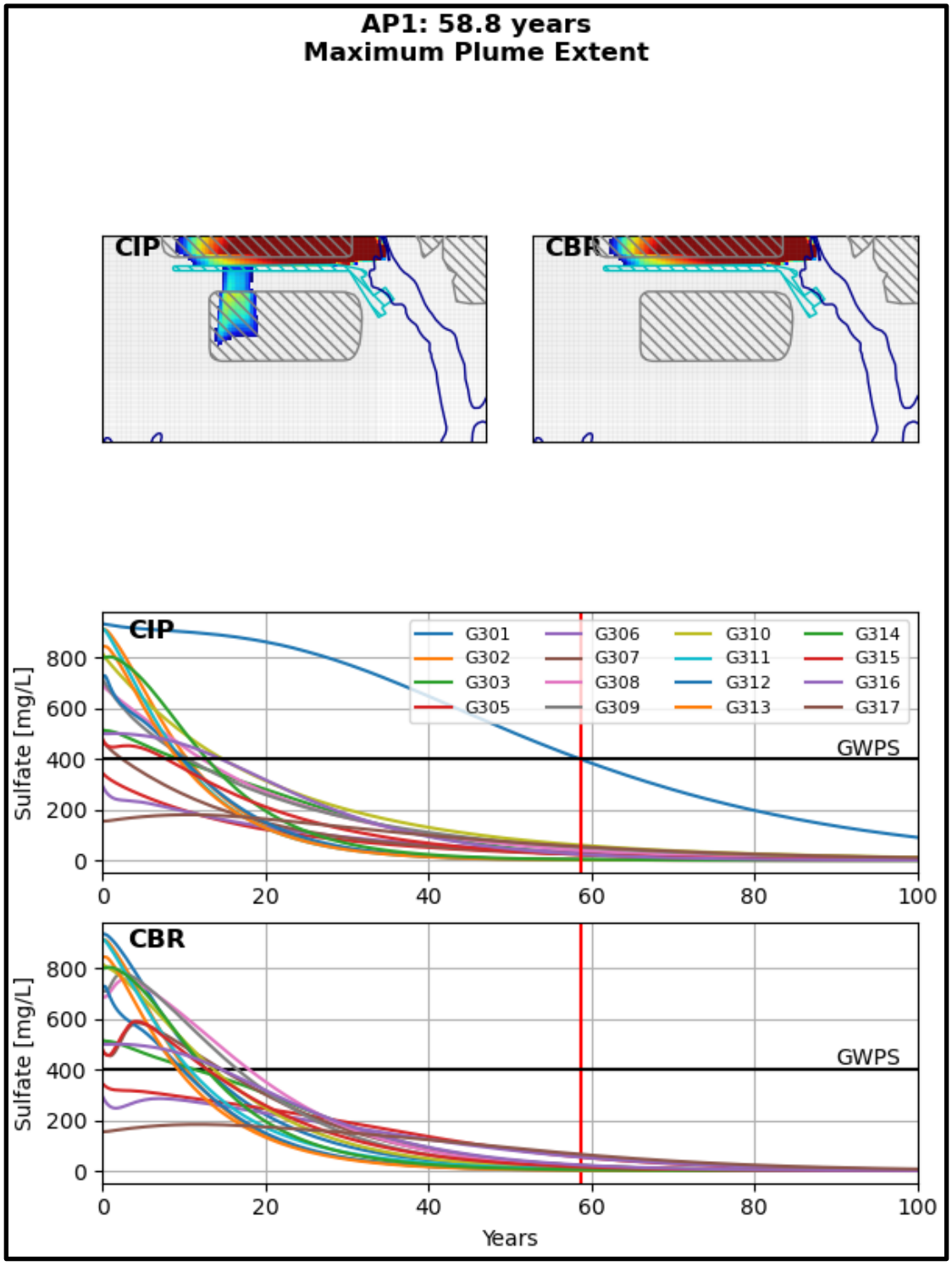
GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL



SIMULATED SULFATE PLUME OF THE UA FOR THE CIP AND CBR SCENARIOS AFTER 58.8 YEARS

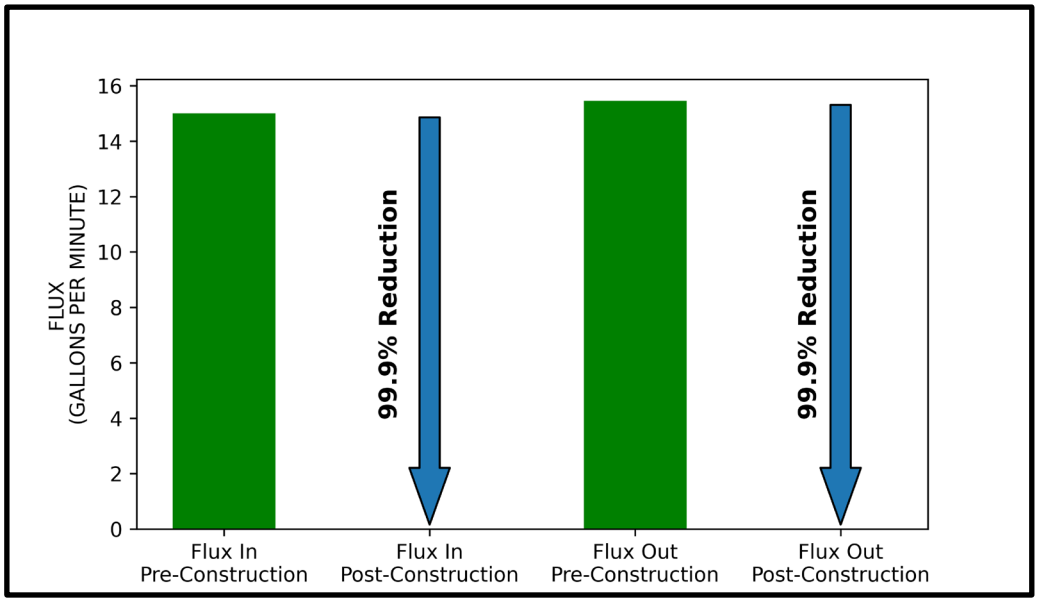
RAMBOLL



SIMULATED MAXIMUM EXTENT OF THE SULFATE PLUME FOR THE CIP AND CBR SCENARIOS AFTER 58.8 YEARS

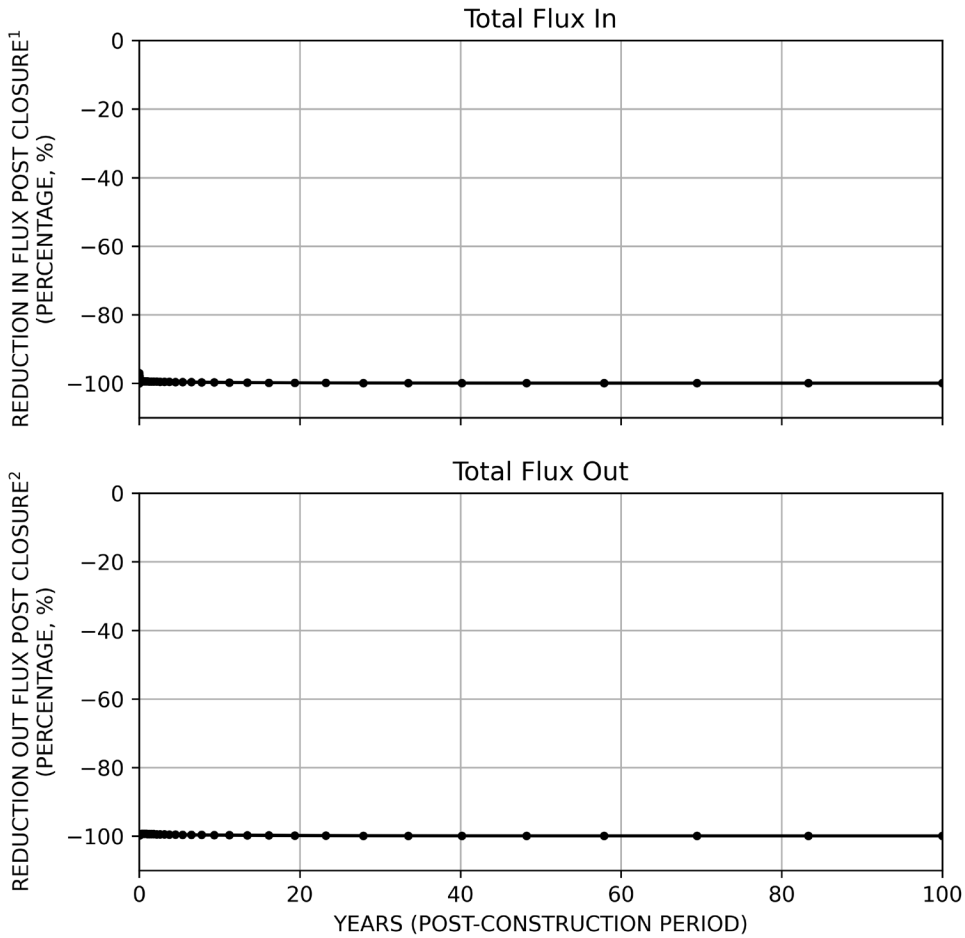
GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL



SCENARIO 1 (CIP) –
HYDRAULIC STEADY STATE REDUCTIONS IN TOTAL FLUX IN AND OUT OF FILL UNIT (CCR)

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS



[1] Reduction in flux in compared to flux in at the end of the calibration model (model period of 42 years). Reduction in flux in are expressed as negative percentages to illustrate decreases in flux over time.

[2] Reduction in flux out compared to flux out at the end of the calibration model (model period of 42 years). Reduction in flux out are expressed as negative percentages to illustrate decreases in flux over time.

SCENARIO 1 (CIP) –
REDUCTIONS IN TOTAL FLUX IN AND OUT OF FILL UNIT (CCR)

GROUNDWATER MODELING REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL

SITE FEATURE

LIMITS OF FINAL COVER

DIFFERENCE BETWEEN BOTTOM OF CCR AND SIMULATED GROUNDWATER SURFACE*
(FEET, POSITIVE VALUES INDICATE SEPARATION)

0 - 5
5.1 - 10
10.1 - 15
15.1 - 20
20.1 - 25
25.1 - 30

0 87.5 175 Feet

*GROUNDWATER SURFACE BASED ON SIMULATED CLOSURE IN PLACE SCENARIO AT HYDRAULIC STABILIZATION.

POTENTIAL ASH SATURATION SIMULATED CLOSURE IN PLACE GROUNDWATER SURFACE

COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 6-9

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APPENDICES

APPENDIX A
EVALUATION OF POTENTIAL GWPS EXCEEDANCES

EVALUATION OF POTENTIAL GROUNDWATER PROTECTION STANDARD EXCEEDANCES

Coffeen Ash Pond No. 1
Coffeen, Illinois

Prepared for

Illinois Power Generating Company

Submitted by

Geosyntec consultants

engineers | scientists | innovators

1 McBride and Son Center Dr Suite 202
Chesterfield, Missouri 63005

July 5, 2022

GLP8029

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Appendix B Figure 1-3: Uppermost Aquifer Groundwater Elevation Contours, April 20, 2021. From Groundwater Monitoring Plan, Ash Pond No. 1, Coffeen Power Plant Report.

LIST OF ACRONYMS AND ABBREVIATIONS

AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CPP	Coffeen Power Plant
DA	Deep Aquifer
DCU	Deep Confining Unit
IPGC	Illinois Power Generation Company
LCU	Lower Confining Unit
mg/L	Milligram per Liter
NID	National Inventory of Dams
ORP	Oxidation-Reduction Potential
QC	Quality Control
SI	Saturation Index
SU	Standard Units
TDS	Total Dissolved Solids
UA	Uppermost Aquifer
UCU	Upper Confining Unit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

SECTION 1

INTRODUCTION

The Illinois Power Generation Company (IPGC) currently operates the Coffeen Power Plant (CPP) and its associated ash ponds. In October 2021, the IPGC submitted an Operating Permit application for the coal combustion residual (CCR) Unit referred to as the Ash Pond Number (No.) 1 (AP1), Vistra identification (ID) No. 101, IEPA ID No. W1350150004-01, and National Inventory of Dams (NID) No. IL50722 (Burns & McDonnell, 2021). The Operating Permit was prepared to comply with Part 845 "Standards of the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845), which was promulgated by the Illinois Pollution Control Board on April 21, 2021. Ramboll Americas Engineer Solutions, Inc. (Ramboll) identified potential groundwater protection standard (GWPS) exceedances for multiple constituents in groundwater samples collected from monitoring wells in the vicinity of AP1, as presented in the Operating Permit Application. This report was developed to further evaluate the potential GWPS exceedances identified.

SECTION 2

BACKGROUND

A brief description of the site location, AP1 design, geology, and groundwater assessment activities to date are described below.

2.1 Site Location and Description

The CPP, operated by the IPGC is located in Montgomery County, Illinois approximately two miles south of the City of Coffeen in Section 11, Township 7 North, and Range 7 East. The CPP is located between the two lobes of Coffeen Lake to the west, east, and south, and is bordered by agricultural land to the north. The CPP operated as a coal-fired power plant from 1964 to November 2019 and has five CCR management units. The approximately 1,100-acre Coffeen Lake was built by damming the McDavid Branch of the East Fork of Shoal Creek in 1963 for use as an artificial cooling lake for the CPP. Historically, coal mines were operated at depth in the vicinity of the CPP as well as a US Minerals processing facility located to the north. Mine shafts, processing facilities, and coal storage associated with these historical operations were located south of AP1.

2.2 Ash Pond 1 Design

Coffeen AP1 is a 23-acre, unlined surface impoundment used to manage CCR and non-CCR waste streams at the CPP. The location of AP1 relative to the proposed monitoring well network is displayed on Figure 2-1 of the Groundwater Monitoring Plan Report (Ramboll, 2021a) and is provided herein as **Appendix A**. AP1 (also known as the Bottom Ash/Recycle Pond) is a reclaimed ash pond that was constructed utilizing the existing earthen berms with reinforcement. AP1 is an unlined surface impoundment which covers an area of approximately 23 acres, has berms up to 41 feet above the surrounding land surface, and a capacity of 300 acre-feet. It primarily received bottom ash and low volume wastes from floor drains in the main power block building. Several years ago, air heater wash and boiler chemical cleaning wastes were directed to AP1, but this practice was discontinued. The bottom ash is periodically removed from AP1 for beneficial uses by a third-party contractor. Sluicing of waste to AP1 ceased prior to November 4, 2019.

2.3 Geology and Hydrogeology

The AP1 geologic and hydrogeologic setting summarized below is excerpted from the Hydrogeologic Site Characterization Report (HCR) for AP1 (Ramboll, 2021b).

There are five principal layers of unlithified material present below AP1 and above bedrock which are categorized into hydrostratigraphic units listed below (from the surface downward) based on stratigraphic relationships and hydrogeologic characteristics:

- **Upper Confining Unit (UCU):** Composed of the Roxana and Peoria Silts (Loess Unit) and the upper clayey portion of the Hagarstown member which are classified as silts-clayey silts and gravelly clay below the surficial soil. The UCU has been eroded east of AP1, near the Unnamed Tributary.

- **Uppermost Aquifer (UA):** The uppermost aquifer is the Hagarstown Member which is classified as primarily sandy-gravelly silts and clays with thin beds of sands. Similar to the Loess Unit, the Hagarstown is absent in some locations near the Unnamed Tributary.

- **Lower Confining Unit (LCU):** Comprised of the Vandalia Member, Mulberry Grove Member, and Smithboro Member. These units include a sandy-silty till with thin, discontinuous sand lenses, a discontinuous and limited extent sandy silt which has infilled prior erosional features, and silty-clayey diamicton, respectively. This unit has been identified as a potential migration pathway (PMP) because downward vertical gradients indicate that there is the potential for impacts to migrate within this unit.

- **Deep Aquifer (DA):** Comprised of sand and sandy silt/clay units of the Yarmouth Soil, which include accretionary deposits of fine sediment and organic materials, typically less than five feet thick and discontinuous across the CPP. This unit is also identified as a PMP, because it is the first permeable unit below the uppermost aquifer.

- **Deep Confining Unit (DCU):** Comprised of the Banner Formation, generally consisting of clays, silts, and sands. The Lierle Clay Member is the upper layer of the Banner Formation which was encountered at the Site.

Bedrock is comprised of the Bond Formation, which consists of limestone and calcareous clays and shale. Bedrock was not encountered in the borings advanced to date at CPP.

Flow of groundwater from central portions of the CPP to Coffeen Lake or the Unnamed Tributary through the UA are the primary pathways for contaminant migration. The LCU and DA underlying the UA have been identified as PMPs. Groundwater elevations are primarily controlled by surface topography, geologic unit topography, and water levels within Coffeen Lake and the Unnamed Tributary. A groundwater divide trending north-south is observed running through the approximate center of the CPP (Figure 1-3 of Ramboll [2021a], provided as **Appendix B**). Phreatic surfaces or water elevations within the surface impoundments are generally consistent and have

not been observed to fluctuate with groundwater elevations, indicating limited hydraulic connection with the surface impoundments.

2.4 Groundwater and AP1 Monitoring

The proposed Part 845 monitoring well network for AP1 was established in the Groundwater Monitoring Plan (Ramboll, 2021a). The proposed monitoring well network consists of sixteen (16) monitoring wells, which are installed in the UA, LCU, DA, and temporary water-level only surface water staff gages. Two of the installed wells are background monitoring wells (G281 and G306) and the remaining fourteen are compliance monitoring wells. Both background wells and most compliance wells are screened within the UA. G307D, G314, and G316 are screened within the LCU, and G314D is screened within the DA. Well locations are shown on **Appendix A**.

SECTION 3
POTENTIAL GROUNDWATER PROTECTION STANDARD EXCEEDANCE REVIEW

An evaluation of the history of potential GWPS exceedances was completed for the Operating Permit application in October 2021 (Burns & McDonnell, 2021). Groundwater concentrations from 2015 to 2021 were evaluated for potential exceedances in accordance with the Statistical Analysis Plan proposed in the Operating Permit application. Potential exceedances are summarized below:

- Boron at monitoring well G313: The boron statistical result at G313 is 3.5 milligrams per liter (mg/L), which exceeds the Part 845 GWPS (3.2 mg/L).

- Cobalt at monitoring well G314: The cobalt statistical result at G314 is 0.00959 mg/L which exceeds the Part 845 GWPS (0.006 mg/L).

- pH (field) at monitoring well G312: The pH statistical result at G312 is 6.4 standard units (SU), which is below the lower limit of the Part 845 GWPS (6.5/9.0 SU).

- Sulfate at monitoring wells G301, G303, G304, G305, G307, G307D, G308, G309, G310, G311, G312, G313, G314, G314D, G315, and G317: The sulfate statistical results ranged from 464 to 1100 mg/L and individually exceed their relevant Part 845 GWPS (400 to 700 mg/L) for the identified wells.

- Total dissolved solids (TDS) at monitoring wells G303, G304, G305, G307, G307D, G308, G309, G310, G311, G312, G313, G314, G315, and G317: The TDS statistical results ranged from 1210 to 1900 mg/L which exceed the Part 845 GWPS (1200 mg/L).

A review of groundwater, porewater, soil, and ash data indicates that the potential exceedances of cobalt at G314 and pH at G312 are not related to AP1, as documented in Section 4. An evaluation of alternative sources of the boron, sulfate, and TDS potential exceedances was not completed at this time.

SECTION 4
LINES OF EVIDENCE

A review of groundwater, porewater, soil, and ash data indicates that the potential GWPS exceedances of cobalt at G314 and the pH value at G312 are not related to AP1, as supported by the lines of evidence (LOE) below:

1. AP1 porewater samples do not contain detectable concentrations of cobalt.
2. Cobalt concentrations in ash samples collected from AP1 are comparable to or lower than cobalt concentrations in soil samples near AP1.
3. Monitoring well G314 has experienced significant changes in oxidation-reduction (redox) conditions since well installation occurred, which may impact cobalt behavior in groundwater.
4. AP1 porewater is slightly basic and would not result in low pH measurements at monitoring well G312.
5. pH values within the proposed monitoring well network are strongly correlated with saturation indices of carbonate minerals in soil near AP1.

4.1 LOE #1: AP1 porewater samples do not contain detectable concentrations of cobalt

Of the three AP1 porewater sampling locations analyzed for cobalt (AP1d, XPW01, and XPW02), none have ever contained cobalt concentrations above the method detection limit of 0.002 mg/L; therefore, cobalt concentrations detected at G314 cannot be derived from a mixing scenario between groundwater and AP1 porewater. In contrast, both background monitoring wells have at times contained cobalt concentrations within the range observed at G314. This indicates that aqueous cobalt is naturally present in groundwater at CPP at variable concentrations.

Figure 1 displays cobalt concentrations over time for G314, background wells G306 and G281, and porewater samples from AP1. Cobalt concentrations at G314 display an increasing trend, but this trend is punctuated by a concentration decrease in the most recent sampling event. The highest values at G314 are comparable to or lower than select results observed at background well G306, suggesting there is variability within the aquifer.

4.2 LOE #2: Cobalt concentrations in ash samples collected from AP1 are comparable to or lower than cobalt concentrations in soil samples near AP1

Soil samples were collected in May 2021 and September 2021 adjacent to select existing monitoring wells and analyzed for total metals. Cobalt concentrations in soil are displayed in **Table 1** along with total cobalt concentrations in ash material collected from AP1. Cobalt concentrations in ash from AP1 (4.3 – 4.8 mg/kg) fall within the range of cobalt concentrations observed in CPP soil (4.0 – 10 mg/kg). Cobalt concentrations in soil are highest at Ash Pond No.2 (AP2) background monitoring well G270, which is in a background location relative to AP1 (**Appendix B**). **Table 1** indicates variability in cobalt concentrations detected in soil across the CPP. Three sample locations (two background locations and one compliance location) contained greater cobalt concentrations than ash samples, indicating that naturally occurring cobalt exists in solid phase across the CPP at equivalent or greater concentrations than within AP1 itself.

4.3 LOE #3: Monitoring well G314 has experienced significant changes in oxidation-reduction (redox) conditions since well installation occurred, which may impact cobalt behavior in groundwater

Groundwater oxidation-reduction potential (ORP) was measured as a field parameter during the sample collection process at monitoring wells in the proposed network. ORP is a measure of the redox conditions of water which, along with other parameters like pH, temperature, and chemical composition, govern the stability of minerals comprising groundwater aquifer solids. ORP values over time at recently installed compliance monitoring wells are displayed on **Figure 2**. ORP values for recently installed wells display a decreasing trend, indicating a shift from highly oxic to near reducing conditions. This decreasing trend is hypothesized to be attributable to stabilization of the new wells following the potential introduction of drilling water involved in the well installation process. Such a change in geochemical conditions can influence the stability of redox-sensitive mineral phases such as iron and manganese oxides. Significantly, decreases in ORP are commonly correlated with dissolution of iron and manganese bearing minerals, leading to the release of ions associated with these mineral phases.

Cobalt is known to undergo isomorphic substitution for iron in crystalline iron minerals such as iron oxides, iron sulfides, and iron carbonates due to the similar ionic radii of approximately 1.56 angstroms (Å) for iron vs. 1.52 Å for cobalt (Clementi and Raimondi, 1963; Krupka and Serne, 2002; Hitzman et al., 2017). Soil samples around AP1 were collected and submitted for mineralogical analysis via X-ray diffraction (XRD) to determine the mineralogical composition of the natural aquifer material. XRD results are shown in **Table 2**. **Table 2** indicates that the majority component of site soils consists of geochemically inert minerals quartz and feldspar (microcline and albite). No iron oxides or iron sulfides were detected in XRD analysis, but iron-bearing carbonate mineral ankerite ($Ca,Fe(CO_3)_2$) was detected at a maximum abundance of 7.7 wt.%.

An Eh-pH diagram displaying the thermodynamic stability of iron phases was generated using the average composition of G314 groundwater (**Figure 3**). Geochemical conditions during initial sampling events favored thermodynamic stability of the ferric (Fe^{3+}) iron hydroxide mineral $Fe(OH)_3$; however, no iron hydroxide or oxide minerals were present in XRD results above the detection limit of 0.5%. **Figure 3** indicates G314 groundwater conditions have shifted in recent sampling events, favoring the formation of ferrous (Fe^{2+}) carbonate mineral siderite ($FeCO_3$). The modeled shift of thermodynamic stability away from iron hydroxide and oxide minerals and towards iron carbonates would result in the release of iron and isomorphically substituted cobalt into groundwater through mineral dissolution reactions.

While siderite was not detected in the XRD results, iron-bearing carbonate mineral ankerite was detected at abundances of up to 7.7 wt.%. Ankerite exists in nature as a solid-solution mineral without a fixed mineral formula. As a result, accurate thermodynamic information is not available for modeling purposes and ankerite was consequently not included in the thermodynamic database used to generate **Figure 3**. It is likely that ankerite thermodynamic stability is favored over siderite stability at G314 and the ankerite detected in XRD analyses is a product of the formation of carbonate minerals in an iron-rich environment.

Naturally occurring cobalt is known to substitute for iron in iron-bearing minerals. Thermodynamic modeling indicates that a recent trend in redox conditions has resulted in a mineral stability shift from iron hydroxides and oxides towards iron carbonates. The presence of ankerite, an iron-bearing carbonate mineral, has been confirmed across the site. The modeled dissolution of iron hydroxide and oxide minerals may have resulted in isomorphically substituted cobalt being released from the crystal structure of these minerals and entering groundwater. The presence of observed iron carbonate minerals in soil samples supports the occurrence of this mineralogical shift.

4.4 LOE #4: AP1 porewater is slightly basic and would not result in low pH measurements at monitoring well G312

Groundwater pH conditions were measured as a field parameter during the sample collection process at monitoring wells within the proposed monitoring well network. A time series plot of field pH measurements at G312, background wells G281 and G306, and AP1 porewater monitoring locations XPW-01 and XPW-02 is provided as **Figure 4**. Groundwater at monitoring well G312 contains pH levels below the calculated lower GWPS for pH of 6.5 SU. Low pH values at G312 cannot be attributed to AP1, because AP1 porewater samples are consistently slightly basic (pH values range from 7.78-8.08). Physical mixing of AP1 porewater with G312 groundwater would result in an increase in pH at G312. In contrast, pH values at background well G306 were occasionally measured at 6.5 SU, which is within the range of measurements observed

at G312. Therefore, low pH conditions at G312 are attributable to natural variability within the aquifer.

4.5 LOE #5: pH values within the proposed monitoring well network are strongly correlated with saturation indices of carbonate minerals in soil near AP1

As mentioned in Section 4.3, composite soil samples from various locations surrounding AP1 were collected and submitted for mineral identification analysis via XRD (**Table 2**). Soil surrounding AP1 contains variable abundances of carbonate minerals such as calcite, dolomite, and ankerite, with the total abundance of carbonates at each location ranging an order of magnitude from 2.7-27.5 wt.%. Carbonate minerals in nature function as pH buffers, capable of neutralizing acidity through reaction with carbonate (CO_3) (Drever, 1988). pH levels at individual wells may be significantly influenced by the presence and abundance of carbonate minerals comprising localized sections of the aquifer unit. Although soil samples were not collected for all wells of interest, carbonate saturation indices (SIs) provide a method to assess the role of carbonate minerals in soil buffering capacity in the absence of XRD results.

United States Geologic Survey (USGS) software package PHREEQC was used to calculate SIs of carbonate minerals at G312 and background wells G281 and G306 based on groundwater compositions. A mineral's SI is an expression of its thermodynamic equilibrium state relative to a liquid (groundwater). If the calculated SI for a mineral is negative, then that mineral is undersaturated relative to groundwater and is thermodynamically favored to dissolve. If the calculated SI for a mineral is positive, then that mineral is supersaturated relative to groundwater and is thermodynamically favored to precipitate. If a mineral's SI is approximately 0 (+\- 0.2), then the mineral is in thermodynamic equilibrium with groundwater. SIs for calcite ($CaCO_3$) and dolomite ($Ca,Mg(CO_3)_2$) were plotted against pH for individual samples (**Figure 5**). **Figure 5** demonstrates a strong positive correlation between pH and carbonate SI. pH values tend to be lower in groundwater that is undersaturated with respect to carbonate minerals. This relationship is expected – monitoring wells which favor carbonate dissolution are likely to contain less carbonate in the solid phase. Absence of carbonate in localized portions of the aquifer results in the inability of these locations to buffer low pH groundwater. According to **Figure 5**, background wells G281 and G306 are near equilibrium or supersaturated with respect to carbonate minerals and are likely to have these minerals present and stable. These wells would then have greater capability to buffer acidic water and retain near-neutral pH values. G312 was not sampled for mineralogy, although **Figure 5** demonstrates that groundwater from this well is undersaturated with respect to carbonate minerals, suggesting that large abundances of carbonate are not likely to be present in aquifer solids at this location.

XRD analyses indicate carbonate mineral abundances around AP1 vary up to an order of magnitude (**Table 2**). Evaluation of carbonate SIs reveals that a strong correlation exists between

carbonate SIs and pH. G312 is undersaturated with respect to calcite and dolomite; therefore, these minerals are likely not present as pH buffers, resulting in lower groundwater pH values where acid neutralizing minerals are not available.

SECTION 5

CONCLUSIONS

Based on these five LOEs, it has been demonstrated that AP1 is not the source of the potential cobalt and pH exceedances identified.

1. AP1 porewater samples do not contain detectable concentrations of cobalt, whereas cobalt concentrations in background well G306 occasionally exceed the relevant GWPS.

2. Cobalt concentrations in ash samples collected from AP1 are comparable to or lower than cobalt concentrations in soil samples from downgradient and background monitoring wells.

3. Monitoring well G314 has experienced significant changes in oxidation-reduction (redox) conditions since well installation occurred, which may cause destabilization of iron-bearing minerals capable of hosting cobalt ions in their crystal structure.

4. AP1 porewater is slightly basic and would not result in low pH measurements at monitoring well G312.

5. pH values within the proposed monitoring well network are strongly correlated with saturation indices of carbonate minerals which are detected at variable abundances across soil near AP1.

SECTION 6

REFERENCES

Burns & McDonnell. 2021. Initial Operating Permit – Coffeen Ash Pond No. 1. October.

Clementi, E., and Raimdoni, D. L. 1963. Atomic screening constants from SCF functions. *J. Chem. Phys.,* 38, 2686.

Drever, J. 1988. *The Geochemistry of Natural Waters*. Englewood Cliffs, N.J: Prentice Hall.

Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.

Krupka, K.M. and Serne, R.J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.

Ramboll. 2021a. Groundwater Monitoring Plan, Ash Pond No.1, Coffeen Power Plant, Coffeen, Illinois. October.

Ramboll. 2021b. Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois. October.

TABLES

Table 1: Cobalt Concentrations in Soil and Ash
Coffeen Power Plant - Ash Pond No. 1

Sample Location	Description	Sample Depth (feet)	Cobalt (mg/kg)
G270	Background	16-20	10
G306	Background	14-16	6.0
G311	Compliance	14-15	4.0
G313	Compliance	8-9	7.0
G316	Compliance	13-16	4.0
XPW01	Ash Pond 1	NA	4.8
XPW02	Ash Pond 1	NA	4.3

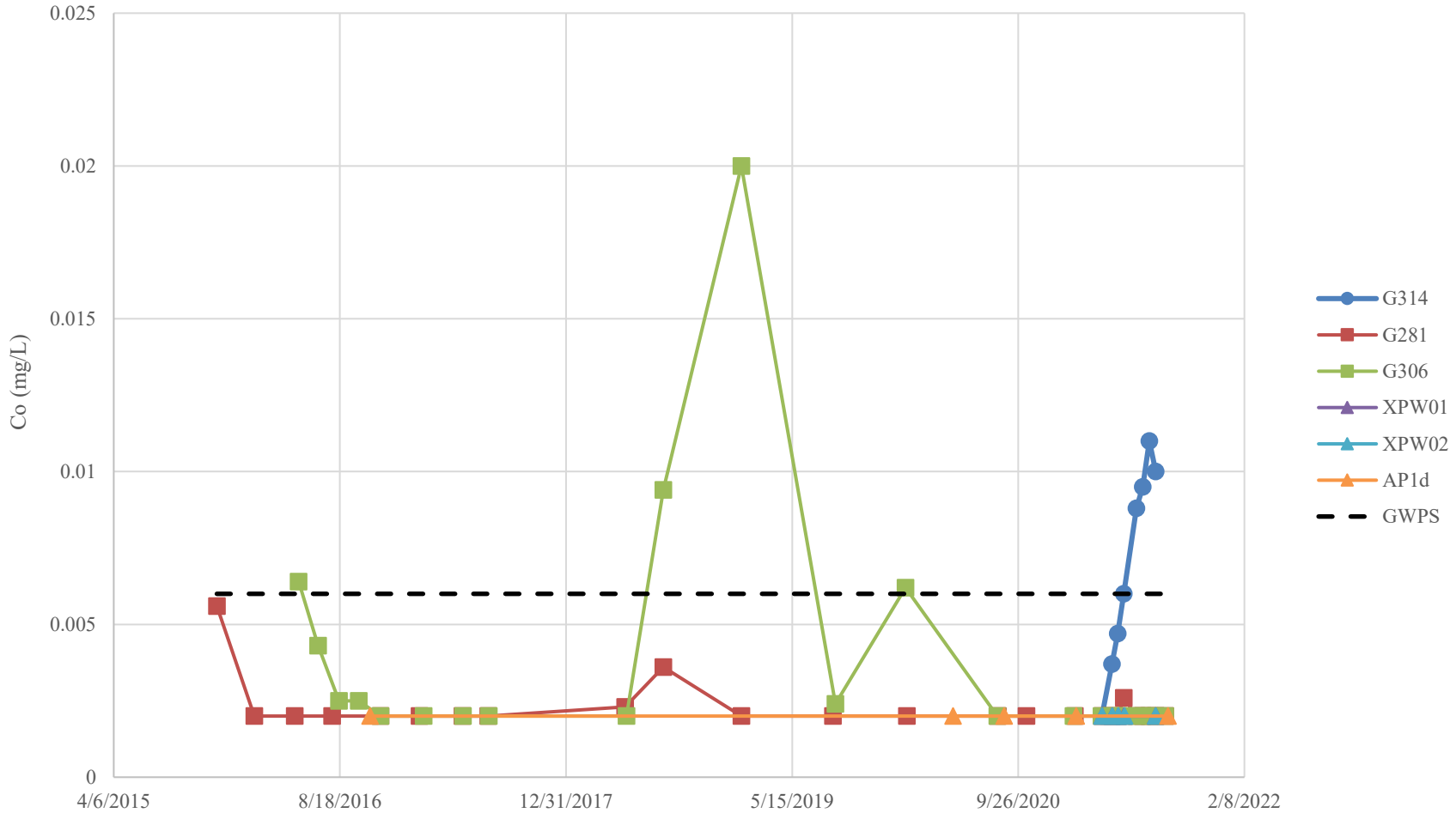
Notes:
Soil samples were composite samples collected over the indicated depth range

Table 2: Summary of X-ray Diffraction Results *Geosyntec Consultants, Inc.*
Coffeen Power Plant - Ash Pond No. 1

Sample ID	**SB-306**	**SB-311**	**SB-313**	**SB-316**
Sample Depth (ft.) / **Mineral**	14-16	14-15	8-9	13-16
Quartz	70.9	58.9	51.3	67.6
Microcline	8.5	7.4	7.6	9.8
Albite	9.6	8.6	7.9	9.6
Chlorite	1.8	1.7	1.1	1.7
Diopside	3.1	3.8	4.6	1.3
Muscovite	-	-	-	7.3
Carbonate Minerals				
Calcite	0.5	2.5	4.1	-
Dolomite	3.5	12.1	15.7	1.9
Ankerite	2.1	5	7.7	0.8
Carbonate Total	*6.1*	*19.6*	*27.5*	*2.7*

Notes:
Results presented in units of weight %
- : Mineral was not detected in sample
Weight % quantities have been normalized to a sum of 100% to remove reporting of amorphous material
Carbonate total consists of calcite, dolomite, and ankerite

FIGURES



Notes: Data displayed for compliance well G314, background wells G281 and G306, and pore water samples XPW01, XPW02, and AP1d. The calculated Groundwater Protection Standard (GWPS) is indicated by the dashed line. Samples which did not contain cobalt concentrations above the method detection limit of 0.002 mg/L are displayed on the figure as having a detected concentration of 0.002 mg/L.

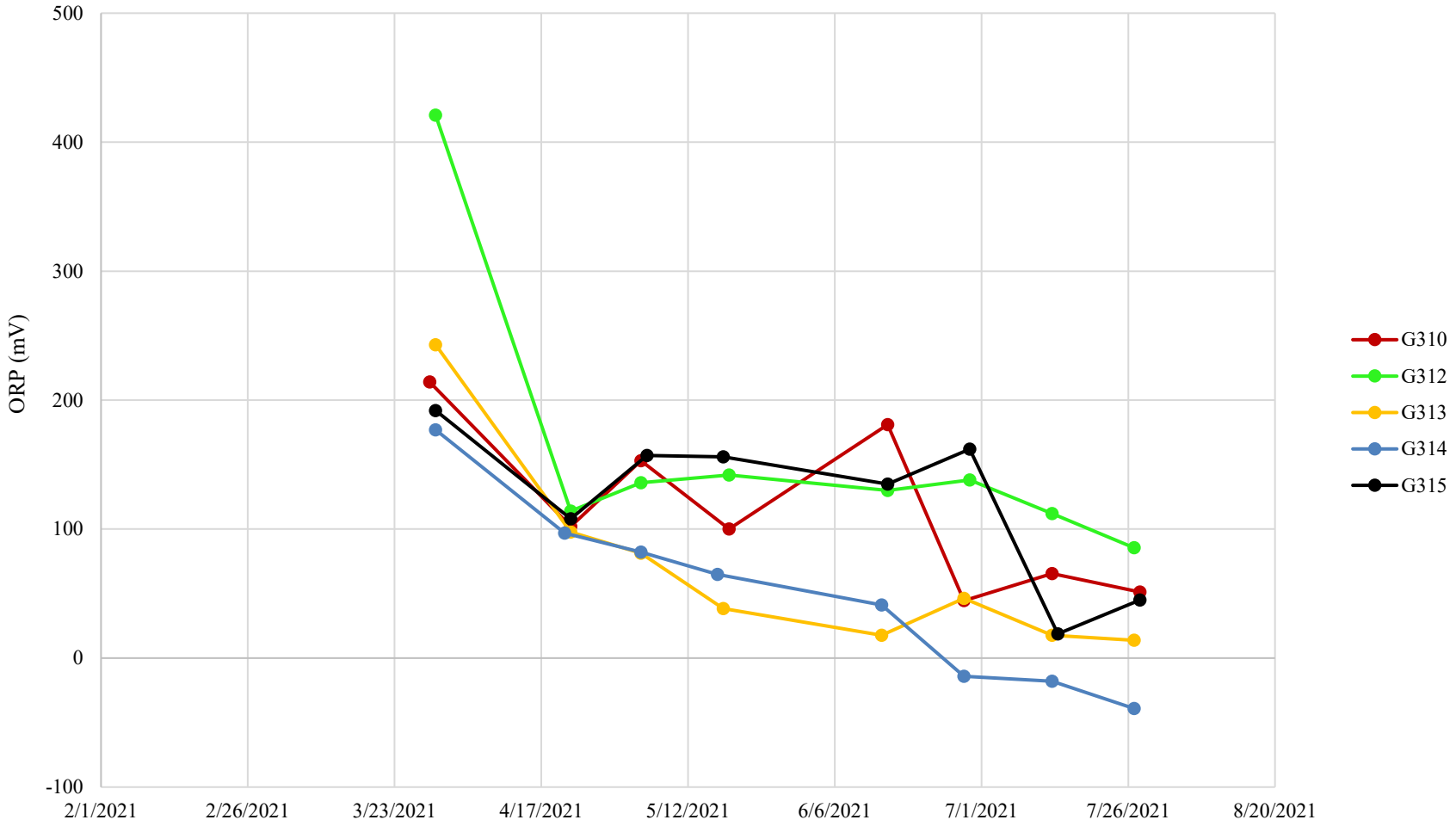
Aqueous Cobalt Time Series

Coffeen Power Plant

Geosyntec consultants

Columbus, OH | April 2022

Figure 1



Notes: Groundwater monitoring began at all wells displayed in March 2021. Positive ORP values are considered indicative of oxic environments, and negative ORP values are considered indicative of anoxic environments.

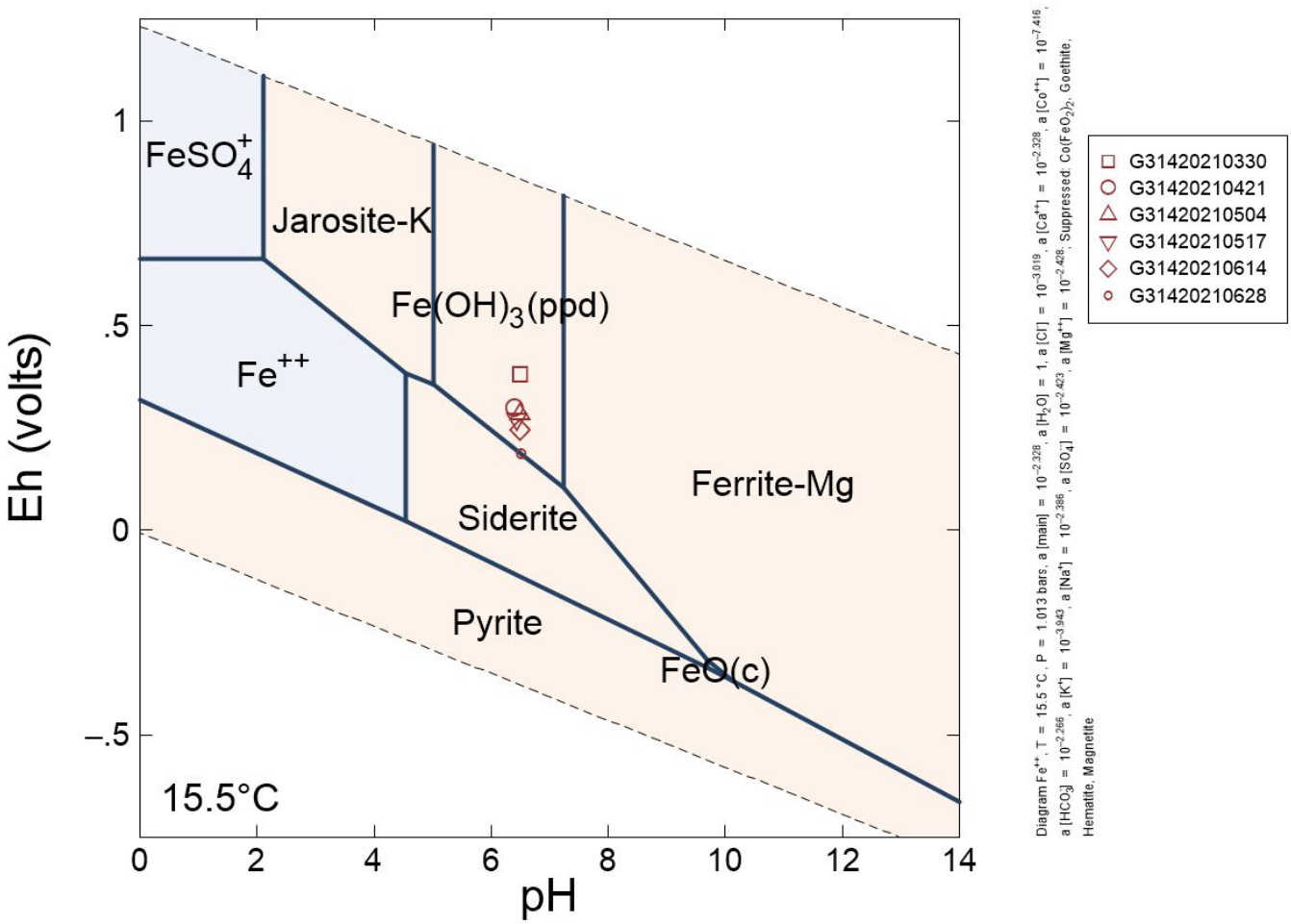
Oxidation-Reduction Potential (ORP) Time Series – Recently Installed Wells

Coffeen Power Plant

Geosyntec consultants

Columbus, OH | April 2022

Figure **2**



Notes: The average groundwater composition of compliance monitoring well G314 was used to establish baseline conditions for the diagram. Eh and pH values for sampling dates at G314 are shown on the diagram. Fe-oxide phases hematite, goethite, and magnetite were suppressed to reflect detected mineralogy from XRD analysis.

G314 Eh-pH Diagram - Iron

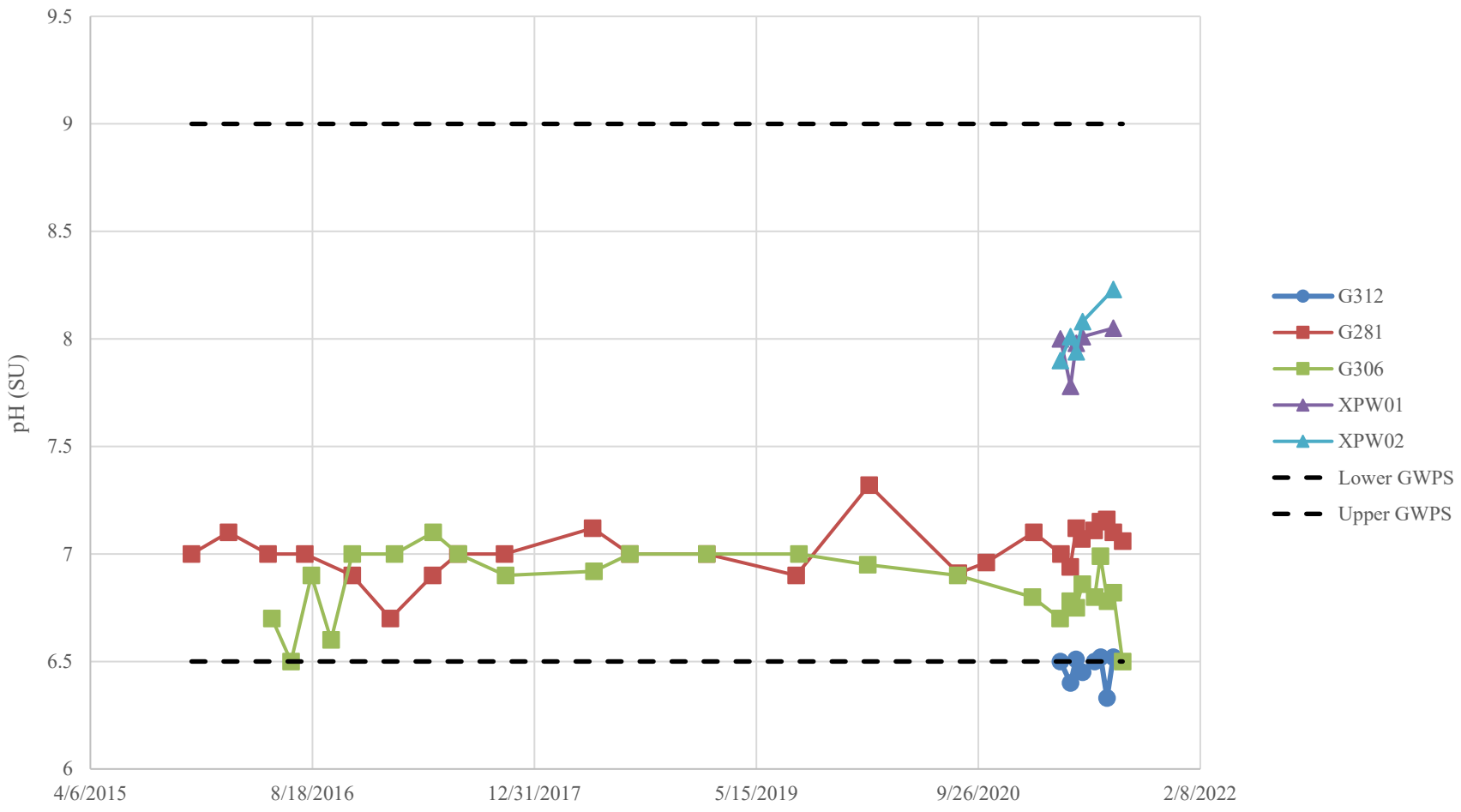
Coffeen Power Plant

Geosyntec consultants

Columbus, Ohio | April 2022

Figure 3

internal info: path, date revised, author



Notes: Data displayed for compliance well G312, background wells G281 and G306, and pore water samples XPW01 and XPW02. The calculated GWPS for the upper and lower pH values are indicated by dashed lines.

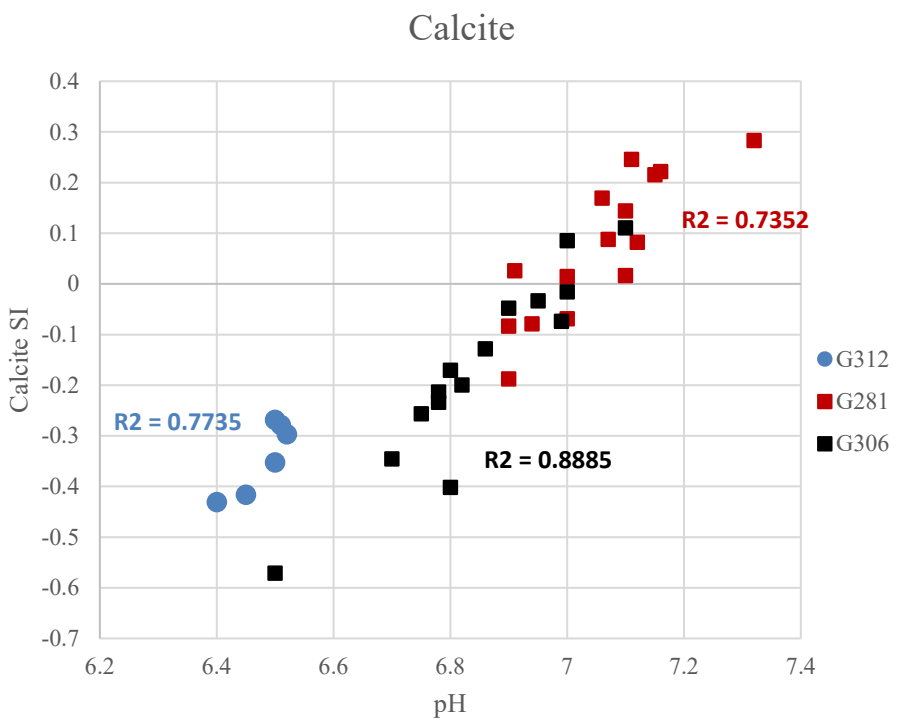
pH Time Series

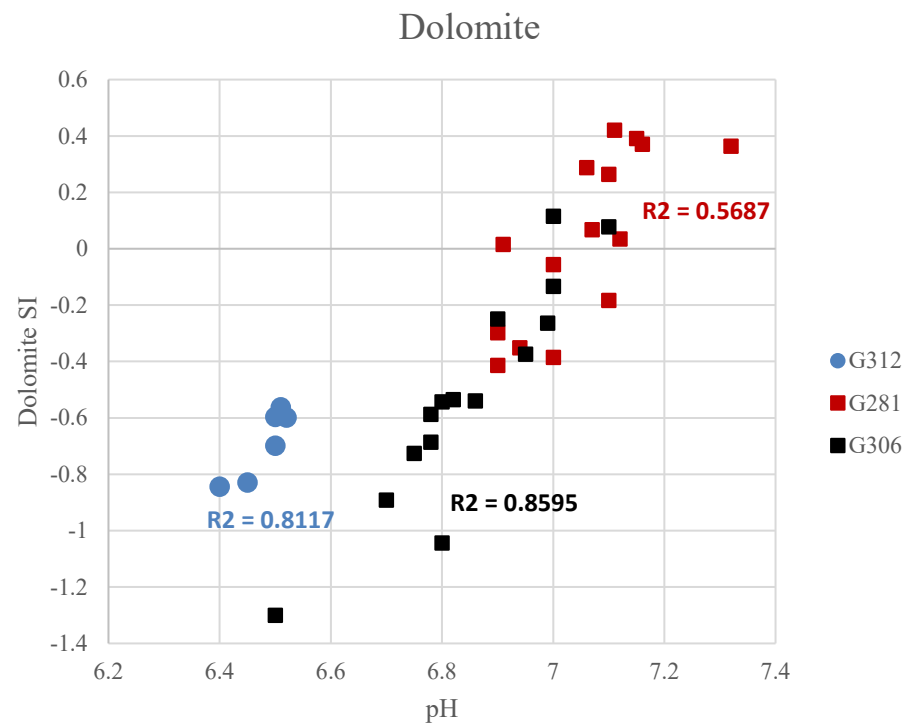
Coffeen Power Plant

Geosyntec consultants

Columbus, OH | April 2022

Figure **4**





Notes: Saturation indices (SIs) were calculated using PHREEQC based on groundwater composition and geochemical characteristics. R^2 values for linear trendlines for each individual well are displayed.

pH vs. Carbonate Saturation Indices

Coffeen Power Plant

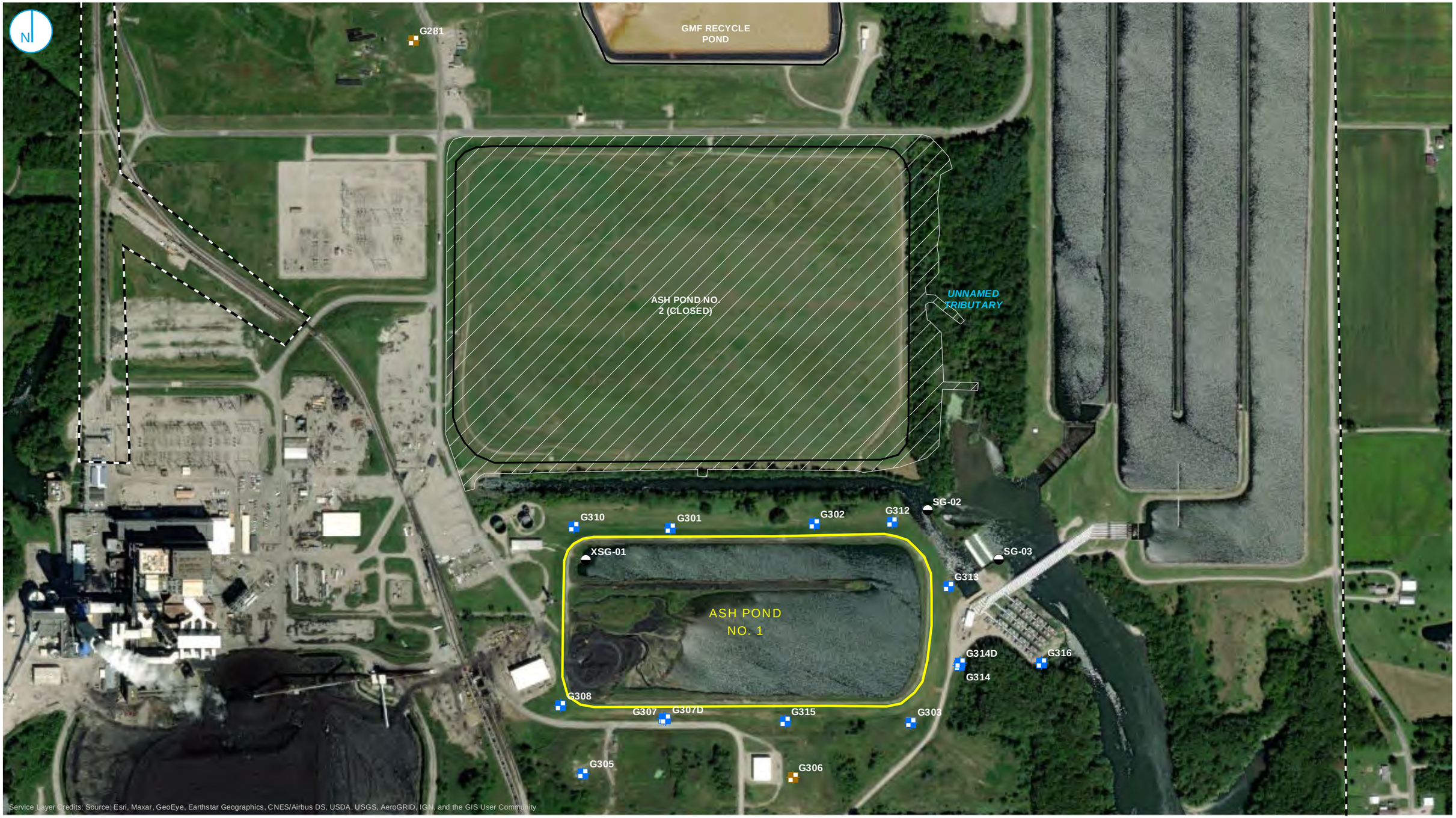
Geosyntec consultants

Columbus, OH | April 2022

Figure 5

APPENDIX A

Figure 2-1: Proposed 845 Groundwater Monitoring Well Network. From Groundwater Monitoring Plan, Ash Pond No. 1, Coffeen Power Plant



Y:\Mapping\Projects\22\2285\MXD\845_Operating_PermitCoffeen\AP1\GMP\Figure 2-1_Proposed Monitoring Well Network.mxd

PROJECT: 169000XXXX | DATED: 10/12/2021 | DESIGNER: HOTCALD

COMPLIANCE WELL
BACKGROUND WELL
STAFF GAGE

PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400 Feet

PROPOSED 845 GROUNDWATER MONITORING WELL NETWORK

GROUNDWATER MONITORING PLAN
ASH POND NO.1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

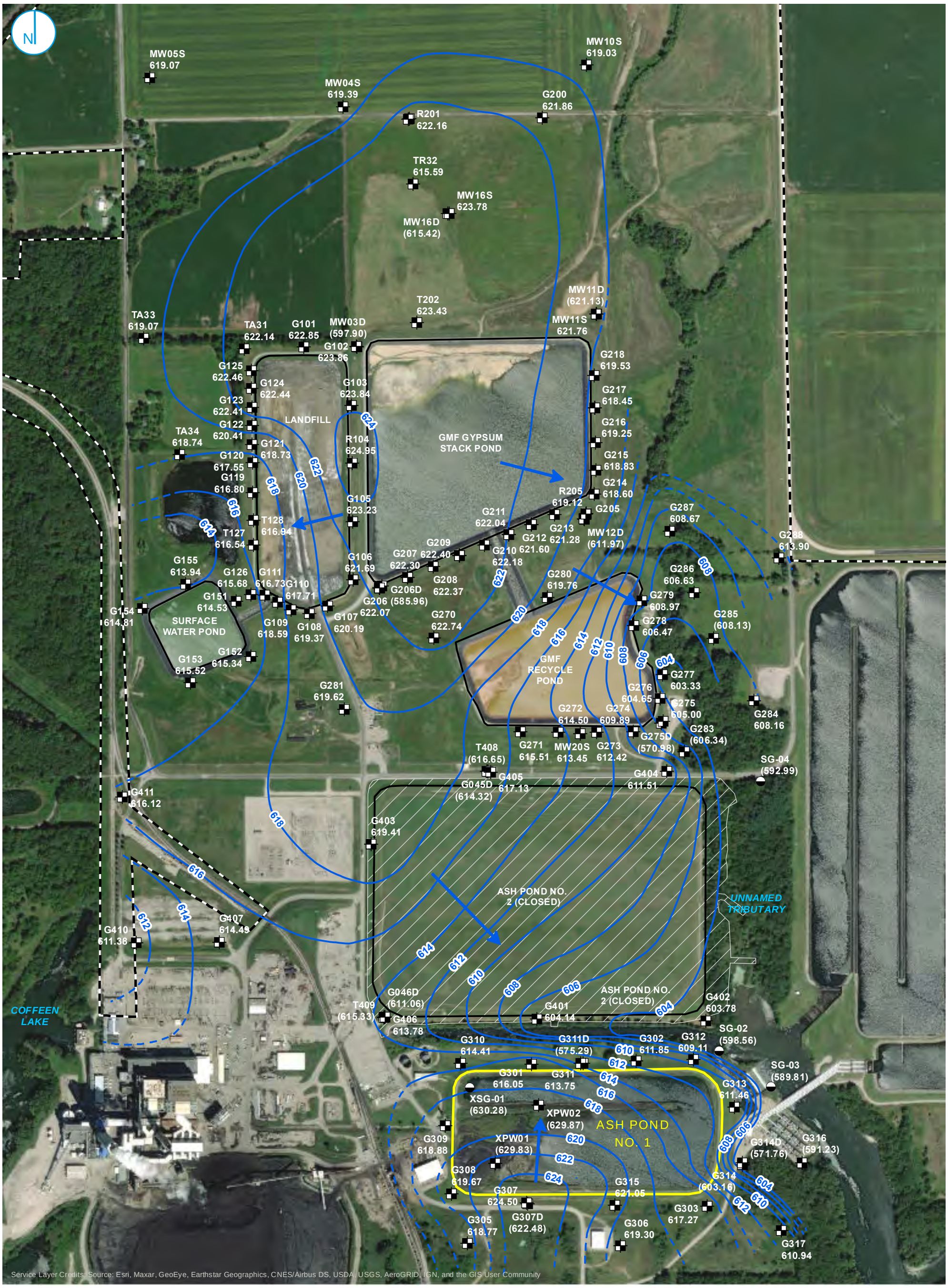
FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

APPENDIX B

Figure 1-3: Uppermost Aquifer Groundwater Elevation Contours, April 20, 2021. From Groundwater Monitoring Plan, Ash Pond No. 1, Coffeen Power Plant



MONITORING WELL
STAFF GAGE
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION

0 275 550 Feet

NOTE:
ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS APRIL 20, 2021

GROUNDWATER MONITORING PLAN
ASH POND NO.1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 1-3

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

APPENDIX B
MODFLOW, MT3DMS, HELP MODEL, AND FLUX EVALUATION DATA EXPORT FILES (ELECTRONIC ONLY)

APPENDIX C
EVALUATION OF PARTITION COEFFICIENT RESULTS

Geosyntec consultants

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Memorandum

Date:	July 5, 2022
To:	David Mitchell, Stu Cravens, Vic Modeer Illinois Power Generating Company
Copies to:	Brian Hennings - Ramboll
From:	Allison Kreinberg, Ryan Fimmen – Geosyntec Consultants, Inc.
Subject:	Evaluation of Partition Coefficient Results – Coffeen Ash Pond No. 1 CCR Unit 101, Coffeen Power Plant, Coffeen, Illinois

INTRODUCTION

The Illinois Power Generation Company (IPGC) currently operates the Coffeen Power Plant (CPP) and its associated ash ponds located in Coffeen, Illinois. Ash Pond Number (No.) 1 (AP1) (Vistra identification (ID) No. 101; Illinois Environmental Protection Agency [IEPA] ID No. W1350150004-01; National Inventory of Dams [NID] No. IL50722) is a 23-acre, unlined SI used to manage CCR (bottom ash) and non-CCR waste streams at the CPP in accordance with the plant's Water Pollution Control Permit 1978-EA-389 issued by the Agency on May 26, 1978. Geosyntec Consultants (Geosyntec) is assisting IPGC with Part 845 compliance at the Site.

IPGC is currently preparing a Construction Permit application for AP1 as required under Section 845.220. As part of the Construction Permit application, groundwater modeling is being completed for known potential exceedances of groundwater protection standards (GWPS) identified in the Operating Permit (Burns & McDonnell, 2021). In the Operating Permit (October 2021), Burns & McDonnell identified potential GWPS exceedances for several compounds potentially associated with AP1, including boron, cobalt, pH (field), sulfate, and total dissolved solids (TDS). An evaluation of potential exceedances of applicable GWPS found that both cobalt and pH potential exceedances are not related to AP1 (Geosyntec, 2022). Batch adsorption testing was conducted for boron and sulfate to generate site-specific partition coefficients. This technical memorandum summarizes the results of the batch adsorption testing and calculation of partition coefficients.

BATCH ATTENUATION TESTING

In 2021, Geosyntec conducted a field investigation at AP1 which included completion of four (4) soil/rock borings ranging in depth from 13 to 18 feet below ground surface. As part of that investigation, soil and groundwater samples were submitted to SiREM Laboratories (Guelph, ON) for batch solid/liquid partitioning testing. A summary of the soil samples used for the batch testing is provided in **Table 1**.

Two groundwater samples (G311 and G313) and three soil samples (SB-306, SB-311, and SB-313) were used for batch attenuation testing at five (5) soil:solution ratios (**Table 1**), each ran in duplicate. For each treatment, 0.1 L of groundwater was brought into contact with varying amounts of soil (0.004 to 0.2 kg, depending on the ratio) and equilibrated over a seven-day period. Each microcosm was amended (i.e., spiked) with sodium sulfate (Na_2SO_4), and the microcosms with G313 groundwater were also amended with boric acid (H_3BO_3), to achieve a target concentration of sulfate and boron, respectively (**Table 2**). The G311 microcosm was not amended with boric acid because potential boron exceedances were not identified in the vicinity of G311. G313 groundwater was combined with aquifer solids both adjacent to downgradient location G311 and background location G306 to understand how partitioning behavior may be affected by position relative to AP1.

An initial sample of the stock solution for each experimental design was collected on Day 0, and a control sample (i.e., only amended G311 or G313 groundwater with no aquifer solids) was collected on Day 7 after tumbling in polypropylene bottleware to evaluate any loss to interactions with the bottleware or ambient conditions. Duplicates were constructed for each microcosm, including the control samples. After seven days of contact time, an aliquot of the free liquid was collected and filtered through a 0.45 micron (µm) filter prior to analysis for dissolved concentrations of sulfate and/or boron. The oxidation/reduction potential (redox) and pH were measured for each batch test at the beginning and end of the contact period and in the control samples.

Data obtained from the tests (**Tables 3** and **4**) were used to construct isotherms for boron and sulfate; 5-point isotherms were constructed by averaging duplicate results for each soil:solution ratio. Mathematical fitting was used to calculate the attenuation distribution coefficients (K_d), assuming linear adsorption. The linear adsorption equation was used:

$$q_e = K_d \times C_e \qquad \text{Eq. 1}$$

where q_e is the mass of constituent adsorbed to the solid phase at equilibrium, C_e is the remaining aqueous constituent concentration at equilibrium, and K_d is the linear sorption coefficient (reported in liters per kilogram [L/kg]). Some of the data showed a deviation from a linear trend, and so were also fitted using non-linear isotherms. The non-linear Langmuir isotherm was used:

$$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \qquad \text{Eq. 2}$$

where q_m is the inverse of the slope and K_L is the Langmuir distribution coefficient. The adsorption data were linearized according to:

$$\frac{C_e}{q_e} = \frac{1}{(K_L \times q_m)} + \frac{C_e}{q_m} \qquad \text{Eq. 3}$$

A common non-linear Freundlich equation was also used:

$$q_e = K_F (C_e)^{1/n} \qquad \text{Eq. 4}$$

where q_e is the mass of constituent adsorbed to the solid phase at equilibrium, C_e is the remaining aqueous constituent concentration at equilibrium, K_F is the Freundlich distribution coefficient, and $1/n$ is a non-linearity constant. The adsorption data were plotted as log-transformed values to perform the non-linear isotherm fitting using the linearized Freundlich equation:

$$log(q_e) = \log(K_F) + (1/n)\log(C_e) \qquad \text{Eq. 5}$$

The calculated linear, Langmuir, and Freundlich distribution coefficients (K_d, K_L, and K_F, respectively) and $1/n$ values are shown in **Tables 5** and **6**.

SUMMARY OF RESULTS

The partition coefficient values for G311 and G313 (denoted below as G313/SB-306 when combined with SB-306 geologic material and G313/SB-313 when combined with the SB-313 geologic material) are presented in **Tables 5** and **6**, respectively. Figures which show the linear, Langmuir, and Freundlich isotherms for boron and sulfate are provided in **Appendix A**.

A boron partition coefficient was not calculated for G311, since the microcosm was not amended with boric acid because potential boron exceedances were not identified in the vicinity. The Freundlich isotherm fit the data best for G313/SB-306 and G313/SB-313, yielding K_F values of 0.65 L/kg and 2.03 L/kg, respectively. Though slightly higher at G313/SB-313, these values are comparable to boron partition coefficients reported in the literature, which range from 0.19 to 1.3 L/kg depending on pH conditions and the amount of sorbent present (EPRI, 2005; Strenge & Peterson, 1989).

The G311 partition coefficient for sulfate ranged from -624 L/kg for the Langmuir isotherm to 10.11 L/kg for the linear isotherm, but the best-fitting Freundlich isotherm yielded a low K_F value of 9.2×10^{-12} L/kg. None of the isotherms showed a high goodness-of-fit (i.e., R^2) for either G313/SB-306 or G313/SB-313, with the highest correlation being 0.51, and were associated with erroneously high (1700 L/kg) and low (-690 L/kg) partition coefficients. An accurate sulfate

partition coefficient could therefore not be calculated from any of the data. These results are consistent with the findings of Strenge and Peterson (1989), who found that partition coefficients for sulfate are 0.0 L/kg, regardless of pH conditions and the amount of sorbent present.

REFERENCES

EPRI, 2005. *Chemical constituents in coal combustion product leachate: boron. Final Report 1005258.*

Burns & McDonnell. 2021. Initial Operating Permit Coffeen GMF Recycle Pond. October

Strenge, D. and Peterson, S. 1989. Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS) (No. PNL-7145). Pacific Northwest National Laboratory, Richland, WA (USA).

Geosyntec. 2022. Evaluation of Potential Groundwater Protection Standard Exceedances. Coffeen Ash Pond No. 1. Coffeen, Illinois. May

TABLES

Table 1 - Batch Attenuation Testing Data Summary
Coffeen AP1

Geosyntec Consultants

Groundwater Sample ID	Soil Sample ID	Soil: Water Ratio
G311	SB-311 (14-15 ft bgs)	2:1.4
		1:1.3
		1:5.7
		1:11.3
		1:27.8
G313	SB-306 (14-16 ft bgs)	2:1.5
		1:1.3
		1:6.0
		1:11.7
		1:28.8
G313	SB-313 (8-9 ft bgs)	2:1.5
		1:1.3
		1:6.0
		1:11.7
		1:28.8

Notes:

ft bgs = feet below ground surface

Table 2 - Microcosm Amendment and Target Concentrations
Coffeen AP1

Groundwater Sample ID	Soil Sample ID	Compound	Amendment	Target Concentration (mg/L)
G311	SB-311 (14-15 ft bgs)	Boron	--	--
		Sulfate	2.76 g of Na_2SO_4	1500
G313	SB-306 (14-16 ft bgs)	Boron	19.73 mL of a 2 g/L H_3BO_3	5
		Sulfate	1.98 g of Na_2SO_4	1500
G313	SB-313 (8-9 ft bgs)	Boron	19.73 mL of a 2 g/L H_3BO_3	5
		Sulfate	1.98 g of Na_2SO_4	1500

Notes:
ft bgs - feet below ground surface
mg/L - milligrams per liter
Na_2SO_4 - sodium sulfate
H_3BO_3 - boric acid

Table 3 - Batch Attenuation Testing Results, G311
Coffeen AP1

Groundwater Sample ID	Geologic Material Sample ID	Treatment	Date	Day	Replicate	Dissolved Sulfate	pH	ORP
						mg/L	SU	mV
G311	--	Groundwater Only Control	25-Jan-22	0	G311-1a	1,589	6.83	-62
					G311-2a	1,826	6.88	-66
					Average Concentration (mg/L)	**1,708**	**6.86**	**-64**
			1-Feb-22	7	G311-1	1,617	6.85	42
					G311-2	1,478	6.85	38
					Average Concentration (mg/L)	**1,548**	**6.85**	**40**
	G311 SB-311 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 2:1-1	1,321	6.92	50
					SB-311:G311 2:1-2	1,302	6.86	100
					Average Concentration (mg/L)	**1,311**	**6.89**	**75**
		1:1 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:1-1	1,727	6.92	51
					SB-311:G311 1:1-2	860	6.88	24
					Average Concentration (mg/L)	**1,294**	**6.90**	**38**
		1:5 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:5-1	1,326	6.87	93
					SB-311:G311 1:5-2	1,516	6.88	56
					Average Concentration (mg/L)	**1,421**	**6.88**	**75**
		1:10 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:10-1	1,570	6.89	27
					SB-311:G311 1:10-2	1,551	6.86	133
					Average Concentration (mg/L)	**1,560**	**6.88**	**80**
		1:20 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:20-1	1,511	6.88	88
					SB-311:G311 1:20-2	1,588	6.86	39
					Average Concentration (mg/L)	**1,550**	**6.87**	**64**

Notes:
mg/L - milligrams per liter
mV - millivolts
SU - Standard Units
ORP - oxidation/reduction potential

Table 4 - Batch Attenuation Testing Results, G313
Coffeen AP1

Groundwater Sample ID	Geologic Material Sample ID	Treatment	Date	Day	Replicate	Dissolved Boron	Dissolved Sulfate	pH	ORP
						mg/L	mg/L	SU	mV
G313	--	Groundwater Only Control	25-Jan-22	0	G313-1a	6.5	1,372	6.98	-60
					G313-2a	6.7	1,473	6.98	-21
					Average Concentration (mg/L)	**6.6**	**1,423**	**6.98**	**-41**
			1-Feb-22	7	G313-1	6.3	1,158	6.98	113
					G313-2	6.2	1,058	6.97	40
					Average Concentration (mg/L)	**6.2**	**1,108**	**6.98**	**77**
	G313 SB-306 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 2:1-1	4.5	884	6.95	46
					SB-306:G313 2:1-2	4.7	779	6.95	44
					Average Concentration (mg/L)	**4.6**	**831**	**6.95**	**45**
		1:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:1-1	5.3	1,049	6.94	75
					SB-306:G313 1:1-2	5.3	976	6.93	44
					Average Concentration (mg/L)	**5.3**	**1,012**	**6.94**	**60**
		1:5 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:5-1	5.8	243	6.95	80
					SB-306:G313 1:5-2	6.1	1,005	6.96	-5
					Average Concentration (mg/L)	**5.9**	**624**	**6.96**	**38**
		1:10 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:10-1	6.1	958	6.96	203
					SB-306:G313 1:10-2	6.1	832	6.97	90
					Average Concentration (mg/L)	**6.1**	**895**	**6.97**	**147**
		1:20 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:20-1	6.0	881	6.96	39
					SB-306:G313 1:20-2	6.0	1,409	6.94	81
					Average Concentration (mg/L)	**6.0**	**1,145**	**6.95**	**60**
	G313 SB-313 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 2:1-1	4.3	852	6.96	164
					SB-313:G313 2:1-2	4.6	900	6.93	143
					Average Concentration (mg/L)	**4.5**	**876**	**6.95**	**154**
		1:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:1-1	4.9	482	6.99	78
					SB-313:G313 1:1-2	5.0	1,000	6.95	39
					Average Concentration (mg/L)	**4.9**	**741**	**6.97**	**59**
		1:5 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:5-1	6.0	1,227	6.96	23
					SB-313:G313 1:5-2	6.2	837	6.97	25
					Average Concentration (mg/L)	**6.1**	**1,032**	**6.97**	**24**
		1:10 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:10-1	6.0	1,459	6.97	63
					SB-313:G313 1:10-2	5.8	2,105	6.98	85
					Average Concentration (mg/L)	**5.9**	**1,782**	**6.98**	**74**
		1:20 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:20-1	5.8	1,000	6.96	125
					SB-313:G313 1:20-2	6.0	1,043	6.97	47
					Average Concentration (mg/L)	**5.9**	**1,022**	**6.97**	**86**

Notes:

mg/L - milligrams per liter
mV - millivolts
SU - Standard Units
ORP - oxidation/reduction potential

Table 5 - Partition Coefficient Results, G311
Coffeen AP1

Analyte	Isotherm	Variable	Value
Sulfate	Linear	R^2	0.61
		K_D (L/kg)	10.11
	Langmuir	R^2	0.65
		q_m (mg/g)	-0.10
		K_L (L/kg)	-6.24E+02
	Freundlich	R^2	0.78
		1/n	10.27
		K_F (L/kg)	9.20E-12

Notes:

K_D - linear partition coefficient

K_L - Langmuir partition coefficient

K_F - Freundlich partition coefficient

q_m - inverse of the slope of the linearized Langmuir isotherm

n - non-linearity constant of the Freundlich isotherm

Table 6 - Partition Coefficient Results, G313
Coffeen AP1

Materials	Analyte	Isotherm	Variable	Value
G313/SB-306	Boron	Linear	R^2	0.37
			K_D (L/kg)	6.13
		Langmuir	R^2	0.76
			q_m (mg/g)	0.00
			K_L (L/kg)	-1.51E+05
		Freundlich	R^2	0.64
			1/n	6.65
			K_F (L/kg)	6.50E-01
	Sulfate	Linear	R^2	0.05
			K_D (L/kg)	3.97
		Langmuir	R^2	0.01
			q_m (mg/g)	2.20
			K_L (L/kg)	1.19E+03
		Freundlich	R^2	0.00
			1/n	-0.06
			K_F (L/kg)	1.70E+03
G313/SB-313	Boron	Linear	R^2	0.24
			K_D (L/kg)	5.68
		Langmuir	R^2	0.50
			q_m (mg/g)	0.00
			K_L (L/kg)	-1.43E+05
		Freundlich	R^2	0.46
			1/n	5.25
			K_F (L/kg)	2.03E+00
	Sulfate	Linear	R^2	0.21
			K_D (L/kg)	-6.50
		Langmuir	R^2	0.51
			q_m (mg/g)	-0.66
			K_L (L/kg)	-6.91E+02
		Freundlich	R^2	--
			1/n	--
			K_F (L/kg)	--

Notes:

The Freundlich isotherm was not calculated for G313/SB-313 because the data were not conducive to log transformation

K_D - linear partition coefficient

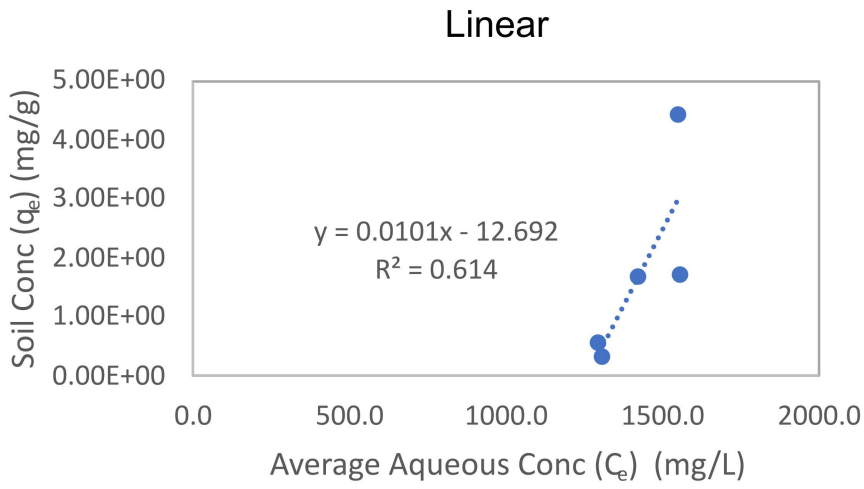
K_L - Langmuir partition coefficient

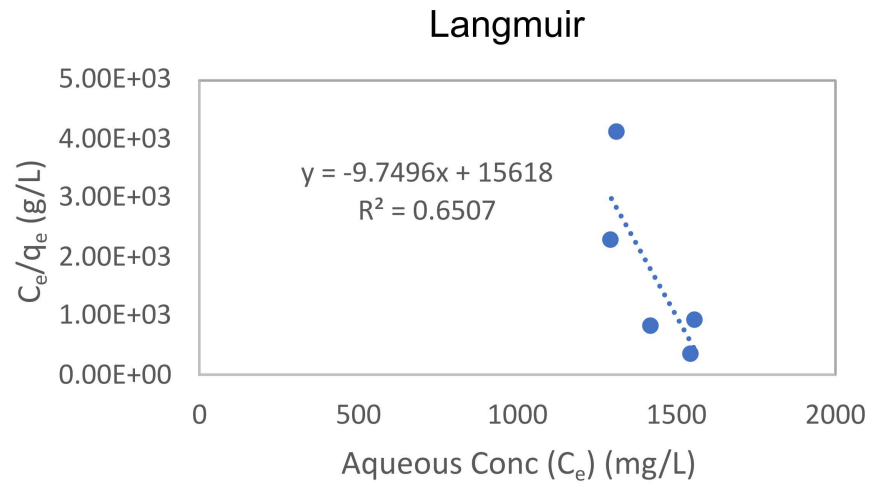
K_F - Freundlich partition coefficient

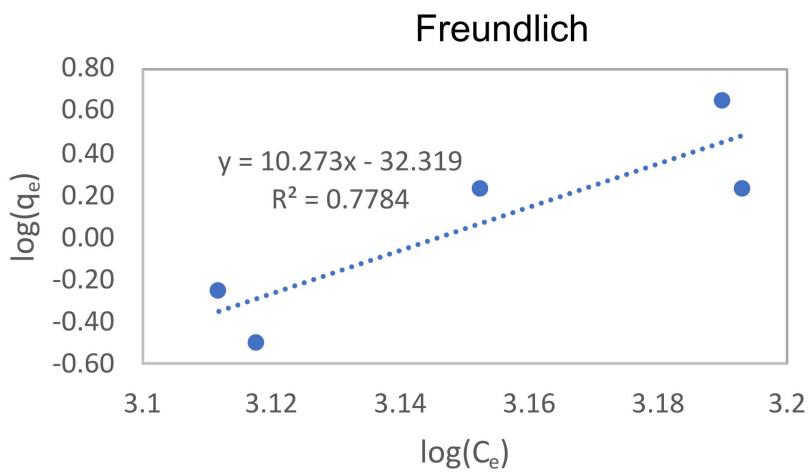
q_m - inverse of the slope of the linearized Langmuir isotherm

n - non-linearity constant of the Freundlich isotherm

APPENDIX A
BATCH TESTING ISOTHERM PLOTS







Notes:
q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G311 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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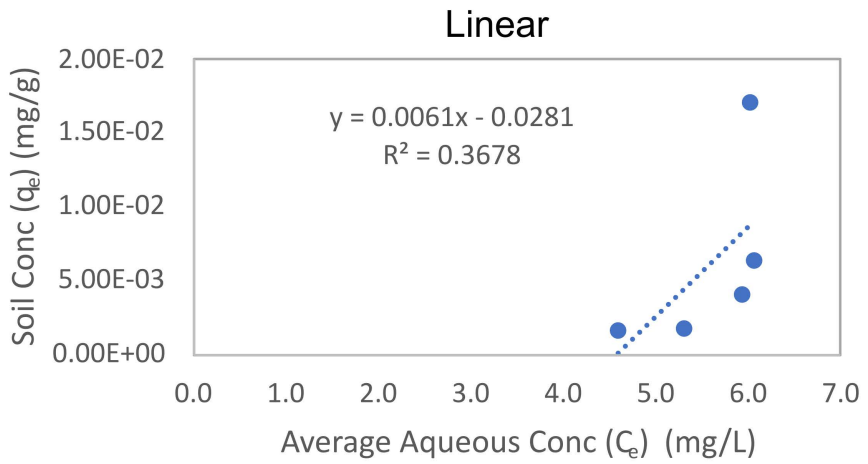
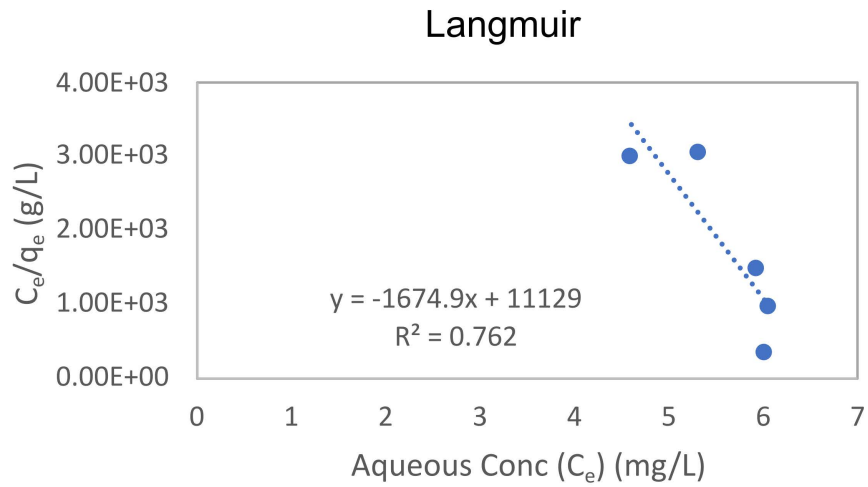
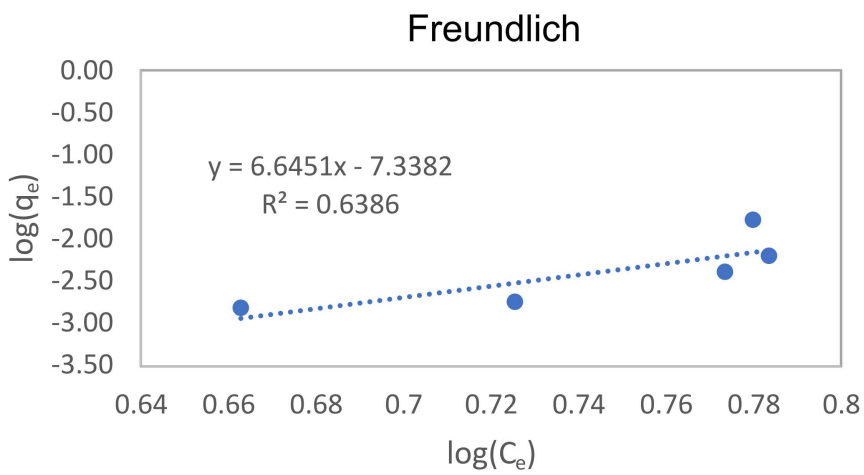
Columbus, OH | May 2022

Figure 1







Notes:

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-306 Boron Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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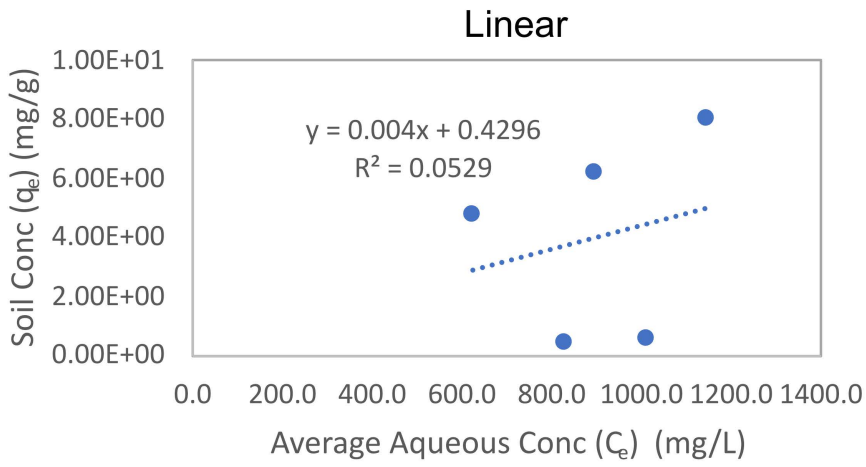
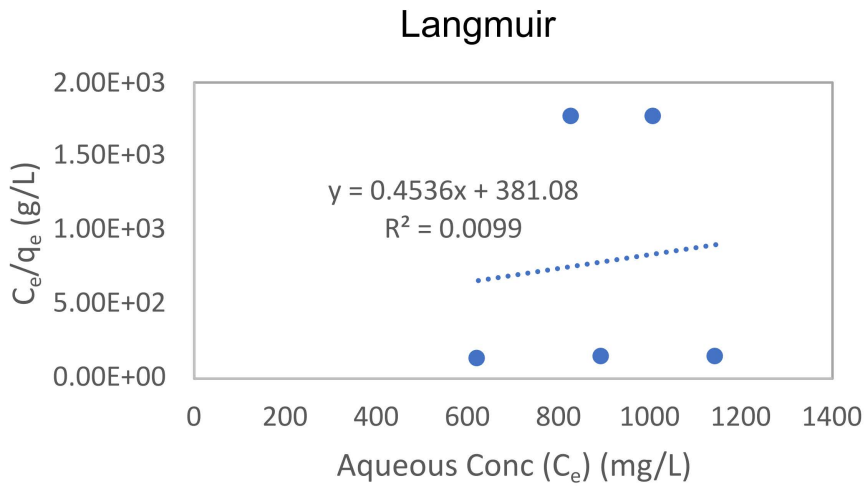
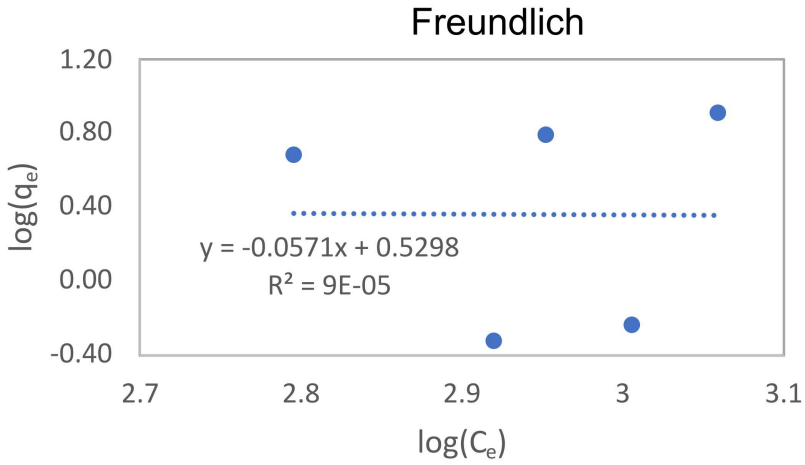
Figure 2







Notes:

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-306 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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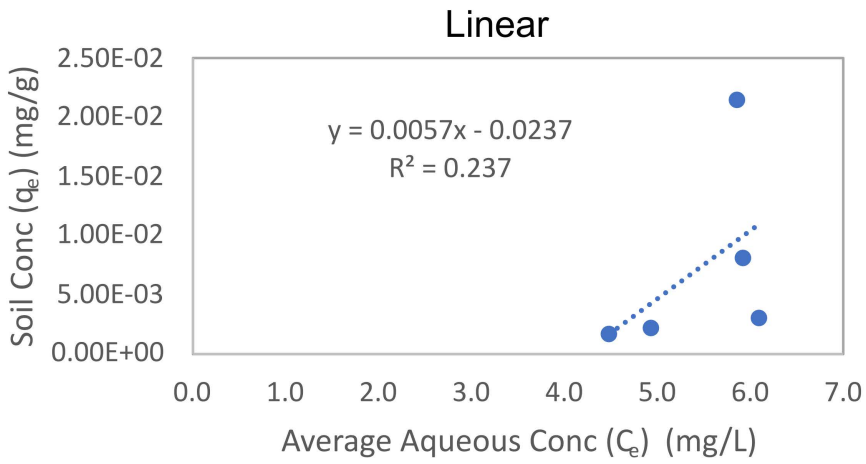
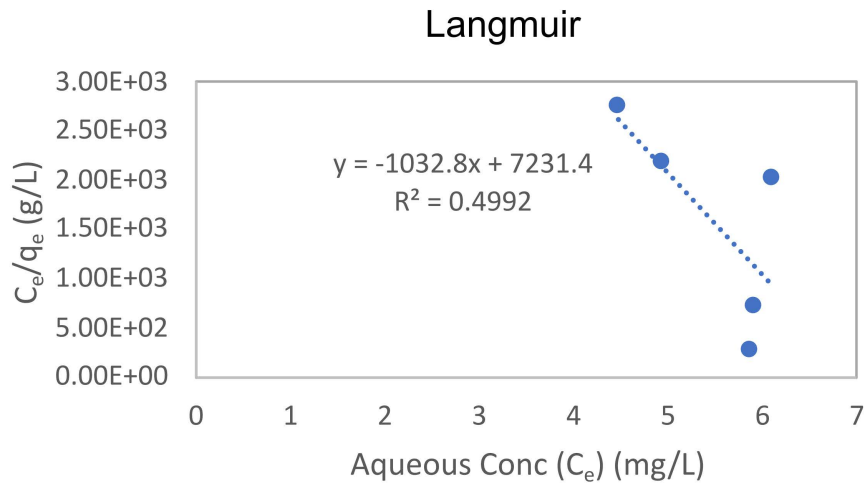
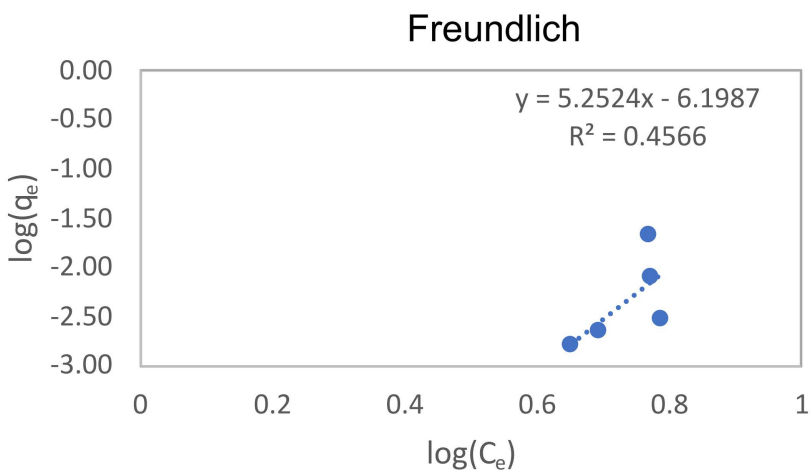
Figure 3







Notes:
q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-313 Boron Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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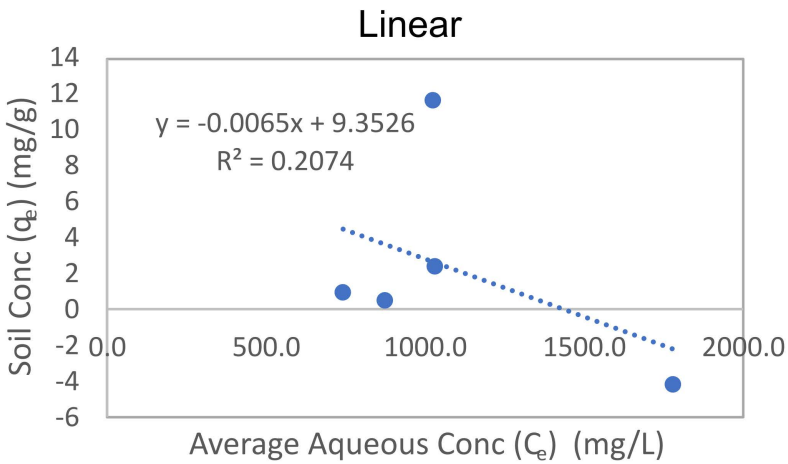
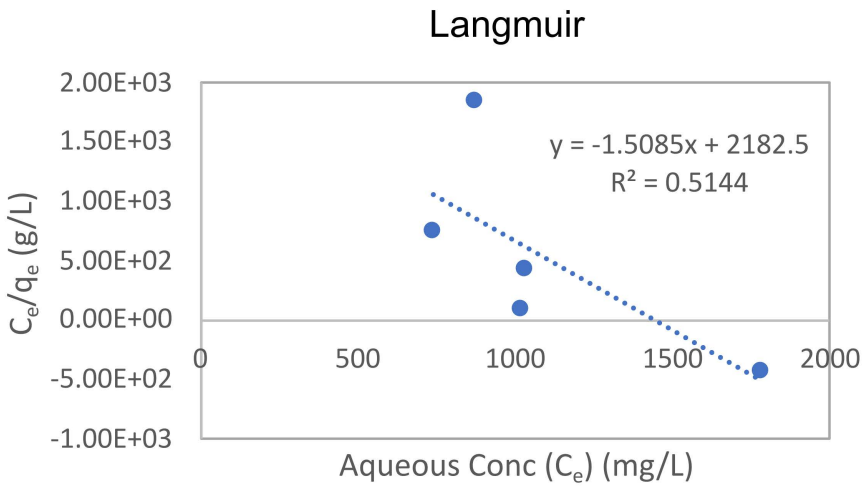
Figure 4





Notes:

The Freundlich isotherm was not calculated because the data were not conducive to log transformation.

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-313 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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Figure 5

APPENDIX D
HELP MODEL OUTPUT FILES

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: COF AP1 CIP **Simulated On:** 6/23/2022 13:38

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam
Material Texture Number 12

Thickness	=	6	inches
Porosity	=	0.471	vol/vol
Field Capacity	=	0.342	vol/vol
Wilting Point	=	0.21	vol/vol
Initial Soil Water Content	=	0.2544	vol/vol
Effective Sat. Hyd. Conductivity	=	4.20E-05	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiC - Silty Clay
Material Texture Number 14

Thickness	=	18	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.3554	vol/vol
Effective Sat. Hyd. Conductivity	=	2.50E-05	cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
10 oz Nonwoven Geotextile
Material Texture Number 123

Thickness	=	0.11	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.5445	vol/vol
Effective Sat. Hyd. Conductivity	=	3.00E-01	cm/sec
Slope	=	5	%
Drainage Length	=	350	ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
High Density Electric Plant Coal Bottom Ash
Material Texture Number 84

Thickness	=	360	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.0762	vol/vol
Effective Sat. Hyd. Conductivity	=	8.80E-05	cm/sec

Layer 6

Type 2 - Lateral Drainage Layer
Loess Unit Silty Clay
Material Texture Number 43

Thickness	=	60	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.371	vol/vol
Effective Sat. Hyd. Conductivity	=	3.85E-08	cm/sec
Slope	=	0	%
Drainage Length	=	0	ft

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	87.9	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	10.37	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	5.654	inches
Upper Limit of Evaporative Storage	=	8.574	inches

Lower Limit of Evaporative Storage	=	4.272	inches
Initial Snow Water	=	0.088108	inches
Initial Water in Layer Materials	=	57.664	inches
Total Initial Water	=	57.752	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.06	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	97	days
End of Growing Season (Julian Date)	=	302	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Coffeen, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.353618	2.511085	2.81508	3.241374	3.956664	4.312863
4.375035	2.656228	3.284204	3.675466	3.677412	3.106835

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
37.3	37.1	50	61.9	69.7	80.6
84.2	81	72.2	62.4	48.1	38

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Average Annual Totals Summary

Title: COF AP1 CIP
Simulated on: 6/23/2022 13:40

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	39.97	[4.83]	1,504,439.0	100.00
Runoff	5.219	[2.734]	196,475.1	13.06
Evapotranspiration	30.032	[3.266]	1,130,503.8	75.14
Subprofile1				
Lateral drainage collected from Layer 3	4.5549	[1.2488]	171,460.7	11.40
Percolation/leakage through Layer 4	0.195970	[0.082153]	7,376.9	0.49
Average Head on Top of Layer 4	4.4608	[1.8873]	---	---
Subprofile2				
Percolation/leakage through Layer 6	0.000911	[0.001146]	34.3	0.00
Water storage				
Change in water storage	0.1585	[1.4776]	5,965.1	0.40

* Note: Average inches are converted to volume based on the user-specified area.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: COF AP1 CBR E 1ft Simulated On: 18/04/2022 12:42

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiC - Silty Clay
Material Texture Number 14

Thickness	=	12	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.2751	vol/vol
Effective Sat. Hyd. Conductivity	=	2.50E-05	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	88.6	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	14.28	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	3.302	inches
Upper Limit of Evaporative Storage	=	5.748	inches
Lower Limit of Evaporative Storage	=	3.012	inches
Initial Snow Water	=	0.088108	inches
Initial Water in Layer Materials	=	3.302	inches
Total Initial Water	=	3.39	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.06	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	97	days
End of Growing Season (Julian Date)	=	302	days

Average Wind Speed	=	8 mph
Average 1st Quarter Relative Humidity	=	72 %
Average 2nd Quarter Relative Humidity	=	64 %
Average 3rd Quarter Relative Humidity	=	71 %
Average 4th Quarter Relative Humidity	=	72 %

Note: Evapotranspiration data was obtained for Coffeen, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.353618	2.511085	2.81508	3.241374	3.956664	4.312863
4.375035	2.656228	3.284204	3.675466	3.677412	3.106835

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
37.3	37.1	50	61.9	69.7	80.6
84.2	81	72.2	62.4	48.1	38

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Average Annual Totals Summary

Title: COF AP1 CBR E 1ft
Simulated on: 18/04/2022 12:43

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	39.97	[4.83]	2,071,686.5	100.00
Runoff	4.098	[2.566]	212,424.0	10.25
Evapotranspiration	28.031	[2.833]	1,453,011.5	70.14
Subprofile1				
Percolation/leakage through Layer 1	7.845754	[2.291827]	406,695.7	19.63
Water storage				
Change in water storage	-0.0086	[0.9272]	-444.6	-0.02

* Note: Average inches are converted to volume based on the user-specified area.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: COF AP1 CBR W 3ft Simulated On: 18/04/2022 17:19

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiC - Silty Clay
Material Texture Number 14

Thickness	=	36	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.3502	vol/vol
Effective Sat. Hyd. Conductivity	=	2.50E-05	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	89.2	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	10.38	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	5.826	inches
Upper Limit of Evaporative Storage	=	8.622	inches
Lower Limit of Evaporative Storage	=	4.518	inches
Initial Snow Water	=	0.088108	inches
Initial Water in Layer Materials	=	12.606	inches
Total Initial Water	=	12.694	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.06	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	97	days
End of Growing Season (Julian Date)	=	302	days

Average Wind Speed	=	8 mph
Average 1st Quarter Relative Humidity	=	72 %
Average 2nd Quarter Relative Humidity	=	64 %
Average 3rd Quarter Relative Humidity	=	71 %
Average 4th Quarter Relative Humidity	=	72 %

Note: Evapotranspiration data was obtained for Coffeen, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.353618	2.511085	2.81508	3.241374	3.956664	4.312863
4.375035	2.656228	3.284204	3.675466	3.677412	3.106835

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
37.3	37.1	50	61.9	69.7	80.6
84.2	81	72.2	62.4	48.1	38

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Average Annual Totals Summary

Title: COF AP1 CBR W 3ft
Simulated on: 18/04/2022 17:20

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	39.97	[4.83]	1,505,889.7	100.00
Runoff	4.277	[2.541]	161,157.5	10.70
Evapotranspiration	29.447	[3.212]	1,109,534.9	73.68
Subprofile1				
Percolation/leakage through Layer 1	6.278209	[2.388206]	236,559.2	15.71
Water storage				
Change in water storage	-0.0361	[1.2459]	-1,361.9	-0.09

* Note: Average inches are converted to volume based on the user-specified area.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: COF AP1 CIP Default **Simulated On:** 6/21/2022 16:04

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.154	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiC - Silty Clay
Material Texture Number 14

Thickness	=	30	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.3698	vol/vol
Effective Sat. Hyd. Conductivity	=	2.50E-05	cm/sec

Layer 3
Type 2 - Lateral Drainage Layer
10 oz Nonwoven Geotextile
Material Texture Number 123

Thickness	=	0.11	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.6794	vol/vol
Effective Sat. Hyd. Conductivity	=	3.00E-01	cm/sec
Slope	=	5	%
Drainage Length	=	350	ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
High Density Electric Plant Coal Bottom Ash
Material Texture Number 84

Thickness	=	360	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.0762	vol/vol
Effective Sat. Hyd. Conductivity	=	8.80E-05	cm/sec

Layer 6

Type 2 - Lateral Drainage Layer
Loess Unit Silty Clay
Material Texture Number 43

Thickness	=	60	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.371	vol/vol
Effective Sat. Hyd. Conductivity	=	3.85E-08	cm/sec
Slope	=	0	%
Drainage Length	=	0	ft

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	85.9	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	10.37	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	5.059	inches
Upper Limit of Evaporative Storage	=	8.136	inches

Lower Limit of Evaporative Storage	=	3.828	inches
Initial Snow Water	=	0.088108	inches
Initial Water in Layer Materials	=	61.794	inches
Total Initial Water	=	61.882	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.06	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	97	days
End of Growing Season (Julian Date)	=	302	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Coffeen, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.353618	2.511085	2.81508	3.241374	3.956664	4.312863
4.375035	2.656228	3.284204	3.675466	3.677412	3.106835

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
37.3	37.1	50	61.9	69.7	80.6
84.2	81	72.2	62.4	48.1	38

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Average Annual Totals Summary

Title: COF AP1 CIP
Simulated on: 6/21/2022 16:05

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	39.97	[4.83]	1,504,439.0	100.00
Runoff	4.089	[2.542]	153,905.0	10.23
Evapotranspiration	30.058	[3.318]	1,131,459.1	75.21
Subprofile1				
Lateral drainage collected from Layer 3	5.5133	[1.5623]	207,537.5	13.80
Percolation/leakage through Layer 4	0.344465	[0.16843]	12,966.7	0.86
Average Head on Top of Layer 4	7.8378	[3.8306]	---	---
Subprofile2				
Percolation/leakage through Layer 6	0.049311	[0.128508]	1,856.2	0.12
Water storage				
Change in water storage	0.2572	[1.781]	9,681.1	0.64

* Note: Average inches are converted to volume based on the user-specified area.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: COF AP1 Default Earth Simulated On: 27/06/2022 18:16

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.1542	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiC - Silty Clay
Material Texture Number 14

Thickness	=	30	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.436	vol/vol
Effective Sat. Hyd. Conductivity	=	2.50E-05	cm/sec

Layer 3
Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 4
Type 1 - Vertical Percolation Layer (Waste)
High Density Electric Plant Coal Bottom Ash

Material Texture Number 84

Thickness	=	360	inches
Porosity	=	0.578	vol/vol
Field Capacity	=	0.076	vol/vol
Wilting Point	=	0.025	vol/vol
Initial Soil Water Content	=	0.0805	vol/vol
Effective Sat. Hyd. Conductivity	=	8.80E-05	cm/sec

Layer 5
Type 2 - Lateral Drainage Layer
Loess Unit Silty Clay
Material Texture Number 43

Thickness	=	60	inches
Porosity	=	0.479	vol/vol
Field Capacity	=	0.371	vol/vol
Wilting Point	=	0.251	vol/vol
Initial Soil Water Content	=	0.371	vol/vol
Effective Sat. Hyd. Conductivity	=	3.85E-08	cm/sec
Slope	=	0	%
Drainage Length	=	0	ft

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	85.9	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	10.37	acres
Evaporative Zone Depth	=	18	inches
Initial Water in Evaporative Zone	=	5.382	inches
Upper Limit of Evaporative Storage	=	8.136	inches
Lower Limit of Evaporative Storage	=	3.828	inches
Initial Snow Water	=	0.088108	inches
Initial Water in Layer Materials	=	80.625	inches
Total Initial Water	=	80.713	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.06	Degrees
Maximum Leaf Area Index	=	4.5	

Start of Growing Season (Julian Date)	=	97	days
End of Growing Season (Julian Date)	=	302	days
Average Wind Speed	=	8	mph
Average 1st Quarter Relative Humidity	=	72	%
Average 2nd Quarter Relative Humidity	=	64	%
Average 3rd Quarter Relative Humidity	=	71	%
Average 4th Quarter Relative Humidity	=	72	%

Note: Evapotranspiration data was obtained for Coffeen, Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.353618	2.511085	2.81508	3.241374	3.956664	4.312863
4.375035	2.656228	3.284204	3.675466	3.677412	3.106835

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
37.3	37.1	50	61.9	69.7	80.6
84.2	81	72.2	62.4	48.1	38

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 39.06/-89.39

Average Annual Totals Summary

Title: COF AP1 Default Earth
Simulated on: 27/06/2022 18:17

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	39.97	[4.83]	1,504,439.0	100.00
Runoff	6.862	[3.483]	258,316.2	17.17
Evapotranspiration	31.176	[3.425]	1,173,551.9	78.01
Subprofile1				
Percolation/leakage through Layer 3	1.992946	[0.073666]	75,020.7	4.99
Average Head on Top of Layer 3	21.7496	[2.1124]	---	---
Subprofile2				
Percolation/leakage through Layer 5	1.698973	[0.713508]	63,954.6	4.25
Water storage				
Change in water storage	0.2289	[1.8082]	8,616.3	0.57

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX E
FLUX EVALUATION DATA

Appendix E. Flux Evaluation Data
GROUNDWATER MODELING REPORT
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Calibration Model					
Model	**Model Period (years)**	**HSU**	**Total Flux In[1] (ft^3/d)**	**Total Flux In (gpm)**	
Calibration Model	42	Fill Unit (CCR)	2888.39	15.00	
Model	**Model Period (years)**	**HSU**	**Total Flux Out[1] (ft^3/d)**	**Total Flux Out (gpm)**	
Calibration Model	42	Fill Unit (CCR)	-2975.75	-15.46	
Scenario 1: CIP (CCR removal from the northwest areas of the Ash Pond, consolidation to the northeast, central and southern areas of the Ash Pond, and construction of a cover system over the remaining CCR)					
Prediction Model	**Construction Period (years)**	**HSU**	**Total Flux In[1] (ft^3/d)**	**Total Flux In (gpm)**	**Reduction in Flux In Post Closure[2] (Percentage, %)**
CIP	56	Fill Unit (CCR)	2.20	0.01	99.92%
Prediction Model	**Construction Period (years)**	**HSU**	**Total Flux Out[1] (ft^3/d)**	**Total Flux Out (gpm)**	**Reduction in Flux Out Post Closure[2] (Percentage, %)**
CIP	56	Fill Unit (CCR)	-2.21	-0.01	99.93%

[O: SLN 6/25/22; C: BGH 6/29/22]

Notes:
1. Total flux in and out source data provided in flux calculation data files included in Appendix B.
2. Reduction in flux as compared to flux at the end of calibration model (model period of 42 years).

CCR = coal combustion residuals
CIP = Closure In Place
HSU = Hydrostratigraphic Unit
% = percentage
ft^3/d = cubic feet per day
gpm = gallons per minute

APPENDIX C
MATERIAL QUANTITY, LABOR, AND MILEAGE ESTIMATES FOR ALTERNATIVE 2 REMEDY

ILLINOIS POWER GENERATING COMPANY - COFFEEN POWER PLANT - ASH POND 1
CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT (CAAA-SIR)
ALTERNATIVE 2 - SOURCE CONTROL WITH GROUNDWATER EXTRACTION TRENCH[1]

ITEM NO.	ENGINEERING, PRE-CONSTRUCTION, AND CONSTRUCTION SUPPORT TASKS	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
1	Engineering Support and CQA During Construction	LS	1	Eng	12	1,728	0	Assumed labor and equipment hours based on Ramboll project experience.
	ENGINEERING, PRE-CONSTRUCTION, AND CONSTRUCTION SUPPORT TASK ESTIMATED SUBTOTAL					**1,728**	**0**	
ITEM NO.	**SITE PREPARATION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
2	Staging Area & Temporary Roads Preparation	-	-	-	-	676	208	Assumes some work general preparation of temporary access roads along the trench alignment will be needed specific to extraction trench construction.
	Subsurface Stabilization Nonwoven Geotextile	SY	8,000	2 Clab	2500	51	0	313219161550: Geosynthetic soil stabilization, geotextile fabric, non-woven, 120 lb tensile strength includes scarifying and compaction. Assumes 0.5 acre staging area and approximately 2,000 ft of temporary access road, 25 ft wide.
	Construct Staging Area & Temporary Roads	SY	8,000	B14	615	624	208	015523500100: Temporary, roads, gravel fill, 8" gravel depth, excluding surfacing. Assumes 0.5 acre staging area and approximately 2,000 ft of temporary access road, 25 ft wide.
3	Construction Soil Erosion & Sediment Controls	-	-	-	-	241	80	Assumes soil erosion and sediment controls will be implemented only during the groundwater extraction trench construction.
	Silt Fence	LF	3,600	B62	650	133	44	312514161000: Synthetic erosion control, silt fence, install and remove, 3' high. Assumes silt fence is installed down both sides of the extraction trench alignment (3,600 ft total).
	Sediment Log, Filter Sock	LF	4,500	A2	1000	108	36	312514160705: Sediment Log, Filter Sock, 9". Assume sediment log is needed along alignment of extraction trench (3,600 LF total) and settling pond perimeter (~900 LF).
4	Temporary Electrical Installation	EA	2	R1B	-	144	0	Electrical installation based on Ramboll experience to install two power drops for low-voltage (120V) power for the pneumatic extraction pumps along the extraction trench, and for the pneumatic transfer pump at the settling pond for discharge of water to outfall.
5	Geotechnical Monitoring	LS	-	GM	-	600	0	Assumes installation of inclinometers, survey prisms, and settlement monitoring devices. Assumes a 4-person crew installs the monitoring system over a period of 3 weeks. Based on Ramboll experience.
	SITE PREPARATION ESTIMATED SUBTOTAL					**1,661**	**288**	
ITEM NO.	**GROUNDWATER EXTRACTION TRENCH CONSTRUCTION**	**Units**	**Quantity**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
6	Materials	-	-	-	-	294	244	Sand/granular material for backfilling the extraction trenches.
	Sand/Granular Backfill	CY	2,050	B13D	376	87	44	Sand/granular backfill for extraction trenches. Assumes trench is 1,600 ft, 38 ft deep, and 3 ft wide and ~30% of trench volume needs to be backfilled with granular material. Based on Ramboll and Specialty Contractor experience.
	Clay Trench Cap	CY	88	B13D	100	14	7	Clay material for extraction trench cap. Assumes trench is 1,600 ft long, 3 ft wide, and cap is approximately 0.5 feet thick. Based on Ramboll experience.
	Haul material to Site	LCY	2,138	B34C	99	173	173	312323203104: Cycle hauling (wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 15 min load/wait/unload, 16.5 C.Y. truck, cycle 50 miles, 45 mph, excludes loading equipment
	Haul material to Trench Locations	CY	2,138	B34G	850	20	20	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld./uld., 15 MPH, cycle 1 mile. Daily output extrapolated down to 10 min wait. Assumes onsite stockpile locations average of 0.25 mile from trench dumping location.
7	Installation of Groundwater Extraction Trench	-	-	-	-	406	405	Assumes trench excavation and construction of clay trench cap.
	Trench Excavation	LF	1,600	OP	200	400	400	OP crew determined from crew information provided by specialty contractor. Assumes total trench length 1,600 ft with an approximate depth of 38 ft.
	Spread Lifts for Clay Trench Cap	LCY	88	B10B	200.0	5	4	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Compaction of Clay Trench Cap	BCY	88	B10F	3000	1	1	312323235060: Compaction; Riding, vibrating roller, 6" lifts, 2 passes. RS Means Crew is B10Y; altered to B10F based on experience.
8	Groundwater Extraction Trench Mechanical Installation	-	-	-	-	687	132	Assumes installation of sumps, equalization tank, transfer pumps and controllers, and associated excavation and backfill.
	Install Sumps	EA	2	Q1	1	64	0	Assumes sump installation from specialty contractor. 18-20" diameter Sch. 40-304 Stainless Steel. Daily output adjusted for scale.
	Install Equalization Tank	EA	2	B6	1	180	60	Assumes installation of equalization tank at each trench and associated site preparation and instrumentation. Assumes 2 days each for installation.
	Install Transfer Pumps and Controllers	EA	2	R30	1	52	0	Installation of transfer pump and pump controller at each extraction trench to convey water from settling pond to discharge outfall based on Ramboll project experience. Assumes inclusion of housing structure and 2 days for installation.
	Excavate Utility Trench for Lines to Compressors and Extraction Pumps	LF	500	B54	860	5	5	312316142750: Utility trench excavating, chain trencher, 40 HP operator riding, 12" wide trench and backfill, 18" deep. Trench installed from power drop/compressor shed to extraction trench to supply compressed air and power to sump pits. Assumes 500 ft distance from compressor shed to trench.
	Install Mechanical Elements and Piping	EA	1	R30	-	260	0	Assumes furnishing all mechanical elements (air compressors, pneumatic extraction pumps, transfer pumps) and associated HDPE housing piping for distribution of power and housing of mechanical elements throughout the extraction trench system. Assumes approximately 10 days of work.
	Excavate Utility Trench for Conveyance to Settling Pond	LF	500	B10R	100	60	40	312316142750: Utility trench excavating, chain trencher, 40 HP operator riding, 12" wide trench and backfill, 18" deep. Trench installed from groundwater extraction trench to convey extracted water to the settling pond.
	Install 8" HDPE Conveyance Pipe to Settling Pond	LF	500	B22A	320	63	25	331413350300: Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21. Includes labor, materials, and machine for installation and welding of HDPE pipe for conveying extracted water from trench to settling pond.
	Backfill with Granular Trench Backfill	LCY	30	B10R	100	4	2	312316133060: Backfill trench, F.E. loader, wheel mtd., 1 C.Y. bucket, 200' haul. Backfill with granular trench backfill. Quantity based on trench dimensions 12" wide, 18" deep, 500 ft long.
9	Construction of Compressor Shed	-	-	-	-	180	60	Construction of housing unit for air compressor shed.
	Construct Compressor Shed	EA	1	B6	-	180	60	Assumes pre-fabricated air compressor shelter, installed primarily by hand with light equipment assistance. Hours are based on Ramboll experience
10	Installation of Settling Pond	-	-	-	-	226	89	Quantity based on 1-acre pond, 2 feet deep. Assume all excavated material is reused for berm construction.
	Excavation and Loading of Settling Pond Material	BCY	3,300	B12D	2080	25	13	312316420300: Excavating, bulk bank measure, hydraulic, crawler mtd., 3 C.Y. cap (300 CY/hr). Assumes loading of material onto trucks.
	Hauling and Placement of Settling Pond Material	LCY	3,300	B34G	3287	8	8	312323206130: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld./uld., 15 MPH, cycle 2,000 ft. Daily output extrapolated down to 600 ft cycle.
	Spreading/Drying Material in Berm	CY	3,300	B10B	1000	40	26	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Compaction of Material in Berm	BCY	3,300	B10F	2600	15	10	312323235060: Compaction; Riding, vibrating roller, 12" lifts, 2 passes. RS Means Crew is B10Y; altered to B10F based on experience.
	Fine Grading of Berm	MSF	36	B11L	30	19	10	312216103600: Fine grading, tops of lagoon banks for compaction. Assumes 10 ft-wide berm around perimeter of 1-acre settling pond.
	Subsurface Stabilization Nonwoven Geotextile	SY	5,000	2 Clab	2500	32	0	313219161550: Geosynthetic soil stabilization, geotextile fabric, non-woven, 120 lb tensile strength includes scarifying and compaction. Assumes 1 acre settling pond.
	Settling Pond Liner	SF	5,000	B63B	1850	86	22	310519531100: Reservoir liners, membrane lining, 40 mil, LLDPE.
11	Extracted Water Discharge Management	-	-	-	-	123	32	Based on approximately 500 ft distance from settling pond to discharge outfall.
	Install Transfer Pump and Controller	EA	1	R30	1	52	0	Installation of transfer pump and pump controller to convey water from settling pond to discharge outfall based on Ramboll project experience. Assumes inclusion of housing structure. Assume 2 days for installation.
	Excavate Utility Trench for Conveyance to Discharge	LF	500	B54	860	5	5	312316142750: Utility trench excavating, chain trencher, 40 HP operator riding, 12" wide trench and backfill, 18" deep. Trench installed from settling pond to convey settled water to outfall for discharge.
	Install 8" HDPE Conveyance Pipe to Discharge	LF	500	B22A	320	63	25	331413350300: Water supply distribution piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21. Includes labor, materials, and machine for installation and welding of HDPE pipe for conveying water from settling pond to discharge point.
	Backfill with Granular Trench Backfill	LCY	30	B10R	100	4	2	312316133060: Backfill trench, F.E. loader, wheel mtd., 1 C.Y. bucket, 200' haul. Backfill with granular trench backfill. Quantity based on trench dimensions 12" wide, 18" deep, 500 ft long.
12	Trench Spoils Management	-	-	-	-	71	53	Quantity based on average area of trench excavation 3 ft wide by 38 ft deep over 1,600 ft extraction trench alignment, 30% volume spoils. Spoils will be hauled to AP1 for use as contouring fill beneath final cover system.
	Loading	CY - as excavated	2,050	B14B	5000	5	3	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket. Spoils volume is 30% of total trench volume per Contractor experience.
	Hauling and Placement within Consolidated AP1 CIP Footprint	CY - as excavated	2,050	B34G	850	19	19	312323206170: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 34 C.Y. off-road, 15 min wait/ld./uld., 15 MPH, cycle 1 mile.
	Spreading/Drying Moisture Conditioning	CY - as excavated	1,025	B10B	1000	12	8	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience. Quantity assumes 50% of volume requires moisture conditioning.
	Spreading Lifts	CY - as excavated	2,050	B10B	1000	25	16	312323170020: Spread dumped material, no compaction, by dozer. Daily output edited to match excavation based on experience.
	Compaction of Material	CY - in place	2,050	B10F	2600	9	6	312323235060: Compaction; Riding, vibrating roller, 12" lifts, 2 passes. RS Means Crew is B10Y; altered to B10F based on experience.
	GROUNDWATER EXTRACTION TRENCH CONSTRUCTION					**1,986**	**1,014**	

ITEM NO.	SITE RESTORATION	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
13	Site Restoration	-	-	-	-	100	23	Assumes restoration of grade surface following extraction trench installation.
	Erosion Control Blanket	SF	8,000	B1	2500	77	0	312514160100: Rolled erosion control mats and blankets, plastic netting stapled, 2" x 1" mesh, 20 mil. Assumes erosion control blanket installed over settling pond berm.
	Lime	MSF	72.0	B66	700	1	1.0	329113234250: Soil preparation, structural soil mixing, spread soil conditioners, ground limestone, 1#/S.Y., tractor spreader. Assume soils possibly being void of nutrients. Quantity disturbed areas including staging area and temporary roads (~1.6 acre total) excluding settling pond.
	Fertilizer	MSF	113.0	B66	700	1	1	329113234150: Soil preparation, structural soil mixing, spread soil conditioners, fertilizer, 0.2#/S.Y., tractor spreader. Assume soils possibly being void of nutrients. Quantity all disturbed areas including staging area and temporary roads (~1 .6 acre total) and new settling pond (1 acre).
	Grassland Mix	MSF	113.0	B66	52	17	17	329219142300: Seeding athletic fields, seeding fescue, tall, 5.5 lb. per M.S.F., tractor spreader. Quantity all disturbed areas including staging area and temporary roads (~1.6 acre total) and new settling pond (1 acre).
	Mulch	MSF	113.0	B65	530	3	3	329113160350: Mulching, Hay, 1" deep, power mulcher, large.
	SITE RESTORATION ESTIMATED SUBTOTAL					**100**	**23**	

ITEM NO.	Corrective Action Operation and Maintenance	Units	Quantity	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
14	Groundwater Extraction Trench Operation & Maintenance	-	-	-	-	7,200	-	Assumes routine maintenance required over the maximum 30 years of operation. Operation excludes the 3 years of confirmation monitoring.
	Field Maintenance	Event	120	TM	-	7,200	0	Assumes quarterly maintenance on pneumatic pumps and air compressors over 30 years of operation. Each maintenance event assumes 2 staff for 3 days to check, clean, and service all mechanical parts.
	Electrical Distribution and Service Charges	MO	360	-	-	-	-	Assumes electrical distribution and usage for operating the extraction and transfer pumps.
15	Non-routine System O&M	-	-	-	-	3,300	660	Assumes non-routine tasks including flushing of groundwater conveyance lines and periodic site visits (e.g., alarm responses or equipment troubleshooting) over 30 years of operation. Operation excludes the 3 years of confirmation monitoring.
	Groundwater Conveyance Line Flushing - Vacuum Truck	LF	30,000	VT	-	1,320	660	330130116140: Pipe, internal cleaning and inspection, cleaning, power rudder with header & cutts, 4"-12" diameter. Assumes one 2-day cleaning event of 1,000 LF of 8" HDPE pipe per year for a total of 30 years of operation.
	Non-Routine Site Visits/Alarm Responses	LS	180	OM	-	1,980	0	Assumes 6 non-routine site visits per year over 30 years of operation. Each non-routine event assumes 2 staff for 1 day.
	CORRECTIVE ACTION OPERATION AND MAINTENANCE SUBTOTAL					**10,500**	**660**	

	Total Labor Hours	Total Equipment Hours
ENGINEERING AND CONSTRUCTION SUBTOTAL	**5,500**	**1,300**
CORRECTIVE ACTION OPERATION AND MAINTENANCE SUBTOTAL	**10,500**	**660**
ENGINEER'S ESTIMATE OF TOTAL CONSTRUCTION AND ENGINEERING HOURS	**5,500**	**1,300**

NOTES:

1. Alternative 2: Source Control with groundwater extraction trench is estimated to take greater than 30 years to achieve groundwater protection standards (GWPS-35 I.A.C Section 845.600) at all perimeter wells associated with AP1 following AP1 closure in place (CIP). Assumes the duration of operation has been limited to a maximum of 30 years plus 3 years of confirmation monitoring (without trench operation).
2. RS Means refers to the 2023 Quarter 4 online edition of RS Means Commercial New Construction.
3. See crew tab (Alt 2 - Crews) for assumptions regarding crew size, total labor hours and required construction equipment, as needed, for each task.
4. See mileage tab (Alt 2 - Mileage) for assumptions regarding total mileage for tasks outlined in this alternative.

ACRONYMS:

AC = Acre
CIP = closure in place
CY = Cubic Yard
Loose: Material swelled when removed from compacted state
EA = Each
GWPS = groundwater protection standards
LF = Linear Foot
LS = Lump Sum
MSF = square feet divided by 1000
MO = Month
O&M = Operation & Maintenance
SF = Square Feet
SY = Square Yard

CREW CODES
ILLINOIS POWER GENERATING COMPANY - COFFEEN POWER PLANT - ASH POND 1
CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT (CAAA-SIR)
ALTERNATIVE 2 - SOURCE CONTROL WITH GROUNDWATER EXTRACTION TRENCH

Item No.	Crew Code	Labor	Daily Labor Hours	Equipment	Daily Equipment Hours	Crew Size	Onsite Labor Hours	Onsite Heavy Equipment Hours
Construction								
2,10	2 Clab	Laborer x2	16	None	0	2	83	0
3	A2	Laborer x2 Truck Driver x1	24	Flatbed Truck, Gas, 1.5 ton	8	3	108	36
13	B1	Labor Foremanx1 Laborer x2	24	None	0	3	77	0
8.9	B6	Laborer x 2 Operator (light) x 1	24	Backhoe Loader, 48 H.P.	8	3	360	120
7,10,12	B10B	Operator x1 Laborer x0.5	12	Dozer, 200 H.P.	8	1.5	82	55
10,12	B10F	Operator (med) x1 Laborer x0.5	12	Tandem Roller, 10, Ton	8	1.5	25	16
8,11	B10R	Operator (med) x 1 Laborer x 0.5	12	Frontend loader, W.M., 1 C.Y.	8	1.5	67	45
10	B11L	Operator (med) x 1 Laborer x 1	16	Grader, 30,000lb	8	2	19	10
10	B12D	Operator (crane) x 1 Laborer x 1	16	Hydraulic excavator, 3.5 C.Y.	8	2	25	13
6	B13D	Operator (crane) x 1 Laborer x 1	16	Hydraulic excavator, 1 C.Y. Trench Box	8	2	101	51
2	B14	Labor Foreman x 1 Operator (light) x1 Laborer x 4	48	Hyd. Excavator, 4.5 C.Y. Backhoe Loader, 48 H.P.	16	6	624	208
12	B14B	Operator (crane) x 1 Laborer x 0.5	12	Hydraulic excavator, 6. C.Y.	8	1.5	5	3
8,11	B22A	Labor Foreman x1 Skilled Worker x1 Laborer x2 Operator (crane) x1	40	S.P. Crane, 4x4, 5 ton Butt Fusion Machine, 4-12" diam.	16	5	125	50
6	B34C	Truck Driver x1	8	Truck Tractor, 6x4, 380 H.P. Dump Trailer, 16.5 C.Y.	8	1	173	173
6,10,12	B34G	Truck Driver x1	8	Dump Truck, Off Hwy., 50 ton	8	1	47	47
8,11	B54	Operator (light) x1	8	Trencher, Chain, 40 H.P.	8	1	9	9
3	B62	Laborer x2 Operator x 1	24	Loader, Skid Steer, 30 H.P.	8	3	133	44
10	B63B	Labor Foreman x1 Laborer x2 Operator (light) x1	32	Loader, Skid Steer, 78 H.P.	8	4	86	22
13	B65	Laborer x1 Truck Driver (light) x1	16	Power Mulcher (large) Flatbed Truck, Gas, 1.5 ton	16	2	3	3
13	B66	Operator (light) x1	8	Loader-Backhoe, 40 H.P.	8	1	20	20
8	Q1	Plumber x1 Plumber Apprentice x1	16	None	0	2	64	0
4	R1B	Electrician x1 Electrician Apprentice x2	24	None	0	3	144	0
8,11	R30	Electrician Foreman x0.25 Electrician x1 Laborer (Semi-Skilled) x2	26	None	0	3.25	364	0
5	GM	Engineering Staff x4	40	Service Vehicle x 2	0	4	600	0
7	OP	Operator x3 Laborer x 2	50	CAT 950 Loader x 3, CAT 374 Excavator x 1 CAT 349 Excavator x 1 Manlift x 1, Telehandlers x 2	50	5	400	400
1	Eng	Engineering Staff x1.2	10	Rental Vehicle x1	0	1.2	1,728	0
				Construction Subtotals			5,500	1,300
Corrective Action Operation & Maintenance								
14	TM	Maintenance Crew x2	20	Service Truck x2 Hand Tools	0	2	7,200	0
15	VT	Laborer x1 Operator x1	20	Vacuum Truck with Flushing Capabilities	10	2	1,320	660
15	OM	Laborer x1	10	Service Truck x1	0	1	1,980	0
				O&M Subtotals			10,500	660
						Totals	**16,000**	**2,000**

Note: Blue shaded crew codes were created by Ramboll based on experience (not pulled from RS Means).

CONSTRUCTION MILEAGE AND LABOR ESTIMATES
ILLINOIS POWER GENERATING COMPANY - COFFEEN POWER PLANT - ASH POND 1
CORRECTIVE ACTION ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT (CAAA-SIR)
ALTERNATIVE 2 - SOURCE CONTROL WITH GROUNDWATER EXTRACTION TRENCH

Construction Mileage and Labor Estimates - Alternative 2: Groundwater Extraction Trench

Item	Quantity	Assumptions
Labor Total Hours	5,474	Per projected Construction total in cost estimate (does not include contingency)
Duration of Onsite Construction Days	70	Total Days
Average Daily Crew Size	5.7	Assumes multiple crew sizes and a 10 hour work day Assumes 1 Ramboll personnel daily for construction oversight
Daily Labor Mobilization Miles	27,704	Includes light and medium commercial vehicles Average of 70 miles round trip per day, as proposed in construction permit for AP1 Closure
Vehicles Miles Onsite	1,979	Includes light and medium commercial vehicles 5 miles per day for onsite miles No contingency Included
Equipment Mobilization Miles - Unloaded	2,910	Average of 500 miles round trip for equipment hauling (from Chicago, IL) Average 1 load of equipment per working week
Equipment Mobilization Miles - Loaded	2,910	Average of 500 miles round trip for equipment hauling (from Chicago, IL) Average 1 load of equipment per working week
Onsite Haul Truck Miles - Unloaded	2,749	34 CY Off Road Dump Truck 1 mile round trip per load
Onsite Haul Truck Miles - Loaded	2,749	34 CY Off Road Dump Truck 1 mile round trip per load
Offsite Haul Truck Miles - Unloaded	31,713	Assumes 16 CY loads of fill materials (gravel/sand backfill and clay cap) are delivered to the site from a regional supplier located within 100 miles of the site
Offsite Haul Truck Miles - Loaded	31,713	Assumes truck is returning to the regional supplier located within 100 miles of the site
Material Delivery Miles - Unloaded	4,656	Misc. construction materials (erosion controls, piping, geotextile) Assumes 200 mile round trip, average 2 trips per working week
Material Delivery Miles - Loaded	4,656	Misc. construction materials (erosion controls, piping, geotextile) Assumes 200 mile round trip, average 2 trips per working week

Operation & Maintenance (O&M) Mileage and Labor Estimates - Alternative 2: Groundwater Extraction Trench

Item	Quantity	Assumptions
Labor Total Hours	10,500	Per projected CM total in cost estimate (does not include contingency)
Duration of Onsite OMM Days	360	Total Days
Average Daily Crew Size	3	Assumes multiple crew sizes and a 10 hour work day
Daily Labor Mobilization Miles	126,000	Includes mob/demob from Chicago (260 miles round trip) and local daily commute mileage (40 round trip miles per day).
Vehicles Miles Onsite	15,750	Includes light and medium commercial vehicles 15 miles per day for onsite miles No contingency Included
Equipment Mobilization Miles - Unloaded	7,500	Average of 500 miles round trip for equipment hauling (from Chicago, IL) Average 1 load of equipment per mobilization (once per year)
Equipment Mobilization Miles - Loaded	7,500	Average of 500 miles round trip for equipment hauling (from Chicago, IL) Average 1 load of equipment per mobilization (once per year)
Onsite Haul Truck Miles - Unloaded	0	-
Onsite Haul Truck Miles - Loaded	0	-
Offsite Haul Truck Miles - Unloaded	0	No spoil handling off-site will occur under this alternative
Offsite Haul Truck Miles - Loaded	0	No spoil handling off-site will occur under this alternative
Material Delivery Miles - Unloaded	0	-
Material Delivery Miles - Loaded	0	-

CAGM = Corrective Action Groundwater Monitoring

Appendix C

Corrective Measures Assessment

Intended for
Illinois Power Generating Company

Date
June 12, 2024

Project No.
1940103584-002

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT

ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS
IEPA ID: W135015004-01

RAMBOLL Bright ideas. Sustainable change.

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT COFFEEN POWER PLANT ASH POND NO. 1

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940103584-002**
Recipient	**Illinois Power Generating Company**
Document type	**35 I.A.C. § 845 Corrective Measures Assessment**
Revision	**FINAL**
Date	**June 12, 2024**
Prepared by	**A. Frances Ackerman, RG, PE**
Checked by	**Lucas P. Carr, PE**
Approved by	**Brian G. Hennings, PG**

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ATTACHMENTS

Attachment A Selected Construction Permit Application Plans

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
ASD	alternative source demonstration
CAAA	Corrective Action Alternatives Analysis
CAP	Corrective Action Plan
CCR	coal combustion residuals
CMA	Corrective Measures Assessment
cm/s	centimeters per second
CPP	Coffeen Power Plant
CSM	conceptual site model
DA	deep aquifer
DCU	deep confining unit
EPRI	Electric Power Research Institute
E001	Event 1
E002	Event 2
E003	Event 3
GMF	Gypsum Management Facility
GMF GSP	GMF Gypsum Stack Pond
GMF RP	GMF Recycle Pond
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard(s)
HCR	Hydrogeologic Site Characterization Report
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
ITRC	National Research Council, Interstate Technology & Regulatory Council
IX	ion exchange
LCU	lower confining unit
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
NRT/OBG	Natural Resource Technology, an OBG Company
PMP	potential migration pathway
PRB	Permeable Reactive Barrier
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
Site	Coffeen Power Plant
TDS	total dissolved solids
UA	uppermost aquifer
UCU	upper confining unit

USEPA	United States Environmental Protection Agency
ZVI	zero-valent iron

1. INTRODUCTION

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has developed this assessment of groundwater corrective measures on behalf of Illinois Power Generating Company (IPGC) to assist in the compliance with the requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments. This assessment applies specifically to the coal combustion residuals (CCR) unit referred to as the Ash Pond Number (No.) 1 (AP1) at the Coffeen Power Plant (CPP), also referred to as CCR Unit identification (ID) No. 101, Illinois Environmental Protection Agency (IEPA) ID No. W1350150004-01, and National Inventory of Dams (NID) No. IL50722. This report addresses content requirements specific to 35 I.A.C. § 845.660 (Assessment of Corrective Measures) for exceedances of boron, sulfate, and total dissolved solids (TDS) at AP1.

1.1 Source Control and Residual Plume Management

IPGC intends to initiate significant source and residual plume management efforts as part of AP1 closure, as documented in the Final Closure Plan and Construction Permit Application that were submitted to IEPA in July of 2022 (Golder Associates USA, Inc., 2022). The proposed closure exceeds the minimum Closure Performance Standards listed in 35 I.A.C § 845.750. The closure will include removing free liquids in accordance with the performance standard in 35 I.A.C § 845 and maintaining that condition during the closure construction period. The closure will reduce the hydraulic head that can force leachate into subsurface soils and is the mechanism that can drive risk to groundwater (United States Environmental Protection Agency [USEPA], 2015a, p. 21342):

> *EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water. Dewatered CCR surface impoundments will no longer be subjected to hydraulic head so the risk of releases, including the risk that the unit will leach into the groundwater, would be no greater than those from CCR landfills.*

AP1 will be closed using a hybrid closure-by-removal and consolidate-and-cap approach that was developed to reduce the waste footprint at closure and to achieve 10 feet of vertical separation between the top of the uppermost aquifer (UA) and the CCR material. All CCR in the eastern portion of AP1 will be removed and relocated to the western portion of the SI, which will be closed in accordance with 35 I.A.C § 845.750. Under this hybrid approach, approximately 58 percent of the current CCR footprint within the surface impoundment (SI) will be removed. The final cover system will consist of a geomembrane final cover system having performance that exceeds the 35 I.A.C § 845.750(c)(2) minimum final cover requirements. The closure has been designed to minimize the post-closure infiltration of liquids into the waste and will physically isolate the CCR in AP1 from contact with surface water and the atmosphere and minimize the potential for release of CCR. The proposed source control is predicted to reduce water flux into and out of AP1 by 99.99 percent and allow the groundwater protection standards (GWPS) to be achieved within approximately 15 to 18 years, with the exception of G301, after the completion of closure (Ramboll, 2022). These source control activities will serve as the primary groundwater corrective measure at AP1. The potentially feasible corrective measures presented herein are intended to be supplementary to the primary groundwater corrective measure (*i.e.,* source control) and are intended to serve as management measures to address any residual plume(s) that remain after completion of source control.

Attachment A includes select figures from the Construction Permit Application that show the proposed final source control and primary corrective action.

1.2 Adaptive Site Management

Adaptive site management strategies will be employed as an integral part of ongoing corrective action at AP1. The adaptive site management approach will allow timely incorporation of new site information over the closure and post-closure life cycle of AP1 to ensure the achievement of the GWPS. The adaptive site management approach is proposed to expedite progress toward meeting the GWPS while acknowledging uncertainties, such as the persistence of current groundwater flow directions and flux quantities and potential related changes in geochemical conditions. A structured decision-making process and explicitly planned iterations between the implemented corrective measures and monitoring results will ensure that remediation is occurring. System performance and the condition of the residual plume will be monitored as the corrective measure(s) selected through the 35 I.A.C. § 845.710 Corrective Action Plan (CAP) process are implemented to supplement the source control measures described above. If the groundwater concentrations do not decrease consistent with the modeling predictions, the adaptive site management approach will facilitate timely modifications or enhancements to the corrective measure(s), as needed in accordance with 35 I.A.C. § 845.680(b). This approach will be employed in response to new site information and/or the performance of the selected corrective measure(s).

The planned adaptive site management strategies are generally consistent with National Research Council, Interstate Technology & Regulatory Council (ITRC) and USEPA methodologies developed to address sites with long remediation times and high levels of uncertainty regarding the remedial actions necessary to achieve final and protective remediation goals (USEPA, 2022). The elements of the proposed adaptive site management strategy at AP1 will be responsive to the changing conditions associated with pond closure and performance of the selected corrective measure(s) and will include the following:

1. Implementing the groundwater corrective measure(s) selected as part of the CAP for the current conditions at AP1. The selected corrective measures may include a combination of the technologies presented in this Corrective Measures Assessment (CMA).

2. Establishing both the absolute remedial objective and functional (interim) goals to monitor progress toward the remedial objective. Achieving the GWPS for 35 I.A.C. § 845.600 constituents at the downgradient waste boundary is the remedial objective for AP1. Specific functional goals will be developed as part of the CAP process. The functional goals will be measurable thresholds for future action and may include short-term or technology-specific objectives and triggers. Functional goals may vary for different locations, CCR constituents or other site-specific considerations (ITRC, 2017) and will serve as benchmarks for comparison to ongoing groundwater monitoring at AP1.

3. Ongoing groundwater monitoring at AP1 will continue throughout the implementation of source control and residual plume management activities. Post-closure monitoring will continue for a period of at least 30 years, in accordance with 35 I.A.C. § 845.780(c). A comprehensive groundwater monitoring plan (GMP) will be developed as part of the CAP process in accordance with 35 I.A.C. § 845.670 and 35 I.A.C. § 845.220(c)(4). The GMP will include the functional goals and proposed action levels.

4. Groundwater monitoring information will be used to guide decisions regarding whether progress toward the remedial goal is advancing as expected and/or whether additional actions may be needed to achieve the remedial objective, in conjunction with IEPA, as required by 35 I.A.C. § 845.680(b).

2. SITE INFORMATION

The CPP is located in Montgomery County in central Illinois, approximately two miles south of the city of Coffeen and about eight miles southeast of the city of Hillsboro. AP1 is located in Section 11, Township 7 North and Range 7 East. AP1 is located south of the power plant and situated in a predominantly agricultural area (**Figure 2-1**). AP1 is located between the two lobes of Coffeen Lake (identified as "Coffeen Lake" and "Unnamed Tributary" on **Figures 2-1** and **2-2**) to the west, east, and south, and is bordered by agricultural land to the north. **Figure 2-2** is a site map showing the location of AP1 (35 I.A.C. § 845 regulated CCR SI and subject of this CMA), Ash Pond No. 2 (AP2), the Gypsum Management Facility (GMF) Gypsum Stack Pond (GMF GSP), GMF Recycle Pond (GMF RP), and the Landfill. The area near AP1 will hereinafter be referred to as the Site.

The CPP was a coal-fired electrical generating plant that began operation in 1964. The plant initially burned bituminous coal from Illinois and CCR from the coal fired units was disposed of in AP1. AP2 was also utilized in the early 1970's and AP1 was reconstructed in 1978. Both of these units were used until the mid-1980's. Beginning in 2010, CCR material was placed in the Landfill, GMF GSP, and GMF RP. Placement of CCR in AP1 ceased prior to November 4, 2019.

2.1 Conceptual Site Model

Significant site investigation has been completed at the CPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, AP1 has been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021), which was prepared to comply with the requirements specified in 35 I.A.C. § 845.620 and expands upon the Hydrogeologic Monitoring Plan (Natural Resource Technology/O'Brien & Gere Engineers, Inc. [NRT/OBG], 2017). The conceptual site model (CSM) is presented below.

In addition to the CCR present at AP1, there are five principal layers of unlithified material present above the bedrock, which are categorized into hydrostratigraphic units below (from surface downward) based on stratigraphic relationships and common hydrogeologic characteristics.

- **Upper Confining Unit (UCU):** Composed of the Roxana and Peoria Silts (Loess Unit) and the upper clayey portion of the Hagarstown member which are classified as silts to clayey silts and gravelly clay below the surficial soil. Loess Unit thickness ranges from 0 feet (absent) to 16 feet and the clayey portion of the Hagarstown member is up to 6 feet thick. The UCU has been eroded east of AP1, near the Unnamed Tributary.
- **Uppermost Aquifer (UA):** The UA is the Hagarstown Member which is classified as primarily sandy to gravelly silts and clays with thin beds of sands. Where present, the sandy portion of the Hagarstown is generally 2 to 4 feet thick. Similar to the Loess Unit, the Hagarstown is absent in some locations near the Unnamed Tributary. Hydraulic conductivities near AP1 ranged from 2.6×10^{-4} to 9.1×10^{-3} centimeters per second (cm/s) (geometric mean of 2.0×10^{-3} cm/s).
- **Lower Confining Unit (LCU):** Comprised of the Vandalia Member, Mulberry Grove Member, and Smithboro Member. These units include a sandy to silty till with thin, discontinuous sand lenses, a discontinuous and limited extent sandy silt which has infilled prior erosional features,

and silty to clayey diamicton, respectively. The Vandalia Member typically ranged in thickness from 11.7 feet in the northern portion of the CPP, to 31.0 feet between the GMF GSP and the GMF RP; the Mulberry Grove Member is represented by pockets (generally less than 2 feet thick); and the Smithboro Member ranges in thickness from 6.7 to 21.2 feet northwest of the landfill. This LCU has been identified as a potential migration pathway (PMP) because downward vertical gradients indicate that there is the potential for impacts to migrate within this unit. Hydraulic conductivities ranged from 1.2×10^{-4} to 2.3×10^{-3} cm/s (geometric mean of 5.0×10^{-4} cm/s).

- **Deep Aquifer (DA):** Sand and sandy silt/clay units of the Yarmouth Soil, which include accretionary deposits of fine sediment and organic materials, typically less than five feet thick and discontinuous across the CPP. Where present, the DA has been identified as a potential PMP due to presence of downward gradients in the overlying LCU and the relatively greater hydraulic conductivities measured in the DA. Hydraulic conductivity in the DA ranged from 1.3×10^{-4} to 1.7×10^{-3} cm/s (geometric mean of 4.4×10^{-4} cm/s).
- **Deep Confining Unit (DCU):** Comprised of the Banner Formation, and generally consists of clays, silts, and sands. The Lierle Clay Member is the upper layer of the Banner Formation which was encountered at the Site. No monitoring wells are screened only within the DCU, and no field hydraulic conductivity tests were conducted for the DCU.

In the UA, groundwater generally migrates from central portions of the CPP to Coffeen Lake or the Unnamed Tributary. The LCU and DA underlying the UA have been identified as PMPs. Groundwater elevations are primarily controlled by surface topography, geologic unit topography, and water levels within Coffeen Lake and the Unnamed Tributary. Groundwater generally flows from the center of the CPP west towards Coffeen Lake, and east towards the Unnamed Tributary, the eastern lobe of Coffeen Lake, and a discharge flume present along the northern perimeter of AP1, resulting in a groundwater divide (high) running through the middle of the CPP. Groundwater elevations and contours for the quarter 2, 2023 groundwater monitoring event (Event 1 [E001]) are presented in **Figure 2-3**.

2.2 Groundwater Quality

Groundwater monitoring in accordance with the proposed GMP and sampling methodologies provided in the operating permit application for AP1 began in the second quarter of 2023. The 35 I.A.C § 845 groundwater monitoring system is displayed on **Figure 2-4** and consists of 12 wells screened in the UA (two background and 10 compliance), three wells screened in the LCU, one well screened in the DA, one temporary water level only CCR staff gage, and two temporary water level only surface water staff gages. The groundwater samples collected from the 16 wells are used to monitor and evaluate groundwater quality and demonstrate compliance with the groundwater quality standards listed in 35 I.A.C. § 845.600(a). The proposed monitoring wells yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)).

The E001 groundwater monitoring event was completed on June 8, 2023. In accordance with 35 I.A.C. § 845.610(b)(3)(C), statistically derived values were compared with the GWPSs summarized in 35 I.A.C. § 845.600 to determine exceedances of the GWPS. The statistical determination identified the following GWPS exceedances at compliance groundwater monitoring wells (Ramboll, 2023):

- Boron in UA well G313
- Sulfate in UA wells G301, G303, G305, G307, G308, G310, G312, and G313; in LCU wells G307D, G314, and G316; and in DA well G314D
- TDS in UA wells G303, G305, G308, G312, G313, and G315; in LCU wells G314 and G316; and in DA well G314D

Subsequent compliance sampling events for Quarter 3 and Quarter 4 2023 (Event 2 [E002] and Event 3 [E003], respectively) were completed in August and November 2023 and groundwater samples were evaluated for exceedances of the GWPS as described in 35 I.A.C. § 845.600 (Ramboll, 2024a; Ramboll, 2024b). The following additional exceedances were identified during the E002 and E003 monitoring events:

- TDS in UA well G310

The boron, sulfate, and TDS exceedances are addressed in this CMA, in accordance with 35 I.A.C. § 845.660.

3. CORRECTIVE MEASURES ASSESSMENT METHODOLOGY

This section describes the CMA methodology initiated in response to the identification of exceedances of the GWPSs for 35 I.A.C. § 845.600 constituents at the downgradient waste boundary of AP1 during the E001 groundwater monitoring event (Ramboll, 2023). The CMA was initiated on January 14, 2024, within 90 days after the detection of exceedance(s) of GWPS. Under 35 I.A.C. § 845, owners and operators of existing CCR SIs must initiate the assessment of corrective measures in accordance with 35 I.A.C. § 845.660 if one or more constituents are detected, and confirmed by an immediate resample, to be in exceedance of a GWPS in 35 I.A.C. § 845.600, and the owner or operator has not demonstrated that: a source other than the CCR SI caused the exceedance, 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 (*i.e.,* an alternative source demonstration [ASD]).

The CMA is the first step in developing a long-term CAP to address the GWPS exceedances at CCR SIs. The process provides a systematic, rational method for evaluating potential corrective measures by first identifying potentially viable technologies and assessing them using qualitative information to eliminate from consideration infeasible or otherwise unacceptable remedial technologies (*i.e.,* the 35 I.A.C. § 845.660). The remaining technologies will be evaluated individually, or assembled into combined alternatives, and further evaluated under the CAP process per 35 I.A.C. § 845.670.

This CMA identified applicable corrective measure technologies and evaluated them for viability, given the site-specific conditions and considerations at AP1, by addressing the following 35 I.A.C § 845.660 evaluation criteria:

- Performance, reliability, ease of implementation and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
- Time required to begin and complete the CAP; and
- Institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the CAP.

The evaluation included qualitative and/or semi-quantitative screening of the potential corrective measures (technologies) relative to their general performance, reliability, and ease of implementation characteristics and their potential impacts, timeframes, and institutional requirements to assess the viability of each technology to address the GWPS exceedances at AP1. This approach provided a reasoned set of corrective measures that could be used, either individually or in combination, to supplement the primary source control measures described in **Section 1.1**. This set of corrective measures will be further evaluated in the Corrective Action Alternatives Assessment (CAAA).

4. DESCRIPTION OF POTENTIAL CORRECTIVE MEASURE TECHNOLOGIES

The potential groundwater corrective measures summarized below are applicable to AP1 and were included in the CMA development and analysis. Site-specific considerations provided in **Section 2** were used to evaluate potential groundwater corrective measures. Each of the corrective measures evaluated may be capable of satisfying the requirements and objectives, listed in **Section 3**, to varying degrees of effectiveness. The corrective measure review process was intended to yield a set of applicable corrective measures that could be used to supplement the primary corrective action, which will be the source control activities described in **Section 1.1** (hybrid consolidate-and-cap approach with a geomembrane final cover system). The source control is expected to reduce downgradient concentrations in the UA to less than the GWPS via naturally occurring physical and chemical processes over an approximately 20-year timeframe. Ongoing monitoring will be an integral part of all corrective measures to verify and document the remedial process. The corrective measures ultimately advanced to the CAAA and selected in the CAP will be used to enhance the effectiveness of the source control and may be used independently or combined into specific remedial alternatives to leverage the advantages of multiple corrective measures to attain GWPSs.

Source control measures will be initiated for AP1, as described in **Section 1.1**; all of the evaluated additional corrective measure technologies are proposed to be supplemental and complementary to source control activities. The following potential corrective measures, commonly used to mitigate groundwater impacts, were considered as a part of the CMA process:

- Source Control with Groundwater Polishing;
- Source Control with Groundwater Extraction (groundwater pumping wells or collection trenches);
- Source Control with a Cutoff Wall; and
- Source Control with In-Situ Treatment (Permeable Reactive Barrier [PRB] or In-Situ Chemical Treatment).

4.1 Source Control with Groundwater Polishing

Both federal and state regulators have long recognized that natural geochemical processes can be an acceptable component of a remedial action when it can achieve remedial action objectives in a reasonable timeframe. In 1999, USEPA published a final policy directive (USEPA, 1999) for groundwater remediation and described the process as follows:

- *"The reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants."*

The USEPA has stated that source control is the most effective means of ensuring the timely attainment of remediation objectives (USEPA, 1999). Natural geochemical processes may be appropriate as a "finishing step" after effective source control implementation (*i.e.*, groundwater polishing), to reduce the residual mass remaining in the groundwater after closure, if there are no risks to receptors and/or the contaminant plume is not expanding. Thus, groundwater polishing would be used in conjunction with the significant planned source control effort at the site, which will consist of a hybrid consolidate-and-cap approach with a final cover system described in **Section 1.1**.

In 2015, USEPA addressed remediation of inorganic compounds in groundwater and noted that the use of natural geochemical processes to address inorganic contaminants: (1) is not intended to constitute a treatment process for inorganic contaminants; (2) when appropriately implemented, can help to restore an aquifer to beneficial uses by immobilizing contaminants onto aquifer solids and providing the primary means for attenuation of contaminants in groundwater; and (3) is not intended to be a "do nothing" response (USEPA, 2015b). Rather, documenting the applicability of natural geochemical processes for groundwater remediation should be thoroughly and adequately supported with site-specific characterization data and analysis (USEPA, 1999; USEPA, 2007; USEPA, 2015b).

Both physical and chemical processes can contribute to the reduction of the small amount of residual mass remaining after closure of AP1, and the toxicity, mobility, volume, or concentration of contaminants in groundwater. Physical processes applicable to CCR constituents in groundwater include dilution, dispersion, and flushing. Chemical processes applicable to CCR constituents in groundwater include precipitation and coprecipitation (*e.g.,* incorporation into sulfide minerals), sorption (*e.g.,* to iron, manganese, aluminum; to other metal oxides or oxyhydroxides; or to sulfide minerals or organic matter), and ion exchange (IX).

All inorganic compounds are subject to physical processes and under typical environmental conditions, physical mechanisms most often exert the dominant control on the CCR constituents of interest, such as sulfate and chloride, and lithium to a more variable degree. Chemical mechanisms are also likely to be active, though not often dominant, such as adsorption, ion exchange, and organic complexation. In combination with source control, these natural controls can provide an effective means to polish residual loading and achieve the GWPS in a reasonable timeframe. Additional data collection and analysis may be required to support the USEPA's evaluation framework (USEPA, 2015b) and obtain regulatory approval.

4.2 Source Control with Groundwater Extraction

Groundwater extraction is one of the most widely used groundwater corrective technologies and has a long history of performance. This corrective measure includes installation of one or more groundwater pumping wells or trenches to control and extract impacted groundwater. Groundwater extraction captures and contains impacted groundwater and can limit plume expansion and/or off-site migration. Construction of a groundwater extraction system typically includes, but is not limited to, the following primary components:

- Designing and constructing a groundwater extraction system consisting of one or more extraction wells and operating at a rate to allow capture of CCR impacted groundwater within the UA and/or the LCU and DA.

- Deepening the discharge flume along the northern perimeter of AP1 to construct an extraction trench in combination with a groundwater pumping system.
- Management of extracted groundwater, which may include modification to the existing National Pollutant Discharge Elimination System (NPDES) permit.
- Ongoing inspection and maintenance of the groundwater extraction system.

Remediation of inorganics by groundwater extraction can be effective, but systems do not always perform as expected. A combination of factors, including geologic heterogeneities, difficulty in flushing low-permeability zones, and rates of contaminant desorption from aquifer solids can limit effectiveness. Groundwater extraction systems require ongoing operation and maintenance to address issues such as iron bacteria and well fouling and to ensure optimal performance. The extracted groundwater must be managed, either by ex-situ treatment or disposal.

Groundwater extraction may reduce the timeframe to achieve GWPS and limit the off-site migration of constituents that exceed the GWPS. Extraction could be accomplished using a groundwater pumping well system or an extraction trench.

4.3 Source Control with a Cutoff Wall

Since the late 1970s and early 1980s, vertical cutoff walls have been used to control and/or isolate impacted groundwater. Low-permeability cutoff walls can be used to prevent horizontal off-site migration of potentially impacted groundwater. Cutoff walls act as barriers to lateral transport of impacted groundwater and can isolate soils that have been impacted by CCR to prevent mixing with unimpacted groundwater. Cutoff walls are often used in conjunction with an interior pumping system to establish an inward gradient within the cutoff wall. The gradient imparted by the pumping system maintains an inward flow through the wall, keeping it from acting as a groundwater dam and controlling potential end-around or breakout flow of contaminated groundwater. Constructing the cutoff wall such that it intersects a low-permeability material at its base, referred to as "keying", greatly increases its effectiveness.

A commonly used cutoff wall construction technology is the slurry trench method, which consists of excavating a trench and backfilling it with a soil-bentonite mixture, often created with the excavated soils, or, for deeper walls, a cement-bentonite mixture that is produced at an onsite batch plant. The trench is temporarily supported with bentonite slurry pumped into the trench during excavation (D'Appolonia & Ryan, 1979). Cutoff wall excavation uses conventional hydraulic excavators, hydraulic excavators equipped with specialized booms to extend their reach (*i.e.,* long-stick excavators), clamshells, or more specialized equipment such as hydromills or secant-pile drill rigs, depending upon trench depth, material excavated, and type of material that the wall is keyed into.

Cutoff walls are a widely accepted technology for containing impacted groundwater. Combining groundwater polishing with a limited cutoff wall and groundwater extraction in specific areas may provide advantages over independent use of these potential corrective technologies. Cutoff walls can be used in combination with groundwater extraction or as part of a PRB system (as the "funnel" in a funnel-and-gate system; **Section 4.4**).

4.4 Source Control with In-Situ Chemical Treatment

The use of in-situ treatment, either by injection or PRBs is a widely used technology for treating impacted groundwater. However, in-situ treatment techniques for boron, sulfate and TDS are not well established, therefore performance is unknown.

Chemical treatment could consist of injection of reactive materials into the subsurface to treat contaminants at specific, targeted locations. Alternately, treatment could be accomplished via PRB, where reactive materials are placed in the subsurface at locations designed to direct the contaminant plume along a flow path through the reactive media. In either system, the contaminants are transformed or otherwise rendered into environmentally acceptable forms to attain remediation concentration goals downgradient of the barrier (Electric Power Research Institute [EPRI], 2006).

As groundwater passes through the PRB under natural gradients, dissolved constituents in the groundwater react with the media and are transformed or immobilized. A variety of media have been used or proposed for use in PRBs. Zero-valent iron (ZVI) has been shown to effectively immobilize some CCR constituents, including arsenic, chromium, cobalt, molybdenum, selenium, and sulfate. Use of a combination media consisting of ZVI and a boron-selective ion exchange resin to treat boron has been documented in a pilot-scale test (EPRI, 2006).

System configurations include continuous PRBs, in which the reactive media extends across the entire path of the contaminant plume; and funnel-and-gate systems, where low-permeability barriers are installed to control groundwater flow through a permeable gate containing the reactive media. Continuous PRBs intersect the entire contaminant plume and do not materially impact the groundwater flow system. Design may or may not include keying the PRB into a low-permeability unit at depth. Funnel-and-gate systems utilize a system of barriers to groundwater flow (funnels) to direct the contaminant plume through the reactive gate. The barriers, typically some form of cutoff wall, are keyed into a low-permeability unit at depth to prevent short circuiting of the plume. Funnel-and-gate design must consider the residence time to allow chemical reactions to occur. Directing the contaminant plume through the reactive gate can significantly increase the flow velocity, thus reducing residence time.

Design of in-situ treatment systems requires rigorous site investigation to characterize the site hydrogeology and to delineate the contaminant plume. A thorough understanding of the geochemical and redox characteristics of the plume is critical to assess the feasibility of the process and select appropriate reactive media. Laboratory studies, including batch studies and column studies using samples of site groundwater, are needed to determine the effectiveness of the selected reactive media at the site (EPRI, 2006). The main considerations in selecting reactive media are as follows (Gavaskar et al., 1998; cited by EPRI, 2006):

- Reactivity – The media should be of adequate reactivity to immobilize a contaminant within the residence time of the design.
- Hydraulic performance – The media should provide adequate flow through the PRB, meaning a greater particle size than the surrounding aquifer materials. Alternatively, gravel beds have been placed in front of barriers to direct flow through the barrier.
- Stability – The media should remain reactive for an amount of time that makes its use economically advantageous over other technologies.

- Environmentally compatible by-products – Any by-products of media reaction should be environmentally acceptable. For example, iron released by ZVI corrosion should not occur at levels exceeding regulatory acceptance levels.
- Availability and price – The media should be easy to obtain in large quantities at a price that does not negate the economic feasibility of using a PRB.

5. ASSESSMENT OF CORRECTIVE MEASURE TECHNOLOGIES

This CMA was initiated to address exceedances of the 35 I.A.C. § 845.600 GWPS for boron, sulfate, and TDS at the downgradient waste boundary of AP1 identified during the E001 groundwater monitoring event (**Section 2.2**).

5.1 Requirements

The potential groundwater corrective technologies described in the previous section were evaluated relative to the requirements presented in **Section 3** and reiterated below:

- Performance, reliability, ease of implementation and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination:
- Time required to begin and complete the CAP; and
- Institutional requirements, such as State or local permit requirement or other environmental or public health requirements that may substantially affect implementation of the CAP.

Table 5-1 presents the qualitative CMA evaluation of each corrective technology relative to these requirements, as well as their ability to address GWPS exceedances of boron, sulfate, and TDS. The following sections provide a summary of these evaluations and a discussion of the potential groundwater corrective measure technologies that may be viable, either independently or in combination, to address GWPS exceedances. This section also provides a summary of corrective measure technologies that have been retained and advanced for evaluation as part of the CAAA process for selecting the final remedy for AP1 per 35 I.A.C. § 845.670.

5.2 Groundwater Corrective Technology Assessment

Source control, consisting of hybrid closure-by-removal and consolidate-and-cap with a final cover system, will be the primary groundwater corrective measure for AP1. Closure is expected to be completed by April 2026 and each of the potential groundwater corrective measure technologies would supplement the positive impact of the closure activities. The following sections evaluate groundwater corrective measure technologies that, when combined with site closure, may be viable to address the boron, sulfate, and TDS GWPS exceedances. Technologies that are not viable for addressing the GWPS at AP1 will be eliminated from further evaluation and viable technologies will be advanced for further evaluation as part of the CAAA process per 35 I.A.C. § 845.600.

5.2.1 Source Control with Groundwater Polishing

Source control corrective measures (**Section 1.1**) will reduce the mass loading to the groundwater system and the groundwater polishing process could decrease the timeframe for attainment of GWPS in the UA. Groundwater flow and fate and transport modeling incorporating only physical processes indicate that source control would meet GWPS in less than the 15 to 18 years post-closure at all locations except G301, where the groundwater model indicates attainment of the GWPS will take 59 years. Physical processes are expected to perform well in the sandier portions of the UA, as discussed below.

Groundwater polishing by natural geochemical processes is a widely accepted component of groundwater remediation and is routinely approved by the IEPA when paired with source control. The performance of groundwater polishing as a groundwater corrective measure varies based on site-specific conditions and additional data collection may be needed to support the design and regulatory approval. The sandier portions of the UA suggest good performance by physical processes in addressing the boron, sulfate, and TDS in AP1. The chemical processes in the fine-grained UCU require further evaluation.

Naturally occurring geochemical processes are ongoing at AP1 and will continue to affect groundwater constituent concentrations during and after AP1 closure. Ongoing monitoring of groundwater conditions is needed to better understand the mechanisms and efficacy of the groundwater polishing process and to confirm the effectiveness over time. Thus, additional groundwater sample collection and analyses would be required to characterize potential mechanisms, as discussed above, and to provide long term monitoring of the remedial progress. Enhancements to the groundwater monitoring system may be required to ensure that groundwater polishing is occurring as predicted by the groundwater and consistent with the adaptive site management approach. The reliability of groundwater polishing as a groundwater corrective measure is high because operation and maintenance requirements are limited. However, the reliability can also vary based on site-specific hydrogeologic and geochemical conditions.

Following characterization and approval of the CAP, monitoring of the groundwater polishing processes and comparison to functional goals established to monitor progress toward the remedial objective could begin prior to, or concurrently with, site closure activities. Installing additional monitoring wells could begin as quickly as within a few months of CAP approval. The time required could be reduced if existing groundwater monitoring well systems could be utilized for monitoring.

No potential safety impacts or exposure to human health or environmental receptors are expected to result from the groundwater polishing processes. Timeframes to achieve GWPS are dependent on site-specific conditions, which require detailed technical analysis which are ongoing and will be evaluated in connection with the CAAA. Selecting groundwater polishing as a corrective measure for AP1 will require approval of the closure and CAP permits by the IEPA.

Monitoring the groundwater polishing to track progress toward achievement of the GWPS, in conjunction with source control at AP1, would require long-term maintenance and monitoring of the groundwater monitoring system to confirm source control and verify the effectiveness in reducing groundwater concentrations to levels below the GWPS. System design could begin immediately after approval of the CAP permit. Additional investigations to characterize site conditions and installation of the final monitoring system could be performed concurrently with the source control (unit closure) activities, which are currently expected to be completed in 2026.

Groundwater polishing processes will continue before and after source control implementation and may be a viable corrective measure for the boron, sulfate, and TDS exceedances at AP1. Therefore, these processes are being advanced to the CAAA for further evaluation.

5.2.2 Source Control with Groundwater Extraction

Source control will reduce the mass loading to the groundwater system and implementing a groundwater extraction system may reduce the time required to attain the GWPS in the UA.

However, the groundwater impacts already present in the low permeability PMP may limit the reduction in time to attain the GWPS that can be achieved by a groundwater extraction system.

Groundwater extraction is a widely accepted corrective measure with a long track record of performance and reliability. It is routinely approved by the IEPA. For a corrective measure using groundwater extraction to effectively control groundwater flow and/or to remove potentially contaminated groundwater, horizontal and vertical capture zone(s) must be created. However, the heterogeneous, varied nature of the UA may result in variable performance of pumping wells. Additionally, the groundwater flow direction and location of the discharge flume under consideration for AP2 may complicate design and may affect performance of a pumping well system. An alternative method for controlling groundwater flow and removing potentially contaminated groundwater could include constructing a discharge trench by lowering the normal water level in the discharge flume located north of AP1 (*i.e.,* dewatering). This option is being considered as part of the corrective measures assessment for AP2 and could passively increase the hydraulic gradient and corresponding groundwater flow velocities between AP1 and the discharge flume, without the need for groundwater collection or active pumping. Cutoff walls (**Section 4.3**) could also be used in conjunction with a pumping system to control potential groundwater movement from the flume.

Implementation of a groundwater extraction system presents design challenges due to the heterogeneous, varied nature of the UA and proximity to the discharge flume. An extraction system in the UA would have to consider the potential for extracting water from the discharge flume. Extracted groundwater would require management, possibly including treatment, which may require specialized equipment and/or contractors. Construction of an extraction system to intercept the natural groundwater flow to the north, or conversion of the flume into an extraction trench, would introduce challenges related to construction access and relocating compliance wells so that they are not affected by other site features.

There could be some impacts associated with constructing and operating a groundwater extraction system, including altering of the groundwater flow system and some limited exposure to extracted groundwater. Additional data collection and analyses would be required to design an extraction system. Construction could be completed within 1 year following completion of a final design. Time of implementation is approximately 3 to 4 years after approval of the CAP permit, including characterization, design, permitting, and construction. Timeframes to achieve GWPS are dependent on site-specific conditions. An extraction system may reduce the time to attain GWPS in the UA relative to the post-closure timeframe predicted by the groundwater modeling. However, accelerated attainment of the GWPS may be limited by the heterogeneity of the UA.

Implementing a groundwater extraction system at AP1 would require IEPA approval of the CAP permit, and discharge of extracted groundwater may require a modification to the NPDES permit, as well as possibly permitting and construction of a new outfall. Depending upon the location of the extraction system, an Illinois Department of Natural Resources (IDNR) dam safety modification permit may also be required to construct an extraction system. The potential for wetlands impacts would require evaluation, depending upon the location of the extraction system.

Groundwater extraction could be viable corrective measure for the boron, sulfate, and TDS exceedances at AP1. Therefore, implementation of groundwater extraction by constructing a groundwater extraction trench is being advanced to the CAAA for further evaluation.

5.2.3 Source Control with Groundwater Cutoff Wall

Source control will reduce the mass loading to the groundwater system and implementing additional groundwater corrective measures may reduce the time required to attain the GWPS in the UA. Groundwater cutoff walls are a widely accepted corrective measure used to control and/or isolate impacted groundwater and are routinely approved by the IEPA. Cutoff walls have a long history of reliable performance as hydraulic barriers, provided they are properly designed and constructed. However, if not coupled with a groundwater extraction system, a cutoff wall will provide directional groundwater control only and may result in redistribution of contaminants and potentially GWPS exceedances at new locations.

Cutoff walls are designed to act as hydraulic barriers; as a result, cutoff walls inherently alter the existing groundwater flow system. Changes to the existing groundwater flow system may need to be controlled to maximize the effectiveness of the remedy by, for example, combining a cutoff wall with groundwater extraction to control build-up of hydraulic head upgradient and around the cutoff walls. The effectiveness of a cutoff wall as a hydraulic barrier also relies on the contrast between the hydraulic conductivity of the aquifer and the cutoff wall. The most effective barriers have hydraulic conductivity values that are several orders of magnitude lower than the geologic materials they are in contact with. A cutoff wall designed with hydraulic conductivity of 1×10^{-7} cm/sec would two to four orders of magnitude lower than the UA, which has hydraulic conductivities from 1.7×10^{-5} to 9.1×10^{-3} cm/s (Ramboll, 2021), and would be an effective containment method in the UA and could improve the performance of a UA extraction system.

Constructing a cutoff wall could result in structural impacts to the AP1 and AP2 embankment dikes, depending on the location of the wall. Specialized construction contractor(s) may be required, which could delay implementation.

Additional data collection and analyses would be required to design a cutoff wall. The time to implement a cutoff wall is approximately 4 to 5 years, including characterization, design, permitting, and construction. Construction could possibly be accelerated by combining with site closure activities. To attain GWPS, cutoff walls require a separate groundwater corrective measure to operate in concert with the cutoff wall(s). Cutoff walls are commonly coupled with groundwater polishing and/or groundwater extraction as groundwater corrective measures. The time to attain GWPS is dependent on the selected groundwater corrective measure or measures that are coupled with the cutoff walls.

Constructing a cutoff wall at AP1 would require IEPA approval of the CAP permit and, depending on the location, an IDNR dam safety modification permit may be required. The potential for wetlands impacts would require evaluation, depending upon the location of the cutoff wall.

Due to the uncertain performance, reliability, and requirement that a cutoff wall be coupled with other groundwater corrective measures, a cutoff wall is not a viable corrective measure for the boron, sulfate, and TDS exceedances at AP1. Therefore, it is not being advanced to the CAAA for further evaluation.

5.2.4 Source Control with In-Situ Treatment

Source control will reduce the mass loading to the groundwater system and implementing additional groundwater corrective measures may reduce the time required to attain the GWPS in the UA. Use of in-situ treatment, either through targeted injection of reactive media or in PRB

systems, to transform contaminants into environmentally acceptable forms to attain the GWPS was considered.

In-situ treatment using IX to address boron, sulfate, and TDS exceedances in groundwater is not an established or widely accepted groundwater corrective measure; therefore, its performance and reliability are unknown. Regulatory acceptance of this innovative approach to achieving the GWPS is uncertain.

In-situ treatment presents design and construction challenges, including targeted reactive media delivery via injection to the low permeability PMP and to the heterogeneous and discontinuous UA. Depending upon the location of the PRB system, construction may affect AP1 embankment and/or final cover system and periodic change-outs of IX resin media may be required.

Additional data collection and analyses would be required to design an in-situ treatment system and bench scale and/or pilot scale testing may be required to demonstrate performance and reliability. Time of implementation is approximately 4 to 6 years after approval of the CAP permit, including characterization, design, permitting, and construction. Timeframes to achieve GWPS are dependent on demonstrations of performance and reliability and on ultimate regulatory acceptance. It is not known whether in-situ treatment would reduce the time to attain GWPS in the UA relative to the post-closure timeframe predicted by the groundwater modeling.

Due to the uncertain performance, reliability, and potential for regulatory acceptance, in-situ chemical treatment is not a viable corrective measure for the boron, sulfate, and TDS exceedances at AP1 and is not being advanced to the CAAA for further evaluation.

5.3 Technologies Advanced to CAAA

Based on the evaluations presented above, the following potential corrective technologies are being advanced to the CAAA, individually or in combination, for more detailed evaluations:

- Source control with groundwater polishing; and,
- Source control and with groundwater extraction.

6. REFERENCES

D'Appolonia, D.J., and Ryan, C.R., 1979, *Soil-Bentonite Slurry Trench Cut-Off Wall*s, Geotechnical Exhibition and Technical Conference, Chicago, Illinois.

Electric Power Research Institute (EPRI), 2006. *Groundwater Remediation of Inorganic Constituents at Coal Combustion Project Management Sites, Technical Report #1012584*, October 2006.

Gavaskar, A.R., N Gupta, B.M. Sass, R.J. Janosy and D. O'Sullivan, 1998. *Permeable Reactive Barriers for Groundwater Remediation: Design, Construction and Monitoring*. Battelle Press.

Golder Associates USA, Inc., 2022. *Part 845 Construction Permit Application for Ash Pond No. 1, Coffeen Power Plant.* July 28, 2022.

Interstate Technology & Regulatory Council (ITRC), 2017. *Remediation Management of Complex Sites*. RMCS-1. Washington, D.C.: Interstate Technology & Regulatory Council, Remediation Management of Complex Sites Team. https://rmcs-1.itrcweb.org.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017. *Hydrogeologic Monitoring Plan, Coffeen Ash Pond No. 1 - CCR Unit ID 101, Coffeen Ash Pond No. 2 - CCR Unit ID 102, Coffeen GMF Gypsum Stack Pond - CCR Unit ID 103, Coffeen GMF Recycle Pond - CCR Unit ID 104, Coffeen Landfill - CCR Unit ID 105, Coffeen Power Station, Coffeen, Illinois.* October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. *Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois*. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2022*. Groundwater Modeling Report*. Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois. July 28, 2022.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2023. 35 I.A.C. § 845.610(b)(3)(D) Groundwater Monitoring Data and Detected Exceedances, Quarter 2, 2023, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois. October 16, 2023.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2024a. 35 I.A.C. § 845.610(b)(3)(D) Groundwater Monitoring Data and Detected Exceedances, Quarter 3, 2023, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois. January 20, 2024.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2024b. 35 I.A.C. § 845.610(b)(3)(D) Groundwater Monitoring Data and Detected Exceedances, Quarter 4, 2023, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois. March 10, 2024.

United States Environmental Protection Agency (USEPA), 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Directive No. 9200.U-17P*. Washington, D.C.: EPA, Office of Solid Waste and Emergency Response.

United States Environmental Protection Agency (USEPA), 2007*. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 – Technical Basis for Assessment.*

EPA/600/R-07/139. National Risk Management Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. October 2007.

United States Environmental Protection Agency (USEPA), 2015a. *80 FR 21302 - Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities*. Federal Register Volume 80, Issue 74. April 17, 2015.

United States Environmental Protection Agency (USEPA), 2015b. *Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites. Directive No. 9283.1-36*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. August 2015.

United States Environmental Protection Agency (USEPA), 2022. *Adaptive Site Management – A Framework for Implementing Adaptive Management at Contaminated Sediment Superfund Sites. Directive No. 9200.1-166*. U.S. Environmental Protection Agency. June 2022.

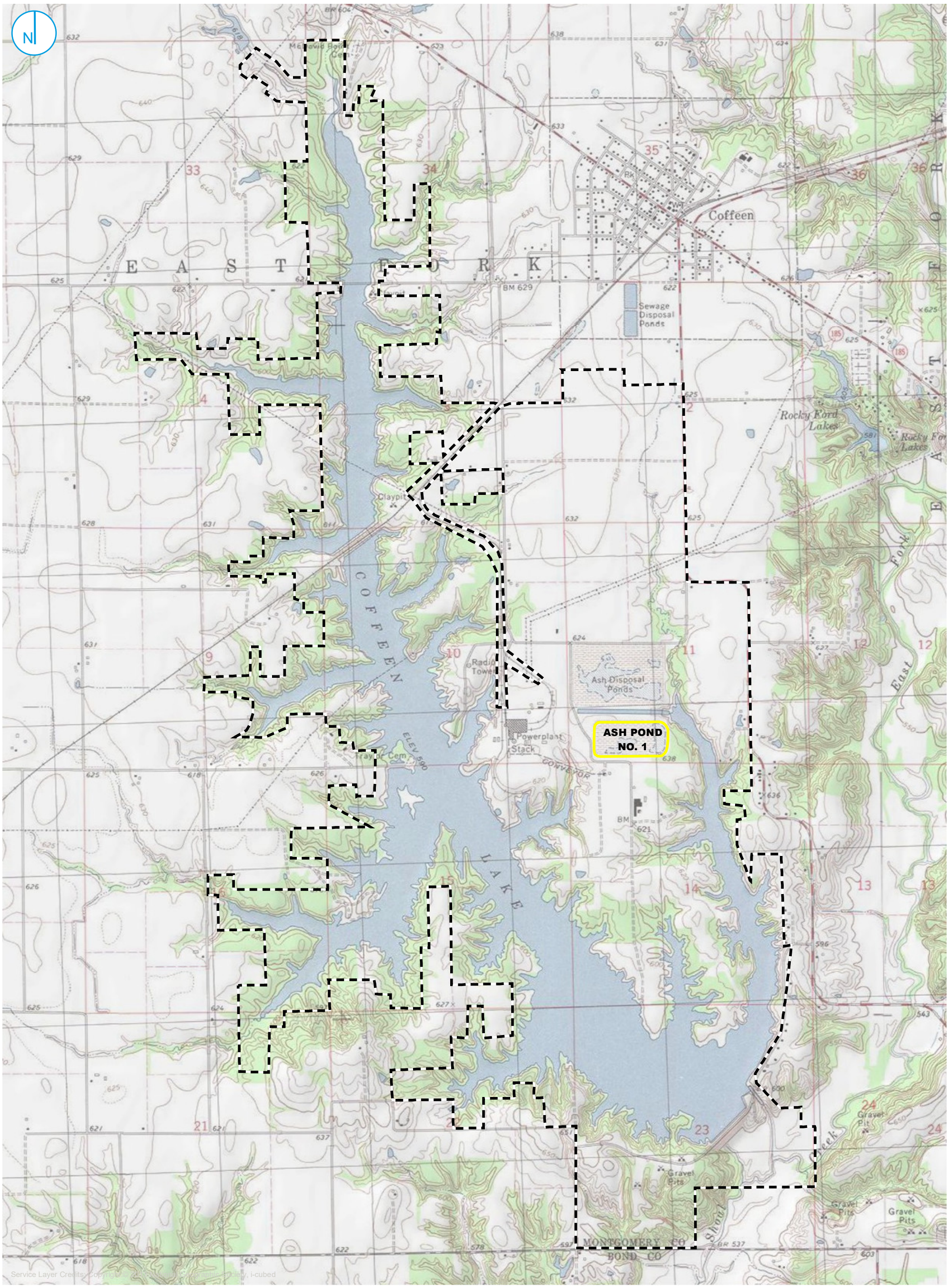
TABLES

Table 5-1.
CORRECTIVE MEASURES ASSESSMENT MATRIX
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS
June 12, 2024

Remedy	Evaluation Factors						
	Performance	**Reliability**	**Ease of Implementation**	**Potential Impacts of Remedy (safety impacts, cross-media impacts, control of exposure to any residual contamination)**	**Time Required to Begin and Implement Remedy[1]**	**Time to Attain Groundwater Protection Standards**	**Institutional Requirements (state/local permit requirements, environmental/public health requirements that affect implementation of remedy)**
Source Control with Groundwater Polishing	Performs best paired with source control, which is expected to be completed prior to 2026. Site conditions are favorable for physical processes, while chemical processes may limited under normal aquifer conditions.	Ongoing analysis will evaluate if the attenuation mechanism has low reversibility, the aquifer has sufficient capacity, and the hydrogeology is favorable for dilution/dispersion.	Long-term monitoring would be required. Implementing would not require extensive specialized equipment or contractors	None identified.	Approximately 90 days after CAP permit approval.	Less than the 15 to 18 years post-closure predicted by the groundwater model at all locations except G301, where the model indicates attainment of the GWPS will take 59 years.	IEPA approval of the closure and CAP permits is required.
Source Control with Groundwater Extraction	Widely accepted and routinely approved technology; variable performance anticipated due to the heterogeneous, varied nature of Uppermost Aquifer and possibly due to proximity of CPP discharge flume (extraction system may capture water from the flume). Deepening the flume to construct an extraction trench under consideration for AP2 may also contribute to performance.	Reliable if properly designed, constructed and maintained. The heterogeneous, varied nature of Uppermost Aquifer may present reliability challenges for pumping wells; a trench may be more reliable.	Design challenges due to heterogeneous, varied nature of Uppermost Aquifer. Specialized contractors unlikely to be necessary. Extracted groundwater would require management, possibly including treatment, which may require specialized equipment/contractors. Construction of an extraction system to intercept the natural groundwater flow to the north would introduce challenges related to construction access and relocating compliance wells so that they are not affected by other site features.	Alters groundwater flow system and there is the some limited potential for contact exposure to extracted groundwater. Groundwater extraction may induce settlement, which could cause structural impacts to the AP1 or AP2 embankments, and/or adjacent structures. The construction of trenches could also cause stability impacts to the AP2 dikes and/or adjacent structures.	Design, permitting and construction is expected to take 3 to 4 years after CAP permit approval. Additional time may be required to permit a trench and a new compliance monitoring well network.	Dependent on site-specific conditions. Accelerated attainment of GWPS will be limited by the low permeability and heterogeneity of the Uppermost Aquifer and may not significantly improve attainment of the GWPS.	IEPA approval of the closure and CAP permits is required. Extracted groundwater could likely be discharged under the NPDES permit. Approval from IEPA for modifications to the compliance monitoring well network proposed in the operating permit would be required. A IDNR dam safety modification permit might also be required, depending on the location of wells and settlement potential and/or extraction trench. If an extraction trench is used, additional permitting related to construction in wetlands and/or Waters of the United States may be required, if they are determined to be present at the site.
Source Control with Groundwater Cutoff Wall	Widely accepted and routinely approved technology with good performance if properly designed and constructed. If not combined with groundwater extraction, a cutoff wall will provide directional control only, thus redirecting flow to other areas where GWPS may be exceeded.	Reliable for groundwater directional control if properly designed and constructed.	Widely used, established technology. May require specialized contractors depending upon the construction/implementation method.	Alters groundwater flow system but does not provide any treatment. Can result in unintended consequences resulting from redirecting contaminants to areas where they are not currently present. May cause structural impacts to the AP1 or AP2 embankments, depending on the location of the wall.	Design, permitting and construction is expected to take 4 to 5 years after CAP approval. Implementation could be accelerated by combining with closure construction activities.	Provides groundwater directional control only. Combination with other groundwater corrective measure(s), such as groundwater extraction or permeable reactive barrier, would reduce the time required to achieve and attain GWPS.	IEPA approval of the closure and CAP permits is required. An IDNR dam safety permit may also be required depending on the location of the cutoff wall. May also require an evaluation and/or permits related to wetlands, if determined to be present in the area of the proposed remedy.
Source Control with In-Situ Treatment (Permeable Reactive Barrier or In-situ Chemical Treatment)	In-situ treatment using IX resins not well established for sulfate or boron; therefore, performance is unknown.	Unknown reliability for sulfate or boron.	Design challenges related to reactive material delivery due to heterogenous, discontinuous nature of Uppermost Aquifer. Could require periodic change-outs of resin media.	May cause structural impacts to the embankment dikes, depending on the location of the PRB.	May require bench scale and/or pilot scale testing as part of design. Design, permitting and construction is expected to take 4 to 6 years after CAP approval.	There is uncertainty regarding whether a in-situ treatment would reduce sulfate or boron concentrations to achieve the GWPS. Dependent on conditions specific to the reactive media used and the site. Treatment technology is not well understood.	IEPA approval of the CAP permit is required. IEPA approval of this innovative and relatively unproved solution may be challenging. An IDNR dam safety permit may also be required depending on the location of wells/PRB. May also require an evaluation and/or permits related to wetlands, if determined to be present in the area of the proposed remedy.

Notes:
[1] Time required to begin and implement remedy includes design, permitting, and construction.
GWPS - groundwater protection standard
AP1 - Ash Pond No. 1
AP2 - Ash Pond No. 2
CAP - Corrective Action Plan
CPP - Coffeen Power Plant
IDNR - Illinois Department of Natural Resources
IEPA - Illinois Environmental Protection Agency
IX - Ion Exchange
PRB - Permeable Reactive Barrier

FIGURES



REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 1,000 2,000 Feet

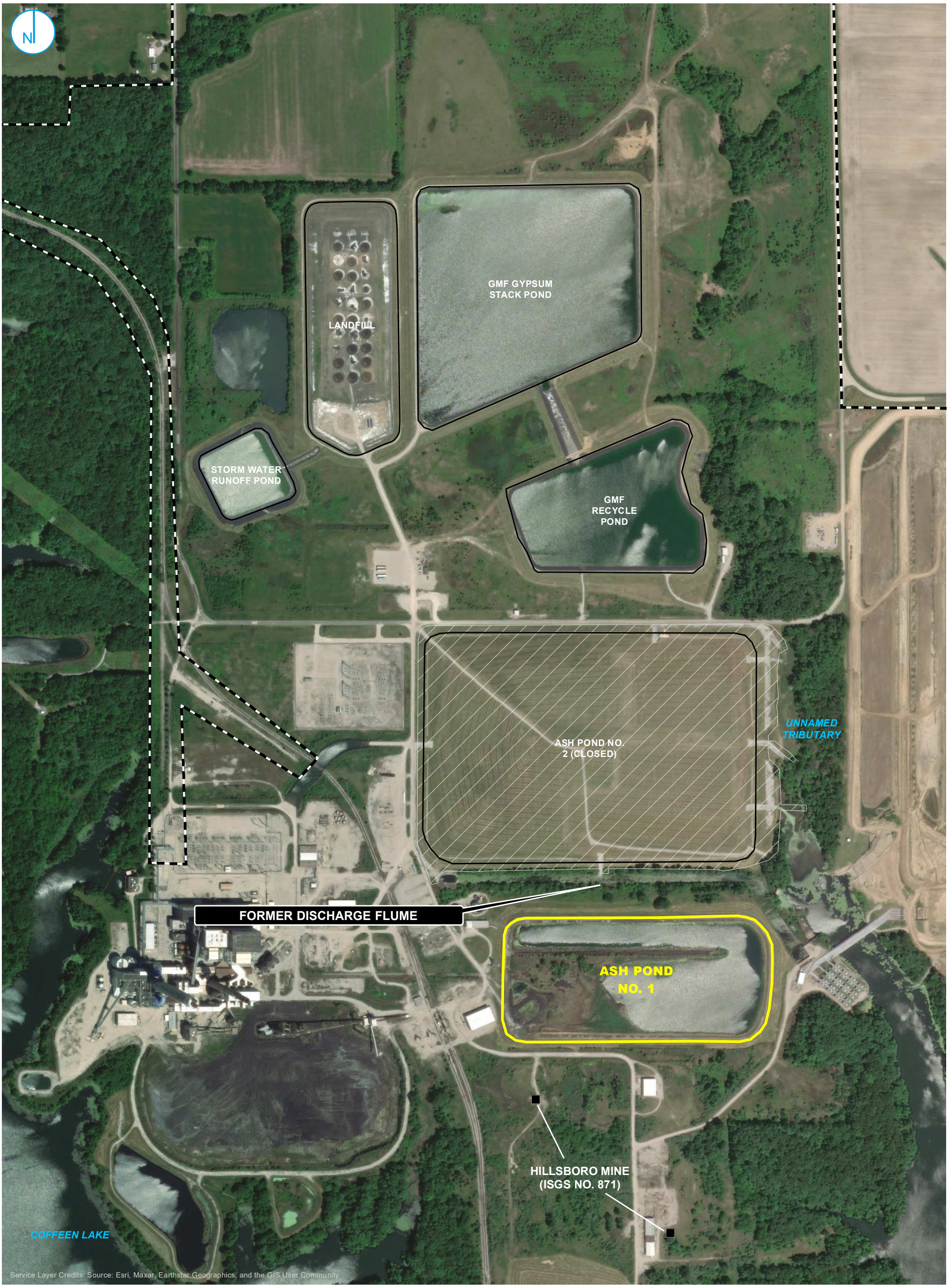
SITE LOCATION MAP

FIGURE 2-1

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
ASH POND NO.1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



- COAL MINE SHAFT
- REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 275 550 Feet

SITE MAP

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
ASH POND NO.1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

- COMPLIANCE MONITORING WELL
- BACKGROUND MONITORING WELL
- MONITORING WELL
- SOURCE SAMPLE LOCATION
- LEACHATE WELL
- STAFF GAGE, CCR UNIT
- STAFF GAGE, RIVER
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 325 650 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

POTENTIOMETRIC SURFACE MAP
APRIL 30, 2023

2023 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-3

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_PermitCoffeen\AP1\GMP\Figure 2-1_Proposed Monitoring Well Network.mxd

PROJECT: 169000XXXX | DATED: 10/12/2021 | DESIGNER: HOTCALD

COMPLIANCE WELL
BACKGROUND WELL
STAFF GAGE
REGULATED UNIT (SUBJECT UNIT) SITE
FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 200 400 Feet

MONITORING WELL LOCATION MAP

35 I.A.C. § 845 CORRECTIVE MEASURES ASSESSMENT
ASH POND NO.1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

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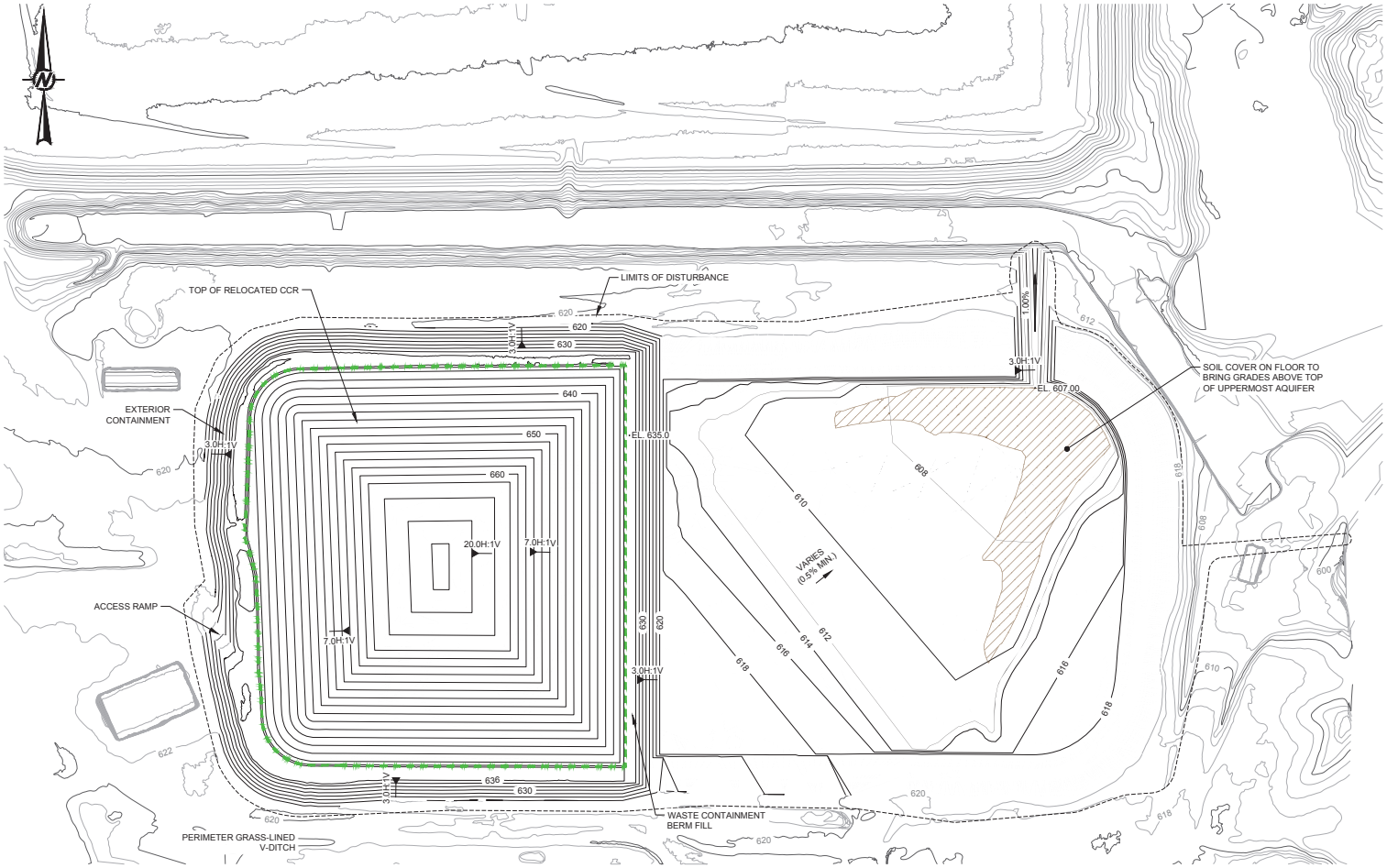
ATTACHMENT A
Selected Construction Permit Application Plans



LEGEND

- 600 — AP1 CLOSURE IN PLACE GRADES (SEE NOTES 1 AND 2)
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 3)
- LIMITS OF RELOCATED CCR WASTE
- PROPOSED STORMWATER FLOW PATH
- LIMITS OF DISTURBANCE

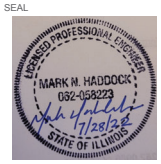
NOTE(S)

1. THE CLOSURE-IN-PLACE CONCEPT FOR ASH POND NO. 1 (AP1) INVOLVES REMOVAL OF PONDED WATER, CONSTRUCTION OF A CCR WASTE CONTAINMENT BERM, REMOVAL AND RELOCATION OF CCR WASTE AND 1 FT (MAX.) OF SUBSOIL EAST OF THE BERM TO WITHIN THE CONSOLIDATED FOOTPRINT, PLACEMENT OF SOIL COVER ON PORTIONS OF THE AP1 FLOOR EAST OF THE BERM, AND FINAL COVER CONSTRUCTION OVER THE CONSOLIDATED FOOTPRINT.
2. AP1 CLOSURE IN PLACE GRADES INCLUDE RELOCATED CCR WASTE, WASTE CONTAINMENT BERM, SOIL COVER OVER THE TOP OF THE UPPERMOST AQUIFER, AND PERIMETER GRADING AROUND AP1 EXTERIOR SIDE SLOPES.
3. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 12/3/2020 AND TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 12/3/2020 & 12/4/2020.

0 100 200
1" = 100' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-07-28	ISSUED FOR PERMIT APPLICATION	ETF	ETF	MWD	MNH

SEAL



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PROJECT
ASH POND NO. 1 CONSTRUCTION PERMIT APPLICATION

TITLE
ASH REGRADING AND CONTAINMENT PLAN

PROJECT NO.	REV.	3 of 6	DRAWING
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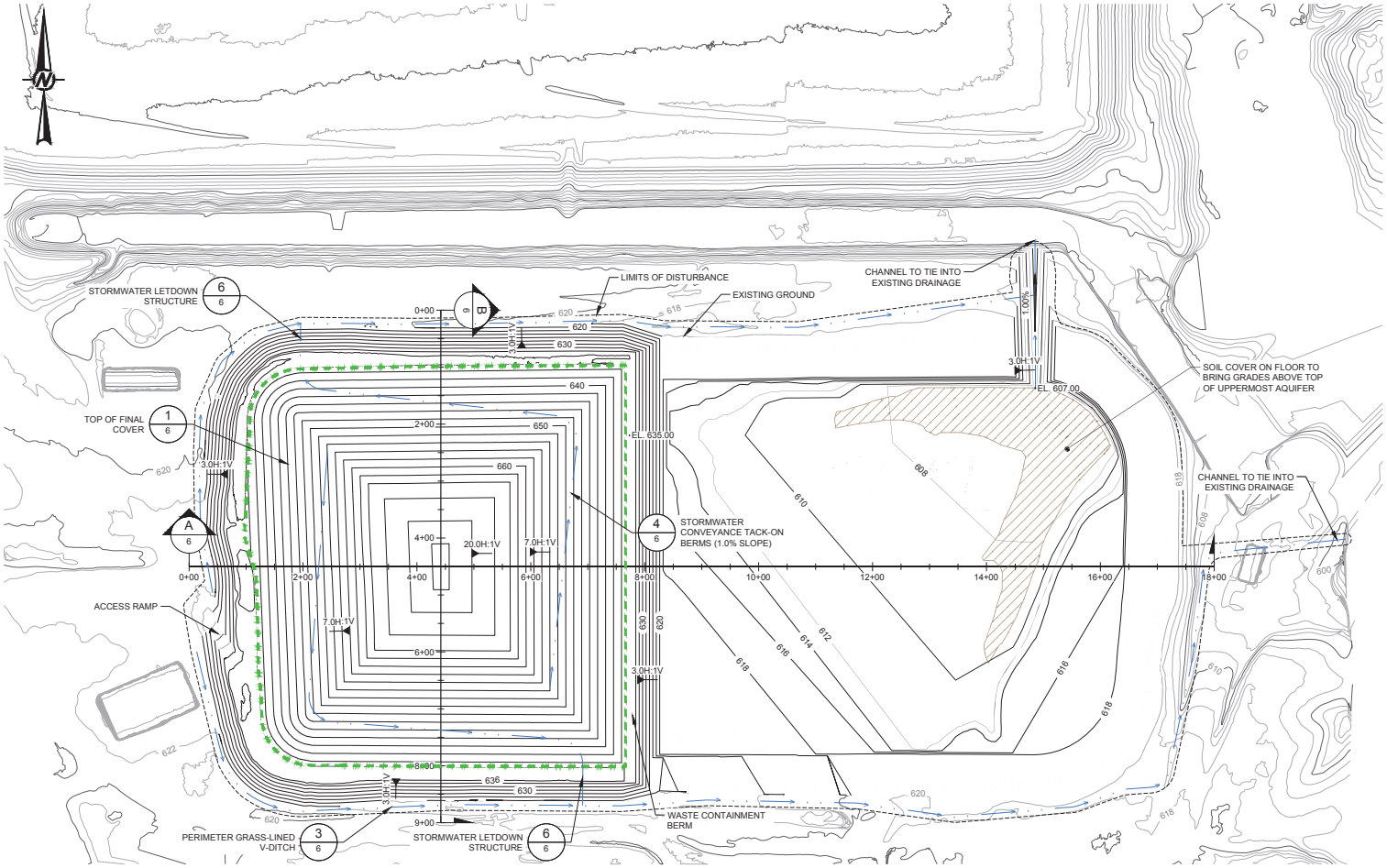

LEGEND

- 600 — FINAL CLOSURE IN PLACE GRADES (SEE NOTES 1 AND 2)
- 600 — EXISTING GROUND CONTOURS (SEE NOTE 3)
- LIMIT OF RELOCATED CCR WASTE
- PROPOSED STORMWATER FLOW PATH
- LIMITS OF DISTURBANCE

NOTE(S)

1. THE CLOSURE-IN-PLACE CONCEPT FOR ASH POND NO. 1 (AP1) INVOLVES REMOVAL OF PONDED WATER, CONSTRUCTION OF A CCR STRUCTURAL WASTE CONTAINMENT BERM, REMOVAL AND RELOCATION OF ASH AND 1 FT (MAX.) OF SUBSOIL EAST OF THE BERM TO WITHIN THE CONSOLIDATED FOOTPRINT, PLACEMENT OF SOIL COVER ON PORTIONS OF AP1 FLOOR EAST OF THE BERM, AND FINAL COVER CONSTRUCTION.
2. FINAL GRADES INCLUDE FINAL COVER, WASTE CONTAINMENT BERM, SOIL COVER OVER TOP OF UPPERMOST AQUIFER, AND PERIMETER GRADING AROUND AP1 EXTERIOR SIDE SLOPES.
3. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 12/3/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 12/3/2020 & 12/4/2020.
4. THE PROPOSED STORMWATER DRAINAGE CONCEPT IS TO SHED WATER INTO EXISTING DRAINAGE CHANNELS NORTH AND EAST OF THE FACILITY. STORMWATER COLLECTED WITHIN AP1 WILL BE DIRECTED INTO AN OPEN CHANNEL THAT BREACHES THE CONSTRUCTED BERM TO CONNECT TO THE EXISTING DRAINAGE.

0 100 200
1" = 100' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-07-28	ISSUED FOR PERMIT APPLICATION	ETF	ETF	MWD	MNH

SEAL

LICENSED PROFESSIONAL ENGINEER
MARK M. HADDOCK
062-058223
7/28/22
STATE OF ILLINOIS

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COFFEEN POWER PLANT

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PROJECT
ASH POND NO. 1 CONSTRUCTION PERMIT APPLICATION

TITLE
FINAL COVER AND STORMWATER PLAN

PROJECT NO. 21465046 | REV. A | 4 of 6 | DRAWING 4

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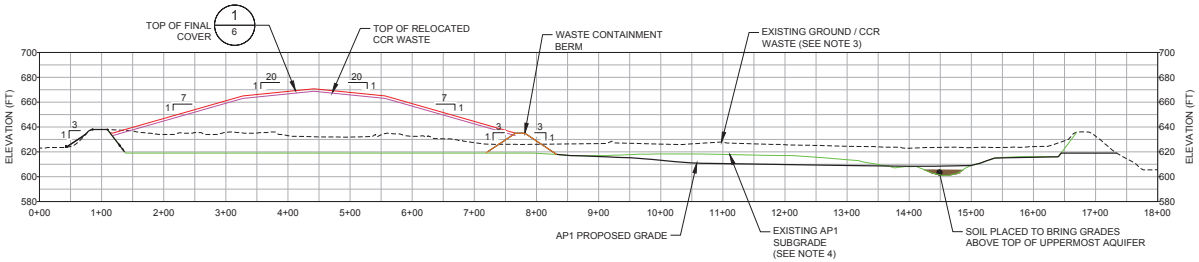
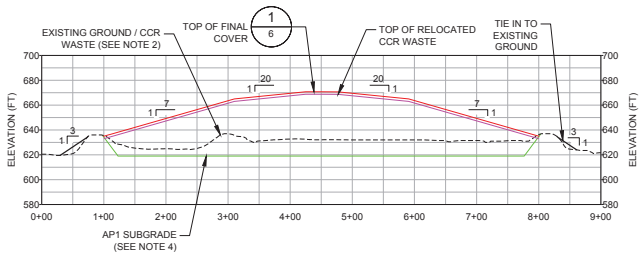
NOTE(S)

1. THE CLOSURE-IN-PLACE CONCEPT FOR ASH POND NO.1 (AP1) INVOLVES REMOVAL OF PONDED WATER, CONSTRUCTION OF A WASTE CONTAINMENT BERM, REMOVAL AND RELOCATION OF CCR WASTE AND 1 FT (MAX.) OF SUBSOIL EAST OF THE BERM TO WITHIN THE CONSOLIDATED FOOTPRINT, PLACEMENT OF SOIL COVER ON PORTIONS OF AP1 FLOOR EAST OF THE BERM, AND FINAL COVER CONSTRUCTION OVER THE CONSOLIDATED FOOTPRINT.
2. AP1 BASE OF ASH GRADES WERE DEVELOPED FROM THE 1963 EARTHWORK AND GRADING PLANS.
3. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 12/3/2020 AND TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 12/3/2020 & 12/4/2020.



SCALE 1" = 100'
VERT. SCALE X2

A / 6 SECTION A



SCALE 1" = 100'
VERT. SCALE X2

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A	2022-07-28	ISSUED FOR PERMIT APPLICATION	ETF	ETF	MWD	MNH

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PROJECT
ASH POND NO. 1 CONSTRUCTION PERMIT APPLICATION

TITLE
CROSS SECTIONS

PROJECT NO.	REV.	5 of 6	DRAWING
21465046	A		5

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Appendix D

Nature and Extent Report

Intended for

Illinois Power Generating Company
134 CIPS Lane
Coffeen, IL 62017
Montgomery County

Date

June 12, 2024

Project No.

1940103584-002

NATURE AND EXTENT REPORT

COFFEEN POWER PLANT, ASH POND NO. 1, IEPA ID NO. W1350150004-01

RAMBOLL Bright ideas. Sustainable change.

NATURE AND EXTENT REPORT
COFFEEN POWER PLANT, ASH POND NO. 1, IEPA ID NO. W1350150004-01

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940103584-002**
Recipient	**Illinois Power Generating Company**
Document type	**Nature and Extent Report**
Revision	**Final**
Date	**June 12, 2024**
Prepared by	**Alison O'Connor, PhD and Nathaniel Keller**
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APPENDICES

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Appendix C Surface Water Sampling Locations and Laboratory Analytical Report
Appendix D Geochemical Conceptual Site Model

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CMA	Corrective Measures Assessment
CPP	Coffeen Power Plant
CSM	conceptual site model
DA	deep aquifer
E001	Event 1
E002	Event 2
E003	Event 3
ft/ft	feet per foot
GCSM	geochemical conceptual site model
GMF	Gypsum Management Facility
GSP	Gypsum Stack Pond
GWPS	groundwater protection standard
HCR	Hydrogeologic Site Characterization Report
HDPE	high-density polyethylene
IEPA	Illinois Environmental Protection Agency
IPGC	Illinois Power Generating Company
LCL	lower confidence limit
LCU	lower confining unit
LF	Landfill
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
No.	number
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RP	Recycle Pond
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
UCU	upper confining unit
USGS	United States Geological Survey
WPCP	Water Pollution Control Permit

EXECUTIVE SUMMARY

Groundwater samples collected at the Coffeen Power Plant (CPP) Ash Pond Number (No.) 1 (AP1) during June 2023 for the Quarter 2, 2023 compliance sampling event (Event 1 [E001]) were evaluated for exceedances of the groundwater protection standards (GWPS) described in Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600. Exceedances were identified in the following hydrostratigraphic units and wells:

- Uppermost aquifer (UA) Exceedances:
  - Boron at G313
  - Sulfate at G301, G303, G305, G307, G308, G310, G312, and G313
  - Total dissolved solids (TDS) at G303, G305, G308, G312, G313, and G315
- Lower Confining Unit (LCU) (potential migration pathway [PMP]) Exceedances:
  - Sulfate at G307D, G314, and G316
  - TDS at G314 and G316
- Deep Aquifer (DA) (PMP) Exceedances:
  - Sulfate at G314D
  - TDS at G314D

As a result of the identified E001 exceedances, a Corrective Measures Assessment (CMA) was initiated on January 14, 2024 in accordance with 35 I.A.C. § 845.660 and submitted on June 12, 2024 [1]. The subsequent compliance sampling events for the Quarter 3 and Quarter 4, 2023 sampling events (Event 2 [E002] and Event 3 [E003]) were completed in August and November 2023 and groundwater samples were evaluated for exceedances of the GWPS as described in 35 I.A.C. § 845.600. Exceedances identified during the E002 event were consistent with those listed above. In addition to the exceedances listed above, the following exceedance was identified in the UA during the E003 Event:

- TDS at G310

Pursuant to 35 I.A.C. § 845.650(e), potential alternative sources for the GWPS exceedances were evaluated, but were not conclusive in demonstrating an alternative source for the GWPS exceedances.

As required by 35 I.A.C. § 845.650(d)(1), this report characterizes the nature and extent of boron, sulfate, and TDS, and relevant site conditions to determine how they may affect the corrective measures ultimately selected for AP1 and documents the additional measures taken in accordance with 35 I.A.C. § 845.650(d).

A boron statistical exceedance of the GWPS was encountered only within the UA at G313. The lateral extent of boron statistical exceedances is defined by existing monitoring wells and surface water samples collected from the former discharge flume and Coffeen Lake. Vertically, the extent of boron statistical exceedances of the GWPS is limited by the presence of low permeability tills, as evidenced by the lack of boron exceedances in the underlying LCU and DA monitoring wells. The boron concentrations are attenuated via surface complexation reactions and by interactions

with clay minerals, which are present in solids across the UA, LCU, and DA. The boron concentrations in Coffeen Lake were evaluated and they do not present unacceptable risk [2].

Sulfate and TDS statistical exceedances of the GWPS were encountered within the three hydrostratigraphic units: the UA, LCU, the DA. In the UA, the extent of sulfate and TDS statistical exceedances of the GWPS are laterally defined to the north and east of AP1 by surface water samples collected from the former discharge flume and Coffeen Lake, while the extent of impacts in the LCU and DA are defined by groundwater flow directions and the results from Coffeen Lake. Delineation of sulfate and TDS statistical exceedances in the UA to the west of the north/south trending groundwater divide is not well defined because of the absence of compliance wells west of G305 and G308. However, westerly groundwater flow at these locations is likely toward a nearby historical drainage and eventually toward Coffeen Lake; the low concentrations of sulfate and TDS in Coffeen Lake surface water samples provides delineation to the west of AP1. The sulfate (and therefore TDS) concentrations are attenuated via surface complexation reactions. Batch attenuation testing with solids from the site indicate that chemical attenuation of sulfate could be limited. Sulfate and TDS concentrations in Coffeen Lake were evaluated and they do not present unacceptable risk [2].

1. INTRODUCTION

35 I.A.C. § 845.650(d)(1) requires the owner or operator of a coal combustion residuals (CCR) surface impoundment (SI) to characterize the nature and extent of a release and relevant site conditions that may affect the remedy ultimately selected for a CCR SI if any constituent regulated under 35 I.A.C. § 845 is found to exceed the GWPS. This report documents the nature and extent of constituents detected above the GWPS that are attributable to the CPP AP1.

The groundwater data and analysis in this report includes results from historical sampling (initiated in 2015) through E003, which was completed on November 21, 2023. Results of the E001, E002, and E003 events were submitted and placed in the facility's operating record by October 16, 2023; January 20, 2024; and March 10, 2024, respectively, as required by 35 I.A.C. § 845.800(d)(15), within 60 days of receiving final laboratory analytical data [3, 4, 5]. The statistical determination presented in the reports identified the following exceedances of the GWPS at compliance groundwater wells in the following hydrostratigraphic units:

- Detected UA Exceedances:
  - Boron at G313
  - Sulfate at G301, G303, G305, G307, G308, G310, G312, and G313
  - TDS at G303, G305, G308, G310, G312, G313, and G315
- Detected LCU Exceedances:
  - Sulfate at G307D, G314, and G316
  - TDS at G314 and G316
- Detected DA Exceedances:
  - Sulfate at G314D
  - TDS at G314D

Pursuant to 35 I.A.C. § 845.650(e), the following were evaluated as potential alternative sources for each GWPS exceedance:

- Sources other than the CCR SI
- Error in sampling and analysis protocol
- Error in statistical analysis
- Natural variation in groundwater quality
- Change in the potentiometric surface and groundwater flow direction.

These evaluations were not conclusive in demonstrating an alternative source for the GWPS exceedances. This Nature and Extent Report discusses in detail the extent of the boron, sulfate, and TDS exceedances as well as a geochemical conceptual site model (GCSM) describing the nature of these exceedances.

2. UNIT BACKGROUND

2.1 Site Location and Description

The CPP is located in Montgomery County in central Illinois, approximately two miles south of the City of Coffeen and about eight miles southeast of the City of Hillsboro (**Figure 2-1**). The CPP was a coal-fired power plant with five CCR units present: AP1 (35 I.A.C. § 845 regulated CCR Unit and subject of this report), Ash Pond No. 2 (AP2), the Gypsum Management Facility (GMF) Gypsum Stack Pond (GSP), GMF Recycle Pond (RP), and Landfill (LF). AP1 is located in Section 11, Township 7 North and Range 3 West. AP1 is located east of the CPP and situated in a predominantly agricultural area (**Figure 2-2**). AP1 is located between two lobes of Coffeen Lake (the western lobe is identified as "Coffeen Lake" and the upper reaches of the eastern lobe are fed by a stream labeled as "Unnamed Tributary" on **Figure 2-2**). The northern edge of AP1 is adjacent to the former discharge flume for the closed generating plant. AP1 is bordered by Coffeen Lake to the east, former plant operations to the west and vacant forested land to the south.

2.2 Description of CCR Unit

The CPP was a coal-fired electrical generating plant that began operation in 1964. The plant initially burned bituminous coal from Illinois and CCR from the coal fired units was disposed of in AP1. AP2 was utilized for CCR disposal beginning in the early 1970's and AP1 was reconstructed in 1978. Both of these units were used until the mid-1980's, beginning in 2010 CCR material was placed in the LF and GMF Units.

- **AP1:** This SI (also known as the Bottom Ash/Recycle Pond) is a reclaimed ash pond that was reconstructed utilizing the existing earthen berms with reinforcement, as provided by Water Pollution Control Permit (WPCP) 1978-EA-389 issued by the Illinois Environmental Protection Agency (IEPA) on May 26, 1978. AP1 (existing unlined SI) covers an area of approximately 23 acres, has berms up to 41 feet above the surrounding land surface, and a volume of 300 acre-feet. It primarily received bottom ash and low volume wastes from floor drains in the main power block building. Several years ago, air heater wash and boiler chemical cleaning wastes were directed to AP1, but this practice was discontinued. The bottom ash was periodically removed for beneficial uses by a third-party contractor. Sluicing of waste to AP1 ceased prior to November 4, 2019. Review of historical aerial imagery of AP1 (observations summarized in **Figure 2-3**) illustrate the extent of CCR deposition through time as well as potential CCR variability (based on observed differences in color). Characterization of the CCR material, including total metals analysis of two samples of materials within AP1, and completion of monitoring wells screened within the CCR was completed in areas of AP1 that were safely accessible in 2021 to meet the requirements of 35 I.A.C. § 845 (**Figure 2-4**) (Hydrogeologic Site Characterization Report [HCR] [6]).

  Water that may come into contact with CCR within the footprint of AP1 becomes CCR source water. CCR source water samples, collected from the porewater monitoring wells (XPW01,

XPW02) screened within the CCR materials at AP1, were used to provide information for groundwater transport modeling[1]. The base of CCR at AP1 is shown in **Figure 2-5**.

- **AP2:** AP2 is a closed (IEPA-approved) SI with a surface area of approximately 60 acres and berms 47 feet higher than the surrounding land surface. AP2 was originally removed from service and capped in the mid 1980's. A clay and soil cap was placed on the surface of the pond with contouring and drainage provided to direct storm water to four engineered revetment down drain structures. Prior to capping, this pond was identified as Outfall 004 in the facility National Pollutant Discharge Elimination System operating permit, IL0000108. Additional closure activities include the construction of a geomembrane cover system that began in July 2019 and was completed on November 17, 2020. Construction was completed in accordance with the Closure and Post Closure Care Plan approved by the IEPA on January 30, 2018 [7].
- **GMF GSP:** The 37-acre GMF GSP received blowdown from the air emission scrubbers and was put into operation in 2010. Construction of the GMF GSP was in accordance with WPCP 2008-EA-4661 and features a composite 60-mil high-density polyethylene (HDPE) liner with 3 feet of recompacted soil with a hydraulic conductivity of 1 x 10^{-7} centimeters per second (cm/s) with internal piping and drains to collect contact water. Construction of the unit required excavation to an elevation of approximately 603 feet[2] and installation of a groundwater underdrain system to eliminate inward pressure on the liner prior to placement of CCR. The GMF GSP underdrain was actively pumped during construction but is no longer actively pumped. Illinois Power Generating Company (IPGC) ceased placement of waste to the GMF GSP prior to April 11, 2021.
- **GMF RP:** The 17-acre GMF RP received blowdown from the air emission scrubbers and was put into operation in 2010. Construction of the GMF RP was in accordance with WPCP 2008-EA-4661 and features a composite 60-mil HDPE liner with 3 feet of recompacted soil with a hydraulic conductivity of 1 x 10^{-7} cm/s with internal piping and drains to collect contact water. Construction of the unit required excavation to an elevation of approximately 601 feet and installation of a groundwater underdrain system to eliminate inward pressure on the liner prior to placement of CCR. The GMF RP underdrain is a passive, gravity drained system. IPGC ceased placement of waste to the GMF RP prior to April 11, 2021.
- **LF:** Fly ash was managed in a permitted composite lined landfill constructed in 2010. The LF has an active groundwater underdrain system that is currently being operated. Additionally, the ash landfill leachate collection system is restricted by rule to no more than one foot of leachate on the composite liner. An IEPA groundwater monitoring program is in effect for the GMF (under Bureau of Water) and Ash Landfill (under Bureau of Land).

[1] Per Federal Register 80 (21302), which promulgated the final Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257 rule, porewater concentrations should be used to characterize potential leaching from impoundments. As discussed further in USEPA's risk assessment of CCR SIs [17], porewater is "collected from the interstitial water between waste particles in surface impoundments as it occurs in the field," and concentrations within the porewater are "the most representative data available for impoundments because these data are field-measured concentrations of leachate." Therefore, CCR source water collected from porewater wells screened near the base of ash within the unit represents the CCR source term.

[2] All elevations in this report are referenced to North American Vertical Datum of 1988 (NAVD88) unless otherwise noted.

2.3 Geology and Hydrogeology

Significant site investigation has been completed at the CPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, AP1 has been well characterized and detailed in the HCR [6].

2.3.1 Hydrostratigraphic Units

In addition to the CCR, five hydrostratigraphic units have been identified at the CPP based on stratigraphic relationships and common hydrogeologic characteristics, and are summarized as follows:

- **Upper Confining Unit (UCU)**: Consists of the Loess Unit and the upper clayey portion of the Hagarstown Member which has generally lower vertical permeability and generally greater than 60 percent fines. This Unit was encountered across most of the CPP, with the exception of the eastern edges of the SIs near the Unnamed Tributary where the unit was eroded following deposition or locations where it has been excavated for construction.
- **Upper Aquifer (UA)**: This unit consists primarily of sand and sandy silts and clays at the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member. This unit is absent in several locations due to weathering and in others due to excavation during construction of the CCR Unit. The hydraulic characteristics of the Hagarstown Member are variable due to the different material compositions, but generally indicate the unit has a moderate hydraulic conductivity.
- **Lower Confining Unit (LCU)**: This unit is composed of the sandy clay till of the Vandalia Member, the silt of the Mulberry Grove Formation, and the compacted clay till of the Smithboro Member. The unit underlies the UA and was encountered in all boring locations on the CPP. Results from laboratory tests completed for vertical hydraulic conductivity indicate the Vandalia Member has a very low vertical hydraulic conductivity.
- **Deep Aquifer (DA)**: This unit consists primarily of sandy silt and sands of the Yarmouth Soil, which are thin (less than 5 feet) and discontinuous across the CPP.
- **Deep Confining Unit (DCU)**: This unit underlies the DA and is composed of the Banner Formation, of which the thick Lierle Clay is the first encountered unit. No boring penetrated the full thickness of this formation.

2.3.2 Uppermost Aquifer

The UA has been identified as the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member. This unit is continuous across the site, but hydraulic characteristics are variable as a result of the unit composition. The UA is absent in several locations due to weathering and in other locations due to excavation during construction of the CCR Unit. The UA exhibits a moderate hydraulic conductivity and is the most likely unit to indicate potential impacts from AP1. Based on the geologic information, the top of the aquifer is highest in elevation along the south-southwest side of AP1, with an elevation of approximately 608 feet. Except in areas where the UCU and UA have been eroded, the top of the UA is typically separated from overlying CCR material by several feet of the low permeability UCU, which consists of the Loess Unit and the upper clayey portion of the Hagarstown Member (**Figures 2-6** and **2-7**). The base of the UA is the top of the LCU, which contains the low permeability Vandalia Member, Mulberry Grove Member, and Smithboro Till.

2.3.3 Potential Migration Pathways

PMPs were interpreted using the lithologic composition and hydrogeologic properties (hydraulic conductivity, hydraulic position with respect to the unit) of the screened materials. In addition to the physical properties, the analytical results from the baseline groundwater monitoring performed in wells screened in the confining units and DA were used to identify PMPs. The UA is the first occurrence of groundwater and therefore the PMPs identified are in geologic units located below the UA. Monitoring wells G307D, G311D, G314, and G316 are considered LCU PMP monitoring locations and G314D is considered a DA PMP monitoring location. Wells G307D, G311D, G314, and G316 evaluate the potential for migration of impacts through the LCU where the UA is absent and potentially into the DA, where monitored.

2.3.4 Regional Bedrock Geology

Bedrock has not been investigated at the site due to the depth to bedrock and presence of two low permeability confining units underlying the UA and above the bedrock, and the intermittent coal beds found within the bedrock. There are no known monitoring wells or production wells screened within the bedrock at CPP. Bedrock has not been encountered at any borings on-site. A literature review was completed to supplement the site geology.

Detailed descriptions of the Pennsylvanian strata of Illinois were published by Willman et al. [8] and Kolata [9]. The Bond Formation includes all strata from the base of the Shoal Creek Limestone Member or the LaSalle Limestone Member to the top of the Millersville Limestone Member or the Livingstone Limestone Member. It is overlain by the Mattoon Formation and underlain by the Modesto Formation. It varies from less than 150 feet thick in eastern Illinois to over 300 feet thick in southeastern Illinois, averaging about 250 feet. The Bond Formation is characterized by a high percentage of limestone and calcareous clays and shales. The Bond and Modesto Formations of the McLeansboro Group also contain multiple thin (typically less than 2 feet) intermittent coal beds. The upper formation of the Kewanee Group is the Carbondale Formation which contains multiple coal beds, including the Herrin (No. 6) Coal, of varying thicknesses (up to 7 feet) [10]. It is bound by thick limestone members (up to 50 feet), the thickest and purest limestones in the Pennsylvanian System of Illinois. Gray shales constitute the greatest part of the formation, although thick channel sandstones are developed locally.

Two mines were operated historically in the vicinity of the site. The Hillsboro Mine located east/southeast of the GSP was operated by the Truax-Traer Coal Company from 1964-1970 and by the Consolidation Coal Company from 1971 through 1983. The mine targeted the Herrin Coal at a depth of 500 to 510 feet below ground surface (bgs), and geological reports included roof problems and slight floor heaving. The Clover Leaf No. 4 Mine located north of the GSP was operated by the Clover Leaf Coal Mining company and the Coffeen Coal Mining Company from 1906 through 1924. The mine targeted the Herrin Coal at a depth of 510 to 544 feet bgs. Geologic reports indicate a massive black shale roof, and unmined areas which could be related to water-bearing sandstones above the roof [11].

2.3.5 Water Table Elevation and Groundwater Flow Direction

Porewater (*i.e.,* CCR source water) elevations within AP1 (as observed in XPW01, XPW02, and XSG-01) are greater than the surrounding areas. The phreatic surface within AP1 in 2023 averaged approximately 629.5 feet, ranging from approximately 628.3 to 630.8 feet in XPW01 and XWP02, respectively (**Table 2-1**). As indicated in **Section 2.3.2**, the groundwater in the UA

is separated from overlying CCR material by a minimum thickness of 10 feet of the low permeability soils of the UCU, except along the eastern edge of AP1 where an incised stream gully was backfilled with native materials and CCR (**Figure 2-5**).

Overall groundwater flow within the UA is divided towards the two lobes of Coffeen Lake. The groundwater divide runs approximately through the center of the CPP, with groundwater east of the divide flowing east to southeast towards the Unnamed Tributary or the eastern lobe of Coffeen Lake and groundwater west of the divide flowing west to southwest towards the western lobe of Coffeen Lake. Groundwater flows north to northeast across AP1 (**Figure 2-8** and **Table 2-1**) toward the former discharge flume and Unnamed Tributary. Based on the elevations of the tributary and groundwater elevations measured east of the tributary (**Appendix A** and **Table 2-1**), the Unnamed Tributary is a hydraulic barrier and prevents groundwater migration east of the Unnamed Tributary. A minor component of flow is present to the southwest, likely toward a historical drainage present prior to AP1 construction and site development (**Appendix B**). During 2023, groundwater elevations in the UA in the vicinity of AP1 ranged from approximately 605 to 624 feet, with the exception of G307, which is the potentiometric high indicating the presence of the groundwater divide and was typically at or above 624 feet (**Figure 2-8**). Although elevations vary seasonally, the groundwater flow direction in the UA is consistent and likely controlled by the proximity and hydraulic connection to both the eastern and western lobes of Coffeen Lake.

LCU (PMP) groundwater elevations are slightly lower than those in the UA and exhibit similar variability in seasonal groundwater elevation as the UA. Groundwater elevation within the LCU ranged from about 590 to 623 feet in 2023 (**Figure 2-8** and **Appendix A**). LCU monitoring wells G307D, G311D, G314, and G316 are nearest AP1 and typically have groundwater elevations ranging from about 590 to 623 feet.

DA (PMP) groundwater elevations are generally lower than those in the UA and LCU (PMP) and ranged from approximately 576 to 618 feet in 2023 (**Figure 2-8** and **Appendix A**). DA monitoring well G314D is adjacent to the eastern boundary of AP1 and typically had groundwater elevations ranging from about 596 to 607 feet during 2023. A groundwater contour map was generated for the DA for the E002 event and groundwater flow within the DA generally follows subsurface topography for the unit (**Figure 2-9**).

No monitoring wells were installed in the UCU during 2021 investigation activities and no wells have historically been installed across solely the UCU because it is not present or is unsaturated where present at the CPP. Groundwater elevations within the DCU and bedrock unit are unknown because no wells are screened within these low hydraulic conductivity units.

2.3.5.1 Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated using available groundwater elevation data from February 2017 to November 2023 at nested well locations within the UA, LCU (upper and lower), and DA. Vertical hydraulic gradients for AP1 are presented in **Table 2-2** and well locations are shown on **Figure 2-8**. The results of the vertical hydraulic gradient calculations between hydrostratigraphic units are summarized below:

- UA to Upper LCU (Vandalia Member):
  - Vertical gradients at well nest G405/T408, located north of AP2, vary between upward and downward with an average (downward) vertical gradient of 0.02 feet per foot (ft/ft).

  - Vertical gradients at well nest G406/T409, located south of AP2 /northwest of AP1, vary between upward and downward with an average (upward) vertical gradient of -0.06 ft/ft. Since 2021, the vertical gradient observed at this well nest has been consistently upward, with the exception of August 2022.

- UA to Lower LCU (Smithboro Member)
  - Well nest G307/G307D, located south of AP1, has consistently downward vertical gradients with an average vertical gradient of 0.13 ft/ft.
  - In well nest G311/G311D gradients are consistently strongly downward, with an average vertical gradient of 0.71 ft/ft.
- Upper LCU (Vandalia Member) to Lower LCU (Smithboro Member)
  - Well nest T408/G45D, located north of AP2, has consistently downward vertical gradients with an average vertical gradient of 0.98 ft/ft. Beginning in 2020, vertical gradients observed at this well nest have become less strongly downward.
  - Vertical gradients at well nest G406/T409, located south of AP2/northwest of AP1, are consistently downward, with the exception of August 2022, with an average vertical gradient of 0.64 ft/ft. Beginning in 2020, vertical gradients observed at this well nest have become less strongly downward.
- LCU to DA
  - Vertical gradients at well nest G314/G314D, located east of AP1, are consistently downward, with an average vertical gradient of 0.69 ft/ft. Beginning in 2022, vertical gradients observed at this well nest have become progressively less strongly downward and the vertical gradient was observed to be upward (-0.01 ft/ft) during December 2023.

Vertical hydraulic gradients indicate there is consistently downward migration of groundwater in most areas of the CPP, with the exception being northwest of AP1, where consistent upward gradients were measured between the UA and upper LCU. However, overall, there has been a decrease in magnitude of downward gradients since approximately 2020, which is likely a result of plant shutdown and placement of a geomembrane on AP2.

2.3.5.2 Impact of Surface Water Bodies on Groundwater Flow

Surface water elevations were measured from various locations along the Unnamed Tributary from March 2021 to December 2023 (**Figure 2-8**). Elevations at SG-04 (near CIPS Trail and determined to be destroyed in October 2023) ranged from 591.94 to 593.38 feet. Surface water elevations near the former discharge flume located between AP1 and AP2 were measured at SG-02 and ranged from 598.34 to 598.75 feet. Surface water elevations from Coffeen Lake at SG-03 (near the outfall east of AP1) ranged from 585.09 to 589.97 feet.

Groundwater contour maps prepared from elevation data measured in monitoring wells indicate groundwater elevations are variable, but flow directions are generally consistent in the UA. Groundwater generally flows from the center of the CPP west towards Coffeen Lake and east towards the Unnamed Tributary and the eastern lobe of Coffeen Lake resulting from a groundwater divide (high) running through the middle of the CPP. This flow pattern is typical for a peninsula of land bordered by a lake. Groundwater flows locally towards the former discharge flume between AP1 and AP2 and to Unnamed Tributary, which flows south to Coffeen Lake.

Groundwater near AP1 discharges locally to the Unnamed Tributary to the east and the former discharge plume to the south, which flow south and east, respectively, into the eastern lobe of Coffeen Lake. The Unnamed Tributary is a local groundwater receiving body that may prevent or reduce groundwater migration east of the Unnamed Tributary.

Construction of the LF, GMF GSP, and GMF RP required removal of the Hagarstown Member, in effect removing the aquifer beneath the footprint of these units [12]. It is uncertain whether these constructed units significantly limit lateral groundwater flow, either by creating no flow zones or by capturing groundwater via their dewatering [13].

2.3.6 Hydraulic Conductivities

2.3.6.1 Field Hydraulic Conductivities

Field hydraulic conductivity tests were performed by Hanson in 2021 as part of characterization efforts to complete 35 I.A.C. § 845 requirements. Individual field hydraulic conductivity test results conducted at AP1 are summarized in **Table 2-3** [6], and tested well locations are included on **Figure 2-8**. The results of the tests are summarized as follows:

- **UA:** Hydraulic conductivities near AP1 ranged from 2.6 x 10^{-4} to 9.1 x 10^{-3} cm/s. Tests had a geometric mean of 2.0 x 10^{-3} cm/s. This is generally consistent with, although higher than, tests conducted prior to 2017 as part of CCR Rule characterization efforts that indicated hydraulic conductivities varied from 1.7 x 10^{-5} to 2.1 x 10^{-3} cm/s, with a geometric mean of 2.9 x 10^{-4} cm/s.
- **LCU:** Hydraulic conductivities ranged from 1.2 x 10^{-4} to 2.3 x 10^{-3} cm/s. Tests had a geometric mean of 5.0 x 10^{-4} cm/s. Monitoring wells with the highest hydraulic conductivities were located near the GMF RP and wells with the lowest hydraulic conductivities were located near AP1. Prior to 2017, field hydraulic conductivity tests completed in the LCU for monitoring well and temporary piezometers (G45D, G46D, T408, and T409) indicate horizontal conductivities from 4.0 x 10^{-8} to 3.4 x 10^{-5} cm/s. The elevated hydraulic conductivity values (10^{-4} to 10^{-3} cm/s) in LCU wells are likely not representative of the primary LCU lithology, but instead reflect the isolated and discontinuous sandy lenses in which the wells are screened.
- **DA:** Geometric mean hydraulic conductivity at DA well G314D, near AP1, was 8.7 x 10^{-5} cm/s and was slightly lower than tests completed in the northern portion of the CPP in 2009 that resulted in hydraulic conductivity values ranging from 1.3 x 10^{-4} to 1.7 x 10^{-3} cm/s, with a geometric mean of 4.4 x 10^{-4} cm/s.
- **DCU:** No monitoring wells are screened only within the DCU, and no field hydraulic conductivity tests have been conducted for the DCU.

2.3.6.2 Laboratory Hydraulic Conductivities

Falling head permeability tests (ASTM D5084 Method F) were performed in the laboratory on samples collected during the 2021 investigations [6] and historically [13]. The results are summarized in **Table 2-4** and discussed below.

- **CCR:** One geotechnical sample of CCR (ash) was collected at XPW02 and the vertical hydraulic conductivity is 8.8 x 10^{-5} cm/s.

- **UCU:**
  - Vertical hydraulic conductivities of samples collected from G307D and G311D near AP1 are 4.8 x 10^{-8} and 2.9 x 10^{-8} cm/s, respectively. These values are consistent with historically reported values.
  - Geotechnical tests conducted prior to 2017 indicated UCU vertical hydraulic conductivity values ranging from 1.3 x 10^{-8} to 5.0 x 10^{-7} cm/s, with a geometric mean of 1.0 x 10^{-7} cm/s.
- **UA:** One geotechnical sample of UA material was collected from G275D, near the GMF RP, with a vertical hydraulic conductivity of 1.6 x 10^{-4} cm/s. No UA samples collected near AP1 were analyzed for vertical hydraulic conductivity.
- **LCU:**
  - Three samples collected from G307D, G311D, and G314D, near AP1, have vertical hydraulic conductivities ranging from 5.5 x 10^{-8} to 3.7 x 10^{-7} cm/s, with a geometric mean of 1.8 x 10^{-7} cm/s. Vertical hydraulic conductivities from 2021 are consistent with those observed historically.
  - Intermittently present within the LCU is the Mulberry Grove Member. Historical vertical hydraulic conductivities of the Mulberry Grove Member were measured as 1.6 x 10^{-6} and 1.9 x 10^{-6} cm/s.
  - Historical laboratory tests reported LCU vertical hydraulic conductivity values ranging from 6.8 x 10^{-9} to 4.5 x 10^{-6} cm/s, with a geometric mean of 3.0 x 10^{-8} cm/s.
- **DA:** No laboratory vertical hydraulic conductivity tests were completed on DA materials.
- **DCU**: No laboratory vertical hydraulic conductivity tests were completed during 2021 on DCU materials. Historical vertical hydraulic conductivity tests were performed on samples collected north and west of the GMF GSP. Vertical hydraulic conductivities of 6.8 x 10^{-9} and 4.5 x 10^{-6} cm/s were reported.
- **Bedrock**: No bedrock samples were analyzed for vertical hydraulic conductivity.

2.4 Groundwater Monitoring

The monitoring system for AP1 is shown on **Figure 2-2** and consists of two background monitoring wells (G281 and G306), 14 compliance monitoring wells (G301, G302, G303, G305, G307, G307D, G308, G310, G312, G313, G314, G314D, G315, and G316), and three temporary water level only surface water staff gages (SG-02, SG-03, and XSG-01) to monitor potential impacts from AP1 [14]. These monitoring wells are screened within the UA (G281, G301, G302, G303, G305, G306, G307, G308, G310, G312, G313, and G315), LCU (G307D, G314, and G316), and DA (G314D) along the perimeter of AP1. Porewater samples are collected from locations XPW01 on the western side of AP1 and XPW02 on the northern side of AP1 (**Figure 2-2**).

2.5 Hydrogeologic Conceptual Site Model

The HCR [6] and information provided above forms the foundation of the AP1 hydrogeological setting. AP1 overlies a potential recharge area for the underlying transmissive geologic media, which are composed of unlithified deposits. Recharge migrates downward into and through the UCU into the UA.

Groundwater flow in the UA at the CPP is divided towards the two lobes of Coffeen Lake. The loess of the UCU and sands of the UA are hydraulically connected. Groundwater flow in the silts and clays of the UCU and LCU is expected to be primarily vertical. The majority of horizontal groundwater migration is expected to be within the lower Hagarstown member (*i.e.,* UA).The geologic conceptual model for the site used for groundwater modeling [15] consists of the following layers:

- Hagarstown Loess Unit (*i.e.*, UCU) – Loess Unit and the upper clayey portion of the Hagarstown Member.
- Hagarstown Member (*i.e.*, UA) – sand and sandy silts and clays at the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member.
- Vandalia Member/Mulberry Grove Member (*i.e.*, LCU) – unweathered sandy clay till and discontinuous silts.
- Smithboro Till (*i.e.*, LCU) – compacted clay till of the Smithboro Member.
- The Yarmouth Soil (*i.e.,* DA) and Lierle Clay (*i.e.,* DCU) were not included in the model, for consistency with the original model [16].

The United States Geological Survey (USGS) National Map places the CPP within the East Fork Shoal Creek watershed subbasin (Hydrologic Unit Code 071402030303). The CPP conceptual site model (CSM) extent is bounded by a hydrological catchment (watershed) divide to the east based on watershed data from USGS. Along the north, south, and east, the model boundary was placed along known waterbodies as much as possible. As such, it is assumed groundwater inflow from adjacent watersheds is negligible through both the UA and LCU. The Coffeen Lake water levels are managed at an average elevation of 591.0 feet. Coffeen Lake, the Unnamed Tributary, and the former discharge flume are the receiving surface water bodies in the area encompassed by the CSM.

Precipitation infiltrates and recharges the groundwater table throughout the site and upgradient of the site. Groundwater in the UCU migrates downward into the sandy material of the lower Hagarstown Formation or weathered Vandalia Till, which is considered the UA. The sands of the UA are separated from the base of CCR in AP1 by the laterally continuous low permeability UCU in the western portion of AP1. Erosion caused by incised streams has occurred along the northeast corner of AP1 which likely results in localized ash contact with the UA. Water that percolates downward from layers overlying the UA is most likely to travel laterally from the site within the UA due to the relatively high permeability (as compared to the underlying LCU) and horizontal gradients present within the UA as described above. Groundwater and surface water elevations indicate groundwater flows towards Coffeen Lake, which is a local receiving body for the UA. Further downward migration is also limited by the relatively thick and low permeability LCU. In portions where the UA isn't present (*i.e.,* G314) groundwater migrates vertically as there is no permeable UA for lateral migration. The Vandalia Till in this location also has lower density and higher porosity (**Table 2-4**) indicating vertical migration may potentially be more prevalent in this area of the site. The lack of UA at this location could indicate that this area experienced more weathering, and the resulting Vandalia Till at this location may have slightly higher permeability.

Based on the geology and hydrogeology, monitoring wells at AP1 can be separated into three distinct groupings that exhibit similar geologic and hydraulic characteristics. Compliance monitoring well groupings are summarized as follows:

- UA wells: shallow wells (generally less than 20 feet bgs) screened in moderate permeability materials (generally about 10^{-3} cm/s) including G301, G302, G305, G307, G308, G310, G312, G313, and G315.
- LCU wells: shallow wells (approximately 20 feet bgs) east of AP1 where the UCU and UA have been eroded (G314 and G316) and a deep well (approximately 60 feet bgs) where the UCU and UA overlie the LCU (G307D). LCU wells are screened in moderate permeability (generally about 10^{-4} cm/s) sand lenses within the low permeability till.
- DA wells: deep well (approximately 50 feet bgs) screened in low to moderate permeability materials (generally about 10^{-5} cm/s) located east of AP1 where the UCU and UA have been eroded (G314D).

3. OCCURRENCE AND DISTRIBUTION OF GROUNDWATER EXCEEDANCES (EXTENT)

Results from groundwater samples collected from AP1 during E001, E002, and E003 were received on August 17, 2023; November 21, 2023; and January 10, 2024, respectively. 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 [3, 4, 5]. Exceedances for which an Alternative Source Demonstration was not completed include the following parameters and wells by hydrostratigraphic unit:

- UA (**Figure 3-1**):
  - Boron at G313
  - Sulfate at G301, G303, G305, G307, G308, G310, G312, and G313
  - TDS at G303, G305, G308, G310, G312, G313, and G315
- LCU (PMP; **Figure 3-2**):
  - Sulfate at G307D, G314, and G316
  - TDS at G314 and G316
- DA (PMP; **Figure 3-3**):
  - Sulfate at G314D
  - TDS at G314D

The extents of exceedances discussed below were defined using existing monitoring wells, including wells present on-site (**Table 3-1**), that may not be included in the 35 I.A.C. § 845 monitoring program.

3.1 Additional Investigation to Define Nature and Extent

Following initial sampling in 2021, potential exceedances of the GWPS were identified for the parameters and locations identified above [3, 4, 5]. Solid phase data were collected and evaluated from 10 locations during monitoring well installation at AP1 to assess potential geological sources of exceedance parameters and to inform the GCSM (discussed further in **Section 4**). Solid samples were collected from XPW01 and XPW02 for CCR source material characterization; from the UA at monitoring wells G306, G307D, G311, G311D, G313, and G316; from the UCU at monitoring wells G307D, G311D, and G314D; from the LCU at monitoring wells G314, G307D, G311D, and G314D; and from the DA at monitoring well G314. Solids samples were collected and analyzed for the following:

- EPA 6010B for Total Metals (iron, aluminum, arsenic, manganese, lead, lithium, molybdenum, cobalt, calcium, beryllium, selenium, and chromium);
- Bulk Mineralogy by Reitveld x-ray diffraction Analysis;
- Bulk elemental composition by x-ray fluorescence;
- Sulfur contents;
- Cation Exchange Capacity Analysis; and,

- Total Organic Carbon Analysis and Loss on Ignition.

Six surface water samples were collected later in 2021 to characterize the water quality in Coffeen Lake to supplement previous samples collected in 2016 (**Appendix C**) [2]. Surface water samples were analyzed for 35 I.A.C. § 845.600 parameters (total and dissolved), ferrous and ferric iron, major ions, and monitored natural attenuation parameters. Data from solids phase and surface water sampling has been incorporated into this report where applicable.

3.2 Extent in the Uppermost Aquifer

Groundwater samples are evaluated quarterly and exceedances are identified following comparison of lower confidence limits (LCLs) to the GWPSs described in 35 I.A.C. § 845.600. The LCLs vary as the dataset is updated to include additional quarterly events (**Table 3-2**). The discussion below includes ranges of concentrations measured in wells with exceedances, because there is no single value for LCLs.

3.2.1 Boron

Boron GWPS (3.2 milligrams per liter [mg/L]) statistical exceedances in the UA are limited to G313. Monitoring well G313 is located on the east berm of the unit, between AP1 and east lobe of Coffeen Lake. Concentrations of boron in G313 range from 3.2 to 5.23 mg/L (**Table 3-3**). The extents of statistical exceedances greater than the GWPS are defined laterally in the UA to the north by monitoring well G312, to the south by monitoring well G303, and to the west by monitoring wells G310 and G308 (**Figure 3-1**). The boring log from G314 and historical topographic maps indicates that the UA has been eroded south and east of G313, and statistical exceedances are not expected to extend a significant distance in these directions due to observed groundwater flow directions and the absence of UA materials observed at G314. Due to the proximity of monitoring well G313 to Coffeen Lake, additional wells cannot be installed to laterally define the eastern extent of boron greater than the GWPS; however, the eastern lobe of Coffeen Lake is located approximately 250 feet downgradient of G313 and comparison of water elevations indicates that groundwater migrates toward Coffeen Lake. The extent of boron statistical exceedances is defined downgradient by surface water sample CL-2 collected near G313, which indicates the boron concentration is 0.086 mg/L, and similar to boron concentrations measured in a Coffeen Lake background sample (BKG-1; 0.086 mg/L) (**Appendix C**).

G314 is screened in the LCU and in close proximity to G313, does not contain statistical exceedances of boron greater than the GWPS and defines the vertical extent of boron GWPS statistical exceedances. Downward migration of boron in the UA at G313 is inhibited by the underlying Vandalia Till, Mulberry Grove Member, and Smithboro Till which are, on average, greater than 15 feet thick at the site. Vertical hydraulic conductivity tests completed on samples of the LCU beneath the UA indicate hydraulic conductivities from 5.5×10^{-8} to 3.7×10^{-7} cm/s. This is very low relative to the horizontal hydraulic conductivity measured within the UA (geometric mean of 2.0×10^{-3} cm/s). The significant contrast in permeability (greater than two orders of magnitude) indicates groundwater at the downgradient edges of AP1 containing elevated concentrations of boron will preferentially migrate horizontally toward the former discharge flume in northeast or to the east toward Coffeen Lake where the UA is present and vertically downward in limited areas (*i.e.*, where the UA is not present and Vandalia Till may be slightly more permeable) into underlying hydrostratigraphic units.

3.2.2 Sulfate

Sulfate statistical exceedances in the UA are located in monitoring wells north of AP1 (G301 and G310), southwest of AP1 (G305, G307, and G308), and east of AP1 (G303, G312, and G313). G313 also contained the boron statistical exceedance discussed above. Concentrations of sulfate in UA wells with GWPS (400 mg/L) statistical exceedances range from 420 to 2,400 mg/L (**Table 3-3**). Coal was historically stored near the southwest corner of AP1 and represents a potential external sulfate source to groundwater. Sulfate has also been identified within solids of the UCU and LCU at concentrations up to 220 milligrams per kilogram [6]. The ability to define the lateral extents of sulfate GWPS exceedances in the UA upgradient of AP1 is limited by the complex groundwater flow patterns influenced by the ash ponds proximity to the groundwater flow divide that runs north-south through the CPP, historical drainage features, and surface water receiving bodies to the north (former discharge flume), east and west (Coffeen Lake east and west lobes), and to a limited extent to the south (Coffeen Lake at southern end of CPP site) (**Figure 3-1**).

The extent of sulfate statistical exceedances is defined downgradient by surface water samples which indicate the sulfate concentrations are between 31 and 110 mg/L (**Appendix C**). The highest sulfate concentrations in surface water samples were located in the former discharge flume (D-1 and D-2; 110 mg/L and 69 mg/L, respectively) between AP1 and AP2. Surface water samples collected from Coffeen Lake (CL-1, CL-2, and CL-3; 33 mg/L, 31 mg/L, and 32 mg/L, respectively) are lower in sulfate than samples concentrations measured in the former discharge flume and are comparable to a Coffeen Lake background sample (BKG-1; 36 mg/L). These results are generally consistent with historical samples collected from Coffeen Lake in 2016 which reported concentrations ranging from 54 - 56 mg/L (**Appendix C**).

Downward migration of sulfate in the UA is inhibited by the underlying Vandalia Till, Mulberry Grove Member, and Smithboro Till which are, on average, greater than 15 feet thick at the site. Vertical hydraulic conductivity tests completed on samples of the LCU beneath the UA indicate hydraulic conductivities from 5.5×10^{-8} to 3.7×10^{-7} cm/s. This is very low relative to the horizontal hydraulic conductivity measured within the UA (geometric mean of 2.0×10^{-3} cm/s). The significant contrast in permeability (greater than two orders of magnitude) indicates groundwater at the downgradient edges of AP1 containing elevated concentrations of sulfate will preferentially migrate horizontally toward the northeast to the former discharge flume or to the east to Coffeen Lake. Vertical downward groundwater movement into underlying hydrostratigraphic units only occurs in limited areas where the UA is not present and the Vandalia is potentially more permeable.

3.2.3 Total Dissolved Solids

TDS results indicate the mass of dissolved material in groundwater is a representation of multiple constituents present in the groundwater. Typically, major ions (such as sulfate) represent the primary contributors to TDS. TDS statistical exceedances in the UA are coincident with many of the sulfate statistical exceedances and are located north of AP1 (G310), southwest of AP1 (G305 and G308), south of AP1 (G315), and east of AP1 (G303, G312, and G313). Concentrations of TDS in UA wells with GWPS statistical exceedances range from 362 to 2,010 mg/L (**Table 3-3**). Similar to sulfate, TDS statistical exceedances are not defined laterally upgradient within the UA around AP1 (**Figure 3-1**) due to complex flow patterns. The extent of TDS statistical exceedances is defined downgradient by surface water samples which indicate the TDS concentrations are between 120 and 240 mg/L (**Appendix C**). The highest TDS concentrations

were located in the former discharge flume (D-1 and D-2; 240 mg/L and 240 mg/L, respectively) between AP1 and AP2. Samples collected from Coffeen Lake (CL-1, CL-2, and CL-3;120 mg/L, 160 mg/L, and 150 mg/L, respectively) are lower in TDS than sample concentrations measured in the former discharge flume and to background surface water measurements collected from Coffeen Lake (BKG-1; 72 mg/L).

Downward migration of TDS in the UA is inhibited by the underlying Vandalia Till, Mulberry Grove Member, and Smithboro Till which are, on average, greater than 15 feet thick at the site. Vertical hydraulic conductivity tests completed on samples of the LCU beneath the UA indicate hydraulic conductivities from 5.5 x 10^{-8} to 3.7 x 10^{-7} cm/s. This is very low relative to the horizontal hydraulic conductivity measured within the UA (geometric mean of 2.0 x 10^{-3} cm/s). The significant contrast in permeability (greater than two orders of magnitude) indicates groundwater at the downgradient edges of AP1 containing elevated concentrations of TDS will preferentially migrate horizontally toward the northeast to the former discharge flume or to the east to Coffeen Lake. Vertical downward groundwater movement into underlying hydrostratigraphic units only occurs in limited areas where the UA is not present and the Vandalia is potentially more permeable.

3.3 Extents in Lower Confining Unit / Potential Migration Pathway

3.3.1 Sulfate

Statistical exceedances of sulfate greater than the GWPS (400 mg/L) were identified at LCU wells G307D, near the southwest corner of AP1, and at G314 and G316, between AP1 and Coffeen Lake. Concentrations of sulfate at these locations (**Figure 3-2**) range from 330 to 2,400 mg/L (**Table 3-3**). Similar to groundwater flow patterns in UA, the ability to define the lateral extents of sulfate GWPS statistical exceedances in the LCU upgradient of AP1 is also limited by the complex groundwater flow patterns influenced by the ash ponds proximity to surface water receiving bodies. Because LCU groundwater flow is expected to be primarily vertical except in areas where the overlying deposits are absent, the lateral extent of sulfate is defined downgradient (east of G314 and G316; west of G307D) by surface water samples. The highest sulfate concentrations in surface water samples were located in the former discharge flume (D-1 and D-2; 110 mg/L and 69 mg/L, respectively) between AP1 and AP2. Surface water samples collected from Coffeen Lake (CL-1, CL-2, and CL-3; 33 mg/L, 31 mg/L, and 32 mg/L, respectively) are lower in sulfate than sample concentrations measured in the former discharge flume and are comparable to a Coffeen Lake background sample (BKG-1; 36 mg/L) (**Appendix C**).

3.3.2 Total Dissolved Solids

TDS results indicate the mass of dissolved material in the groundwater and is a representation of multiple constituents present in the groundwater. Typically, major ions (such as sulfate) represent the primary contributors to TDS. Statistical exceedances of TDS greater than the GWPS (1,200 mg/L) were identified at G314 and G316 (**Figure 3-2**), with concentrations ranging from 1,100 to 4,000 mg/L (**Table 3-3**) at these locations. Sulfate statistical exceedances were also determined at these wells.

TDS GWPS statistical exceedances within the LCU are defined to the west by G307D. To the east and south, LCU exceedances can be defined downgradient by TDS concentrations in Coffeen Lake. Samples collected from Coffeen Lake (CL-1, CL-2, and CL-3) have TDS concentrations from

120 to 160 mg/L and are slightly higher than TDS samples collected from a Coffeen Lake background sample (BKG-1; 72 mg/L). TDS exceedances are defined to the north by former discharge flume samples (D-1 and D-2), which were both 240 mg/L (**Appendix C**).

3.4 Extents in Deep Aquifer / Potential Migration Pathway

3.4.1 Sulfate

Sulfate GWPS (400 mg/L) statistical exceedances were identified at G314D. Sulfate concentrations at this location range from 670 to 1,100 mg/L (**Table 3-3**). Sulfate statistical exceedances are not defined laterally by monitoring wells within the DA around AP1 (**Figure 3-3**) but are expected to be limited to the areas where the UA is not present and by flow directions (**Figure 2-9**) which indicate flow toward Coffeen Lake. Delineation within the DA may be complicated by a secondary source of sulfate in the solid phase at certain locations including G314D (Appendix D).

3.4.2 Total Dissolved Solids

TDS results indicate the mass of dissolved material in the groundwater and is a representation of multiple constituents present in the groundwater. Typically, major ions (such as sulfate) represent the primary contributors to TDS. TDS GWPS (1,200 mg/L) statistical exceedances were also identified at G314D. Concentrations of TDS at this location range from 1,600 to 2,420 mg/L (**Table 3-3**). TDS statistical exceedances are not defined laterally within the DA around AP1 (**Figure 3-3**), but, like sulfate, are expected to be limited to the areas where the UA is not present and by flow directions (**Figure 2-9**) which indicate flow toward Coffeen Lake.

4. GEOCHEMICAL CONCEPTUAL SITE MODEL (NATURE)

A GCSM was developed to describe the conditions of the groundwater in the vicinity of CPP AP1 and is summarized here (full analysis presented in **Appendix D**). The GCSM describes the geochemical processes that contribute to the mobilization, distribution, and attenuation of chemicals in the environment. Only parameters that have exceeded the GWPS in AP1 groundwater and will be addressed in the Corrective Action Plan are included in the GCSM. As discussed in previous sections, the exceedances observed at AP1 include boron, sulfate, and TDS.

CCR porewater is water "collected from the interstitial water between waste particles in surface impoundments as it occurs in the field" [17] and represents the material potentially leached from impoundments. CCR materials are the primary source of constituent loading to CCR porewater (*i.e.*, CCR source water). Over an extended period (*e.g.*, months to years), CCR porewater (*i.e.*, water contained within the interstitial pore spaces of CCR that can be sampled by low-flow groundwater sampling methods) reaches equilibrium with the CCR materials. The porewater is therefore representative of the mobile phase constituents capable of migrating into underlying materials and potentially downgradient in groundwater. AP1 CCR source water is therefore the primary indicator of constituents *available* to groundwater and is considered as the primary source term for environmental investigation and fate and transport modeling. AP1 appears to be the primary source of boron and sulfate to downgradient groundwater. However, the poor correlation between boron and sulfate in groundwater and higher concentrations of sulfate in the LCU and DA than in AP1 suggest the potential for a secondary source. TDS is a measure of inorganic and organic substances in solution. TDS trends are generally consistent with those of sulfate in the GMF RP groundwater system.

Conditions within UA, LCU, and DA groundwater are predicted to favor amorphous iron oxide stability at some locations, and the presence of iron oxides in some site solids indicates a portion of the boron and sulfate in the groundwater system may be attenuated via surface complexation reactions. Boron may be further attenuated via interactions with clay minerals, which are present in solids across the UA, LCU, and DA. Batch attenuation testing with solids from the site indicate that chemical attenuation of boron is possible, while chemical attenuation of sulfate could be minimal.

5. COMBINED GEOCHEMICAL AND HYDROGEOLOGIC CONCEPTUAL SITE MODELS

5.1 Boron Conceptual Site Model

The CSM describing current conditions at AP1 combining the hydrogeologic and geochemical CSMs for boron is as follows. Water that may come into contact with CCR in AP1 becomes porewater within the unlined CCR unit. Porewater containing elevated concentrations of boron is capable of migrating into and mixing with groundwater of the UA. Groundwater within the higher hydraulic conductivity zones of the UA in the vicinity of AP1 travels horizontally outward from AP1. The horizontal migration of groundwater outward from AP1 is influenced by groundwater flow gradients towards adjacent receiving water bodies including the former discharge flume, Unnamed Tributary, and ultimately into the east and west lobes of Coffeen Lake.

Conditions within the UA are predicted to favor amorphous iron oxide stability at many locations and the presence of iron oxides in some site solids indicates a portion of the boron in the groundwater system may be attenuated via surface complexation reactions. Boron may be further attenuated via interactions with clay minerals, which are present in solids across the UA. Batch attenuation testing with solids from the site indicate that chemical attenuation of boron is possible. These differences in geochemical conditions in the UA, in combination with the heterogeneities of the sand, sandy silts, and clays within the UA, may contribute to GWPS exceedances of boron in only one compliance well location downgradient of the CCR unit.

5.2 Sulfate and TDS Conceptual Site Model

The CSM describing current conditions at AP1 combining the hydrogeologic and geochemical CSMs for sulfate and TDS is as follows. Water that may come into contact with CCR in AP1 becomes porewater within the unlined CCR unit. Porewater containing elevated concentrations of sulfate and TDS is capable of migrating into and mixing with groundwater of the UA. Groundwater within the UA and in the higher hydraulic conductivity transmissive zones of the LCU in the vicinity of AP1 travels horizontally outward from AP1. The horizontal migration of groundwater outward from AP1 is influenced by groundwater flow gradients towards adjacent receiving water bodies including the former discharge flume, Unnamed Tributary, and ultimately into the east and west lobes of Coffeen Lake. Although downward vertical migration of sulfate and TDS in groundwater is limited by low hydraulic conductivities of the LCU clay, the consistent vertical hydraulic gradients measured at well nest G314, lower densities and higher porosity measured in the till, and the presence of thin, sandy transmissive zones and vertical fractures present in the LCU may provide a pathway for sulfate and TDS to migrate into the DA at the eastern edge (G314D) of AP1.

Conditions within the UA, LCU, and DA are predicted to favor amorphous iron oxide stability at many locations and the presence of iron oxides in some site solids indicates a portion of the sulfate in the groundwater system may be attenuated via surface complexation reactions. Sulfate may be further attenuated via interactions with clay minerals, which are present in solids across the UA and LCU. Batch attenuation testing with solids from the site indicate that chemical attenuation of sulfate could be minimal. These differences in geochemical conditions in the UA, LCU, and DA aquifer, heterogeneities of the hydrostratigraphic units surrounding and below AP1, and relatively higher concentrations of sulfate and TDS, may contribute to GWPS exceedances of sulfate and TDS in locations absent of boron GWPS exceedances.

A screening level risk human health and ecological risk assessment [2] was performed to characterize potential risks to human and ecological receptors that may be exposed to CCR constituents present in Coffeen Lake that may have originated from AP1. The risk assessment evaluation considered contaminants of interest if the maximum detected constituent concentration in groundwater exceeded a human health-based benchmark or a maximum detected constituent concentrations in groundwater exceeded an ecological surface water benchmark protective of aquatic life. Based on the evaluation presented in the risk assessment, no unacceptable risks to human or ecological receptors in Coffeen Lake resulting from CCR exposures associated with AP1 were identified. This means that the risks from the site, in particular the migration of constituents in groundwater to Coffeen Lake that are attributable to AP1, are likely indistinguishable from normal background risks.

6. CONCLUSIONS AND FUTURE ACTIVITIES

In accordance with 35 I.A.C. § 845.650(d)(1), the nature and extent of GWPS statistical exceedances of boron, sulfate, and TDS have been described in sufficient detail to support a complete and accurate assessment of the corrective measures necessary to effectively clean up all releases from AP1.

The lateral extents of statistical exceedances in the UA are illustrated in **Figure 3-1**. As discussed in **Sections 3.2.1, 3.2.2,** and **3.3.3**, boron, sulfate, and TDS statistical exceedances are defined downgradient by Coffeen Lake surface water samples collected in 2021. Boron extent is further defined downgradient of G313 by monitoring wells G314 and G316. Sulfate and TDS statistical exceedances are not expected to extend a significant distance to the south or west due to the north-south groundwater divide, the presence of a former drainage feature, and observed groundwater flow direction within the UA around AP1. Boron, sulfate, and TDS statistical exceedances are constrained vertically by the underlying Vandalia Till.

The lateral extents of statistical exceedances in the LCU are illustrated in **Figure 3-2**. As discussed in **Sections 3.3.1** and **3.3.2**, sulfate and TDS statistical exceedances are defined downgradient by Coffeen Lake surface water samples collected in 2021. Sulfate and TDS statistical exceedances are not expected to extend a significant distance to the south or west due to the north-south groundwater divide, the presence of a former drainage feature, and observed groundwater flow direction within the UA and LCU around AP1.

The lateral extents of statistical exceedances in the DA are illustrated in **Figure 3-3**. As discussed in **Sections 3.4.1** and **3.4.2**, sulfate and TDS are expected to be limited to the areas where the higher permeability UA is not present above the DA and are constrained by the discontinuous occurrence of the lithologic unit and the presence of low hydraulic conductivity clay that separates AP1 from the DA. Sulfate statistical exceedances are also expected to be limited by flow direction within the DA toward Coffeen Lake.

Sulfate was selected for modeling source control presented in the Final Closure Plan and was identified as a surrogate for boron and TDS, as described in the Groundwater Modeling Report [15]. For modeling purposes, it was assumed that sulfate would not significantly sorb or chemically react with aquifer solids (soil adsorption coefficient [Kd] was set to 0 milliliters per gram), which is a conservative estimate for predicting contaminant transport times in the model.

7. REFERENCES

[1] Ramboll Americas Engineering Solutions, Inc. (Ramboll), "35 I.A.C. § 845 Corrective Measures Assessment, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois, IEPA ID: W135015004-01," April 24, 2024.

[2] Gradient, "Human Health and Ecological Risk Assessment, Ash Pond 1, Coffeen Power Plant, Coffeen Illinois," July 28, 2022.

[3] Ramboll, "35 I.A.C. § 845.610(b)(3)(D) Groundwater Monitoring Data and Detected Exceedances, 2023 Quarter 2, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," October 16, 2023.

[4] Ramboll, "35 I.A.C. § 845.610(b)(3)(D) Groundwater Monitoring Data and Detected Exceedances, 2023 Quarter 3, Ash Pond No. 1, CoffeenPower Plant, Coffeen, Illinois," January 20, 2024.

[5] Ramboll, "35 I.A.C. § 845.610(b)(3)(D) Groundwater Monitoring Data and Detected Exceedances, 2023 Quarter 4, Ash Pond No. 1, CoffeenPower Plant, Coffeen, Illinois," March 10, 2024.

[6] Ramboll, "Hydrogeologic Site Characterization Report. Coffeen Power Plant, Ash Pond No. 1, Coffeen, Illinois. Illinois Power Generating Company," October 25, 2021.

[7] Geosyntec Consultants Inc., "Closure and Post Closure Care Plan, Old West Ash Pond, Old West Polishing Pond at Dynegy Midwest Generation, LLC, Hennepin Power Station," 2017.

[8] H. Willman, E. Atherton, T. Buschbach, C. Collinson, J. Frye, M. Hopkins, J. Lineback and J. Simon, Handbook of Illinois Stratigraphy, vol. Bulletin 95, Illinois State Geological Survey, 1975, p. 261.

[9] D. Kolata, *Bedrock Geology of Illinois. Scale 1:500,000,* Illinois State Geological Survey Map, 2005.

[10] Illinois State Geological Survey (ISGS), "ILSTRAT: The Online Handbook of Illinois Stratigraphy," 2020. [Online]. Available: https://ilstratwiki.web.illinois.edu/wiki/Main_Page.

[11] Illinois State Geological Survey (ISGS), "Directory of Coal Mines in Illinois, Christian County," August 2019. [Online]. Available: https://wikiimage.isgs.illinois.edu/ilmines/webfiles/mines-series/mines-directory/pdf-files/mines-directory-christian.pdf. [Accessed August 2019].

[12] Hanson Professional Services, Inc. (Hanson), "40 C.F.R. 257.60 Uppermost Aquifer Considerations, Gypsum Pond, Illinois Power Holdings LLC, Coffeen Energy Center, Montgomery County, Illinois," April 2016.

[13] Natural Resource Technology, Inc., an OBG Company, "Hydrogeologic Monitoring Plan," Coffeen Ash Pond No. 1 – CCR Unit ID 101, Coffeen Ash Pond No. 2 – CCR Unit ID 102, Coffeen GMF Gypsum Stack Pond – CCR Unit ID 103, Coffeen GMF Recycle Pond – CCR Unit ID 104, Coffeen Landfill – CCR Unit ID 105, Coffeen Power Plant, Coffeen, Illinois, October 17, 2017.

[14] Ramboll, "Groundwater Monitoring Plan, Coffeen Power Plant, Ash Pond No. 1, Coffeen, Illinois, Illinois Power Generating Company," October 25, 2021.

[15] Ramboll, "Groundwater Monitoring Report, Coffeen Power Plant, Ash Pond No. 1, Coffeen, Illinois. Illinois Power Generating Company.," July 28, 2022.

[16] Natural Resource Technology, an OBG Company, "Groundwater Model Report, Hennepin West Ash System, Hennepin, Illinois," December 20, 2017.

[17] United States Environmental Protection Agency, "Human and Ecological Risk Assessment of Coal Combustion Residuals (2050-AE81)," December 2014.

TABLES

Table 2-1. Summary of Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G281	Background	05/30/2023	6.64	619.71
G301	Compliance	06/06/2023	[7.49]	[615.16]
G302	Compliance	05/30/2023	11.04	608.99
G303	Compliance	05/30/2023	5.92	616.09
G305	Compliance	05/30/2023	7.63	618.03
G306	Background	05/30/2023	8.13	617.77
G307	Compliance	06/05/2023	[0.07]	[624.53]
G307D	Compliance	05/30/2023	2.48	622.39
G308	Compliance	05/30/2023	5.56	619.02
G310	Compliance	05/30/2023	9.57	613.29
G312	Compliance	05/30/2023	12.42	607.35
G313	Compliance	06/06/2023	[3.03]	[611.27]
G314	Compliance	05/30/2023	4.81	609.06
G314D	Compliance	05/30/2023	6.69	607.00
G315	Compliance	06/07/2023	[3.60]	[619.92]
G316	Compliance	05/30/2023	12.28	590.31
XSG-01	Water Level	05/30/2023	5.45	630.07
SG-02	Water Level	05/30/2023	7.47	598.40
SG-03	Water Level	05/30/2023	9.85	585.09

Notes:
BMP = below measuring point
Bracketing [ ] indicates that the measurement was obtained outside of the 24-hour period from initiation of depth to groundwater measurements.
NAVD88 = North American Vertical Datum of 1988

Table 2-1. Summary of Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G281	Background	08/08/2023	6.39	619.97
G301	Compliance	08/08/2023	8.11	614.54
G302	Compliance	08/08/2023	12.68	607.36
G303	Compliance	08/08/2023	8.40	613.62
G305	Compliance	08/08/2023	9.19	616.48
G306	Background	08/08/2023	9.70	616.21
G307	Compliance	08/08/2023	0.70	623.90
G307D	Compliance	08/08/2023	7.89	616.99
G308	Compliance	08/08/2023	5.09	619.50
G310	Compliance	08/08/2023	10.30	612.57
G312	Compliance	08/08/2023	14.00	605.78
G313	Compliance	08/08/2023	3.01	611.29
G314	Compliance	08/08/2023	4.88	609.00
G314D	Compliance	08/08/2023	7.78	605.92
G315	Compliance	08/08/2023	3.50	620.02
G316	Compliance	08/08/2023	11.70	590.89
XSG-01	Water Level	08/08/2023	6.25	629.27
SG-03	Water Level	08/08/2023	9.65	585.29

Notes:
Only wells with groundwater elevations measured are included.
BMP = below measuring point
NAVD88 = North American Vertical Datum of 1988

Table 2-1. Summary of Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G281	Background	11/13/2023	8.59	617.77
G301	Compliance	11/13/2023	8.43	614.22
G302	Compliance	11/13/2023	13.16	606.88
G303	Compliance	11/13/2023	9.32	612.70
G305	Compliance	11/13/2023	8.50	617.17
G306	Background	11/13/2023	10.13	615.78
G307	Compliance	11/13/2023	1.96	622.64
G307D	Compliance	11/13/2023	12.36	612.52
G308	Compliance	11/13/2023	6.00	618.59
G310	Compliance	11/13/2023	10.56	612.31
G312	Compliance	11/13/2023	Dry	
G313	Compliance	11/13/2023	3.36	610.94
G314	Compliance	11/13/2023	5.67	608.21
G314D	Compliance	11/13/2023	7.97	605.73
G315	Compliance	11/13/2023	4.11	619.41
G316	Compliance	11/13/2023	12.46	590.13
XSG-01	Water Level	11/13/2023	10.38	625.14
SG-02	Water Level	11/13/2023	7.36	598.51
SG-03	Water Level	11/13/2023	9.71	585.23

Notes:
Only wells with groundwater elevations measured are included.
BMP = below measuring point
NAVD88 = North American Vertical Datum of 1988

Table 2-2. Vertical Hydraulic Gradients

Nature and Extent Report

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Date	G405 Groundwater Elevation (ft NAVD88)	T408 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UA	LCU (upper)				
2/4/2017	618.47	619.46	-0.99	12.00	-0.08	up
5/13/2017	618.74	619.00	-0.26	12.00	-0.02	up
7/8/2017	618.54	619.12	-0.58	12.00	-0.05	up
10/21/2017	614.47	614.81	-0.34	12.00	-0.03	up
5/8/2018	618.94	615.82	3.12	12.00	0.26	down
8/2/2018	617.55	614.45	3.10	12.00	0.26	down
10/23/2018	616.40	616.30	0.10	12.00	0.01	down
1/15/2019	616.81	617.01	-0.20	12.00	-0.02	up
8/5/2019	617.72	617.15	0.57	12.00	0.05	down
1/20/2020	619.28	619.13	0.15	12.00	0.01	down
8/10/2020	617.62	617.38	0.24	12.00	0.02	down
1/20/2021	617.12	616.85	0.27	12.00	0.02	down
4/20/2021	617.13	616.65	0.48	12.00	0.04	down
7/26/2021	617.37	617.21	0.16	12.00	0.01	down
8/16/2021	617.28	617.22	0.06	12.00	0.00	down
10/25/2021	618.12	615.50	2.62	12.00	0.22	down
2/7/2022	617.28	616.88	0.40	12.00	0.03	down
5/9/2022	617.91	617.78	0.13	12.00	0.01	down
8/23/2022	616.85	616.99	-0.14	12.00	-0.01	up
2/13/2023	617.50	617.16	0.34	12.00	0.03	down
5/30/2023	616.79	616.66	0.13	12.00	0.01	down
8/8/2023	616.78	616.62	0.16	12.00	0.01	down
10/24/2023	615.79	615.97	-0.18	12.00	-0.02	up
11/13/2023	615.90	616.06	-0.16	12.00	-0.01	up
			Middle of screen elevation G405D			610.0
			Middle of screen elevation T408			598.0

Table 2-2. Vertical Hydraulic Gradients

Nature and Extent Report

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Date	G406 Groundwater Elevation (ft NAVD88)	T409 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UA	LCU (upper)				
2/4/2017	617.52	615.93	1.59	8.23	0.19	down
5/13/2017	616.20	616.75	-0.55	8.23	-0.07	up
7/8/2017	616.29	617.05	-0.76	8.23	-0.09	up
10/21/2017	611.27	612.16	-0.89	8.23	-0.11	up
5/8/2018	615.47	616.02	-0.55	8.23	-0.07	up
8/2/2018	615.75	615.25	0.50	8.23	0.06	down
10/23/2018	614.11	613.96	0.15	8.23	0.02	down
1/15/2019	615.36	614.78	0.58	8.23	0.07	down
8/5/2019	616.50	615.10	1.40	8.23	0.17	down
1/20/2020	617.48	617.16	0.32	8.23	0.04	down
8/10/2020	615.54	615.43	0.11	8.23	0.01	down
1/20/2021	612.97	614.41	-1.44	8.23	-0.17	up
4/20/2021	613.78	615.33	-1.55	8.23	-0.19	up
7/26/2021	614.20	615.72	-1.52	8.23	-0.18	up
8/16/2021	613.82	615.42	-1.60	8.23	-0.19	up
10/25/2021	614.93	616.43	-1.50	8.23	-0.18	up
2/7/2022	613.55	614.97	-1.42	8.23	-0.17	up
5/9/2022	615.36	616.81	-1.45	8.23	-0.18	up
8/23/2022	613.47	610.73	2.74	8.23	0.33	down
2/13/2023	614.11	615.65	-1.54	8.23	-0.19	up
5/30/2023	612.29	613.74	-1.45	8.23	-0.18	up
8/8/2023	613.87	615.02	-1.15	8.23	-0.14	up
10/24/2023	611.28	612.55	-1.27	8.23	-0.15	up
11/13/2023	611.53	613.01	-1.48	8.23	-0.18	up
			Middle of screen elevation G406			605.9
			Middle of screen elevation T409			597.7

Table 2-2. Vertical Hydraulic Gradients

Nature and Extent Report

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Date	T408 Groundwater Elevation (ft NAVD88) LCU (upper)	G45D Groundwater Elevation (ft NAVD88) LCU (lower)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
2/4/2017	619.46	587.71	31.75	13.78	2.30	down
5/13/2017	619.00	586.19	32.81	13.78	2.38	down
7/8/2017	619.12	586.29	32.83	13.78	2.38	down
10/21/2017	614.81	584.69	30.12	13.78	2.19	down
5/8/2018	615.82	587.56	28.26	13.78	2.05	down
8/2/2018	614.45	585.81	28.64	13.78	2.08	down
10/23/2018	616.30	584.60	31.70	13.78	2.30	down
1/15/2019	617.01	586.96	30.05	13.78	2.18	down
8/5/2019	617.15	588.04	29.11	13.78	2.11	down
8/10/2020	617.38	614.21	3.17	13.78	0.23	down
1/20/2021	616.85	614.60	2.25	13.78	0.16	down
4/20/2021	616.65	614.32	2.33	13.78	0.17	down
7/26/2021	617.21	613.58	3.63	13.78	0.26	down
8/16/2021	617.22	613.83	3.39	13.78	0.25	down
10/25/2021	615.50	614.51	0.99	13.78	0.07	down
2/7/2022	616.88	615.01	1.87	13.78	0.14	down
5/9/2022	617.78	614.95	2.83	13.78	0.21	down
8/23/2022	616.99	614.58	2.41	13.78	0.17	down
2/13/2023	617.16	614.69	2.47	13.78	0.18	down
5/30/2023	616.66	613.99	2.67	13.78	0.19	down
8/8/2023	616.62	613.47	3.15	13.78	0.23	down
10/24/2023	615.97	613.40	2.57	13.78	0.19	down
11/13/2023	616.06	613.55	2.51	13.78	0.18	down
			Middle of screen elevation T408			598.0
			Middle of screen elevation G45D			584.2

Table 2-2. Vertical Hydraulic Gradients

Nature and Extent Report

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Date	T409 Groundwater Elevation (ft NAVD88) LCU (upper)	G46D Groundwater Elevation (ft NAVD88) LCU (lower)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
2/4/2017	615.93	586.06	29.87	22.19	1.35	down
5/13/2017	616.75	584.87	31.88	22.19	1.44	down
7/8/2017	617.05	585.22	31.83	22.19	1.43	down
5/8/2018	616.02	585.86	30.16	22.19	1.36	down
8/2/2018	615.25	583.95	31.30	22.19	1.41	down
10/23/2018	613.96	582.05	31.91	22.19	1.44	down
1/15/2019	614.78	583.17	31.61	22.19	1.42	down
8/5/2019	615.10	583.68	31.42	22.19	1.42	down
8/10/2020	615.43	609.00	6.43	22.19	0.29	down
1/20/2021	614.41	610.49	3.92	22.19	0.18	down
4/20/2021	615.33	611.06	4.27	22.19	0.19	down
7/26/2021	615.72	607.21	8.51	22.19	0.38	down
8/16/2021	615.42	608.17	7.25	22.19	0.33	down
10/25/2021	616.43	609.87	6.56	22.19	0.30	down
2/7/2022	614.97	610.71	4.26	22.19	0.19	down
5/9/2022	616.81	611.34	5.47	22.19	0.25	down
8/23/2022	610.73	615.13	-4.40	22.19	-0.20	up
2/13/2023	615.65	610.39	5.26	22.19	0.24	down
5/30/2023	613.74	610.70	3.04	22.19	0.14	down
8/8/2023	615.02	610.14	4.88	22.19	0.22	down
10/24/2023	612.55	609.65	2.90	22.19	0.13	down
11/13/2023	613.01	609.70	3.31	22.19	0.15	down
			Middle of screen elevation T409			597.7
			Middle of screen elevation G46D			575.5

Table 2-2. Vertical Hydraulic Gradients

Nature and Extent Report

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Date	G307 Groundwater Elevation (ft NAVD88)	G307D Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UA	LCU (lower)				
4/20/2021	624.50	622.48	2.02	38.06	0.05	down
5/17/2021	624.45	622.44	2.01	38.06	0.05	down
7/12/2021	624.45	622.59	1.86	38.06	0.05	down
8/16/2021	624.46	621.49	2.97	38.06	0.08	down
2/7/2022	624.60	622.32	2.28	38.06	0.06	down
5/9/2022	624.60	616.31	8.29	38.06	0.22	down
8/23/2022	624.60	615.09	9.51	38.06	0.25	down
2/13/2023	624.60	622.13	2.47	38.06	0.06	down
8/8/2023	623.90	616.99	6.91	38.06	0.18	down
11/13/2023	622.64	612.52	10.12	38.06	0.27	down
			Middle of screen elevation G307			606.7
			Middle of screen elevation G307D			568.6

Date	G311 Groundwater Elevation (ft NAVD88)	G311D Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	UA	LCU (lower)				
3/29/2021	616.54	575.42	41.12	43.41	0.95	down
4/22/2021	613.68	575.74	37.94	43.41	0.87	down
5/3/2021	614.01	573.09	40.92	43.41	0.94	down
5/17/2021	613.86	572.40	41.46	43.41	0.96	down
6/9/2021	613.13	573.85	39.28	43.41	0.90	down
6/15/2021	612.78	575.25	37.53	43.41	0.86	down
6/23/2021	612.45	571.74	40.71	43.41	0.94	down
7/12/2021	613.75	571.63	42.12	43.41	0.97	down
7/26/2021	613.05	569.74	43.31	43.41	1.00	down
8/16/2021	613.30	570.34	42.96	43.41	0.99	down
10/25/2021	615.13	583.70	31.43	43.41	0.72	down
2/7/2022	614.28	593.14	21.14	43.41	0.49	down
5/9/2022	615.74	596.43	19.31	43.41	0.44	down
8/23/2022	613.19	597.46	15.73	43.41	0.36	down
5/30/2023	612.78	597.98	14.80	43.41	0.34	down
8/8/2023	611.96	597.72	14.24	43.41	0.33	down
10/24/2023	611.75	597.73	14.02	43.41	0.32	down
11/13/2023	611.66	597.09	14.57	43.41	0.34	down
			Middle of screen elevation G311			606.7
			Middle of screen elevation G311D			563.3

Table 2-2. Vertical Hydraulic Gradients

Nature and Extent Report

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Date	G314 Groundwater Elevation (ft NAVD88) LCU (upper)	G314D Groundwater Elevation (ft NAVD88) DA (PMP)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
3/29/2021	596.40	572.75	23.65	29.76	0.79	down
4/20/2021	603.16	571.76	31.40	27.40	1.15	down
5/3/2021	604.66	568.77	35.89	27.40	1.31	down
5/17/2021	605.61	566.84	38.77	27.40	1.42	down
6/9/2021	607.54	567.45	40.09	27.40	1.46	down
6/14/2021	608.16	568.60	39.56	27.40	1.44	down
6/23/2021	605.19	566.77	38.42	27.40	1.40	down
7/12/2021	605.32	566.88	38.44	27.40	1.40	down
7/26/2021	606.66	566.65	40.01	27.40	1.46	down
8/16/2021	608.60	567.28	41.32	27.40	1.51	down
10/25/2021	610.36	581.05	29.31	27.40	1.07	down
2/7/2022	607.85	590.46	17.39	27.40	0.63	down
5/9/2022	609.11	594.81	14.30	27.40	0.52	down
8/23/2022	610.58	595.70	14.88	27.40	0.54	down
2/13/2023	607.74	597.30	10.44	27.40	0.38	down
3/30/2023	604.91	603.71	1.20	27.40	0.04	down
4/30/2023	608.34	606.21	2.13	27.40	0.08	down
5/30/2023	609.06	607.00	2.06	27.40	0.08	down
6/8/2023	604.44	601.90	2.54	27.40	0.09	down
7/8/2023	608.20	606.45	1.75	27.40	0.06	down
8/8/2023	609.00	605.92	3.08	27.40	0.11	down
9/25/2023	608.92	605.20	3.72	27.40	0.14	down
10/24/2023	608.58	605.14	3.44	27.40	0.13	down
11/13/2023	608.21	605.73	2.48	27.40	0.09	down
12/18/2023	606.49	606.66	-0.17	27.40	-0.01	up
			Middle of screen elevation G314			594.0
			Middle of screen elevation G314D			566.6

[O: KLT 6/4/21, C:YMD 6/7/21; U:KLT 8/25/21, C:EDP 8/31/21]
[KLT 5/3/24, C: SSW 5/7/24]

Notes:

[1] Distance change was calculated using the midpoint of the piezometer screen and water table surface. If the water table surface was above the top of the monitoring well screen, then distance change was calculated using the midpoint of both screens.

[2] Vertical gradients between ±0.0015 are considered flat, and typically have less than 0.02 foot difference in groundwater elevation between wells.

DA = deep aquifer
dh = head change
dl = distance change
ft = foot/feet
LCU (lower) = lower confining unit (Smithboro)
LCU (upper) = lower confining unit (Vandalia)
NAVD88 = North American Vertical Datum of 1988
PMP = potential migration pathway
UA = uppermost aquifer

Table 2-3. Field Hydraulic Conductivities
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

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) Hydraulic Conductivity (cm/s)	Rising Head (Slug Out) Hydraulic Conductivity (cm/s)	Minimum Hydraulic Conductivity (cm/s)	Maximum Hydraulic Conductivity (cm/s)	Hydraulic Conductivity Geometric Mean (cm/s)
Uppermost Aquifer											
G301	D	604.31	4.65	(ML)s	solid	Kansas Geological Survey	1.1E-03	1.2E-03	2.6E-04	9.1E-03	2.0E-03
G303	D	599.07	10	CL	solid	Kansas Geological Survey	2.8E-04	2.6E-04			
G308	D	606.70	4.79	s(ML), s(CL), (CL)s	solid	Kansas Geological Survey	5.5E-03	1.6E-03			
G309	D	605.02	4.78	SP, s(CL), (ML)s	solid	Kansas Geological Survey	9.1E-03	8.8E-04			
G310	D	604.86	4.79	SM, s(ML)	solid	Kansas Geological Survey	7.5E-03	5.9E-03			
G311	D	604.28	4.77	s(ML), s(CL)	solid	Bouwer-Rice	1.5E-03	- -			
G312	D	602.34	4.79	s(ML), s(CL)	solid	Kansas Geological Survey	1.1E-03	1.1E-03			
G313	D	600.40	4.81	SP, s(ML), (CL)s	solid	Kansas Geological Survey	2.7E-03	3.5E-03			
G315	D	606.46	4.79	s(CL)	solid	Kansas Geological Survey	6.6E-03	5.8E-03			
Lower Confining Unit											
G307D	D	563.76	9.77	(CL)s	solid	Kansas Geological Survey	3.2E-04	1.2E-04	1.2E-04	2.3E-03	5.0E-04
G311D	D	558.29	9.94	CL	solid	Kansas Geological Survey	3.8E-04	2.1E-04			
G316	D	584.82	4.80	SP, s(ML), (CL)s	solid	Kansas Geological Survey	2.3E-03	2.3E-03			
Deep Aquifer (PMP)											
G314D	D	561.76	9.77	SP, s(CL)	solid	Bouwer-Rice	3.3E-04	2.3E-05	2.3E-05	3.3E-04	8.7E-05

[O: KLT 07/09/21; C:EDP 8/31/21]

Notes:
1. All wells are constructed from 2 inch PVC with 0.01 inch slotted screens.
- - = Test not analyzed/performed
cm/s = centimeters per second
D = downgradient
ft = foot/feet
NAVD88 = North American Vertical Datum of 1988
PMP= potential migration pathway
PVC = polyvinyl chloride

USCS = Unified Soil Classification System
CL = Lean Clay
s(CL) = Sandy Lean Clay
(CL)s = Lean Clay with Sand
s(ML) = Sandy Silt
(ML)s = Silt with Sand
SM = Silty Sand
SP = Poorly-Graded Sand

Table 2-4. Geotechnical Data Summary
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Calculated Porosity [1] (%)	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	USCS	Gravel (%)	Sand (%)	Fines (%)
Loess Unit															
G307D/Comp 1	G307D	4	12.8	19.4	107.5	2.59	33.5	--	33	16	17	CL	0	33	67
G307D, ST5	G307D	8	10	21.6	105.0	--	--	4.8E-08	--	--	--	CL/CH	--	--	--
G311D/Comp 1	G311D	4	22 **	16.5	115.7	2.64	29.8	--	31	13	18	CL	0	35	65
G311D, ST4	G311D	6	8	19.0	107.5	--	--	2.9E-08	--	--	--	CL	--	--	--
G314D/Comp 1	G314D	4.2	17	16.5	113.6	2.61	30.2	--	29	14	15	CL	0	34	66
Hagarstown Member															
G307D/Comp 2	G307D	12.8	14	19.2	--	2.59	--	--	NP	NP	NP	SW	14	79	7
G311D/Comp 2	G311D	12	14	11.4	126.8	2.68	24.2	--	18	13	5	SM	0	65	35
G314D/Comp 2	G314D	17.3	21.6	12.2	123.4	2.64	25.1	--	29	14	15	CL	0	28	72
Vandalia Member															
G307D/Comp 3	G307D	18	34.9	8.7	131.6	2.60	18.9	--	19	13	6	SP-SM	0	44	56
G311D/Comp 3	G311D	18 **	42	11.4	124.8	2.61	23.4	--	30	15	15	CL	0	28	72
G311D, ST14	G311D	28	30	16.2	116.7	--	--	5.5E-08	--	--	--	CL	--	--	--
G314D/Comp 3	G314D	21.8	45.5	14.6	115.7	2.56	27.6	--	31	15	16	CL	0	26	74
Smithboro Member															
G307D/Comp 4	G307D	40	54	15.6	115.7	2.61	29.0	--	30	15	15	CL	0	28	72
G307D, ST22	G307D	42	44	15.0	118.8	--	--	3.7E-07	--	--	--	CL	--	--	--
G311D/Comp 4	G311D	44	52	15.5	114.2	2.56	28.5	--	30	16	14	CL	0	26	74
G314D, ST18	G314D	37	39	16.6	115.0	--	--	3.0E-07	--	--	--	CL	--	--	--
Yarmouth Soil															
G314D/Comp 4	G314D	46	47	14.9	--	2.61	--	--	--	--	--	SP-SM	0	84	16
Lierle Clay															
G307D/Comp 5	G307D	54	60	8.7	134.6	2.67	19.2	--	47	18	29	CL	0	20	80
G311D/Comp 5	G311D	52	60	18.9	108.0	2.59	33.2	--	37	17	20	CL	0	19	81
G314D/Comp 5	G314D	47.8	52	17.5	109.6	2.58	31.9	--	43	18	25	CL	0	24	76
G314D/Comp 6	G314D	52.2	62.9	13.6	120.2	2.64	27.0	--	37	18	19	CL	0	19	81
Banner Formation															
G314D/Comp 7	G314D	73.9	82.5	14.0	120.3	2.64	27.0	--	29	19	10	CL	0	16	84
G314D/Comp 8	G314D	93.5	100.3	8.5	123.6	2.73	27.4	--	35	19	16	CL	0	16	84

Table 2-4. Geotechnical Data Summary
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Calculated Porosity [1] (%)	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	USCS	Gravel (%)	Sand (%)	Fines (%)
CCR															
XPW02 Bulk	XPW02	0	17.7	12.5	110.8	2.60	31.7	8.8E-05	--	--	--	Bottom Ash	0	90	10

[O:KLT, QC: FPO][U: FPO, QC:KLT 8/9/21][U:KLT 8/13/21, C:EDP 8/30/21]

Notes:
[1] Porosity calculated as relationship of bulk density (p_b) to particle density (p_d) ($n = 100[1- (p_b/p_d)]$)
-- = not analyzed
% = Percent
** = not all sampled in the noted interval were included in this composite sample
bgs = below ground surface
cm/s = centimeters per second
ft = foot/feet
LL = Liquid limit
NP = Non Plastic
pcf = pounds per cubic foot
PI = Plasticity Index
PL = Plastic Limit

USCS = Unified Soil Classification System
CH = Fat Clay
CL = Lean Clay
ML = Silt
SC = Clayey Sand
SM = Silty Sand
SP-SM = Poorly Graded-Sand with Silt
SW = Well-Graded Sand

Table 3-1. Monitoring Well Construction Details
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Location	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft bgs)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G281	UA	09/08/2015	--	626.43	Top of Disk	623.82	15.51	20.16	608.31	603.66	20.3	603.50	4.7	2	39.0654052	-89.3993221
G301	UA	09/04/2015	--	622.56	Top of Disk	620.88	11.31	15.96	608.96	604.31	16.21	604.10	4.7	2	39.05951	-89.395415
G302	UA	09/04/2015	--	619.95	Top of Disk	618.52	13.21	17.86	604.74	600.09	18.39	599.60	4.7	2	39.059544	-89.393192
G303	UA	08/26/2010	--	621.93	Top of Disk	619.33	10	20	609.07	599.07	20.4	598.70	10	2	39.057144	-89.391721
G305	UA	05/03/2016	625.67	625.84	Top of PVC	623.23	13.44	18.27	609.10	604.27	18.5	604.10	4.8	2	39.056558	-89.396798
G306	UA	05/03/2016	625.91	626.08	Top of PVC	623.57	13.07	17.68	609.77	605.16	17.9	604.80	4.6	2	39.056494	-89.393556
G307	UA	07/27/2016	624.60	624.60	Top of PVC	624.73	12.96	17.8	609.12	604.28	18.22	603.90	4.8	2	39.057214	-89.395545
G307D	LCU	01/19/2021	624.88	625.05	Top of PVC	622.51	48.98	58.75	573.53	563.76	59.6	562.50	9.8	2	39.05721	-89.39552
G308	UA	01/18/2021	624.59	624.76	Top of PVC	621.59	10.1	14.89	611.49	606.70	15.24	605.80	4.8	2	39.057379	-89.397134
G310	UA	02/09/2021	622.87	622.88	Top of PVC	619.89	10.24	15.03	609.65	604.86	15.38	604.00	4.8	2	39.059532	-89.396907
G312	UA	01/15/2021	619.78	619.95	Top of PVC	616.92	9.79	14.58	607.13	602.34	14.93	601.70	4.8	2	39.059558	-89.391983
G313	UA	02/05/2021	614.30	614.30	Top of PVC	611.51	6.3	11.11	605.21	600.40	11.46	599.50	4.8	2	39.058773	-89.391124
G314	LCU	02/05/2021	613.88	614.05	Top of PVC	611.11	14.56	19.58	596.55	591.53	20.02	591.10	5	2	39.05782	-89.390964
G314D	DA	02/04/2021	613.70	613.71	Top of PVC	610.87	39.34	49.11	571.53	561.76	49.47	510.60	9.8	2	39.057852	-89.390958
G315	UA	01/14/2021	623.52	623.69	Top of PVC	620.94	9.69	14.48	611.25	606.46	14.85	605.00	4.8	2	39.057165	-89.393667
G316	LCU	02/26/2021	602.59	602.59	Top of PVC	599.64	10.02	14.82	589.62	584.82	15.16	583.90	4.8	2	39.057847	-89.389698
XPW01	CCR	01/14/2021	634.57	634.36	Top of PVC	631.85	8.21	12.98	623.64	618.87	13.36	617.90	4.8	2	39.057878	-89.396196
XPW02	CCR	02/08/2021	639.69	639.86	Top of PVC	636.64	8.05	17.85	628.59	618.79	18.2	618.40	9.8	2	39.058828	-89.395267

Notes:
All elevation data are presented relative to the North American Vertical Datum of 1988 (NAVD88), GEOID 12A
-- = not measured/recorded
bgs = below ground surface
CCR = Coal Combustion Residuals
DA = Deep Aquifer
ft = foot or feet
HSU = Hydrostratigraphic Unit
LCU = Lower Confining Unit
PVC = polyvinyl chloride
UA = Uppermost Aquifer

Table 3-2. Exceedance Parameter Statistical Results
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Location	Parameter	Unit	Groundwater Protection Standard	2023 Q2 LCL	2023 Q3 LCL	2023 Q4 LCL
G313	Boron, total	mg/L	3.20	3.28	3.29	3.30
G301	Sulfate, total	mg/L	400	664	652	644
G303	Sulfate, total	mg/L	400	708	708	611
G305	Sulfate, total	mg/L	400	787	801	808
G307	Sulfate, total	mg/L	400	513	--	456
G307D	Sulfate, total	mg/L	400	622	602	516
G308	Sulfate, total	mg/L	400	1,030	1,020	871
G310	Sulfate, total	mg/L	400	553	-6,390a	-5,310a
G312	Sulfate, total	mg/L	400	696	721	--
G313	Sulfate, total	mg/L	400	491	-517a	-487a
G314	Sulfate, total	mg/L	400	2,000	2,000	2,000
G314D	Sulfate, total	mg/L	400	674	735	780
G316	Sulfate, total	mg/L	400	660	660	660
G303	Total Dissolved Solids	mg/L	1,200	1,510	1,510	1,510
G305	Total Dissolved Solids	mg/L	1,200	1,280	1,320	1,350
G308	Total Dissolved Solids	mg/L	1,200	1,810	1,800	1,600
G310	Total Dissolved Solids	mg/L	1,200	1,100	1,100	1,240
G312	Total Dissolved Solids	mg/L	1,200	1,460	1,420	--
G313	Total Dissolved Solids	mg/L	1,200	1,600	1,520	1,510
G314	Total Dissolved Solids	mg/L	1,200	3,400	3,400	3,400
G314D	Total Dissolved Solids	mg/L	1,200	1,640	1,760	1,600
G315	Total Dissolved Solids	mg/L	1,200	1,320	1,290	1,100
G316	Total Dissolved Solids	mg/L	1,200	1,600	1,600	1,600

Notes:
-- = data not available (well reported dry or inaccessible during compliance sampling event)
LCL = Lower Confidence Level
mg/L = milligrams per liter
a: Negative LCL values are the result of downward trends in the data. The confidence interval around a trend line, particularly a non-parametric estimation, may be wide at the most recent sample point due to lack of data density.

Table 3-3. Summary of Groundwater Data
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

HSU	Location	Parameter	Unit	Sample Count	Non-Detect Result Count	Percent Non-Detect Results	First Sample	Last Sample	Minimum	Median	Mean	Maximum
CCR	XPW01	Boron, total	mg/L	6	0	0	03/30/2021	08/10/2023	2.40	2.50	2.78	3.97
CCR	XPW01	Sulfate, total	mg/L	10	0	0	03/30/2021	11/17/2023	480	750	743	860
CCR	XPW01	Total Dissolved Solids	mg/L	10	0	0	03/30/2021	11/17/2023	1,020	1,200	1,210	1,400
CCR	XPW02	Boron, total	mg/L	6	0	0	03/30/2021	08/10/2023	1.92	2.40	2.29	2.40
CCR	XPW02	Sulfate, total	mg/L	10	0	0	03/30/2021	11/17/2023	175	575	488	650
CCR	XPW02	Total Dissolved Solids	mg/L	10	0	0	03/30/2021	11/17/2023	522	1,000	896	1,100
DA	G314D	Boron, total	mg/L	9	0	0	03/30/2021	11/20/2023	0.130	0.180	0.175	0.236
DA	G314D	Sulfate, total	mg/L	8	0	0	03/30/2021	11/20/2023	670	1,040	959	1,100
DA	G314D	Total Dissolved Solids	mg/L	8	0	0	03/30/2021	11/20/2023	1,600	2,390	2,188	2,420
LCU	G307D	Boron, total	mg/L	9	0	0	03/29/2021	11/17/2023	1.01	1.40	1.51	2.54
LCU	G307D	Sulfate, total	mg/L	8	0	0	03/29/2021	11/17/2023	537	725	712	850
LCU	G307D	Total Dissolved Solids	mg/L	8	0	0	03/29/2021	11/17/2023	1,040	1,250	1,252	1,500
LCU	G314	Boron, total	mg/L	12	0	0	03/30/2021	11/20/2023	0.120	0.175	0.196	0.420
LCU	G314	Sulfate, total	mg/L	12	0	0	03/30/2021	11/20/2023	830	2,035	1,991	2,400
LCU	G314	Total Dissolved Solids	mg/L	12	0	0	03/30/2021	11/20/2023	1,900	3,700	3,569	4,000
LCU	G316	Boron, total	mg/L	12	0	0	03/30/2021	11/20/2023	0.330	0.430	0.433	0.550
LCU	G316	Sulfate, total	mg/L	12	0	0	03/30/2021	11/20/2023	330	740	697	840
LCU	G316	Total Dissolved Solids	mg/L	12	0	0	03/30/2021	11/20/2023	1,100	1,610	1,608	1,800
UA	G281	Boron, total	mg/L	35	19	54	11/20/2015	11/20/2023	<0.0071	0.0100	0.0170	0.110
UA	G281	Sulfate, total	mg/L	35	0	0	11/20/2015	11/20/2023	140	280	287	380
UA	G281	Total Dissolved Solids	mg/L	35	0	0	11/20/2015	11/20/2023	700	870	866	1,000
UA	G301	Boron, total	mg/L	23	0	0	11/20/2015	11/20/2023	1.90	2.20	2.28	2.90
UA	G301	Sulfate, total	mg/L	23	0	0	11/20/2015	11/20/2023	513	710	700	860
UA	G301	Total Dissolved Solids	mg/L	23	0	0	11/20/2015	11/20/2023	900	1,100	1,155	1,500
UA	G302	Boron, total	mg/L	23	0	0	11/20/2015	11/20/2023	1.10	1.90	1.86	2.96
UA	G302	Sulfate, total	mg/L	23	0	0	11/20/2015	11/20/2023	260	430	412	530
UA	G302	Total Dissolved Solids	mg/L	23	0	0	11/20/2015	11/20/2023	780	1,100	1,046	1,400
UA	G303	Boron, total	mg/L	23	0	0	11/20/2015	11/21/2023	1.40	1.80	1.96	2.98
UA	G303	Sulfate, total	mg/L	23	0	0	11/20/2015	11/21/2023	590	740	749	870
UA	G303	Total Dissolved Solids	mg/L	23	0	0	11/20/2015	11/21/2023	1,200	1,600	1,610	1,900
UA	G305	Boron, total	mg/L	9	0	0	05/19/2016	11/17/2023	1.80	2.44	2.33	2.70
UA	G305	Sulfate, total	mg/L	9	0	0	05/19/2016	11/17/2023	710	890	880	980
UA	G305	Total Dissolved Solids	mg/L	9	0	0	05/19/2016	11/17/2023	1,300	1,500	1,490	1,800
UA	G306	Boron, total	mg/L	31	0	0	05/19/2016	11/17/2023	2.22	2.70	2.73	3.50
UA	G306	Sulfate, total	mg/L	31	0	0	05/19/2016	11/17/2023	5.90	250	258	700
UA	G306	Total Dissolved Solids	mg/L	31	0	0	05/19/2016	11/17/2023	455	700	700	900
UA	G307	Boron, total	mg/L	19	0	0	08/16/2016	11/21/2023	1.80	2.10	2.07	2.35
UA	G307	Sulfate, total	mg/L	19	0	0	08/16/2016	11/21/2023	490	980	908	1,300
UA	G307	Total Dissolved Solids	mg/L	19	0	0	08/16/2016	11/21/2023	915	1,400	1,352	1,600

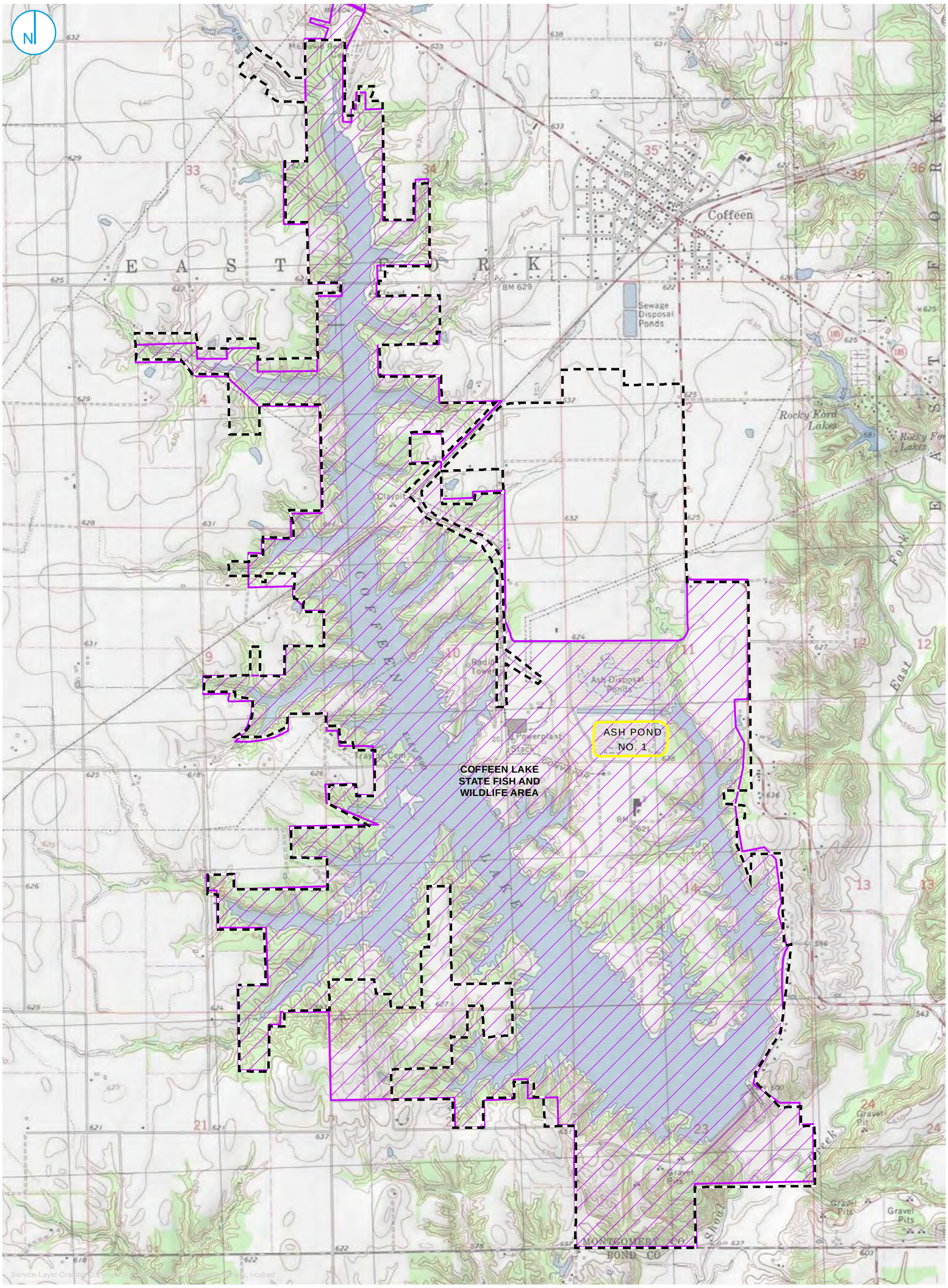
Table 3-3. Summary of Groundwater Data
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

HSU	Location	Parameter	Unit	Sample Count	Non-Detect Result Count	Percent Non-Detect Results	First Sample	Last Sample	Minimum	Median	Mean	Maximum
UA	G308	Boron, total	mg/L	12	0	0	03/29/2021	11/17/2023	2.40	2.55	2.58	2.88
UA	G308	Sulfate, total	mg/L	12	0	0	03/29/2021	11/17/2023	936	1,100	1,074	1,200
UA	G308	Total Dissolved Solids	mg/L	12	0	0	03/29/2021	11/17/2023	1,640	1,850	1,842	2,000
UA	G310	Boron, total	mg/L	12	0	0	03/29/2021	11/20/2023	1.60	1.80	1.82	2.08
UA	G310	Sulfate, total	mg/L	12	0	0	03/29/2021	11/20/2023	420	840	861	2,300
UA	G310	Total Dissolved Solids	mg/L	12	0	0	03/29/2021	11/20/2023	1,100	1,500	1,398	1,600
UA	G312	Boron, total	mg/L	10	0	0	03/30/2021	08/09/2023	1.30	1.65	2.01	3.51
UA	G312	Sulfate, total	mg/L	10	0	0	03/30/2021	08/09/2023	600	905	842	1,000
UA	G312	Total Dissolved Solids	mg/L	10	0	0	03/30/2021	08/09/2023	1,300	1,700	1,681	2,010
UA	G313	Boron, total	mg/L	12	0	0	03/30/2021	11/20/2023	3.20	3.40	3.55	5.23
UA	G313	Sulfate, total	mg/L	12	0	0	03/30/2021	11/20/2023	667	735	747	970
UA	G313	Total Dissolved Solids	mg/L	12	0	0	03/30/2021	11/20/2023	1,400	1,600	1,588	1,800
UA	G315	Boron, total	mg/L	12	0	0	03/30/2021	11/21/2023	1.20	1.30	1.34	1.90
UA	G315	Sulfate, total	mg/L	12	0	0	03/30/2021	11/21/2023	588	865	811	1,100
UA	G315	Total Dissolved Solids	mg/L	12	0	0	03/30/2021	11/21/2023	362	1,500	1,354	1,700

Notes:

< = less than the method detection limit
CCR = Coal Combustion Residuals
DA = Deep Aquifer
HSU = Hydrostratigraphic Unit
LCU = Lower Confining Unit
mg/L = milligrams per liter
UA = Uppermost Aquifer

FIGURES



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
COFFEEN LAKE STATE FISH AND WILDLIFE AREA

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 2-1

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

- COMPLIANCE MONITORING WELL
- BACKGROUND MONITORING WELL
- PORE WATER WELL
- STAFF GAGE, CCR UNIT
- STAFF GAGE, RIVER
- COAL MINE SHAFT
- REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 275 550 Feet

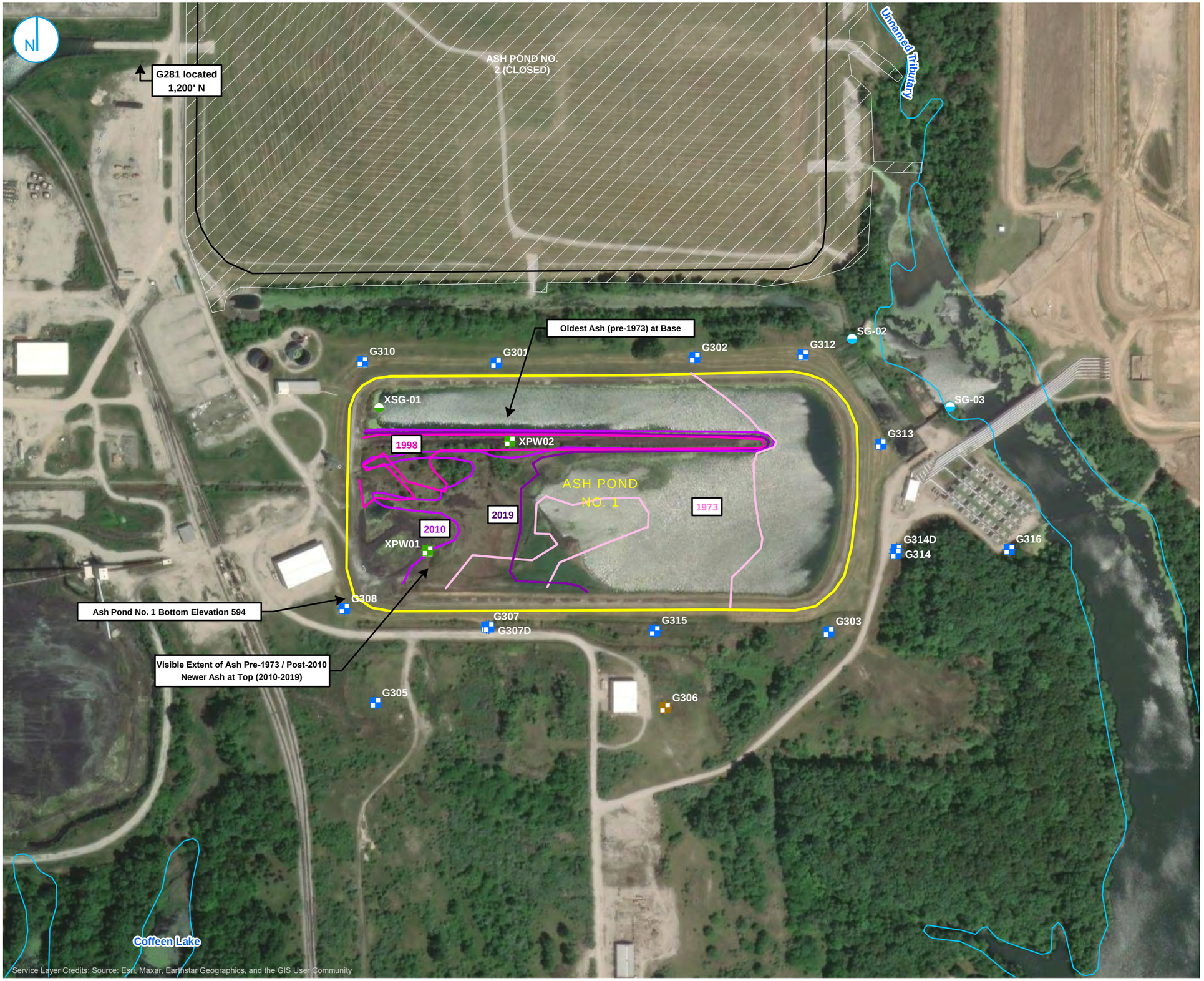
MONITORING WELL LOCATION MAP

FIGURE 2-2

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



COMPLIANCE MONITORING WELL
BACKGROUND MONITORING WELL
PORE WATER WELL
STAFF GAGE, RIVER
STAFF GAGE, CCR UNIT
APPROXIMATE LIMITS OF ASH BASED ON 1973 AERIAL
APPROXIMATE LIMITS OF ASH BASED ON 1998 AERIAL
APPROXIMATE LIMITS OF ASH BASED ON 2010 AERIAL
APPROXIMATE LIMITS OF ASH BASED ON 2019 AERIAL
SURFACE WATER FEATURE
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER

0 150 300 Feet

CCR OBSERVATIONS

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\Nature_and_Extent\COF\Nature_and_Extent_Report\101\Figure 2-3. CCR Observations.mxd

PROJECT: 169000XXXX | DATED: 5/3/2024 | DESIGNER: GALARNMC

Y:\Mapping\Projects\222285\MXD\Nature_and_Extent\COR\Nature_and_Extent_Report\101\Figure 2-4_CCR Access Summary.mxd

PROJECT: 169000XXXX | DATED: 5/3/2024 | DESIGNER: GALARNMC

PORE WATER WELL
STAFF GAGE, CCR UNIT
630 ELEVATION CONTOUR
ELEVATION BELOW 630
REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 75 150 Feet

CCR ACCESS SUMMARY

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\221285\MXD\Nature_and_Extent\COF\Nature_and_Extent_Report\101\Figure 2-5_Base of CCR.mxd

PROJECT: 169000XXXX | DATED: 5/3/2024 | DESIGNER: GALARNMC

5-FT BOTTOM OF ASH ELEVATION

1-FT BOTTOM OF ASH ELEVATION

REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

0 75 150 Feet

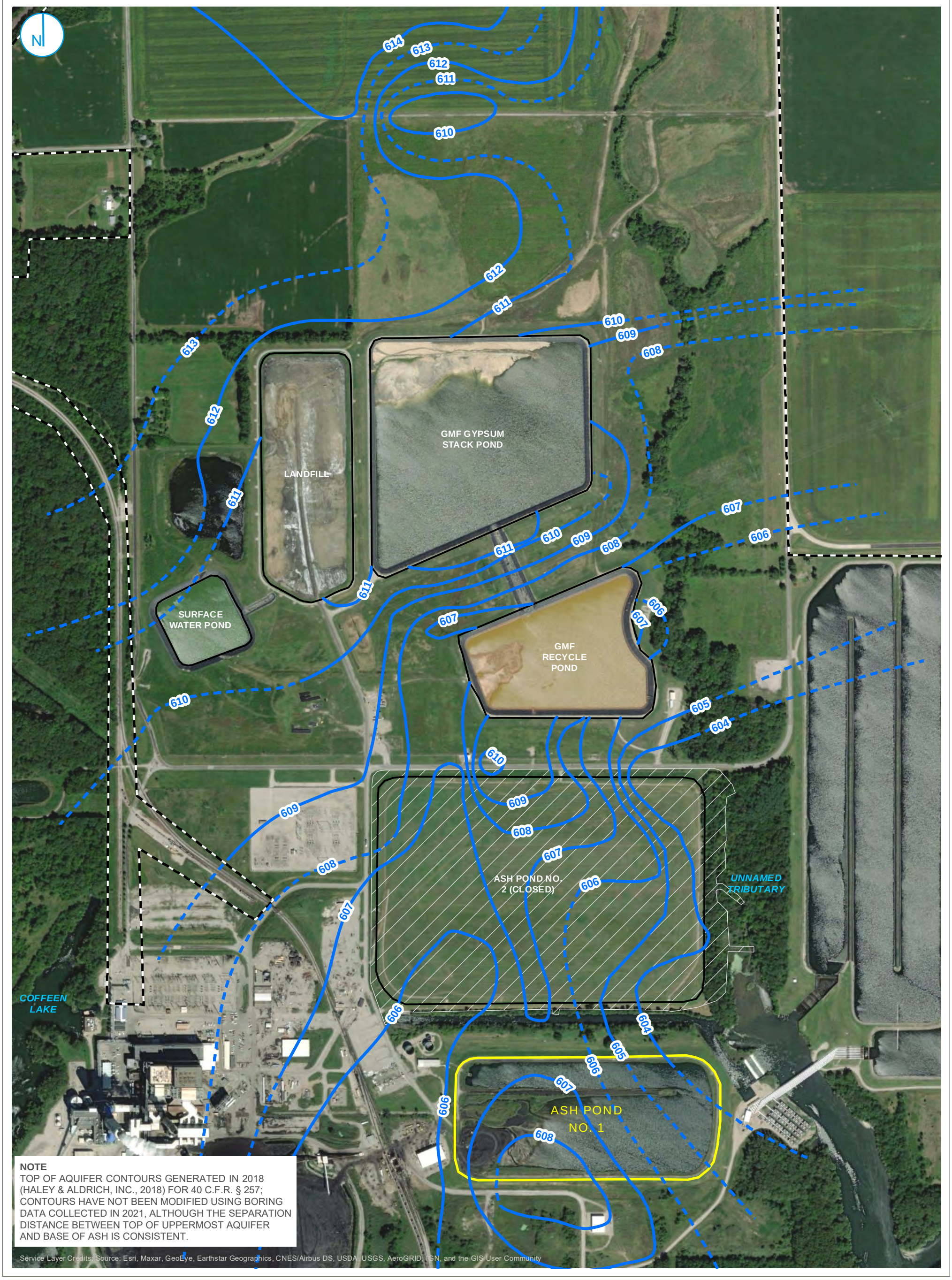
BASE OF CCR

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-5

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



HAGARSTOWN MEMBER ELEVATION CONTOUR (1-FT INTERVAL, NAVD88)
INFERRED HAGARSTOWN MEMBER ELEVATION CONTOUR
PART 845 REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 275 550 Feet

TOP OF UPPERMOST AQUIFER

FIGURE 2-6

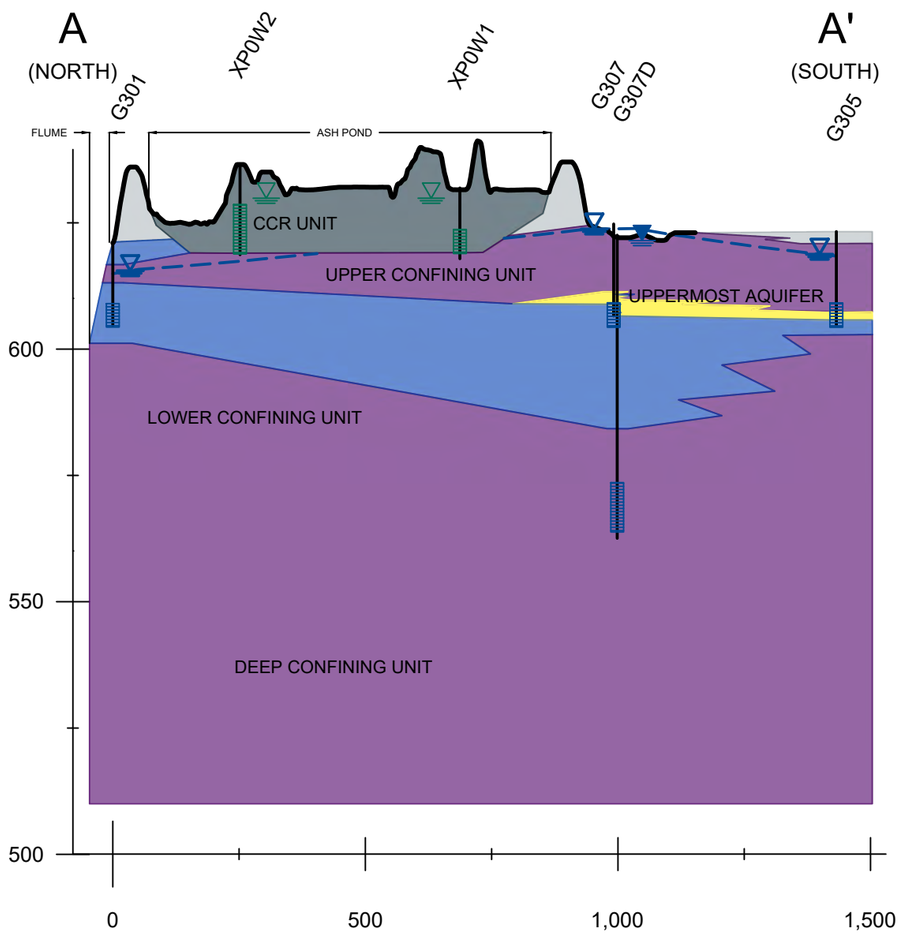
NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

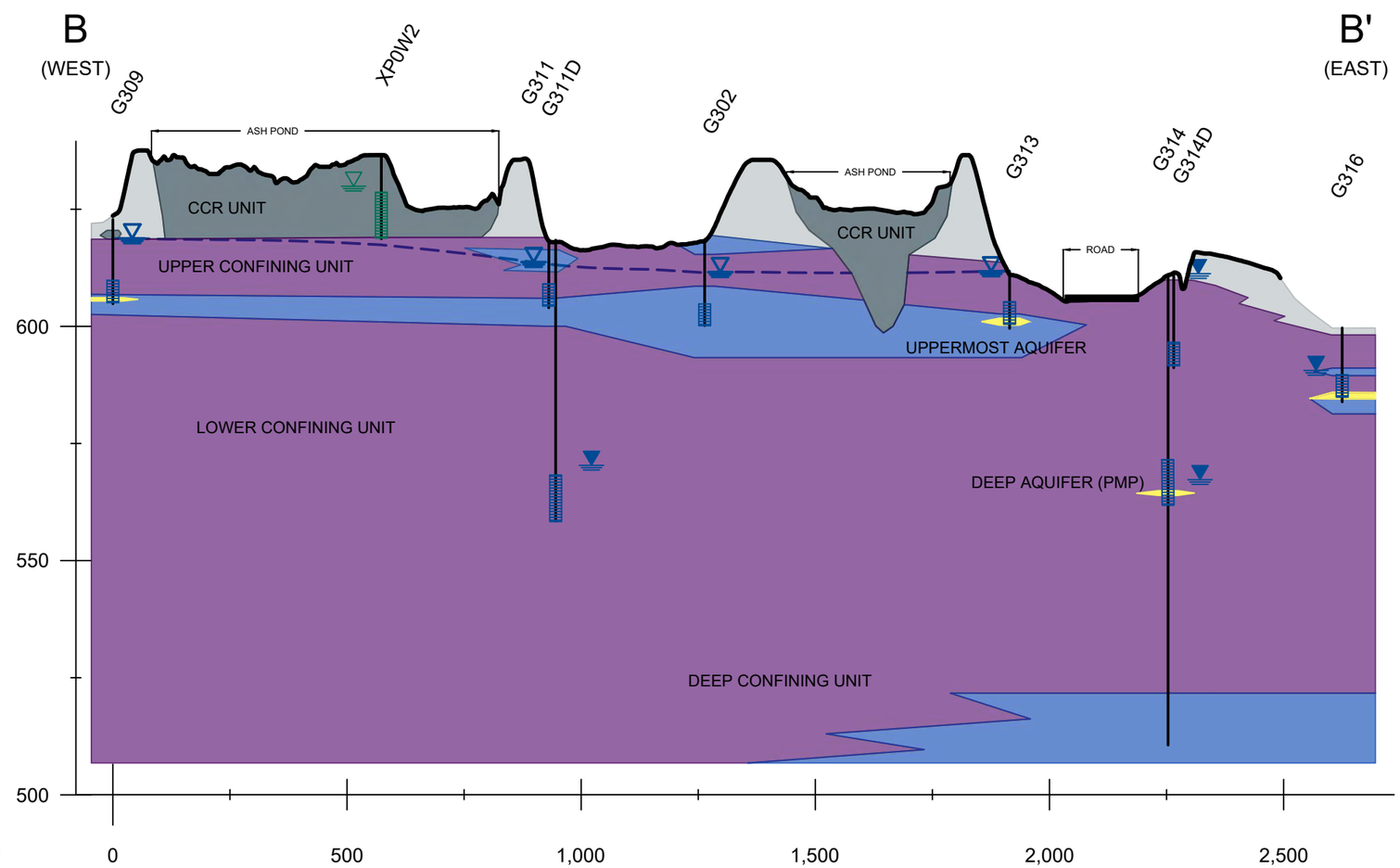
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

NOTES

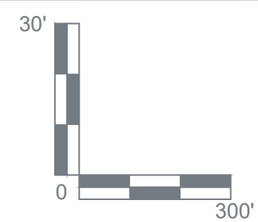
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on July 26, 2021.





LEGEND

- COAL COMBUSTION RESIDUALS (CCR)
- FILL
- CLAY (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- WELL SCREEN INTERVAL
- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
- UPPERMOST AQUIFER GROUNDWATER ELEVATION
- POREWATER ELEVATION
- BEDROCK GROUNDWATER / OTHER GROUNDWATER / SURFACE WATER ELEVATION(S)



GEOLOGIC CROSS SECTIONS
A-A' & B-B'

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-7

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

- COMPLIANCE MONITORING WELL
- BACKGROUND MONITORING WELL
- PORE WATER WELL
- LEACHATE WELL
- MONITORING WELL
- STAFF GAGE, CCR UNIT
- STAFF GAGE, RIVER
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- REGULATED UNIT (SUBJECT UNIT)
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY
- SITE FEATURE

0 325 650 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP MAY 30, 2023 (E001)

FIGURE 2-8

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 325 650 Feet

DEEP AQUIFER POTENTIOMETRIC SURFACE MAP AUGUST 8, 2023 (E002)

FIGURE 2-9

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

- TOTAL BORON EXCEEDANCE
- TOTAL SULFATE EXCEEDANCE
- TOTAL DISSOLVED SOLIDS EXCEEDANCE
- COMPLIANCE WELL WITHOUT EXCEEDANCE
- REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 275 550 Feet

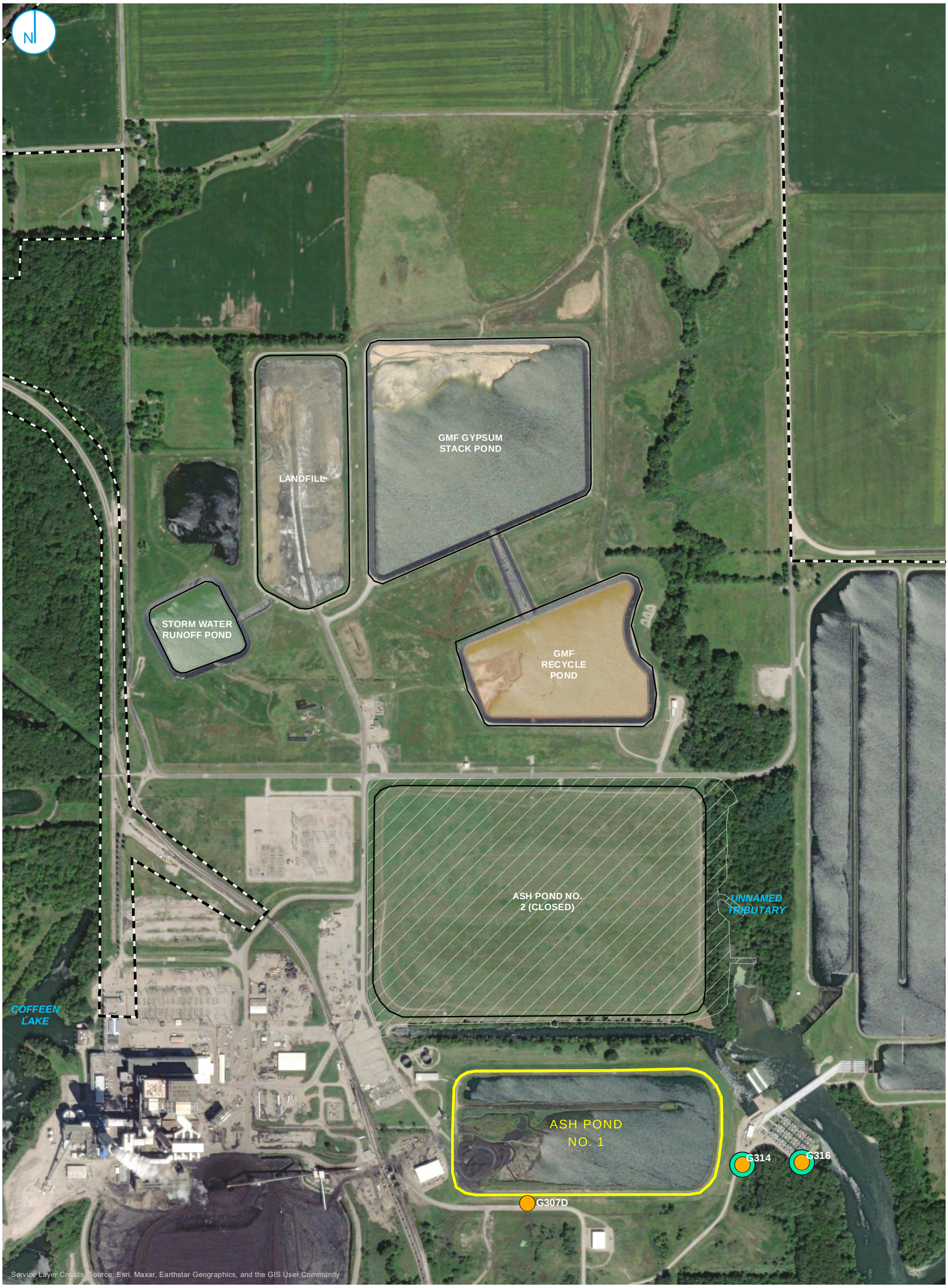
GWPS EXCEEDANCE MAP UPPERMOST AQUIFER

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 3-1

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



TOTAL SULFATE EXCEEDANCE
TOTAL DISSOLVED SOLIDS

REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 275 550 Feet

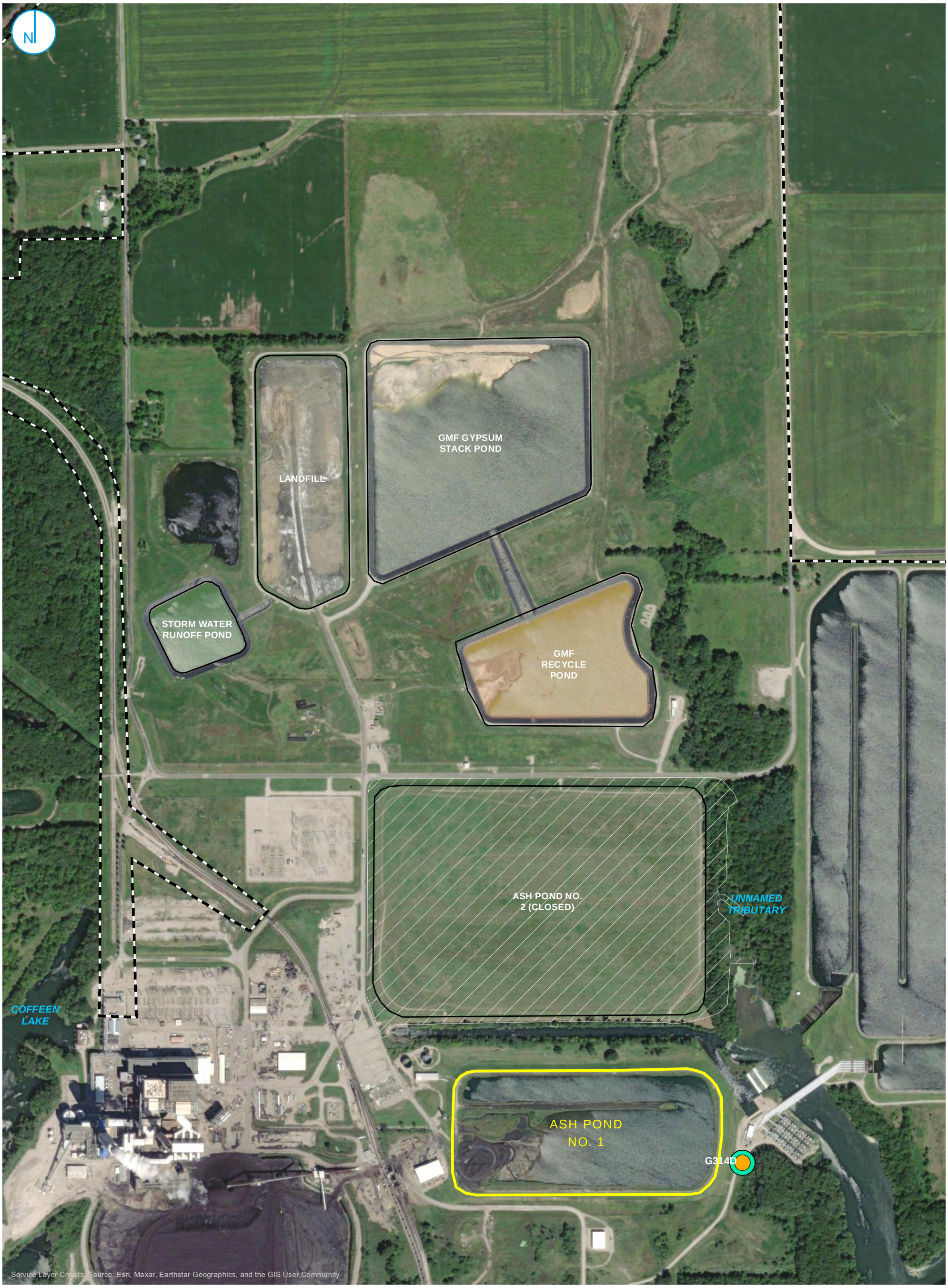
GWPS EXCEEDANCE MAP LOWER CONFINING UNIT

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 3-2

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



TOTAL SULFATE EXCEEDANCE
TOTAL DISSOLVED SOLIDS EXCEEDANCE

REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 275 550 Feet

GWPS EXCEEDANCE MAP DEEP AQUIFER

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 3-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

APPENDICES

APPENDIX A
Site-Wide Groundwater Elevations

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G045D	Water Level	LCU	02/13/2023	9.12	614.69
G045D	Water Level	LCU	05/30/2023	9.82	613.99
G045D	Water Level	LCU	08/08/2023	10.34	613.47
G045D	Water Level	LCU	10/24/2023	10.41	613.40
G045D	Water Level	LCU	11/13/2023	10.26	613.55
G046D	Water Level	LCU	02/13/2023	14.85	610.39
G046D	Water Level	LCU	05/30/2023	14.54	610.70
G046D	Water Level	LCU	08/08/2023	15.10	610.14
G046D	Water Level	LCU	10/24/2023	15.59	609.65
G046D	Water Level	LCU	11/13/2023	15.54	609.70
G1001	Water Level	LCU	02/13/2023	6.12	591.49
G1001	Water Level	LCU	03/30/2023	6.09	591.51
G1001	Water Level	LCU	04/30/2023	6.53	591.07
G1001	Water Level	LCU	05/30/2023	6.61	590.99
G1001	Water Level	LCU	08/08/2023	6.32	591.29
G1001	Water Level	LCU	09/25/2023	6.14	591.46
G1001	Water Level	LCU	10/24/2023	6.20	591.41
G1001	Water Level	LCU	11/13/2023	6.49	591.12
G1001	Water Level	LCU	12/18/2023	5.88	591.73
G1003	Water Level	LCU	02/13/2023	Dry	Dry
G1003	Water Level	LCU	05/30/2023	Dry	Dry
G1003	Water Level	LCU	08/08/2023	Dry	Dry
G1003	Water Level	LCU	10/24/2023	Dry	Dry
G1003	Water Level	LCU	11/13/2023	Dry	Dry
G101	Water Level	UA	02/13/2023	4.71	622.89
G101	Water Level	UA	05/30/2023	6.53	621.07
G101	Water Level	UA	08/08/2023	11.16	616.44
G101	Water Level	UA	10/25/2023	14.15	613.45
G101	Water Level	UA	11/13/2023	13.95	613.65
G102	Water Level	UA	02/13/2023	4.80	624.24
G102	Water Level	UA	08/08/2023	10.34	618.70
G102	Water Level	UA	10/24/2023	12.60	616.44
G102	Water Level	UA	11/13/2023	12.84	616.20
G102	Water Level	UA	12/18/2023	12.82	616.22

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G103	Water Level	UA	02/13/2023	9.59	624.21
G103	Water Level	UA	03/30/2023	7.94	625.85
G103	Water Level	UA	04/30/2023	9.58	624.21
G103	Water Level	UA	05/30/2023	10.49	623.31
G103	Water Level	UA	06/08/2023	11.00	622.80
G103	Water Level	UA	07/08/2023	12.05	621.74
G103	Water Level	UA	08/08/2023	13.53	620.27
G103	Water Level	UA	09/25/2023	14.74	619.06
G103	Water Level	UA	10/25/2023	15.66	618.14
G103	Water Level	UA	11/13/2023	16.00	617.80
G103	Water Level	UA	12/18/2023	16.24	617.56
G105	Water Level	UA	02/13/2023	8.24	623.84
G105	Water Level	UA	08/08/2023	10.84	621.24
G105	Water Level	UA	09/25/2023	15.74	616.34
G105	Water Level	UA	10/25/2023	12.90	619.18
G105	Water Level	UA	11/13/2023	13.46	618.62
G105	Water Level	UA	12/18/2023	13.63	618.45
G106	Water Level	UA	02/13/2023	8.44	622.71
G106	Water Level	UA	03/30/2023	7.82	623.32
G106	Water Level	UA	04/30/2023	9.16	621.98
G106	Water Level	UA	05/30/2023	9.81	621.33
G106	Water Level	UA	06/08/2023	10.39	620.76
G106	Water Level	UA	07/08/2023	10.50	620.65
G106	Water Level	UA	08/08/2023	12.17	618.98
G106	Water Level	UA	09/25/2023	12.97	618.18
G106	Water Level	UA	10/25/2023	14.01	617.14
G106	Water Level	UA	11/13/2023	14.21	616.94
G106	Water Level	UA	12/18/2023	13.87	617.28
G107	Water Level	UA	02/13/2023	9.07	621.15
G107	Water Level	UA	05/30/2023	10.85	619.37
G107	Water Level	UA	08/08/2023	12.76	617.46
G107	Water Level	UA	10/25/2023	14.31	615.91
G107	Water Level	UA	11/13/2023	14.40	615.82
G108	Water Level	UA	02/13/2023	9.67	620.55

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G108	Water Level	UA	05/30/2023	11.65	618.57
G108	Water Level	UA	08/08/2023	13.24	616.98
G108	Water Level	UA	10/25/2023	14.89	615.33
G108	Water Level	UA	11/13/2023	14.96	615.26
G109	Water Level	UA	02/13/2023	9.81	619.95
G109	Water Level	UA	05/30/2023	11.89	617.87
G109	Water Level	UA	08/08/2023	13.64	616.12
G109	Water Level	UA	10/25/2023	14.89	614.87
G109	Water Level	UA	11/13/2023	15.09	614.67
G110	Water Level	UA	02/13/2023	10.80	618.85
G110	Water Level	UA	05/30/2023	12.70	616.95
G110	Water Level	UA	08/08/2023	14.16	615.49
G110	Water Level	UA	10/25/2023	15.31	614.34
G110	Water Level	UA	11/13/2023	15.43	614.22
G111	Water Level	UA	02/13/2023	12.91	616.99
G111	Water Level	UA	05/30/2023	13.70	616.20
G111	Water Level	UA	08/08/2023	14.95	614.95
G111	Water Level	UA	10/25/2023	16.00	613.90
G111	Water Level	UA	11/13/2023	16.09	613.81
G119	Water Level	UA	02/13/2023	14.64	616.91
G119	Water Level	UA	05/30/2023	15.08	616.47
G119	Water Level	UA	08/08/2023	15.65	615.90
G119	Water Level	UA	10/25/2023	16.40	615.15
G119	Water Level	UA	11/13/2023	16.25	615.30
G120	Water Level	UA	02/13/2023	14.43	617.44
G120	Water Level	UA	05/30/2023	14.86	617.01
G120	Water Level	UA	08/08/2023	16.31	615.56
G120	Water Level	UA	10/25/2023	17.18	614.69
G120	Water Level	UA	11/13/2023	17.08	614.79
G121	Water Level	UA	02/13/2023	14.72	618.11
G121	Water Level	UA	05/30/2023	15.38	617.45
G121	Water Level	UA	08/08/2023	18.40	614.43
G121	Water Level	UA	10/25/2023	19.45	613.38
G121	Water Level	UA	11/13/2023	18.96	613.87

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G122	Water Level	UA	02/13/2023	13.89	618.80
G122	Water Level	UA	05/30/2023	14.00	618.69
G122	Water Level	UA	08/08/2023	19.54	613.15
G122	Water Level	UA	10/25/2023	21.21	611.48
G122	Water Level	UA	11/13/2023	20.40	612.29
G123	Water Level	UA	02/13/2023	11.80	621.16
G123	Water Level	UA	05/30/2023	12.68	620.28
G123	Water Level	UA	08/08/2023	18.57	614.39
G123	Water Level	UA	10/25/2023	20.09	612.87
G123	Water Level	UA	11/13/2023	19.94	613.02
G124	Water Level	UA	02/13/2023	12.14	621.25
G124	Water Level	UA	05/30/2023	13.43	619.96
G124	Water Level	UA	08/08/2023	18.49	614.90
G124	Water Level	UA	10/25/2023	21.05	612.34
G124	Water Level	UA	11/13/2023	Dry	Dry
G125	Water Level	UA	02/13/2023	11.99	621.52
G125	Water Level	UA	05/30/2023	13.54	619.97
G125	Water Level	UA	08/08/2023	18.53	614.98
G125	Water Level	UA	10/25/2023	21.21	612.30
G125	Water Level	UA	11/13/2023	Dry	Dry
G126	Water Level	UA	02/13/2023	8.92	616.47
G126	Water Level	UA	05/30/2023	10.04	615.35
G126	Water Level	UA	08/08/2023	10.93	614.46
G126	Water Level	UA	10/25/2023	11.85	613.54
G126	Water Level	UA	11/13/2023	11.91	613.48
G151	Water Level	UA	02/13/2023	10.88	615.05
G151	Water Level	UA	05/30/2023	11.58	614.35
G151	Water Level	UA	08/08/2023	12.22	613.71
G151	Water Level	UA	10/25/2023	12.99	612.94
G151	Water Level	UA	11/13/2023	12.97	612.96
G152	Water Level	UA	02/13/2023	10.25	616.27
G152	Water Level	UA	05/30/2023	11.11	615.41
G152	Water Level	UA	08/08/2023	12.40	614.12
G152	Water Level	UA	10/25/2023	13.42	613.10

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G152	Water Level	UA	11/13/2023	13.07	613.45
G153	Water Level	UA	02/13/2023	12.24	614.16
G153	Water Level	UA	05/30/2023	11.40	615.00
G153	Water Level	UA	08/08/2023	13.08	613.32
G153	Water Level	UA	10/25/2023	14.81	611.59
G153	Water Level	UA	11/13/2023	14.90	611.50
G154	Water Level	UA	02/13/2023	10.91	615.44
G154	Water Level	UA	05/30/2023	13.15	613.20
G154	Water Level	UA	08/08/2023	14.60	611.75
G154	Water Level	UA	10/25/2023	15.90	610.45
G154	Water Level	UA	11/13/2023	15.76	610.59
G155	Water Level	UA	02/13/2023	11.56	614.30
G155	Water Level	UA	05/30/2023	12.44	613.42
G155	Water Level	UA	08/08/2023	13.21	612.65
G155	Water Level	UA	10/25/2023	14.01	611.85
G155	Water Level	UA	11/13/2023	13.92	611.94
G200	Water Level	UA	02/13/2023	2.91	623.03
G200	Water Level	UA	03/30/2023	3.01	622.92
G200	Water Level	UA	04/30/2023	4.51	621.42
G200	Water Level	UA	05/30/2023	5.89	620.04
G200	Water Level	UA	06/08/2023	6.44	619.49
G200	Water Level	UA	08/08/2023	9.21	616.73
G200	Water Level	UA	09/25/2023	10.61	615.33
G200	Water Level	UA	10/25/2023	11.51	614.43
G200	Water Level	UA	11/13/2023	11.88	614.06
G200	Water Level	UA	12/18/2023	11.48	614.46
G206	Water Level	UA	02/13/2023	9.20	623.62
G206	Water Level	UA	03/30/2023	9.12	623.69
G206	Water Level	UA	04/30/2023	10.27	622.54
G206	Water Level	UA	05/30/2023	11.17	621.64
G206	Water Level	UA	07/08/2023	12.13	620.69
G206	Water Level	UA	08/08/2023	13.89	618.93
G206	Water Level	UA	09/25/2023	14.74	618.08
G206	Water Level	UA	10/25/2023	15.71	617.11

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G206	Water Level	UA	11/13/2023	16.16	616.66
G206	Water Level	UA	12/18/2023	15.85	616.97
G206D	Water Level	DA	02/13/2023	9.92	624.22
G206D	Water Level	DA	02/16/2023	[29.69]	[604.16]
G206D	Water Level	DA	03/30/2023	32.14	601.99
G206D	Water Level	DA	04/30/2023	30.53	603.60
G206D	Water Level	DA	05/30/2023	30.22	603.91
G206D	Water Level	DA	07/08/2023	30.10	604.04
G206D	Water Level	DA	08/08/2023	30.04	604.10
G206D	Water Level	DA	09/25/2023	30.08	604.06
G206D	Water Level	DA	10/25/2023	30.34	603.80
G206D	Water Level	DA	11/13/2023	30.40	603.74
G206D	Water Level	DA	12/18/2023	30.32	603.82
G207	Water Level	UA	02/13/2023	10.25	622.96
G207	Water Level	UA	03/30/2023	9.67	623.53
G207	Water Level	UA	04/30/2023	10.55	622.65
G207	Water Level	UA	05/30/2023	11.47	621.73
G207	Water Level	UA	07/08/2023	12.45	620.76
G207	Water Level	UA	08/08/2023	14.20	619.01
G207	Water Level	UA	09/25/2023	15.27	617.94
G207	Water Level	UA	10/25/2023	16.24	616.97
G207	Water Level	UA	11/13/2023	16.67	616.54
G207	Water Level	UA	12/18/2023	16.31	616.90
G208	Water Level	UA	02/13/2023	10.28	622.88
G208	Water Level	UA	03/30/2023	9.65	623.50
G208	Water Level	UA	04/30/2023	10.30	622.85
G208	Water Level	UA	05/30/2023	11.10	622.05
G208	Water Level	UA	06/08/2023	12.38	620.78
G208	Water Level	UA	07/08/2023	12.32	620.83
G208	Water Level	UA	08/08/2023	14.08	619.08
G208	Water Level	UA	09/25/2023	15.31	617.84
G208	Water Level	UA	10/25/2023	16.25	616.91
G208	Water Level	UA	11/13/2023	16.66	616.50
G208	Water Level	UA	12/18/2023	16.24	616.92

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G209	Water Level	UA	02/13/2023	10.01	622.90
G209	Water Level	UA	03/30/2023	9.63	623.27
G209	Water Level	UA	04/30/2023	10.25	622.65
G209	Water Level	UA	05/30/2023	11.07	621.83
G209	Water Level	UA	07/08/2023	11.82	621.08
G209	Water Level	UA	08/08/2023	13.79	619.12
G209	Water Level	UA	09/25/2023	14.78	618.13
G209	Water Level	UA	10/25/2023	15.60	617.31
G209	Water Level	UA	11/13/2023	16.24	616.67
G209	Water Level	UA	12/18/2023	16.04	616.87
G210	Water Level	UA	02/13/2023	10.49	622.50
G210	Water Level	UA	03/30/2023	9.73	623.25
G210	Water Level	UA	04/30/2023	10.36	622.62
G210	Water Level	UA	05/30/2023	11.09	621.89
G210	Water Level	UA	06/08/2023	11.76	621.23
G210	Water Level	UA	07/08/2023	12.29	620.70
G210	Water Level	UA	08/08/2023	13.75	619.24
G210	Water Level	UA	09/25/2023	14.67	618.32
G210	Water Level	UA	10/25/2023	15.52	617.47
G210	Water Level	UA	11/13/2023	15.82	617.17
G210	Water Level	UA	12/18/2023	15.99	617.00
G211	Water Level	UA	02/13/2023	9.90	622.74
G211	Water Level	UA	03/30/2023	9.18	623.45
G211	Water Level	UA	04/30/2023	9.99	622.64
G211	Water Level	UA	05/30/2023	10.54	622.09
G211	Water Level	UA	06/08/2023	11.76	620.88
G211	Water Level	UA	07/08/2023	12.43	620.21
G211	Water Level	UA	08/08/2023	13.44	619.20
G211	Water Level	UA	09/25/2023	14.74	617.90
G211	Water Level	UA	10/25/2023	15.15	617.49
G211	Water Level	UA	11/13/2023	15.61	617.03
G211	Water Level	UA	12/18/2023	15.93	616.71
G212	Water Level	UA	02/13/2023	10.38	622.51
G212	Water Level	UA	03/30/2023	9.77	623.11

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G212	Water Level	UA	04/30/2023	10.89	621.99
G212	Water Level	UA	05/30/2023	11.64	621.24
G212	Water Level	UA	06/08/2023	12.80	620.08
G212	Water Level	UA	07/08/2023	13.48	619.41
G212	Water Level	UA	08/08/2023	14.61	618.28
G212	Water Level	UA	09/25/2023	15.97	616.92
G212	Water Level	UA	10/25/2023	16.46	616.43
G212	Water Level	UA	11/13/2023	16.92	615.97
G212	Water Level	UA	12/18/2023	17.00	615.89
G213	Water Level	UA	02/13/2023	10.83	621.98
G213	Water Level	UA	03/30/2023	10.15	622.65
G213	Water Level	UA	04/30/2023	11.04	621.76
G213	Water Level	UA	05/30/2023	11.96	620.84
G213	Water Level	UA	06/08/2023	12.80	620.00
G213	Water Level	UA	07/08/2023	13.50	619.31
G213	Water Level	UA	08/08/2023	15.05	617.76
G213	Water Level	UA	09/25/2023	15.90	616.91
G213	Water Level	UA	10/25/2023	16.81	616.00
G213	Water Level	UA	11/13/2023	17.41	615.40
G213	Water Level	UA	12/18/2023	17.34	615.47
G214	Water Level	UA	02/13/2023	14.53	618.32
G214	Water Level	UA	03/30/2023	13.04	619.80
G214	Water Level	UA	04/30/2023	13.98	618.86
G214	Water Level	UA	05/30/2023	14.73	618.11
G214	Water Level	UA	06/08/2023	15.56	617.29
G214	Water Level	UA	07/08/2023	16.44	616.41
G214	Water Level	UA	08/08/2023	17.64	615.21
G214	Water Level	UA	09/25/2023	18.42	614.43
G214	Water Level	UA	10/25/2023	19.14	613.71
G214	Water Level	UA	11/13/2023	19.35	613.50
G214	Water Level	UA	12/18/2023	19.23	613.62
G215	Water Level	UA	02/13/2023	14.38	618.68
G215	Water Level	UA	03/30/2023	13.16	619.89
G215	Water Level	UA	04/30/2023	14.03	619.02

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G215	Water Level	UA	05/30/2023	14.76	618.29
G215	Water Level	UA	06/08/2023	15.46	617.59
G215	Water Level	UA	07/08/2023	16.06	616.99
G215	Water Level	UA	08/08/2023	17.22	615.84
G215	Water Level	UA	09/25/2023	18.06	614.99
G215	Water Level	UA	10/25/2023	18.41	614.65
G215	Water Level	UA	11/13/2023	19.03	614.03
G215	Water Level	UA	12/18/2023	18.75	614.31
G216	Water Level	UA	02/13/2023	13.54	619.22
G216	Water Level	UA	03/30/2023	12.27	620.48
G216	Water Level	UA	04/30/2023	12.94	619.81
G216	Water Level	UA	05/30/2023	13.63	619.12
G216	Water Level	UA	06/08/2023	14.99	617.77
G216	Water Level	UA	07/08/2023	15.42	617.33
G216	Water Level	UA	08/08/2023	16.51	616.25
G216	Water Level	UA	09/25/2023	17.38	615.38
G216	Water Level	UA	10/25/2023	17.86	614.90
G216	Water Level	UA	11/13/2023	18.21	614.55
G216	Water Level	UA	12/18/2023	18.00	614.76
G217	Water Level	UA	02/13/2023	14.72	618.38
G217	Water Level	UA	08/08/2023	18.29	614.81
G217	Water Level	UA	10/25/2023	19.51	613.59
G217	Water Level	UA	11/13/2023	19.68	613.42
G217	Water Level	UA	12/18/2023	19.33	613.77
G218	Water Level	UA	02/13/2023	13.71	619.40
G218	Water Level	UA	03/30/2023	12.50	620.60
G218	Water Level	UA	04/30/2023	12.98	620.12
G218	Water Level	UA	05/30/2023	13.72	619.38
G218	Water Level	UA	06/08/2023	15.11	618.00
G218	Water Level	UA	07/08/2023	15.80	617.31
G218	Water Level	UA	08/08/2023	16.98	616.13
G218	Water Level	UA	09/25/2023	17.95	615.16
G218	Water Level	UA	10/25/2023	18.48	614.63
G218	Water Level	UA	11/13/2023	18.67	614.44

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G218	Water Level	UA	12/18/2023	18.38	614.73
G270	Water Level	UA	02/13/2023	2.53	623.33
G270	Water Level	UA	03/30/2023	2.41	623.44
G270	Water Level	UA	04/30/2023	2.83	623.02
G270	Water Level	UA	05/30/2023	5.06	620.79
G270	Water Level	UA	08/14/2023	[8.52]	[617.34]
G270	Water Level	UA	10/25/2023	10.92	614.94
G270	Water Level	UA	11/13/2023	10.90	614.96
G270	Water Level	UA	12/18/2023	9.84	616.02
G271	Water Level	UA	02/13/2023	8.93	616.64
G271	Water Level	UA	03/30/2023	7.12	618.44
G271	Water Level	UA	04/30/2023	8.97	616.59
G271	Water Level	UA	05/30/2023	9.28	616.28
G271	Water Level	UA	06/08/2023	9.57	615.99
G271	Water Level	UA	07/08/2023	9.83	615.73
G271	Water Level	UA	08/08/2023	11.20	614.37
G271	Water Level	UA	09/25/2023	12.44	613.13
G271	Water Level	UA	10/25/2023	12.95	612.62
G271	Water Level	UA	11/13/2023	13.00	612.57
G271	Water Level	UA	12/18/2023	12.79	612.78
G272	Water Level	UA	02/13/2023	8.55	615.26
G272	Water Level	UA	03/30/2023	6.96	616.84
G272	Water Level	UA	04/30/2023	9.20	614.60
G272	Water Level	UA	05/30/2023	9.48	614.32
G272	Water Level	UA	08/08/2023	10.55	613.26
G272	Water Level	UA	09/25/2023	11.63	612.18
G272	Water Level	UA	10/25/2023	12.03	611.78
G272	Water Level	UA	11/13/2023	12.01	611.80
G272	Water Level	UA	12/18/2023	11.81	612.00
G273	Water Level	UA	02/13/2023	8.95	614.07
G273	Water Level	UA	03/30/2023	7.80	615.21
G273	Water Level	UA	04/30/2023	10.09	612.92
G273	Water Level	UA	05/30/2023	10.41	612.60
G273	Water Level	UA	08/08/2023	11.56	611.46

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G273	Water Level	UA	09/25/2023	12.39	610.63
G273	Water Level	UA	10/25/2023	12.78	610.24
G273	Water Level	UA	11/13/2023	12.71	610.31
G273	Water Level	UA	12/18/2023	12.40	610.62
G274	Water Level	UA	02/13/2023	13.22	610.82
G274	Water Level	UA	03/30/2023	11.96	612.07
G274	Water Level	UA	04/30/2023	13.85	610.18
G274	Water Level	UA	05/30/2023	14.16	609.87
G274	Water Level	UA	06/08/2023	14.41	609.63
G274	Water Level	UA	07/08/2023	14.33	609.70
G274	Water Level	UA	08/08/2023	14.99	609.05
G274	Water Level	UA	09/25/2023	15.46	608.57
G274	Water Level	UA	10/25/2023	Dry	Dry
G274	Water Level	UA	11/13/2023	15.77	608.27
G274	Water Level	UA	12/18/2023	15.53	608.51
G275	Water Level	UA	02/13/2023	13.02	605.24
G275	Water Level	UA	05/30/2023	13.38	604.88
G275	Water Level	UA	08/08/2023	Dry	Dry
G275	Water Level	UA	11/13/2023	Dry	Dry
G275D	Water Level	DA	02/13/2023	39.49	580.82
G275D	Water Level	DA	08/08/2023	31.27	589.04
G275D	Water Level	DA	09/25/2023	42.29	578.02
G275D	Water Level	DA	10/25/2023	39.74	580.57
G275D	Water Level	DA	12/18/2023	43.46	576.85
G276	Water Level	UA	02/13/2023	27.37	604.63
G276	Water Level	UA	03/30/2023	25.78	606.21
G276	Water Level	UA	04/30/2023	26.04	605.95
G276	Water Level	UA	05/30/2023	26.60	605.39
G276	Water Level	UA	06/08/2023	26.84	605.16
G276	Water Level	UA	07/08/2023	27.27	604.73
G276	Water Level	UA	08/08/2023	27.75	604.25
G276	Water Level	UA	10/25/2023	28.49	603.51
G276	Water Level	UA	11/13/2023	28.59	603.41
G276	Water Level	UA	12/18/2023	28.71	603.29

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G277	Water Level	UA	02/13/2023	19.67	603.41
G277	Water Level	UA	05/30/2023	18.21	604.87
G277	Water Level	UA	08/08/2023	19.76	603.32
G277	Water Level	UA	11/13/2023	Dry	Dry
G278	Water Level	UA	02/13/2023	19.95	611.22
G278	Water Level	UA	05/30/2023	21.75	609.42
G278	Water Level	UA	08/08/2023	20.98	610.19
G278	Water Level	UA	10/25/2023	23.48	607.69
G278	Water Level	UA	11/13/2023	24.23	606.94
G279	Water Level	UA	02/13/2023	20.83	611.21
G279	Water Level	UA	05/30/2023	22.73	609.31
G279	Water Level	UA	08/08/2023	23.69	608.35
G279	Water Level	UA	10/25/2023	24.56	607.48
G279	Water Level	UA	11/13/2023	23.39	608.65
G280	Water Level	UA	02/13/2023	3.01	622.34
G280	Water Level	UA	03/30/2023	2.74	622.60
G280	Water Level	UA	04/30/2023	3.52	621.82
G280	Water Level	UA	05/30/2023	3.96	621.38
G280	Water Level	UA	08/08/2023	5.80	619.55
G280	Water Level	UA	09/25/2023	7.42	617.92
G280	Water Level	UA	10/25/2023	8.56	616.79
G280	Water Level	UA	11/13/2023	8.91	616.44
G280	Water Level	UA	12/18/2023	9.04	616.31
G281	Water Level	UA	02/13/2023	4.63	621.73
G281	Water Level	UA	03/30/2023	3.94	622.41
G281	Water Level	UA	04/30/2023	6.44	619.91
G281	Water Level	UA	05/30/2023	6.64	619.71
G281	Water Level	UA	08/08/2023	6.39	619.97
G281	Water Level	UA	10/24/2023	8.64	617.72
G281	Water Level	UA	11/13/2023	8.59	617.77
G281	Water Level	UA	12/18/2023	6.83	619.53
G283	Water Level	LCU	02/13/2023	4.61	606.14
G283	Water Level	LCU	03/30/2023	3.55	607.19
G283	Water Level	LCU	04/30/2023	4.71	606.03

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G283	Water Level	LCU	05/30/2023	5.60	605.14
G283	Water Level	LCU	08/14/2023	[7.45]	[603.30]
G283	Water Level	LCU	10/24/2023	7.79	602.96
G283	Water Level	LCU	11/13/2023	7.22	603.53
G283	Water Level	LCU	12/18/2023	6.49	604.26
G284	Water Level	UA	02/13/2023	9.72	608.70
G284	Water Level	UA	03/30/2023	8.65	609.76
G284	Water Level	UA	04/30/2023	11.62	606.79
G284	Water Level	UA	05/30/2023	12.43	605.98
G284	Water Level	UA	08/14/2023	[12.28]	[606.14]
G284	Water Level	UA	10/24/2023	Dry	Dry
G284	Water Level	UA	11/13/2023	Dry	Dry
G284	Water Level	UA	12/18/2023	12.91	605.51
G285	Water Level	LCU	02/13/2023	6.12	607.40
G285	Water Level	LCU	03/30/2023	4.18	609.33
G285	Water Level	LCU	04/30/2023	5.80	607.71
G285	Water Level	LCU	05/30/2023	6.71	606.80
G285	Water Level	LCU	07/08/2023	8.14	605.37
G285	Water Level	LCU	08/08/2023	8.25	605.26
G285	Water Level	LCU	08/14/2023	[8.44]	[605.08]
G285	Water Level	LCU	09/25/2023	8.47	605.05
G285	Water Level	LCU	10/24/2023	8.96	604.56
G285	Water Level	LCU	11/13/2023	9.38	604.14
G285	Water Level	LCU	12/18/2023	8.03	605.49
G286	Water Level	UA	02/13/2023	6.18	606.95
G286	Water Level	UA	08/10/2023	[Dry]	[Dry]
G286	Water Level	UA	10/24/2023	Dry	Dry
G286	Water Level	UA	11/13/2023	Dry	Dry
G286	Water Level	UA	12/18/2023	Dry	Dry
G287	Water Level	UA	02/13/2023	5.75	611.70
G288	Water Level	UA	02/13/2023	9.78	610.29
G288	Water Level	UA	03/30/2023	4.70	615.37
G288	Water Level	UA	04/30/2023	6.66	613.41
G288	Water Level	UA	05/30/2023	7.40	612.67

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G288	Water Level	UA	06/08/2023	8.05	612.02
G288	Water Level	UA	07/08/2023	7.65	612.42
G288	Water Level	UA	08/08/2023	8.62	611.45
G288	Water Level	UA	08/11/2023	[8.70]	[611.37]
G288	Water Level	UA	09/25/2023	9.57	610.50
G288	Water Level	UA	10/24/2023	9.95	610.12
G288	Water Level	UA	11/13/2023	9.84	610.23
G288	Water Level	UA	12/18/2023	8.56	611.51
G301	Water Level	UA	02/13/2023	5.30	617.35
G301	Water Level	UA	06/08/2023	7.70	614.94
G301	Water Level	UA	07/08/2023	7.82	614.82
G301	Water Level	UA	08/08/2023	8.11	614.54
G301	Water Level	UA	10/24/2023	8.51	614.14
G301	Water Level	UA	11/13/2023	8.43	614.22
G301	Water Level	UA	12/18/2023	8.00	614.65
G302	Water Level	UA	02/13/2023	7.16	612.88
G302	Water Level	UA	03/30/2023	4.68	615.35
G302	Water Level	UA	04/30/2023	9.10	610.93
G302	Water Level	UA	05/30/2023	11.04	608.99
G302	Water Level	UA	06/08/2023	11.57	608.46
G302	Water Level	UA	07/08/2023	12.07	607.96
G302	Water Level	UA	08/08/2023	12.68	607.36
G302	Water Level	UA	09/25/2023	13.12	606.92
G302	Water Level	UA	11/13/2023	13.16	606.88
G302	Water Level	UA	12/18/2023	12.47	607.57
G303	Water Level	UA	02/13/2023	4.20	617.82
G303	Water Level	UA	03/30/2023	3.62	618.39
G303	Water Level	UA	04/30/2023	4.62	617.39
G303	Water Level	UA	05/30/2023	5.92	616.09
G303	Water Level	UA	08/08/2023	8.40	613.62
G303	Water Level	UA	09/25/2023	9.18	612.83
G303	Water Level	UA	10/24/2023	9.71	612.31
G303	Water Level	UA	11/13/2023	9.32	612.70
G303	Water Level	UA	12/18/2023	8.22	613.80

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G305	Water Level	UA	02/13/2023	6.08	619.59
G305	Water Level	UA	03/30/2023	5.81	619.85
G305	Water Level	UA	04/30/2023	6.59	619.07
G305	Water Level	UA	05/30/2023	7.63	618.03
G305	Water Level	UA	06/08/2023	8.35	617.31
G305	Water Level	UA	07/08/2023	8.23	617.43
G305	Water Level	UA	08/08/2023	9.19	616.48
G305	Water Level	UA	10/24/2023	9.95	615.72
G305	Water Level	UA	11/13/2023	8.50	617.17
G305	Water Level	UA	12/18/2023	8.24	617.43
G306	Water Level	UA	02/13/2023	5.80	620.11
G306	Water Level	UA	03/30/2023	5.41	620.49
G306	Water Level	UA	04/30/2023	6.64	619.26
G306	Water Level	UA	05/30/2023	8.13	617.77
G306	Water Level	UA	06/08/2023	9.18	616.72
G306	Water Level	UA	07/08/2023	8.60	617.30
G306	Water Level	UA	08/08/2023	9.70	616.21
G306	Water Level	UA	10/24/2023	10.81	615.10
G306	Water Level	UA	11/13/2023	10.13	615.78
G306	Water Level	UA	12/18/2023	7.56	618.35
G307	Water Level	UA	02/13/2023	Above Top of Casing	Above Top of Casing
G307	Water Level	UA	08/08/2023	0.70	623.90
G307	Water Level	UA	11/13/2023	1.96	622.64
G307D	Water Level	LCU	02/13/2023	2.75	622.13
G307D	Water Level	LCU	03/30/2023	2.32	622.55
G307D	Water Level	LCU	04/30/2023	2.41	622.46
G307D	Water Level	LCU	05/30/2023	2.48	622.39
G307D	Water Level	LCU	08/08/2023	7.89	616.99
G307D	Water Level	LCU	10/24/2023	11.33	613.55
G307D	Water Level	LCU	11/13/2023	12.36	612.52
G307D	Water Level	LCU	12/18/2023	7.55	617.33
G308	Water Level	UA	02/13/2023	3.88	620.71
G308	Water Level	UA	03/30/2023	3.79	620.79
G308	Water Level	UA	04/30/2023	4.84	619.74

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G308	Water Level	UA	05/30/2023	5.56	619.02
G308	Water Level	UA	06/08/2023	5.93	618.66
G308	Water Level	UA	07/08/2023	5.37	619.22
G308	Water Level	UA	08/08/2023	5.09	619.50
G308	Water Level	UA	09/25/2023	6.16	618.42
G308	Water Level	UA	10/24/2023	6.19	618.40
G308	Water Level	UA	11/13/2023	6.00	618.59
G308	Water Level	UA	12/18/2023	4.71	619.88
G309	Water Level	UA	02/13/2023	9.64	616.24
G309	Water Level	UA	08/08/2023	8.04	617.84
G309	Water Level	UA	09/25/2023	8.24	617.64
G309	Water Level	UA	10/24/2023	8.69	617.19
G309	Water Level	UA	11/13/2023	8.32	617.56
G309	Water Level	UA	12/18/2023	7.60	618.28
G310	Water Level	UA	02/13/2023	7.09	615.78
G310	Water Level	UA	03/30/2023	6.42	616.44
G310	Water Level	UA	04/30/2023	8.94	613.92
G310	Water Level	UA	05/30/2023	9.57	613.29
G310	Water Level	UA	06/08/2023	9.96	612.90
G310	Water Level	UA	08/08/2023	10.30	612.57
G310	Water Level	UA	09/25/2023	10.73	612.14
G310	Water Level	UA	10/24/2023	10.82	612.05
G310	Water Level	UA	11/13/2023	10.56	612.31
G310	Water Level	UA	12/18/2023	9.95	612.92
G311	Water Level	UA	05/30/2023	8.26	612.78
G311	Water Level	UA	08/08/2023	9.08	611.96
G311	Water Level	UA	10/24/2023	9.29	611.75
G311	Water Level	UA	11/13/2023	9.38	611.66
G311D	Water Level	LCU	02/13/2023	23.66	597.58
G311D	Water Level	LCU	05/30/2023	23.26	597.98
G311D	Water Level	LCU	08/08/2023	23.52	597.72
G311D	Water Level	LCU	10/24/2023	23.51	597.73
G311D	Water Level	LCU	11/13/2023	24.15	597.09
G312	Water Level	UA	03/30/2023	8.28	611.49

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G312	Water Level	UA	04/30/2023	10.81	608.96
G312	Water Level	UA	05/30/2023	12.42	607.35
G312	Water Level	UA	06/08/2023	12.87	606.91
G312	Water Level	UA	07/08/2023	13.42	606.36
G312	Water Level	UA	08/08/2023	14.00	605.78
G312	Water Level	UA	10/24/2023	Dry	Dry
G312	Water Level	UA	11/13/2023	Dry	Dry
G312	Water Level	UA	12/18/2023	14.45	605.33
G313	Water Level	UA	02/13/2023	3.24	611.06
G313	Water Level	UA	08/08/2023	3.01	611.29
G313	Water Level	UA	10/24/2023	3.08	611.22
G313	Water Level	UA	11/13/2023	3.36	610.94
G313	Water Level	UA	12/18/2023	3.48	610.82
G314	Water Level	LCU	02/13/2023	6.14	607.74
G314	Water Level	LCU	03/30/2023	8.96	604.91
G314	Water Level	LCU	04/30/2023	5.53	608.34
G314	Water Level	LCU	05/30/2023	4.81	609.06
G314	Water Level	LCU	06/08/2023	9.43	604.44
G314	Water Level	LCU	07/08/2023	5.67	608.20
G314	Water Level	LCU	08/08/2023	4.88	609.00
G314	Water Level	LCU	09/25/2023	4.96	608.92
G314	Water Level	LCU	10/24/2023	5.30	608.58
G314	Water Level	LCU	11/13/2023	5.67	608.21
G314	Water Level	LCU	12/18/2023	7.39	606.49
G314D	Water Level	DA	02/13/2023	16.40	597.30
G314D	Water Level	DA	03/30/2023	9.98	603.71
G314D	Water Level	DA	04/30/2023	7.48	606.21
G314D	Water Level	DA	05/30/2023	6.69	607.00
G314D	Water Level	DA	06/08/2023	11.80	601.90
G314D	Water Level	DA	07/08/2023	7.25	606.45
G314D	Water Level	DA	08/08/2023	7.78	605.92
G314D	Water Level	DA	09/25/2023	8.50	605.20
G314D	Water Level	DA	10/24/2023	8.56	605.14
G314D	Water Level	DA	11/13/2023	7.97	605.73

Appendix A. Site-Wide Groundwater Elevations
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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G314D	Water Level	DA	12/18/2023	7.04	606.66
G315	Water Level	UA	02/13/2023	2.08	621.44
G315	Water Level	UA	08/08/2023	3.50	620.02
G315	Water Level	UA	10/24/2023	4.04	619.48
G315	Water Level	UA	11/13/2023	4.11	619.41
G315	Water Level	UA	12/18/2023	2.55	620.97
G316	Water Level	LCU	02/13/2023	11.53	591.06
G316	Water Level	LCU	05/30/2023	12.28	590.31
G316	Water Level	LCU	08/08/2023	11.70	590.89
G316	Water Level	LCU	10/24/2023	12.54	590.05
G316	Water Level	LCU	11/13/2023	12.46	590.13
G317	Water Level	UA	02/13/2023	34.52	607.41
G317	Water Level	UA	08/08/2023	Dry	Dry
G317	Water Level	UA	09/25/2023	37.42	604.51
G317	Water Level	UA	10/24/2023	Dry	Dry
G317	Water Level	UA	11/13/2023	Dry	Dry
G317	Water Level	UA	12/18/2023	38.02	603.91
G401	Water Level	UA	02/13/2023	21.17	604.40
G401	Water Level	UA	05/30/2023	21.72	603.85
G401	Water Level	UA	08/08/2023	21.75	603.82
G401	Water Level	UA	10/24/2023	21.66	603.91
G401	Water Level	UA	11/13/2023	13.63	611.94
G402	Water Level	UA	02/13/2023	8.83	604.54
G402	Water Level	UA	03/30/2023	8.23	605.13
G402	Water Level	UA	04/30/2023	9.59	603.77
G402	Water Level	UA	05/30/2023	10.56	602.80
G402	Water Level	UA	06/08/2023	10.94	602.43
G402	Water Level	UA	07/08/2023	11.08	602.29
G402	Water Level	UA	08/08/2023	11.65	601.72
G402	Water Level	UA	10/24/2023	12.01	601.36
G402	Water Level	UA	11/13/2023	11.71	601.66
G402	Water Level	UA	12/18/2023	11.48	601.89
G403	Water Level	UA	02/13/2023	6.05	620.42
G403	Water Level	UA	03/30/2023	5.81	620.65

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G403	Water Level	UA	04/30/2023	7.09	619.37
G403	Water Level	UA	05/30/2023	8.13	618.33
G403	Water Level	UA	06/08/2023	8.74	617.73
G403	Water Level	UA	07/08/2023	7.21	619.26
G403	Water Level	UA	08/08/2023	7.45	619.02
G403	Water Level	UA	09/25/2023	8.82	617.64
G403	Water Level	UA	10/24/2023	8.62	617.85
G403	Water Level	UA	11/13/2023	8.27	618.20
G403	Water Level	UA	12/18/2023	6.64	619.83
G404	Water Level	UA	02/13/2023	3.46	612.21
G404	Water Level	UA	03/30/2023	3.24	612.42
G404	Water Level	UA	04/30/2023	4.64	611.02
G404	Water Level	UA	05/30/2023	5.42	610.24
G404	Water Level	UA	08/14/2023	[5.62]	[610.05]
G404	Water Level	UA	10/24/2023	7.09	608.58
G404	Water Level	UA	11/13/2023	6.48	609.19
G404	Water Level	UA	12/18/2023	4.70	610.97
G405	Water Level	UA	02/13/2023	6.13	617.50
G405	Water Level	UA	03/30/2023	5.87	617.75
G405	Water Level	UA	04/30/2023	6.53	617.09
G405	Water Level	UA	05/30/2023	6.83	616.79
G405	Water Level	UA	06/08/2023	7.08	616.55
G405	Water Level	UA	07/08/2023	6.59	617.04
G405	Water Level	UA	08/08/2023	6.85	616.78
G405	Water Level	UA	09/25/2023	7.59	616.04
G405	Water Level	UA	10/24/2023	7.84	615.79
G405	Water Level	UA	11/13/2023	7.73	615.90
G405	Water Level	UA	12/18/2023	6.55	617.08
G406	Water Level	UA	02/13/2023	11.25	614.11
G406	Water Level	UA	03/30/2023	9.94	615.41
G406	Water Level	UA	04/30/2023	12.48	612.87
G406	Water Level	UA	05/30/2023	13.06	612.29
G406	Water Level	UA	06/08/2023	13.75	611.61
G406	Water Level	UA	07/08/2023	11.92	613.44

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
G406	Water Level	UA	08/08/2023	11.49	613.87
G406	Water Level	UA	09/25/2023	13.95	611.41
G406	Water Level	UA	10/24/2023	14.08	611.28
G406	Water Level	UA	11/13/2023	13.83	611.53
G406	Water Level	UA	12/18/2023	12.03	613.33
G407	Water Level	UA	02/13/2023	5.60	615.72
G407	Water Level	UA	03/30/2023	5.49	615.82
G407	Water Level	UA	04/30/2023	6.91	614.40
G407	Water Level	UA	05/30/2023	7.35	613.96
G407	Water Level	UA	06/08/2023	8.75	612.57
G407	Water Level	UA	07/08/2023	8.22	613.10
G407	Water Level	UA	08/08/2023	8.79	612.53
G407	Water Level	UA	10/24/2023	8.39	612.93
G407	Water Level	UA	11/13/2023	8.31	613.01
G407	Water Level	UA	12/18/2023	6.76	614.56
G410	Water Level	UA	02/13/2023	7.44	612.35
G410	Water Level	UA	05/30/2023	8.99	610.80
G410	Water Level	UA	08/08/2023	9.66	610.13
G410	Water Level	UA	10/24/2023	10.88	608.91
G410	Water Level	UA	11/13/2023	10.68	609.11
G411	Water Level	UA	02/13/2023	6.15	617.10
G411	Water Level	UA	05/30/2023	8.52	614.73
G411	Water Level	UA	08/08/2023	8.69	614.56
G411	Water Level	UA	10/24/2023	11.33	611.92
G411	Water Level	UA	11/13/2023	11.20	612.05
MW03D	Water Level	DA	02/13/2023	30.75	598.26
MW03D	Water Level	DA	03/30/2023	30.43	598.57
MW03D	Water Level	DA	04/30/2023	30.00	599.01
MW03D	Water Level	DA	05/30/2023	30.11	598.90
MW03D	Water Level	DA	06/08/2023	30.17	598.83
MW03D	Water Level	DA	07/08/2023	30.39	598.62
MW03D	Water Level	DA	08/08/2023	30.65	598.36
MW03D	Water Level	DA	09/25/2023	29.29	599.72
MW03D	Water Level	DA	10/25/2023	29.64	599.37

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
MW03D	Water Level	DA	11/13/2023	32.01	597.00
MW03D	Water Level	DA	12/18/2023	32.08	596.93
MW04S	Water Level	UA	02/13/2023	4.30	621.59
MW04S	Water Level	UA	05/30/2023	6.63	619.26
MW04S	Water Level	UA	08/08/2023	9.80	616.09
MW04S	Water Level	UA	11/13/2023	12.20	613.69
MW05S	Water Level	UA	02/13/2023	5.22	620.73
MW05S	Water Level	UA	05/30/2023	7.25	618.70
MW05S	Water Level	UA	08/08/2023	9.35	616.60
MW05D	Water Level	DA	02/13/2023	19.65	606.26
MW05D	Water Level	DA	05/30/2023	18.29	607.62
MW05D	Water Level	DA	08/08/2023	21.12	604.79
MW06S	Water Level	UA	02/13/2023	4.51	621.64
MW06S	Water Level	UA	05/30/2023	6.45	619.70
MW06S	Water Level	UA	08/08/2023	8.72	617.43
MW06S	Water Level	UA	10/24/2023	9.94	616.21
MW06S	Water Level	UA	11/13/2023	8.91	617.24
MW07S	Water Level	UA	02/13/2023	3.15	624.45
MW07S	Water Level	UA	05/30/2023	5.23	622.37
MW07S	Water Level	UA	08/08/2023	7.79	619.81
MW07S	Water Level	UA	10/24/2023	9.37	618.23
MW07S	Water Level	UA	11/13/2023	8.48	619.12
MW09S	Water Level	UA	02/13/2023	3.14	624.48
MW09S	Water Level	UA	05/30/2023	5.45	622.17
MW09S	Water Level	UA	08/08/2023	8.11	619.51
MW09D	Water Level	LCU	05/30/2023	13.91	613.70
MW09D	Water Level	LCU	08/08/2023	14.73	612.88
MW10S	Water Level	UA	05/30/2023	5.44	619.01
MW10S	Water Level	UA	08/08/2023	8.67	615.78
MW10D	Water Level	LCU	02/14/2023	3.41	621.06
MW10D	Water Level	LCU	05/30/2023	15.73	608.74
MW10D	Water Level	LCU	08/08/2023	18.69	605.78
MW11S	Water Level	UA	02/14/2023	3.78	621.49
MW11S	Water Level	UA	08/08/2023	8.00	617.27

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
MW11D	Water Level	LCU	02/14/2023	4.73	620.79
MW11D	Water Level	LCU	03/30/2023	3.97	621.55
MW11D	Water Level	LCU	04/30/2023	4.00	621.51
MW11D	Water Level	LCU	05/30/2023	4.76	620.75
MW11D	Water Level	LCU	06/08/2023	6.52	618.99
MW11D	Water Level	LCU	07/08/2023	7.38	618.14
MW11D	Water Level	LCU	08/08/2023	8.57	616.95
MW12S	Water Level	UA	02/14/2023	5.30	620.01
MW12S	Water Level	UA	05/30/2023	7.36	617.95
MW12S	Water Level	UA	08/08/2023	10.87	614.44
MW12S	Water Level	UA	10/25/2023	12.51	612.80
MW12S	Water Level	UA	11/13/2023	12.80	612.51
MW12D	Water Level	DA	02/14/2023	13.63	611.58
MW12D	Water Level	DA	03/30/2023	13.17	612.04
MW12D	Water Level	DA	04/30/2023	12.69	612.52
MW12D	Water Level	DA	05/30/2023	12.71	612.50
MW12D	Water Level	DA	06/08/2023	12.80	612.41
MW12D	Water Level	DA	07/08/2023	13.31	611.90
MW12D	Water Level	DA	08/08/2023	13.93	611.28
MW12D	Water Level	DA	09/25/2023	14.86	610.35
MW12D	Water Level	DA	10/25/2023	15.32	609.89
MW12D	Water Level	DA	11/13/2023	15.64	609.57
MW12D	Water Level	DA	12/18/2023	16.00	609.21
MW13S	Water Level	UA	02/13/2023	8.55	617.41
MW13S	Water Level	UA	05/30/2023	10.19	615.77
MW13S	Water Level	UA	08/08/2023	11.34	614.62
MW13S	Water Level	UA	10/25/2023	12.79	613.17
MW13S	Water Level	UA	11/13/2023	12.33	613.63
MW13D	Water Level	DA	02/13/2023	1.20	624.66
MW13D	Water Level	DA	05/30/2023	13.52	612.34
MW13D	Water Level	DA	08/08/2023	12.86	613.00
MW13D	Water Level	DA	10/25/2023	12.75	613.11
MW13D	Water Level	DA	11/13/2023	12.45	613.41
MW16S	Water Level	UA	02/14/2023	6.61	622.86

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
MW16S	Water Level	UA	03/30/2023	3.70	625.77
MW16S	Water Level	UA	04/30/2023	5.10	624.37
MW16S	Water Level	UA	05/30/2023	6.89	622.57
MW16S	Water Level	UA	06/08/2023	8.31	621.16
MW16S	Water Level	UA	07/08/2023	9.95	619.52
MW16S	Water Level	UA	08/08/2023	11.63	617.84
MW16D	Water Level	DA	02/14/2023	14.63	614.75
MW16D	Water Level	DA	03/30/2023	13.05	616.33
MW16D	Water Level	DA	04/30/2023	12.09	617.29
MW16D	Water Level	DA	05/30/2023	11.83	617.55
MW16D	Water Level	DA	06/08/2023	11.85	617.53
MW16D	Water Level	DA	07/08/2023	12.34	617.04
MW16D	Water Level	DA	08/08/2023	12.97	616.41
MW17S	Water Level	UA	05/30/2023	6.91	623.65
MW17S	Water Level	UA	08/08/2023	10.81	619.75
MW17D	Water Level	DA	02/14/2023	19.92	610.37
MW17D	Water Level	DA	05/30/2023	13.33	616.96
MW17D	Water Level	DA	08/08/2023	14.58	615.71
MW20S	Water Level	UA	02/13/2023	8.21	614.69
MW20S	Water Level	UA	03/30/2023	6.59	616.31
MW20S	Water Level	UA	04/30/2023	8.97	613.93
MW20S	Water Level	UA	05/30/2023	9.28	613.61
MW20S	Water Level	UA	06/08/2023	9.56	613.33
MW20S	Water Level	UA	07/08/2023	9.63	613.26
MW20S	Water Level	UA	08/08/2023	10.60	612.30
MW20S	Water Level	UA	09/25/2023	11.53	611.37
MW20S	Water Level	UA	10/25/2023	11.74	611.16
MW20S	Water Level	UA	11/13/2023	11.96	610.94
MW20S	Water Level	UA	12/18/2023	11.60	611.30
R104	Water Level	UA	02/14/2023	7.44	625.40
R104	Water Level	UA	03/30/2023	6.14	626.69
R104	Water Level	UA	04/30/2023	7.47	625.36
R104	Water Level	UA	05/30/2023	8.02	624.81
R104	Water Level	UA	06/08/2023	8.41	624.43

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
R104	Water Level	UA	07/08/2023	8.92	623.92
R104	Water Level	UA	08/08/2023	10.45	622.39
R104	Water Level	UA	09/25/2023	11.50	621.34
R104	Water Level	UA	10/25/2023	12.52	620.32
R104	Water Level	UA	11/13/2023	12.91	619.93
R104	Water Level	UA	12/18/2023	12.81	620.03
R201	Water Level	UA	02/14/2023	2.80	623.54
R201	Water Level	UA	03/30/2023	2.56	623.77
R201	Water Level	UA	04/30/2023	3.95	622.38
R201	Water Level	UA	05/30/2023	5.31	621.02
R201	Water Level	UA	06/08/2023	6.13	620.21
R201	Water Level	UA	07/08/2023	6.75	619.59
R201	Water Level	UA	08/08/2023	11.61	614.73
R201	Water Level	UA	09/25/2023	10.12	616.22
R201	Water Level	UA	10/24/2023	11.20	615.14
R201	Water Level	UA	11/13/2023	11.73	614.61
R201	Water Level	UA	12/18/2023	11.37	614.97
R205	Water Level	UA	02/13/2023	7.49	617.03
R205	Water Level	UA	08/08/2023	9.69	614.83
R205	Water Level	UA	10/25/2023	11.16	613.36
R205	Water Level	UA	11/13/2023	11.48	613.04
R205	Water Level	UA	12/18/2023	11.16	613.36
T127	Water Level	UA	02/13/2023	14.15	616.81
T127	Water Level	UA	05/30/2023	14.56	616.40
T127	Water Level	UA	08/08/2023	15.20	615.76
T127	Water Level	UA	10/25/2023	15.99	614.97
T127	Water Level	UA	11/13/2023	15.95	615.01
T128	Water Level	UA	02/13/2023	13.97	616.96
T128	Water Level	UA	05/30/2023	14.26	616.67
T128	Water Level	UA	08/08/2023	14.80	616.13
T128	Water Level	UA	10/25/2023	15.54	615.39
T128	Water Level	UA	11/13/2023	15.50	615.43
T202	Water Level	UA	02/13/2023	5.04	623.59
T202	Water Level	UA	05/30/2023	5.80	622.83

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Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
T202	Water Level	UA	08/08/2023	9.23	619.40
T202	Water Level	UA	10/24/2023	11.02	617.61
T202	Water Level	UA	11/13/2023	11.66	616.97
T408	Water Level	LCU	02/13/2023	6.92	617.16
T408	Water Level	LCU	05/30/2023	7.42	616.66
T408	Water Level	LCU	08/08/2023	7.46	616.62
T408	Water Level	LCU	10/24/2023	8.11	615.97
T408	Water Level	LCU	11/13/2023	8.02	616.06
T409	Water Level	LCU	02/13/2023	9.36	615.65
T409	Water Level	LCU	05/30/2023	11.27	613.74
T409	Water Level	LCU	08/08/2023	9.99	615.02
T409	Water Level	LCU	10/24/2023	12.46	612.55
T409	Water Level	LCU	11/13/2023	12.00	613.01
TA31	Water Level	UA	02/13/2023	5.00	621.55
TA31	Water Level	UA	05/30/2023	7.06	619.49
TA31	Water Level	UA	08/08/2023	11.98	614.57
TA31	Water Level	UA	10/24/2023	14.65	611.90
TA31	Water Level	UA	11/13/2023	14.31	612.24
TA33	Water Level	UA	02/13/2023	8.04	617.23
TA33	Water Level	UA	05/30/2023	8.42	616.85
TA33	Water Level	UA	08/08/2023	12.10	613.17
TA33	Water Level	UA	10/24/2023	13.86	611.41
TA33	Water Level	UA	11/13/2023	13.98	611.29
TA34	Water Level	UA	02/13/2023	8.03	618.49
TA34	Water Level	UA	05/30/2023	9.48	617.04
TA34	Water Level	UA	08/08/2023	18.31	608.21
TA34	Water Level	UA	10/24/2023	12.98	613.54
TA34	Water Level	UA	11/13/2023	12.60	613.92
TR32	Water Level	UA	02/13/2023	6.11	615.57
TR32	Water Level	UA	05/30/2023	6.18	615.50
TR32	Water Level	UA	10/24/2023	9.02	612.66
TR32	Water Level	UA	11/13/2023	9.67	612.01
X201	Water Level	S	02/14/2023	--	614.71
X201	Water Level	S	03/30/2023	--	614.53

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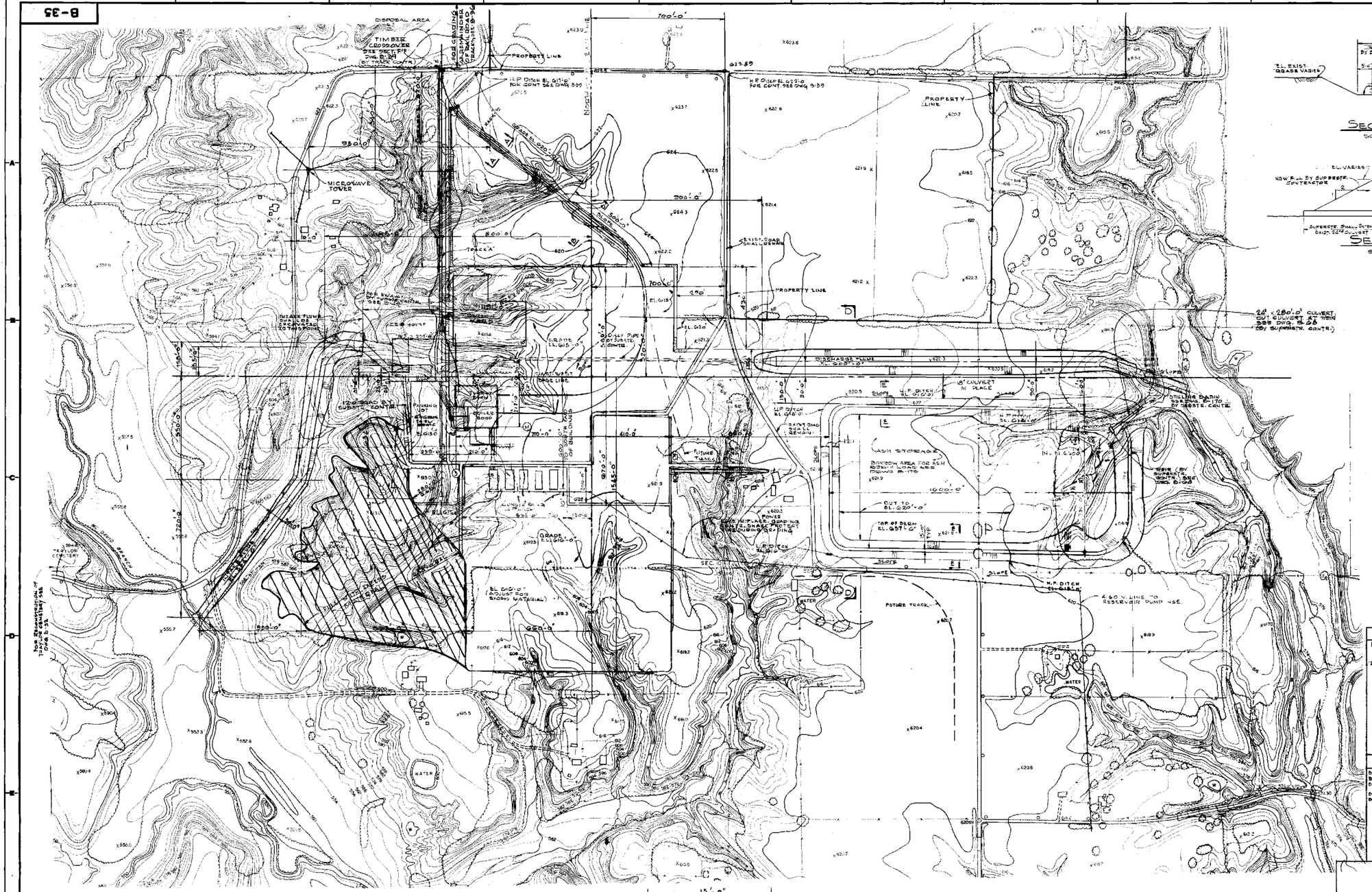
Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
X201	Water Level	S	04/30/2023	--	614.69
X201	Water Level	S	05/30/2023	--	614.93
X201	Water Level	S	08/08/2023	--	615.31
X201	Water Level	S	11/13/2023	[34.00]	[584.47]
X201	Water Level	S	12/12/2023	--	617.10
XPW01	Water Level	CCR	02/13/2023	4.51	630.06
XPW01	Water Level	CCR	03/30/2023	3.99	630.57
XPW01	Water Level	CCR	04/30/2023	4.24	630.32
XPW01	Water Level	CCR	05/30/2023	4.56	630.00
XPW01	Water Level	CCR	08/08/2023	5.29	629.28
XPW01	Water Level	CCR	10/24/2023	6.03	628.54
XPW01	Water Level	CCR	11/13/2023	6.32	628.25
XPW01	Water Level	CCR	12/18/2023	6.11	628.46
XPW02	Water Level	CCR	02/13/2023	9.38	630.31
XPW02	Water Level	CCR	03/30/2023	8.87	630.81
XPW02	Water Level	CCR	04/30/2023	9.11	630.57
XPW02	Water Level	CCR	05/30/2023	9.40	630.28
XPW02	Water Level	CCR	08/08/2023	10.30	629.39
XPW02	Water Level	CCR	09/25/2023	10.71	628.98
XPW02	Water Level	CCR	10/24/2023	10.93	628.76
XPW02	Water Level	CCR	11/13/2023	11.12	628.57
XPW02	Water Level	CCR	12/18/2023	11.02	628.67
NE Riser	Water Level	S	02/14/2023	--	625.24
XSG-01	Water Level	CCR	02/13/2023	5.40	630.12
XSG-01	Water Level	CCR	05/30/2023	5.45	630.07
XSG-01	Water Level	CCR	08/08/2023	6.25	629.27
XSG-01	Water Level	CCR	10/24/2023	7.02	628.50
XSG-01	Water Level	CCR	11/13/2023	10.38	625.14
XSG-01	Water Level	CCR	12/18/2023	7.04	628.48
SG-02	Water Level	SW	02/13/2023	7.25	598.62
SG-02	Water Level	SW	05/30/2023	7.47	598.40
SG-02	Water Level	SW	10/24/2023	7.49	598.38
SG-02	Water Level	SW	11/13/2023	7.36	598.51
SG-02	Water Level	SW	12/18/2023	7.31	598.56

Appendix A. Site-Wide Groundwater Elevations
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Well ID	Well Type	Monitored Unit	Date	Depth to Groundwater (feet BMP)	Groundwater Elevation (feet NAVD88)
SG-03	Water Level	SW	02/13/2023	9.55	585.39
SG-03	Water Level	SW	05/30/2023	9.85	585.09
SG-03	Water Level	SW	08/08/2023	9.65	585.29
SG-03	Water Level	SW	10/24/2023	8.96	585.98
SG-03	Water Level	SW	11/13/2023	9.71	585.23
SG-03	Water Level	SW	12/18/2023	8.92	586.02
SG-04	Water Level	SW	02/13/2023	6.27	593.25
SG-04	Water Level	SW	05/30/2023	6.41	593.11

Notes:
Bracketing [] indicates that the measurement was obtained outside of the 24-hour period from initiaion of depth to groundwater measurements.
BMP = below measuring point
CCR = coal combustion residuals
DA = deep aquifer
LCU = lower confining unit
NAVD88 = North American Vertical Datum of 1988
S = source
SW = surface water
UA = uppermost aquifer

APPENDIX B
Historical Topographic Map and Ash Pond No. 1 Layout and Grading



SUBSTRUCTURE BIDS
1-15-69
THIS DWG FOR
REFERENCE ONLY

NOTES

1. ALL WORK ON THESE DRAWINGS SHALL BE BY GRADING CONTRACTOR IN ACCORDANCE WITH JOB SPEC. A-1813 UNLESS OTHERWISE NOTED
2. ALL SLOPES SHALL BE 2:1 UNLESS OTHERWISE NOTED.

REFERENCE DRAWINGS

B-26	PRELIMINARY GRADING
B-32	RECONSTRUCTION OF TRAYLOR CEMETERY
B-36	TRACK LAYOUT
B-38	TRACK LAYOUT - SECTIONS & DETAILS
B-39	ROADWAY & DRAINAGE PLAN

SCANNED BY S&L

REVISIONS		
	11-2-62	[illegible]
A	11-14-62	ADDENDUM #1
B	12-5-62	[illegible]
C	12-18-62	[illegible]
	1-3-63	[illegible]
D	12-26-62	[illegible]
E	1-28-63	[illegible]
F	2-18-63	[illegible]
G	3-14-63	[illegible]
	3-21-63	[illegible]
H	5-26-63	[illegible]
J	4-5-63	[illegible]
K	4-15-63	[illegible]
L	4-19-63	M.D. ADDED NOTE
M	5-20-63	[illegible]
N	12-17-63	[illegible]
P	2-18-64	[illegible]
Q	3-17-64	[illegible]
R	4-28-64	GN [illegible]
R	11-16-64	GN [illegible]
S	09-08-95	SCANNED BY S&L

EARTHWORK & GRADING PLAN
UNIT I
COFFEEN POWER STATION
CENTRAL ILL. PUBLIC SERVICE CO.
COFFEEN, ILLINOIS

SCALE 1" = 200'-0" & AS NOTED

DRAWN CORTEZ 10-24-62

CHECKED J. COLLINS 12-28-62

ENGINEER W. Mullen 1-2-63

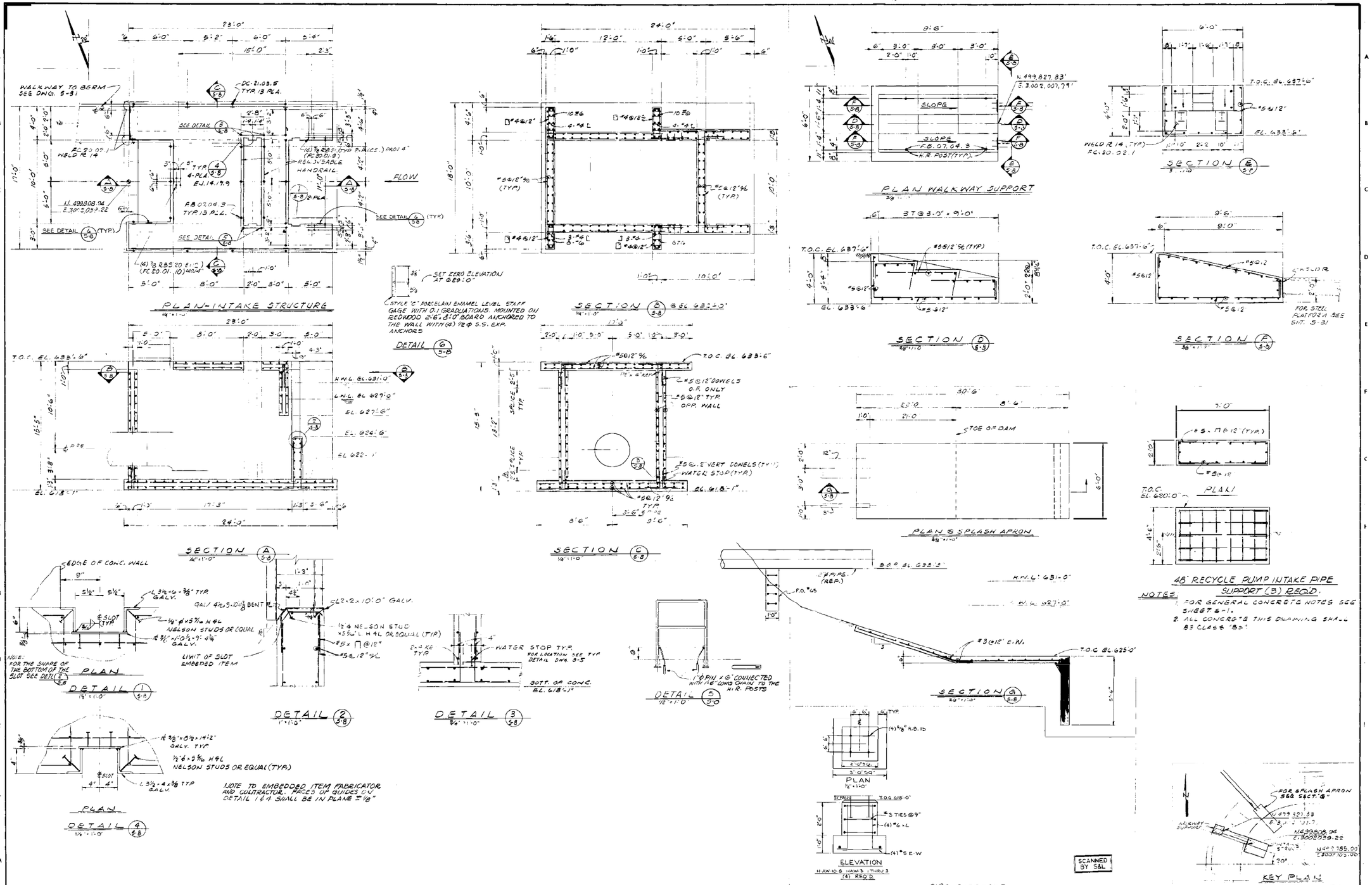
APPROVED R.N. Bergha 1-2-63

JOB NO. 3094

SARGENT & LUNDY
ENGINEERS
CHICAGO 3, ILLINOIS

DRAWING NO.
B-35

MICROFILMED JAN 12 1966



STATE OF ILLINOIS
6-11-79
VLADIMIR FOTIK
81-3493
STRUCTURAL ENGINEER

NO.	REVISIONS	DATE	BY	CHK'D	APP'D
1	REVISED DET. 1, 2, & 3 ADDED DET. 4 REVISED SECT. A & B & G.	4/26/78	TOB		
2	REVISED ELEV. ADDED NOTE, DIMS. SECT. CALLOUT REMP. ADDED DETAIL 5 & 6 48" RECYCLE PUMP INTAKE PIPE SUPPORTS & 8" PIPE, REVISED DIMS. PIPE SUPPORTS	9/11/78	TVT	TF	
3	REMOVED PIPE SUPPORTS MAINT. TRIG	4/9/79	TVT	TF	
4	FIELD REVISION	6-1-81	JFD		TVF
5	SCANNED BY S&L	2-23-86			

NO.	REFERENCE DRAWINGS
S-3.1	STRUCT. MISC. STRUCT. & DETAILS
M-42	YARD PIPING PLOT PLAN
S-4.5	LAYOUT & GRADING PLAN
M-43	YARD PIPING, SECTIONS & DETAILS

PRINT RECORD								
DATE ISSUED	7/25/78	7/14/78	7/14/78	7/21/78	10/1/79			
REVISION NO.	0	1	2	3	4			
FOR	BID	BID	AFC	DATE	DATE			
CUSTOMER	4	4	6	6	9			
FIELD	—	—	2	2	2			
INTRA CO.	7-13	7-13	AR	AR	AR			
0201-200	6	6	8-15	8-15	8-15			

ENG. RECORD			DRAWING STATUS	
DRAWN	7-13	3-28	ISSUED	DATE
CHECKED	CJW	6/26/78	PRELIMINARY	
MECH. CK.	RW	6-6-78	FOR COMMENTS AND/OR APPROVAL	
STRUCT. CK.	VF	6-6-78	APPROVED FOR CONSTRUCTION	
ELECT. CK.	VF	6-6-78		
PIPING CK.	RBS	6-6-78	REVISED & APPROVED FOR CONSTRUCTION	6-6-79
APPROVED	JGW	6-6-78	REV. 2	6-13-79
APPROVED			REV. 3	

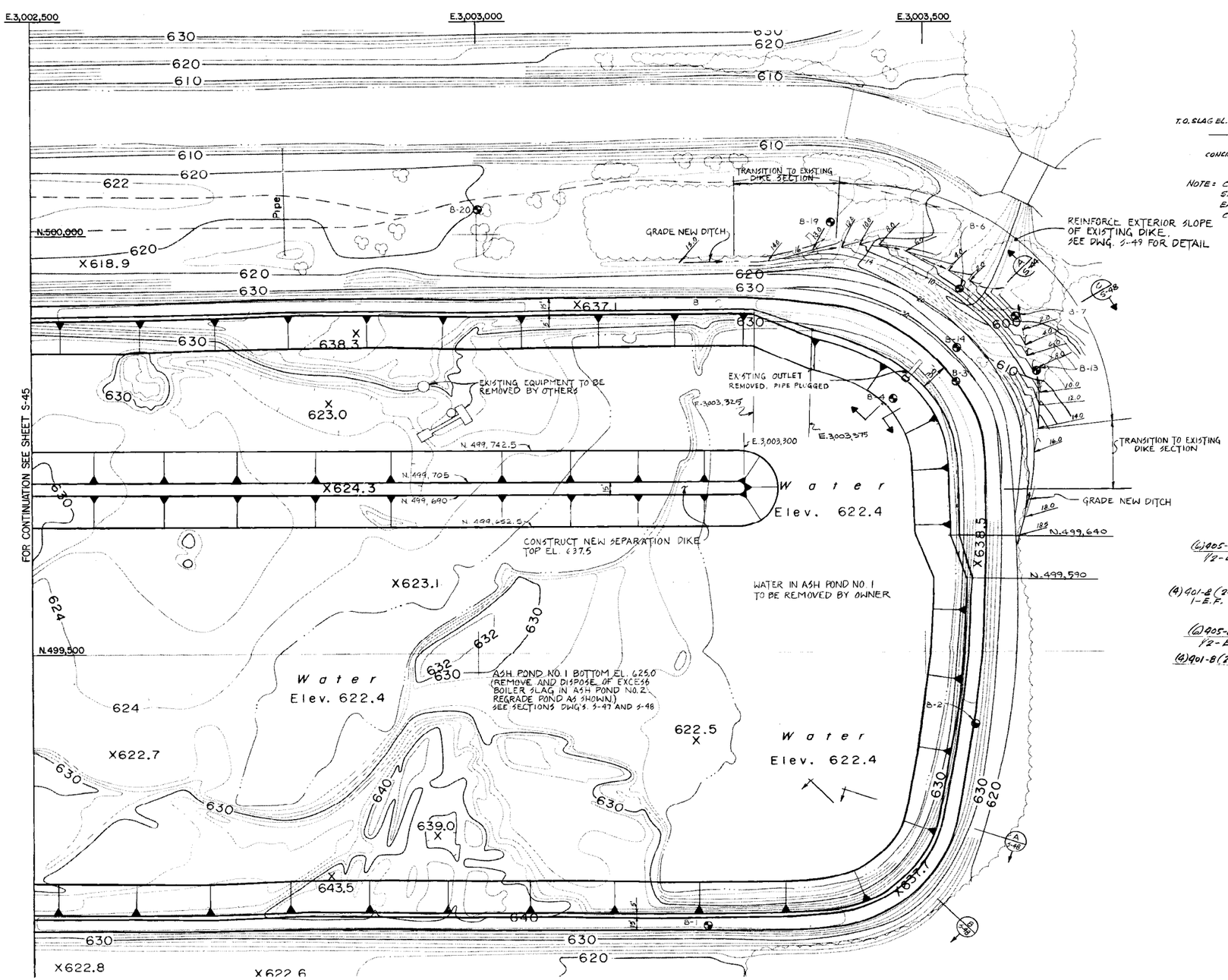
ARE APPROVED FOR CONSTRUCTION UNLESS EARLIER & DATED BELOW. ALL PRINTS BEARING EARLIER DATE & FOR REVISION NO.

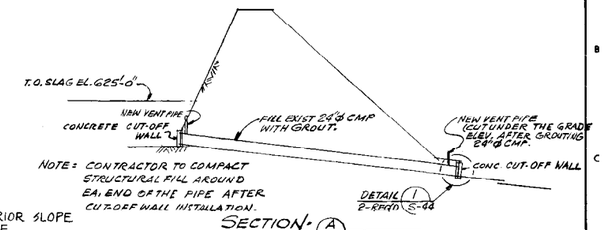
CONCRETE
RECYCLE PUMP HOUSE - INTAKE STRUCTURE
& MISCELLANEOUS FOUNDATIONS

WASTEWATER MANAGEMENT FACILITIES
CENTRAL ILLINOIS PUBLIC SERVICE COMPANY
COFFEEN POWER STATION

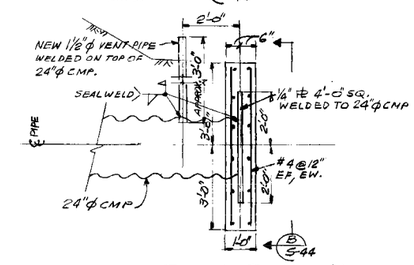
SCALE: AS NOTED
Stearns-Roger INCORPORATED
ORDER NO. C-20000
DWG. NO. L-22886
0201
SHEET NO. S-8
REV. 2

FORM 8975

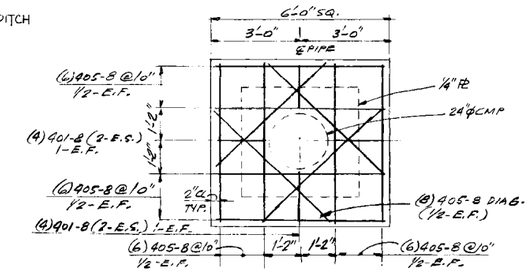




SECTION A S-44
N.T.S.



DETAIL 1 (2-REQ'D) S-44
1/2"=1'-0"



SECTION B (2-REQ'D) S-44
1/2"=1'-0"

NOTES:

1. FOR LEGEND SEE DWG S-40.
2. FOR ASH POND NO. 1 CROSS SECTIONS SEE DWGS S-47, S-48 & S-49.
3. FOR SITE PLAN SEE DWG S-40.

SCANNED BY S&L

S.R. NO. Y2-4

STATE OF ILLINOIS 6-9-78 V. LAUTAUK FOTIK 81-3493 STRUCTURAL ENGINEER

NO.	REVISIONS	DATE	BY	CH'D	APP'D	NO.
1	GENERAL REVISIONS	4-11-78	W.S.B.			
2	APPROVED FOR CONSTRUCTION	6/1/78	JKS	SN		
3	REVISED NOTE	6/6/78	TVT	[illegible]		
4	ADD'D SECTION "A" & "B" AND DETAIL "1"	8-5-78	[illegible]	[illegible]		
5	RELOCATED N.E. CORNER EMBANKMENT, ASH POND #1	6/1/81	JJD		TAS	
6	SCANNED BY S&L	2/24/98				
7				CRN		

REFERENCE DRAWINGS

PRINT RECORD					
DATE ISSUED	9/14/78	3/14/78	4/4/78	4/17/78	6/1/78
REVISION NO.	0	1	2	3	4
FOR	BID	BID	CONST.	BARC	BARC
CUSTOMER	4	4	6	10	10
FIELD	—	—	2	2	2
INTRA CO.	7+15	7+15	AR	AR	AR
0201-200	6	6+15	8+15	8+15	8+16

ENG. RECORD		
DRAWN	W.S.B.	1/31/78
CHECKED	JKS	4/6/78
MECH. CK.	DKU	6-8-78
STRUCT. CK.	[illegible]	6-8-78
ELECT. CK.	[illegible]	6-8-78
PIPING CK.	[illegible]	6/8/78
APPROVED	[illegible]	6-8-78
APPROVED		

DRAWING STATUS	
ISSUED	DATE
PRELIMINARY	
FOR COMMENTS AND/OR APPROVAL	
APPROVED FOR CONSTRUCTION	6/9/78
REVISED & APPROVED FOR CONSTRUCTION	6-8-79

NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED BY MATER SHEETS ALL PRINTS DESIGNS EARLIER DATE A/OR REVISION #

CIVIL

LAYOUT & GRADING PLAN SHEET 4

WASTEWATER MANAGEMENT FACILITIES
CENTRAL ILLINOIS PUBLIC SERVICE COMPANY
COFFEEN POWER STATION

SCALE 1"=50'

Stearns-Roger INCORPORATED

ORDER NO. C-20000

DWG. NO. L-22898

0201

SHEET NO. S-44

REV. 6

APPENDIX C
Surface Water Sampling Locations and Laboratory Analytical Report

GSI Surface Water Sample

Background Surface Water Sample

Figure adapted by Ramboll from Geosyntec-provided figure

N

0 520 Feet

Notes:
Locations are approximate

Surface Water Sampling Locations

134 Cips Lane
Coffeen, Illinois

Geosyntec consultants

St. Louis | July 2021

Figure 3

S:\Company\Projects_post_2014\GLP8005_Coffeen MNA\GIS\Porewater and Sediment Sampling Loactions.mxd 7/22/2021 8:27:18 AM

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-203343-1
Client Project/Site: GLP8029 Coffeen, IL

For:
Geosyntec Consultants, Inc.
2100 Commonwealth Blvd.
Suite 100
Ann Arbor, Michigan 48105

Attn: Brian Ares

Authorized for release by:
8/20/2021 1:48:27 PM

Robin Kintz, Project Manager II
(708)534-5200
Robin.Kintz@Eurofinset.com

LINKS

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The test results in this report meet all 2003 NELAC, 2009 TNI, and 2016 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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Sample Summary 9
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QC Sample Results 22
Chronicle 27
Certification Summary 31
Chain of Custody 32
Receipt Checklists 33

Job ID: 500-203343-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-203343-1

Comments
No additional comments.

Receipt
The samples were received on 8/5/2021 9:45 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperatures of the 2 coolers at receipt time were 1.1º C and 2.5º C.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Field Service / Mobile Lab
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry
Methods 300.0, 9056A: Due to the high concentration of Chloride, the matrix spike / matrix spike duplicate (MS/MSD) for analytical batch 500-614638 could not be evaluated for accuracy and precision. The associated laboratory control sample (LCS) met acceptance criteria.

Method 9060A: One of the CCV replicates failed to meet criteria at 89% recovery for DOC. The average was within control; therefore, the data have been reported. The RPD was within control as well. The following samples are affected: D-2-20210803 (500-203343-1), D-1-20210803 (500-203343-2), BKG-1-20210803 (500-203343-3), CL-1-20210803 (500-203343-4), DUP-20210803 (500-203343-5), CL-2-20210803 (500-203343-6), CL-3-20210803 (500-203343-7), (CCB 500-613783/21) and (CCV 500-613783/20).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: D-2-20210803 — Lab Sample ID: 500-203343-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.30		0.050	0.0056	mg/L	1		6010B	Total/NA
Calcium	45		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.24		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	13	B	0.10	0.049	mg/L	1		6010B	Total/NA
Manganese	0.20		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	3.2	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	13	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.30		0.050	0.0056	mg/L	1		6010B	Dissolved
Calcium, Dissolved	46		0.20	0.053	mg/L	1		6010B	Dissolved
Iron, Dissolved	0.15	J	0.20	0.082	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	13	B	0.10	0.049	mg/L	1		6010B	Dissolved
Manganese, Dissolved	0.20		0.010	0.0023	mg/L	1		6010B	Dissolved
Potassium, Dissolved	3.2	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	13	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	7.2		0.20	0.17	mg/L	1		9056A	Total/NA
Sulfate	69		4.0	1.9	mg/L	20		9056A	Total/NA
Alkalinity	100		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	240		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.24		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.24		0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Sulfide	0.25	J	1.0	0.23	mg/L	1		SM 4500 S2 F	Total/NA
Dissolved Organic Carbon - Duplicate	3.6		1.0	0.47	mg/L	1		9060A	Dissolved

Client Sample ID: D-1-20210803 — Lab Sample ID: 500-203343-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.33		0.050	0.0056	mg/L	1		6010B	Total/NA
Calcium	53		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.23		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	16	B	0.10	0.049	mg/L	1		6010B	Total/NA
Manganese	0.030		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	2.5	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	19	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.32		0.050	0.0056	mg/L	1		6010B	Dissolved
Calcium, Dissolved	52		0.20	0.053	mg/L	1		6010B	Dissolved
Iron, Dissolved	0.13	J	0.20	0.082	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	16	B	0.10	0.049	mg/L	1		6010B	Dissolved
Manganese, Dissolved	0.024		0.010	0.0023	mg/L	1		6010B	Dissolved
Potassium, Dissolved	2.5	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	18	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	9.1		0.40	0.34	mg/L	2		9056A	Total/NA
Sulfate	110		5.0	2.4	mg/L	25		9056A	Total/NA
Alkalinity	100		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	240		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.23		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.13	J	0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Dissolved Organic Carbon - Duplicate	3.3		1.0	0.47	mg/L	1		9060A	Dissolved

Client Sample ID: BKG-1-20210803 — Lab Sample ID: 500-203343-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.082		0.050	0.0056	mg/L	1		6010B	Total/NA

This Detection Summary does not include radiochemical test results.

Eurofins TestAmerica, Chicago

Detection Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: BKG-1-20210803 (Continued) — Lab Sample ID: 500-203343-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Calcium	20		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.27		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	10	B	0.10	0.049	mg/L	1		6010B	Total/NA
Manganese	0.037		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	4.9	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	12	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.079		0.050	0.0056	mg/L	1		6010B	Dissolved
Calcium, Dissolved	20		0.20	0.053	mg/L	1		6010B	Dissolved
Iron, Dissolved	0.19	J	0.20	0.082	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	10	B	0.10	0.049	mg/L	1		6010B	Dissolved
Potassium, Dissolved	4.9	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	12	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	12		2.0	1.7	mg/L	10		9056A	Total/NA
Sulfate	36		2.0	0.95	mg/L	10		9056A	Total/NA
Alkalinity	65		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	72		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.27		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.12	J	0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Dissolved Organic Carbon - Duplicate	5.0		1.0	0.47	mg/L	1		9060A	Dissolved

Client Sample ID: CL-1-20210803 — Lab Sample ID: 500-203343-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.10		0.050	0.0056	mg/L	1		6010B	Total/NA
Calcium	23		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.38		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	11	B	0.10	0.049	mg/L	1		6010B	Total/NA
Manganese	0.037		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	4.5	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	11	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.12		0.050	0.0056	mg/L	1		6010B	Dissolved
Calcium, Dissolved	26		0.20	0.053	mg/L	1		6010B	Dissolved
Iron, Dissolved	0.68		0.20	0.082	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	11	B	0.10	0.049	mg/L	1		6010B	Dissolved
Manganese, Dissolved	0.062		0.010	0.0023	mg/L	1		6010B	Dissolved
Potassium, Dissolved	4.7	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	12	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	11		0.40	0.34	mg/L	2		9056A	Total/NA
Sulfate	33		2.0	0.95	mg/L	10		9056A	Total/NA
Alkalinity	68		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	120		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.38		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.21		0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Dissolved Organic Carbon - Duplicate	5.4		1.0	0.47	mg/L	1		9060A	Dissolved

Client Sample ID: DUP-20210803 — Lab Sample ID: 500-203343-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.086		0.050	0.0056	mg/L	1		6010B	Total/NA
Calcium	21		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.39		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	10	B	0.10	0.049	mg/L	1		6010B	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: DUP-20210803 (Continued) — Lab Sample ID: 500-203343-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Manganese	0.052		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	4.7	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	11	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.086		0.050	0.0056	mg/L	1		6010B	Dissolved
Calcium, Dissolved	21		0.20	0.053	mg/L	1		6010B	Dissolved
Iron, Dissolved	0.087	J	0.20	0.082	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	10	B	0.10	0.049	mg/L	1		6010B	Dissolved
Potassium, Dissolved	4.7	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	11	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	11		0.40	0.34	mg/L	2		9056A	Total/NA
Sulfate	33		2.0	0.95	mg/L	10		9056A	Total/NA
Alkalinity	65		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	110		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.39		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.14	J	0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Dissolved Organic Carbon - Duplicate	4.9		1.0	0.47	mg/L	1		9060A	Dissolved

Client Sample ID: CL-2-20210803 — Lab Sample ID: 500-203343-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.086		0.050	0.0056	mg/L	1		6010B	Total/NA
Calcium	21		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.38		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	10	B	0.10	0.049	mg/L	1		6010B	Total/NA
Manganese	0.051		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	4.7	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	11	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.087		0.050	0.0056	mg/L	1		6010B	Dissolved
Calcium, Dissolved	22		0.20	0.053	mg/L	1		6010B	Dissolved
Iron, Dissolved	0.13	J	0.20	0.082	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	10	B	0.10	0.049	mg/L	1		6010B	Dissolved
Potassium, Dissolved	4.7	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	11	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	11		0.40	0.34	mg/L	2		9056A	Total/NA
Sulfate	31		2.0	0.95	mg/L	10		9056A	Total/NA
Alkalinity	65		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	160		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.38		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.12	J	0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Dissolved Organic Carbon - Duplicate	4.9		1.0	0.47	mg/L	1		9060A	Dissolved

Client Sample ID: CL-3-20210803 — Lab Sample ID: 500-203343-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Boron	0.086		0.050	0.0056	mg/L	1		6010B	Total/NA
Calcium	21		0.20	0.053	mg/L	1		6010B	Total/NA
Iron	0.31		0.20	0.082	mg/L	1		6010B	Total/NA
Magnesium	11	B	0.10	0.049	mg/L	1		6010B	Total/NA
Manganese	0.046		0.010	0.0023	mg/L	1		6010B	Total/NA
Potassium	4.9	B	0.50	0.066	mg/L	1		6010B	Total/NA
Sodium	11	B	1.0	0.097	mg/L	1		6010B	Total/NA
Boron, Dissolved	0.084		0.050	0.0056	mg/L	1		6010B	Dissolved

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: CL-3-20210803 (Continued)

Lab Sample ID: 500-203343-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Calcium, Dissolved	21		0.20	0.053	mg/L	1		6010B	Dissolved
Magnesium, Dissolved	10	B	0.10	0.049	mg/L	1		6010B	Dissolved
Potassium, Dissolved	4.6	B	0.50	0.066	mg/L	1		6010B	Dissolved
Sodium, Dissolved	11	B	1.0	0.097	mg/L	1		6010B	Dissolved
Chloride	11		0.40	0.34	mg/L	2		9056A	Total/NA
Sulfate	32		2.0	0.95	mg/L	10		9056A	Total/NA
Alkalinity	63		5.0	3.7	mg/L	1		SM 2320B	Total/NA
Total Dissolved Solids	150		10	4.3	mg/L	1		SM 2540C	Total/NA
Ferric Iron	0.31		0.20	0.10	mg/L	1		SM 3500	Total/NA
Phosphorus as PO4	0.095	J	0.15	0.073	mg/L	1		SM 4500 P E	Total/NA
Dissolved Organic Carbon - Duplicate	4.9		1.0	0.47	mg/L	1		9060A	Dissolved

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL CHI
9056A	Anions, Ion Chromatography	SW846	TAL CHI
9060A	Organic Carbon, Dissolved (DOC)	SW846	TAL CHI
SM 2320B	Alkalinity	SM	TAL CHI
SM 2540C	Solids, Total Dissolved (TDS)	SM	TAL CHI
SM 3500	Iron, Ferric	SM	TAL CHI
SM 3500 Fe B	Iron, Ferrous	SM	TAL CHI
SM 4500 P E	Phosphorus	SM	TAL CHI
SM 4500 S2 F	Sulfide, Total	SM	TAL CHI
3010A	Preparation, Total Metals	SW846	TAL CHI
SM 4500 P B	Phosphorous, Total and Ortho	SM	TAL CHI

Protocol References:

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
500-203343-1	D-2-20210803	Water	08/03/21 10:15	08/05/21 09:45
500-203343-2	D-1-20210803	Water	08/03/21 10:50	08/05/21 09:45
500-203343-3	BKG-1-20210803	Water	08/03/21 12:45	08/05/21 09:45
500-203343-4	CL-1-20210803	Water	08/03/21 13:20	08/05/21 09:45
500-203343-5	DUP-20210803	Water	08/03/21 13:30	08/05/21 09:45
500-203343-6	CL-2-20210803	Water	08/03/21 13:50	08/05/21 09:45
500-203343-7	CL-3-20210803	Water	08/03/21 14:20	08/05/21 09:45

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: D-2-20210803

Date Collected: 08/03/21 10:15
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-1

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.30		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:27	1
Calcium	45		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:27	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:27	1
Iron	0.24		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:27	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:27	1
Magnesium	13	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:27	1
Manganese	0.20		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:27	1
Potassium	3.2	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:27	1
Sodium	13	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:27	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	0.30		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:31	1
Calcium, Dissolved	46		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:31	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:31	1
Iron, Dissolved	0.15	J	0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:31	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:31	1
Magnesium, Dissolved	13	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:31	1
Manganese, Dissolved	0.20		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:31	1
Potassium, Dissolved	3.2	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:31	1
Sodium, Dissolved	13	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:31	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	7.2		0.20	0.17	mg/L			08/17/21 16:12	1
Sulfate	69		4.0	1.9	mg/L			08/18/21 12:53	20
Alkalinity	100		5.0	3.7	mg/L			08/15/21 19:00	1
Total Dissolved Solids	240		10	4.3	mg/L			08/09/21 09:49	1
Ferric Iron	0.24		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 04:46	1
Phosphorus as PO4	0.24		0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:20	1
Sulfide	0.25	J	1.0	0.23	mg/L			08/10/21 00:05	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	3.6		1.0	0.47	mg/L			08/09/21 23:09	1

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: D-1-20210803

Date Collected: 08/03/21 10:50
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-2

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**0.33**		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:34	1
Calcium	**53**		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:34	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:34	1
Iron	**0.23**		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:34	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:34	1
Magnesium	**16**	**B**	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:34	1
Manganese	**0.030**		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:34	1
Potassium	**2.5**	**B**	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:34	1
Sodium	**19**	**B**	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:34	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	**0.32**		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:38	1
Calcium, Dissolved	**52**		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:38	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:38	1
Iron, Dissolved	**0.13**	**J**	0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:38	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:38	1
Magnesium, Dissolved	**16**	**B**	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:38	1
Manganese, Dissolved	**0.024**		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:38	1
Potassium, Dissolved	**2.5**	**B**	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:38	1
Sodium, Dissolved	**18**	**B**	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:38	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**9.1**		0.40	0.34	mg/L			08/19/21 11:37	2
Sulfate	**110**		5.0	2.4	mg/L			08/18/21 13:07	25
Alkalinity	**100**		5.0	3.7	mg/L			08/15/21 19:07	1
Total Dissolved Solids	**240**		10	4.3	mg/L			08/09/21 09:51	1
Ferric Iron	**0.23**		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 04:55	1
Phosphorus as PO4	**0.13**	**J**	0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:21	1
Sulfide	<1.0		1.0	0.23	mg/L			08/10/21 00:08	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	**3.3**		1.0	0.47	mg/L			08/09/21 23:16	1

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: BKG-1-20210803

Date Collected: 08/03/21 12:45
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-3

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.082		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:42	1
Calcium	20		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:42	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:42	1
Iron	0.27		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:42	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:42	1
Magnesium	10	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:42	1
Manganese	0.037		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:42	1
Potassium	4.9	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:42	1
Sodium	12	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:42	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	0.079		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:46	1
Calcium, Dissolved	20		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:46	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:46	1
Iron, Dissolved	0.19	J	0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:46	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:46	1
Magnesium, Dissolved	10	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:46	1
Manganese, Dissolved	<0.010		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:46	1
Potassium, Dissolved	4.9	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:46	1
Sodium, Dissolved	12	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:46	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	12		2.0	1.7	mg/L			08/17/21 17:48	10
Sulfate	36		2.0	0.95	mg/L			08/18/21 13:48	10
Alkalinity	65		5.0	3.7	mg/L			08/15/21 19:14	1
Total Dissolved Solids	72		10	4.3	mg/L			08/09/21 09:54	1
Ferric Iron	0.27		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 04:58	1
Phosphorus as PO4	0.12	J	0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:22	1
Sulfide	<1.0		1.0	0.23	mg/L			08/10/21 00:12	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	5.0		1.0	0.47	mg/L			08/09/21 23:26	1

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: CL-1-20210803

Date Collected: 08/03/21 13:20
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-4

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.10		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:50	1
Calcium	23		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:50	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:50	1
Iron	0.38		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:50	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:50	1
Magnesium	11	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:50	1
Manganese	0.037		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:50	1
Potassium	4.5	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:50	1
Sodium	11	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:50	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	0.12		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:54	1
Calcium, Dissolved	26		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:54	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:54	1
Iron, Dissolved	0.68		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:54	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:54	1
Magnesium, Dissolved	11	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:54	1
Manganese, Dissolved	0.062		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:54	1
Potassium, Dissolved	4.7	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:54	1
Sodium, Dissolved	12	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:54	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	11		0.40	0.34	mg/L			08/17/21 18:01	2
Sulfate	33		2.0	0.95	mg/L			08/18/21 14:01	10
Alkalinity	68		5.0	3.7	mg/L			08/15/21 19:21	1
Total Dissolved Solids	120		10	4.3	mg/L			08/09/21 09:56	1
Ferric Iron	0.38		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 05:00	1
Phosphorus as PO4	0.21		0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:23	1
Sulfide	<1.0		1.0	0.23	mg/L			08/10/21 00:16	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	5.4		1.0	0.47	mg/L			08/09/21 23:33	1

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: DUP-20210803

Date Collected: 08/03/21 13:30
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-5

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	0.086		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 23:58	1
Calcium	21		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 23:58	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 23:58	1
Iron	0.39		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 23:58	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 23:58	1
Magnesium	10	B	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 23:58	1
Manganese	0.052		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 23:58	1
Potassium	4.7	B	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 23:58	1
Sodium	11	B	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 23:58	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	0.086		0.050	0.0056	mg/L		08/10/21 08:44	08/11/21 00:14	1
Calcium, Dissolved	21		0.20	0.053	mg/L		08/10/21 08:44	08/11/21 00:14	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/11/21 00:14	1
Iron, Dissolved	0.087	J	0.20	0.082	mg/L		08/10/21 08:44	08/11/21 00:14	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/11/21 00:14	1
Magnesium, Dissolved	10	B	0.10	0.049	mg/L		08/10/21 08:44	08/11/21 00:14	1
Manganese, Dissolved	<0.010		0.010	0.0023	mg/L		08/10/21 08:44	08/11/21 00:14	1
Potassium, Dissolved	4.7	B	0.50	0.066	mg/L		08/10/21 08:44	08/11/21 00:14	1
Sodium, Dissolved	11	B	1.0	0.097	mg/L		08/10/21 08:44	08/11/21 00:14	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	11		0.40	0.34	mg/L			08/17/21 18:28	2
Sulfate	33		2.0	0.95	mg/L			08/18/21 14:15	10
Alkalinity	65		5.0	3.7	mg/L			08/15/21 19:28	1
Total Dissolved Solids	110		10	4.3	mg/L			08/09/21 09:59	1
Ferric Iron	0.39		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 05:03	1
Phosphorus as PO4	0.14	J	0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:42	1
Sulfide	<1.0		1.0	0.23	mg/L			08/10/21 00:20	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	4.9		1.0	0.47	mg/L			08/09/21 23:40	1

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: CL-2-20210803

Date Collected: 08/03/21 13:50
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-6

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**0.086**		0.050	0.0056	mg/L		08/10/21 08:44	08/11/21 00:18	1
Calcium	**21**		0.20	0.053	mg/L		08/10/21 08:44	08/11/21 00:18	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/11/21 00:18	1
Iron	**0.38**		0.20	0.082	mg/L		08/10/21 08:44	08/11/21 00:18	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/11/21 00:18	1
Magnesium	**10**	**B**	0.10	0.049	mg/L		08/10/21 08:44	08/11/21 00:18	1
Manganese	**0.051**		0.010	0.0023	mg/L		08/10/21 08:44	08/11/21 00:18	1
Potassium	**4.7**	**B**	0.50	0.066	mg/L		08/10/21 08:44	08/11/21 00:18	1
Sodium	**11**	**B**	1.0	0.097	mg/L		08/10/21 08:44	08/11/21 00:18	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	**0.087**		0.050	0.0056	mg/L		08/10/21 08:44	08/11/21 00:21	1
Calcium, Dissolved	**22**		0.20	0.053	mg/L		08/10/21 08:44	08/11/21 00:21	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/11/21 00:21	1
Iron, Dissolved	**0.13**	**J**	0.20	0.082	mg/L		08/10/21 08:44	08/11/21 00:21	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/11/21 00:21	1
Magnesium, Dissolved	**10**	**B**	0.10	0.049	mg/L		08/10/21 08:44	08/11/21 00:21	1
Manganese, Dissolved	<0.010		0.010	0.0023	mg/L		08/10/21 08:44	08/11/21 00:21	1
Potassium, Dissolved	**4.7**	**B**	0.50	0.066	mg/L		08/10/21 08:44	08/11/21 00:21	1
Sodium, Dissolved	**11**	**B**	1.0	0.097	mg/L		08/10/21 08:44	08/11/21 00:21	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**11**		0.40	0.34	mg/L			08/17/21 18:55	2
Sulfate	**31**		2.0	0.95	mg/L			08/18/21 14:29	10
Alkalinity	**65**		5.0	3.7	mg/L			08/15/21 19:35	1
Total Dissolved Solids	**160**		10	4.3	mg/L			08/09/21 10:02	1
Ferric Iron	**0.38**		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 05:06	1
Phosphorus as PO4	**0.12**	**J**	0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:43	1
Sulfide	<1.0		1.0	0.23	mg/L			08/10/21 00:23	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	**4.9**		1.0	0.47	mg/L			08/09/21 23:47	1

Client Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: CL-3-20210803

Date Collected: 08/03/21 14:20
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-7

Matrix: Water

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**0.086**		0.050	0.0056	mg/L		08/10/21 08:44	08/11/21 00:25	1
Calcium	**21**		0.20	0.053	mg/L		08/10/21 08:44	08/11/21 00:25	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/11/21 00:25	1
Iron	**0.31**		0.20	0.082	mg/L		08/10/21 08:44	08/11/21 00:25	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/11/21 00:25	1
Magnesium	**11**	**B**	0.10	0.049	mg/L		08/10/21 08:44	08/11/21 00:25	1
Manganese	**0.046**		0.010	0.0023	mg/L		08/10/21 08:44	08/11/21 00:25	1
Potassium	**4.9**	**B**	0.50	0.066	mg/L		08/10/21 08:44	08/11/21 00:25	1
Sodium	**11**	**B**	1.0	0.097	mg/L		08/10/21 08:44	08/11/21 00:25	1

Method: 6010B - Metals (ICP) - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron, Dissolved	**0.084**		0.050	0.0056	mg/L		08/10/21 08:44	08/11/21 00:29	1
Calcium, Dissolved	**21**		0.20	0.053	mg/L		08/10/21 08:44	08/11/21 00:29	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/11/21 00:29	1
Iron, Dissolved	<0.20		0.20	0.082	mg/L		08/10/21 08:44	08/11/21 00:29	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/11/21 00:29	1
Magnesium, Dissolved	**10**	**B**	0.10	0.049	mg/L		08/10/21 08:44	08/11/21 00:29	1
Manganese, Dissolved	<0.010		0.010	0.0023	mg/L		08/10/21 08:44	08/11/21 00:29	1
Potassium, Dissolved	**4.6**	**B**	0.50	0.066	mg/L		08/10/21 08:44	08/11/21 00:29	1
Sodium, Dissolved	**11**	**B**	1.0	0.097	mg/L		08/10/21 08:44	08/11/21 00:29	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	**11**		0.40	0.34	mg/L			08/17/21 19:23	2
Sulfate	**32**		2.0	0.95	mg/L			08/18/21 14:42	10
Alkalinity	**63**		5.0	3.7	mg/L			08/15/21 19:41	1
Total Dissolved Solids	**150**		10	4.3	mg/L			08/09/21 10:04	1
Ferric Iron	**0.31**		0.20	0.10	mg/L			08/19/21 14:42	1
Ferrous Iron	<0.050	HF	0.050	0.050	mg/L			08/11/21 05:09	1
Phosphorus as PO4	**0.095**	**J**	0.15	0.073	mg/L		08/15/21 12:30	08/18/21 12:44	1
Sulfide	<1.0		1.0	0.23	mg/L			08/10/21 00:27	1

General Chemistry - Dissolved

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	**4.9**		1.0	0.47	mg/L			08/09/21 23:55	1

Qualifiers

Metals

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

QC Association Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Metals

Prep Batch: 613499

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Dissolved	Water	3010A	
500-203343-1	D-2-20210803	Total/NA	Water	3010A	
500-203343-2	D-1-20210803	Dissolved	Water	3010A	
500-203343-2	D-1-20210803	Total/NA	Water	3010A	
500-203343-3	BKG-1-20210803	Dissolved	Water	3010A	
500-203343-3	BKG-1-20210803	Total/NA	Water	3010A	
500-203343-4	CL-1-20210803	Dissolved	Water	3010A	
500-203343-4	CL-1-20210803	Total/NA	Water	3010A	
500-203343-5	DUP-20210803	Dissolved	Water	3010A	
500-203343-5	DUP-20210803	Total/NA	Water	3010A	
500-203343-6	CL-2-20210803	Dissolved	Water	3010A	
500-203343-6	CL-2-20210803	Total/NA	Water	3010A	
500-203343-7	CL-3-20210803	Dissolved	Water	3010A	
500-203343-7	CL-3-20210803	Total/NA	Water	3010A	
MB 500-613499/1-A	Method Blank	Total/NA	Water	3010A	
LCS 500-613499/2-A	Lab Control Sample	Total/NA	Water	3010A	

Analysis Batch: 613679

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Dissolved	Water	6010B	613499
500-203343-1	D-2-20210803	Total/NA	Water	6010B	613499
500-203343-2	D-1-20210803	Dissolved	Water	6010B	613499
500-203343-2	D-1-20210803	Total/NA	Water	6010B	613499
500-203343-3	BKG-1-20210803	Dissolved	Water	6010B	613499
500-203343-3	BKG-1-20210803	Total/NA	Water	6010B	613499
500-203343-4	CL-1-20210803	Dissolved	Water	6010B	613499
500-203343-4	CL-1-20210803	Total/NA	Water	6010B	613499
500-203343-5	DUP-20210803	Dissolved	Water	6010B	613499
500-203343-5	DUP-20210803	Total/NA	Water	6010B	613499
500-203343-6	CL-2-20210803	Dissolved	Water	6010B	613499
500-203343-6	CL-2-20210803	Total/NA	Water	6010B	613499
500-203343-7	CL-3-20210803	Dissolved	Water	6010B	613499
500-203343-7	CL-3-20210803	Total/NA	Water	6010B	613499
MB 500-613499/1-A	Method Blank	Total/NA	Water	6010B	613499
LCS 500-613499/2-A	Lab Control Sample	Total/NA	Water	6010B	613499

General Chemistry

Analysis Batch: 613305

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 2540C	
500-203343-2	D-1-20210803	Total/NA	Water	SM 2540C	
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 2540C	
500-203343-4	CL-1-20210803	Total/NA	Water	SM 2540C	
500-203343-5	DUP-20210803	Total/NA	Water	SM 2540C	
500-203343-6	CL-2-20210803	Total/NA	Water	SM 2540C	
500-203343-7	CL-3-20210803	Total/NA	Water	SM 2540C	
MB 500-613305/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 500-613305/2	Lab Control Sample	Total/NA	Water	SM 2540C	
500-203340-B-2 MS	Matrix Spike	Total/NA	Water	SM 2540C	
500-203340-B-3 DU	Duplicate	Total/NA	Water	SM 2540C	

QC Association Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

General Chemistry

Analysis Batch: 613311

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-2	D-1-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-4	CL-1-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-5	DUP-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-6	CL-2-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-7	CL-3-20210803	Total/NA	Water	SM 3500 Fe B	
MB 500-613311/1	Method Blank	Total/NA	Water	SM 3500 Fe B	
LCS 500-613311/2	Lab Control Sample	Total/NA	Water	SM 3500 Fe B	
500-203343-1 MS	D-2-20210803	Total/NA	Water	SM 3500 Fe B	
500-203343-1 MSD	D-2-20210803	Total/NA	Water	SM 3500 Fe B	

Analysis Batch: 613518

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 4500 S2 F	
500-203343-2	D-1-20210803	Total/NA	Water	SM 4500 S2 F	
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 4500 S2 F	
500-203343-4	CL-1-20210803	Total/NA	Water	SM 4500 S2 F	
500-203343-5	DUP-20210803	Total/NA	Water	SM 4500 S2 F	
500-203343-6	CL-2-20210803	Total/NA	Water	SM 4500 S2 F	
500-203343-7	CL-3-20210803	Total/NA	Water	SM 4500 S2 F	
MB 500-613518/1	Method Blank	Total/NA	Water	SM 4500 S2 F	
LCS 500-613518/2	Lab Control Sample	Total/NA	Water	SM 4500 S2 F	
180-125221-A-1 MS	Matrix Spike	Total/NA	Water	SM 4500 S2 F	
180-125221-A-1 MSD	Matrix Spike Duplicate	Total/NA	Water	SM 4500 S2 F	

Analysis Batch: 613783

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Dissolved	Water	9060A	
500-203343-2	D-1-20210803	Dissolved	Water	9060A	
500-203343-3	BKG-1-20210803	Dissolved	Water	9060A	
500-203343-4	CL-1-20210803	Dissolved	Water	9060A	
500-203343-5	DUP-20210803	Dissolved	Water	9060A	
500-203343-6	CL-2-20210803	Dissolved	Water	9060A	
500-203343-7	CL-3-20210803	Dissolved	Water	9060A	
MB 500-613783/9	Method Blank	Dissolved	Water	9060A	
LCS 500-613783/10	Lab Control Sample	Dissolved	Water	9060A	

Prep Batch: 614309

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 4500 P B	
500-203343-2	D-1-20210803	Total/NA	Water	SM 4500 P B	
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 4500 P B	
500-203343-4	CL-1-20210803	Total/NA	Water	SM 4500 P B	
500-203343-5	DUP-20210803	Total/NA	Water	SM 4500 P B	
500-203343-6	CL-2-20210803	Total/NA	Water	SM 4500 P B	
500-203343-7	CL-3-20210803	Total/NA	Water	SM 4500 P B	
MB 500-614309/1-A	Method Blank	Total/NA	Water	SM 4500 P B	
LCS 500-614309/2-A	Lab Control Sample	Total/NA	Water	SM 4500 P B	

QC Association Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

General Chemistry

Analysis Batch: 614414

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 2320B	
500-203343-2	D-1-20210803	Total/NA	Water	SM 2320B	
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 2320B	
500-203343-4	CL-1-20210803	Total/NA	Water	SM 2320B	
500-203343-5	DUP-20210803	Total/NA	Water	SM 2320B	
500-203343-6	CL-2-20210803	Total/NA	Water	SM 2320B	
500-203343-7	CL-3-20210803	Total/NA	Water	SM 2320B	
MB 500-614414/3	Method Blank	Total/NA	Water	SM 2320B	
LCS 500-614414/4	Lab Control Sample	Total/NA	Water	SM 2320B	
500-203363-E-1 DU	Duplicate	Total/NA	Water	SM 2320B	

Analysis Batch: 614638

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	9056A	
500-203343-3	BKG-1-20210803	Total/NA	Water	9056A	
500-203343-4	CL-1-20210803	Total/NA	Water	9056A	
500-203343-5	DUP-20210803	Total/NA	Water	9056A	
500-203343-6	CL-2-20210803	Total/NA	Water	9056A	
500-203343-7	CL-3-20210803	Total/NA	Water	9056A	
MB 500-614638/3	Method Blank	Total/NA	Water	9056A	
LCS 500-614638/4	Lab Control Sample	Total/NA	Water	9056A	
500-203337-F-2 MS	Matrix Spike	Total/NA	Water	9056A	
500-203337-F-2 MSD	Matrix Spike Duplicate	Total/NA	Water	9056A	

Analysis Batch: 614916

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 4500 P E	614309
500-203343-2	D-1-20210803	Total/NA	Water	SM 4500 P E	614309
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 4500 P E	614309
500-203343-4	CL-1-20210803	Total/NA	Water	SM 4500 P E	614309
500-203343-5	DUP-20210803	Total/NA	Water	SM 4500 P E	614309
500-203343-6	CL-2-20210803	Total/NA	Water	SM 4500 P E	614309
500-203343-7	CL-3-20210803	Total/NA	Water	SM 4500 P E	614309
MB 500-614309/1-A	Method Blank	Total/NA	Water	SM 4500 P E	614309
LCS 500-614309/2-A	Lab Control Sample	Total/NA	Water	SM 4500 P E	614309

Analysis Batch: 614951

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	9056A	
500-203343-2	D-1-20210803	Total/NA	Water	9056A	
500-203343-3	BKG-1-20210803	Total/NA	Water	9056A	
500-203343-4	CL-1-20210803	Total/NA	Water	9056A	
500-203343-5	DUP-20210803	Total/NA	Water	9056A	
500-203343-6	CL-2-20210803	Total/NA	Water	9056A	
500-203343-7	CL-3-20210803	Total/NA	Water	9056A	
MB 500-614951/3	Method Blank	Total/NA	Water	9056A	
LCS 500-614951/4	Lab Control Sample	Total/NA	Water	9056A	

Analysis Batch: 615118

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-2	D-1-20210803	Total/NA	Water	9056A	

General Chemistry (Continued)

Analysis Batch: 615118 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-615118/3	Method Blank	Total/NA	Water	9056A	
LCS 500-615118/4	Lab Control Sample	Total/NA	Water	9056A	

Analysis Batch: 615136

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-203343-1	D-2-20210803	Total/NA	Water	SM 3500	
500-203343-2	D-1-20210803	Total/NA	Water	SM 3500	
500-203343-3	BKG-1-20210803	Total/NA	Water	SM 3500	
500-203343-4	CL-1-20210803	Total/NA	Water	SM 3500	
500-203343-5	DUP-20210803	Total/NA	Water	SM 3500	
500-203343-6	CL-2-20210803	Total/NA	Water	SM 3500	
500-203343-7	CL-3-20210803	Total/NA	Water	SM 3500	

QC Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 500-613499/1-A
Matrix: Water
Analysis Batch: 613679

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 613499

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	<0.050		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 22:21	1
Boron, Dissolved	<0.050		0.050	0.0056	mg/L		08/10/21 08:44	08/10/21 22:21	1
Calcium	<0.20		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 22:21	1
Calcium, Dissolved	<0.20		0.20	0.053	mg/L		08/10/21 08:44	08/10/21 22:21	1
Cobalt	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 22:21	1
Cobalt, Dissolved	<0.0050		0.0050	0.00078	mg/L		08/10/21 08:44	08/10/21 22:21	1
Iron	<0.20		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 22:21	1
Iron, Dissolved	<0.20		0.20	0.082	mg/L		08/10/21 08:44	08/10/21 22:21	1
Lithium	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 22:21	1
Lithium, Dissolved	<0.010		0.010	0.0044	mg/L		08/10/21 08:44	08/10/21 22:21	1
Magnesium	0.0812	J	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 22:21	1
Magnesium, Dissolved	0.0812	J	0.10	0.049	mg/L		08/10/21 08:44	08/10/21 22:21	1
Manganese	<0.010		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 22:21	1
Manganese, Dissolved	<0.010		0.010	0.0023	mg/L		08/10/21 08:44	08/10/21 22:21	1
Potassium	0.185	J	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 22:21	1
Potassium, Dissolved	0.185	J	0.50	0.066	mg/L		08/10/21 08:44	08/10/21 22:21	1
Sodium	0.165	J	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 22:21	1
Sodium, Dissolved	0.165	J	1.0	0.097	mg/L		08/10/21 08:44	08/10/21 22:21	1

Lab Sample ID: LCS 500-613499/2-A
Matrix: Water
Analysis Batch: 613679

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 613499

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Boron	1.00	0.822		mg/L		82	80 - 120
Boron, Dissolved	1.00	0.822		mg/L		82	80 - 120
Calcium	10.0	10.7		mg/L		107	80 - 120
Calcium, Dissolved	10.0	10.7		mg/L		107	80 - 120
Cobalt	0.500	0.498		mg/L		100	80 - 120
Cobalt, Dissolved	0.500	0.498		mg/L		100	80 - 120
Iron	1.00	1.15		mg/L		115	80 - 120
Iron, Dissolved	1.00	1.15		mg/L		115	80 - 120
Lithium	0.500	0.525		mg/L		105	80 - 120
Lithium, Dissolved	0.500	0.525		mg/L		105	80 - 120
Magnesium	10.0	10.0		mg/L		100	80 - 120
Magnesium, Dissolved	10.0	10.0		mg/L		100	80 - 120
Manganese	0.500	0.522		mg/L		104	80 - 120
Manganese, Dissolved	0.500	0.522		mg/L		104	80 - 120
Potassium	10.0	10.1		mg/L		101	80 - 120
Potassium, Dissolved	10.0	10.1		mg/L		101	80 - 120
Sodium	10.0	9.94		mg/L		99	80 - 120
Sodium, Dissolved	10.0	9.94		mg/L		99	80 - 120

QC Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Method: 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 500-614638/3 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614638

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<0.20		0.20	0.17	mg/L			08/17/21 11:40	1

Lab Sample ID: LCS 500-614638/4 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614638

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	3.00	2.81		mg/L		94	80 - 120

Lab Sample ID: 500-203337-F-2 MS — **Client Sample ID: Matrix Spike**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614638

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	430		100	487	4	mg/L		60	80 - 120

Lab Sample ID: 500-203337-F-2 MSD — **Client Sample ID: Matrix Spike Duplicate**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614638

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloride	430		100	491	4	mg/L		64	80 - 120	1	15

Lab Sample ID: MB 500-614951/3 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614951

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<0.20		0.20	0.17	mg/L			08/18/21 11:04	1
Sulfate	<0.20		0.20	0.095	mg/L			08/18/21 11:04	1

Lab Sample ID: LCS 500-614951/4 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614951

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	3.00	3.27		mg/L		109	80 - 120
Sulfate	5.00	5.30		mg/L		106	80 - 120

Lab Sample ID: MB 500-615118/3 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 615118

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<0.20		0.20	0.17	mg/L			08/19/21 11:03	1
Sulfate	<0.20		0.20	0.095	mg/L			08/19/21 11:03	1

Method: 9056A - Anions, Ion Chromatography (Continued)

Lab Sample ID: LCS 500-615118/4 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 615118

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	3.00	3.27		mg/L		109	80 - 120
Sulfate	5.00	5.30		mg/L		106	80 - 120

Method: 9060A - Organic Carbon, Dissolved (DOC)

Lab Sample ID: MB 500-613783/9 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Dissolved**
Analysis Batch: 613783

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dissolved Organic Carbon - Duplicate	<1.0		1.0	0.47	mg/L			08/09/21 21:30	1

Lab Sample ID: LCS 500-613783/10 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Dissolved**
Analysis Batch: 613783

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
DOC Result 1	10.0	9.57		mg/L		96	86 - 116
DOC Result 2	10.0	9.57		mg/L		96	86 - 116
Dissolved Organic Carbon - Duplicate	10.0	9.57		mg/L		96	86 - 116

Method: SM 2320B - Alkalinity

Lab Sample ID: MB 500-614414/3 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614414

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	<5.0		5.0	3.7	mg/L			08/15/21 16:27	1

Lab Sample ID: LCS 500-614414/4 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614414

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Alkalinity	500	454		mg/L		91	90 - 110

Lab Sample ID: 500-203363-E-1 DU — **Client Sample ID: Duplicate**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614414

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Alkalinity	180		181		mg/L		2	20

QC Sample Results

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 500-613305/1 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613305

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	<10		10	4.3	mg/L			08/09/21 09:31	1

Lab Sample ID: LCS 500-613305/2 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613305

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	250	238		mg/L		95	80 - 120

Lab Sample ID: 500-203340-B-2 MS — **Client Sample ID: Matrix Spike**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613305

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Dissolved Solids	490		250	792		mg/L		120	75 - 125

Lab Sample ID: 500-203340-B-3 DU — **Client Sample ID: Duplicate**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613305

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Dissolved Solids	480		472		mg/L		2	5

Method: SM 3500 Fe B - Iron, Ferrous

Lab Sample ID: MB 500-613311/1 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613311

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ferrous Iron	<0.050		0.050	0.050	mg/L			08/11/21 04:41	1

Lab Sample ID: LCS 500-613311/2 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613311

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Ferrous Iron	0.500	0.500		mg/L		100	80 - 120

Lab Sample ID: 500-203343-1 MS — **Client Sample ID: D-2-20210803**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613311

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Ferrous Iron	<0.050	HF	0.500	0.500		mg/L		100	75 - 125

Method: SM 3500 Fe B - Iron, Ferrous (Continued)

Lab Sample ID: 500-203343-1 MSD — **Client Sample ID: D-2-20210803**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613311

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Ferrous Iron	<0.050	HF	0.500	0.500		mg/L		100	75 - 125	0	20

Method: SM 4500 P E - Phosphorus

Lab Sample ID: MB 500-614309/1-A — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614916 — **Prep Batch: 614309**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phosphorus as PO4	<0.15		0.15	0.073	mg/L		08/15/21 12:30	08/18/21 11:49	1

Lab Sample ID: LCS 500-614309/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 614916 — **Prep Batch: 614309**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Phosphorus as PO4	1.54	1.56		mg/L		101	88 - 123

Method: SM 4500 S2 F - Sulfide, Total

Lab Sample ID: MB 500-613518/1 — **Client Sample ID: Method Blank**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613518

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	<1.0		1.0	0.23	mg/L			08/09/21 23:35	1

Lab Sample ID: LCS 500-613518/2 — **Client Sample ID: Lab Control Sample**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613518

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfide	3.84	3.87		mg/L		101	85 - 115

Lab Sample ID: 180-125221-A-1 MS — **Client Sample ID: Matrix Spike**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613518

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfide	<1.0		3.84	3.57		mg/L		93	75 - 125

Lab Sample ID: 180-125221-A-1 MSD — **Client Sample ID: Matrix Spike Duplicate**
Matrix: Water — **Prep Type: Total/NA**
Analysis Batch: 613518

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Sulfide	<1.0		3.84	3.75		mg/L		98	75 - 125	5	20

Lab Chronicle

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: D-2-20210803

Lab Sample ID: 500-203343-1

Date Collected: 08/03/21 10:15
Matrix: Water
Date Received: 08/05/21 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/10/21 23:31	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/10/21 23:27	EEN	TAL CHI
Total/NA	Analysis	9056A		1	614638	08/17/21 16:12	EAT	TAL CHI
Total/NA	Analysis	9056A		20	614951	08/18/21 12:53	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:09		
					(End)	08/09/21 23:09		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:00	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 09:49	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 04:46	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:20	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:05		
					(End)	08/10/21 00:08		

Client Sample ID: D-1-20210803

Lab Sample ID: 500-203343-2

Date Collected: 08/03/21 10:50
Matrix: Water
Date Received: 08/05/21 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/10/21 23:38	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/10/21 23:34	EEN	TAL CHI
Total/NA	Analysis	9056A		25	614951	08/18/21 13:07	EAT	TAL CHI
Total/NA	Analysis	9056A		2	615118	08/19/21 11:37	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:16		
					(End)	08/09/21 23:16		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:07	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 09:51	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 04:55	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:21	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:08		
					(End)	08/10/21 00:12		

Lab Chronicle

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: BKG-1-20210803

Lab Sample ID: 500-203343-3

Date Collected: 08/03/21 12:45
Date Received: 08/05/21 09:45

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/10/21 23:46	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/10/21 23:42	EEN	TAL CHI
Total/NA	Analysis	9056A		10	614638	08/17/21 17:48	EAT	TAL CHI
Total/NA	Analysis	9056A		10	614951	08/18/21 13:48	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:26		
					(End)	08/09/21 23:26		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:14	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 09:54	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 04:58	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:22	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:12		
					(End)	08/10/21 00:16		

Client Sample ID: CL-1-20210803

Lab Sample ID: 500-203343-4

Date Collected: 08/03/21 13:20
Date Received: 08/05/21 09:45

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/10/21 23:54	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/10/21 23:50	EEN	TAL CHI
Total/NA	Analysis	9056A		2	614638	08/17/21 18:01	EAT	TAL CHI
Total/NA	Analysis	9056A		10	614951	08/18/21 14:01	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:33		
					(End)	08/09/21 23:33		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:21	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 09:56	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 05:00	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:23	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:16		
					(End)	08/10/21 00:20		

Lab Chronicle

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: DUP-20210803

Lab Sample ID: 500-203343-5

Date Collected: 08/03/21 13:30
Matrix: Water
Date Received: 08/05/21 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/11/21 00:14	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/10/21 23:58	EEN	TAL CHI
Total/NA	Analysis	9056A		2	614638	08/17/21 18:28	EAT	TAL CHI
Total/NA	Analysis	9056A		10	614951	08/18/21 14:15	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:40		
					(End)	08/09/21 23:40		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:28	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 09:59	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 05:03	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:42	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:20		
					(End)	08/10/21 00:23		

Client Sample ID: CL-2-20210803

Lab Sample ID: 500-203343-6

Date Collected: 08/03/21 13:50
Matrix: Water
Date Received: 08/05/21 09:45

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/11/21 00:21	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/11/21 00:18	EEN	TAL CHI
Total/NA	Analysis	9056A		2	614638	08/17/21 18:55	EAT	TAL CHI
Total/NA	Analysis	9056A		10	614951	08/18/21 14:29	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:47		
					(End)	08/09/21 23:47		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:35	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 10:02	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 05:06	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:43	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:23		
					(End)	08/10/21 00:27		

Lab Chronicle

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Client Sample ID: CL-3-20210803

Date Collected: 08/03/21 14:20
Date Received: 08/05/21 09:45

Lab Sample ID: 500-203343-7

Matrix: Water

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Dissolved	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Dissolved	Analysis	6010B		1	613679	08/11/21 00:29	EEN	TAL CHI
Total/NA	Prep	3010A			613499	08/10/21 08:44	BDE	TAL CHI
Total/NA	Analysis	6010B		1	613679	08/11/21 00:25	EEN	TAL CHI
Total/NA	Analysis	9056A		2	614638	08/17/21 19:23	EAT	TAL CHI
Total/NA	Analysis	9056A		10	614951	08/18/21 14:42	EAT	TAL CHI
Dissolved	Analysis	9060A		1	613783		TMS	TAL CHI
					(Start)	08/09/21 23:55		
					(End)	08/09/21 23:55		
Total/NA	Analysis	SM 2320B		1	614414	08/15/21 19:41	MS	TAL CHI
Total/NA	Analysis	SM 2540C		1	613305	08/09/21 10:04	CLB	TAL CHI
Total/NA	Analysis	SM 3500		1	615136	08/19/21 14:42	PFK	TAL CHI
Total/NA	Analysis	SM 3500 Fe B		1	613311	08/11/21 05:09	CLB	TAL CHI
Total/NA	Prep	SM 4500 P B			614309	08/15/21 12:30	JMP	TAL CHI
Total/NA	Analysis	SM 4500 P E		1	614916	08/18/21 12:44	JMP	TAL CHI
Total/NA	Analysis	SM 4500 S2 F		1	613518		CLB	TAL CHI
					(Start)	08/10/21 00:27		
					(End)	08/10/21 00:31		

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Geosyntec Consultants, Inc.
Project/Site: GLP8029 Coffeen, IL

Job ID: 500-203343-1

Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Illinois	NELAP	IL00035	04-29-22

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park IL 60484
Phone 708-534-5200 Fax 708-534-5211

Chain of Custody Record

eurofins Environment Testing America

500-203343 COC

Client Information	Sampler: Nick Williams	Lab PM: Kintz Robin M	Ca	COC No: 500-93566-41606 1
Client Contact: Brian Ares	Phone: 317 694 9143	E-Mail: Robin Kintz@Eurofinset com	Sta	Page: Page 1 of 1
Company: Geosyntec Consultants Inc	PWSID:			Job #: 500-203343
Address: 2100 Commonwealth Blvd Suite 100	Due Date Requested:			
City: Ann Arbor	TAT Requested (days):			
State Zip: MI 48105	Compliance Project: Δ Yes Δ No			
Phone: 734-794-1548(Tel)	PO #: Purchase Order not required			
Email: bares@geosyntec com	WO #:			
Project Name: GLP8029 Coffeen IL	Project #: 50019213			
Site:	SSOW#:			

Analysis Requested

	Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water S=solid O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9056A - Chloride, Sulfate	6010B - Metals (ICP) - 9 elements	6010B - Dissolved Metals (ICP) - 9 elements	4500_P_E - Phosphorus as PO4	SM4500_S2_F - Sulfide	9060A_Diss - Organic Carbon Dissolved (DOC)	2320B 2540C 3500_F+2_B_Calc 3500_F+3_B_Calc	~~9056A Chloride, Sulfate (Dissolved)~~	Total Number of containers	Special Instructions/Note
				Preservation Code:				N	D	D	S	CB	S	N	N		
1	D-2-20210803	8/3/21	1015	G	W		N	X	X	X	X	X	X	X	X		Filtered in field for
2	D-1-20210803		1050	G	W		N	X	X	X	X	X	X	X	X		Dissolved Metals, DOC,
3	BKG-1-20210803		1245	G	W		N	X	X	X	X	X	X	X	X		~~and Dissolved Chloride,~~
4	CL-1-20210803		1320	G	W		N	X	X	X	X	X	X	X	X		~~Sulfate~~ NW
5	DUP-20210803		1330	G	W		N	X	X	X	X	X	X	X	X		
6	CL-2-20210803		1350	G	W		N	X	X	X	X	X	X	X	X		
7	CL-3-20210803		1420	G	W		N	X	X	X	X	X	X	X	X NW		

Preservation Codes

A	HCL	M	Hexane
B	NaOH	N	None
C	Zn Acetate	O	AsNaO2
D	Nitric Acid	P	Na2O4S
E	NaHSO4	Q	Na2SO3
F	MeOH	R	Na2S2O3
G	Amchlor	S	H2SO4
H	Ascorbic Acid	T	TSP Dodecahydrate
I	Ice	U	Acetone
J	DI Water	V	MCAA
K	EDTA	W	pH 4-5
L	EDA	Z	other (specify)

Other:

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months

Deliverable Requested I II III IV Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by	Date	Time	Method of Shipment

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
[signature]	8/4/21 930	GO	[signature]	8/5/21 0945	ETA
Relinquished by:	Date/Time	Company	Received by:	Date/Time	Company
Relinquished by:	Date/Time	Company	Received by:	Date/Time	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No | Cooler Temperature(s) °C and Other Remarks

Login Sample Receipt Checklist

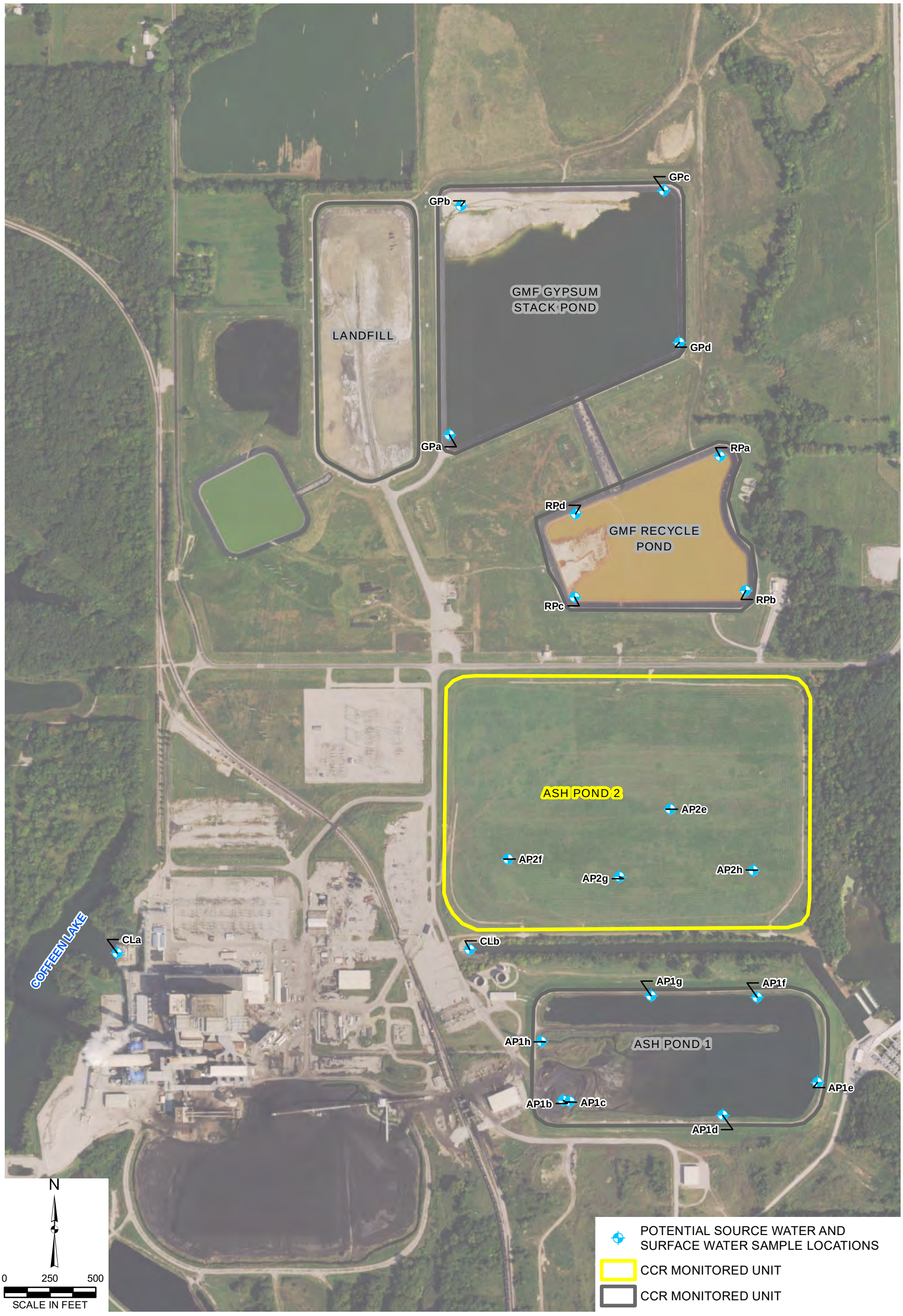
Client: Geosyntec Consultants, Inc.

Job Number: 500-203343-1

Login Number: 203343
List Number: 1
Creator: James, Jeff A

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	1.1, 2.5
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	



DRAWN BY/DATE:
SDS 12/21/16
REVIEWED BY/DATE:
NRK 12/21/16
APPROVED BY/DATE:
SJC 12/22/16

POTENTIAL SOURCE WATER AND SURFACE WATER SAMPLE LOCATIONS

HYDROGEOLOGIC CHARACTERIZATION REPORT
ASH POND 2
COFFEEN POWER STATION
COFFEEN, IL

PROJECT NO: 2380

FIGURE NO: 14

Natural Resource Technology

Y:\Mapping\Projects\23\2380\MXD\HGCR\Figure 14_Potential Source Water And Surface Water Sample Locations.mxd Author: tcushman Date/Time: 12/22/2016, 2:59:50 PM

Surface Water Sample Location Map

Coffeen Power Station

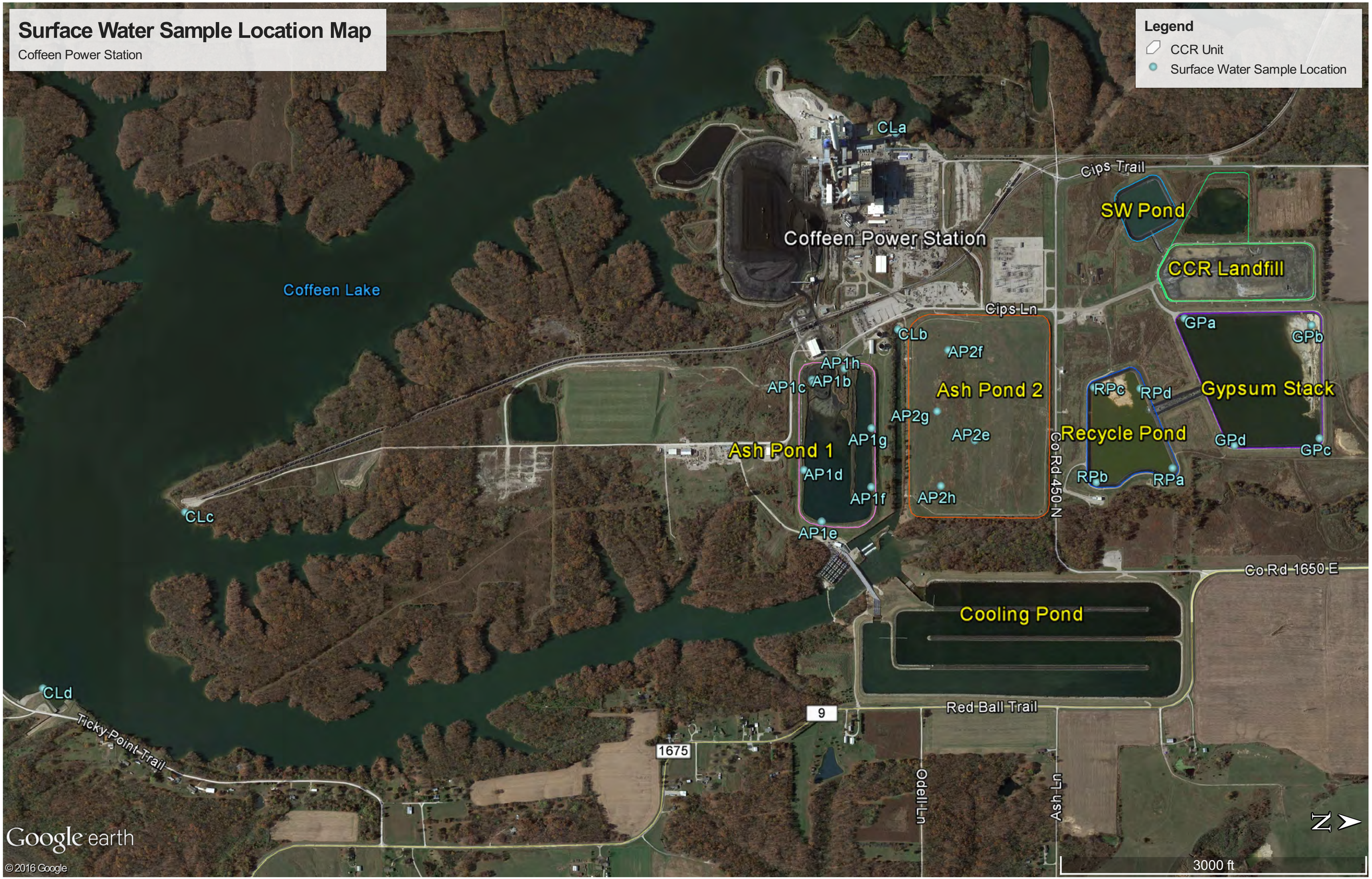


Table 10
Potential Source Water and Surface Water Sampling Results - October 24, 2016
Hydrogeologic Characterization Report
Coffeen Energy Center

Sample ID	Sample Location	Alkalinity, bicarbonate mg/L	Alkalinity, carbonate mg/L	Antimony, Total ug/L	Arsenic, Total ug/L	Barium, Total ug/L	Beryllium, Total ug/L	Boron, Total ug/L	Cadmium, Total ug/L	Calcium, Total mg/l	Chloride, Total mg/L	Chromium, Total ug/L	Cobalt, Total ug/L	Fluoride, Total mg/L	Lithium, Total ug/L	Magnesium, Total mg/L	Mercury, Total ug/L	Molybdenum , Total ug/L	pH	Potassium, Total mg/L	Selenium, Total ug/L	Sodium, Total mg/l	Solids - total dissolved solids (TDS) mg/L	Sulfate, Total mg/L	Thallium, Total ug/L
AP1a	Ash Pond 1	90	< 2.0	3.1	7.2	130	< 1.0	3800	< 1.0	380	3.2	< 4.0	< 2.0	< 0.250	39	67	< 0.20	47	6.99	7.3	3.0	33	1800	1500	< 1.0
AP1b		120	< 2.0	3.3	17	100	< 1.0	3100	< 1.0	320	13	< 4.0	< 2.0	0.977	47	52	< 0.20	100	7.01	18	6.9	53	1600	1300	< 1.0
AP1c		80	< 2.0	< 3.0	18	130	< 1.0	2900	< 1.0	390	13	< 4.0	< 2.0	0.614	51	49	< 0.20	81	7.05	18	3.1	59	1900	1600	< 1.0
AP1d		90	< 20	< 3.0	2.0	200	< 1.0	2000	< 1.0	210	18	< 4.0	< 2.0	1.08	55	35	< 0.20	31	7.21	26	1.5	83	980	1000	< 1.0
AP1e		80	< 2.0	< 3.0	1.4	160	< 1.0	2100	< 1.0	200	18	< 4.0	< 2.0	1.00	55	34	< 0.20	30	7.12	26	1.2	80	1200	960	< 1.0
AP1f		110	< 20	< 3.0	1.5	150	< 1.0	2100	< 1.0	200	17	< 4.0	< 2.0	1.00	57	35	< 0.20	31	7.20	26	1.2	82	1200	1000	< 1.0
AP1g		75	< 2.0	< 3.0	1.3	140	< 1.0	2100	< 1.0	210	17	< 4.0	< 2.0	1.00	56	32	< 0.20	29	7.21	26	1.4	100	1200	970	< 1.0
AP1h		90	< 20	< 3.0	1.5	180	< 1.0	2200	< 1.0	230	17	< 4.0	< 2.0	0.980	55	30	< 0.20	31	7.41	27	1.2	110	1200	1000	< 1.0
AP2e	Ash Pond 2	55	< 20	< 3.0	23	26	< 1.0	5300	< 1.0	210	< 5.0	< 4.0	< 2.0	0.438	190	40	< 0.20	90	6.49	27	< 1.0	25	1700	1500	< 1.0
AP2f		100	< 20	< 3.0	1.2	22	< 2.0	2000	< 1.0	170	< 5.0	< 4.0	< 2.0	0.398	130	33	< 0.20	3.2	6.42	21	< 1.0	14	1700	1500	< 1.0
AP2g		4.0	< 2.0	< 3.0	5.5	20	< 2.0	4300	4.6	410	< 5.0	< 4.0	< 2.0	0.506	180	51	< 0.20	41	6.46	29	< 1.0	27	2400	2300	< 1.0
AP2h		140	< 2.0	< 3.0	75	23	< 1.0	14000	< 1.0	310	1.7	< 4.0	< 2.0	0.406	120	29	< 0.20	570	7.17	40	< 1.0	39	1500	1300	< 1.0
CLa	Coffeen Lake	80	< 2.0	< 3.0	1.8	54	< 1.0	270	< 1.0	23	23	< 4.0	< 2.0	0.443	< 10	12	< 0.20	5.0	7.22	7.4	< 1.0	19	190	55	< 1.0
CLb		80	< 2.0	< 3.0	1.8	52	< 1.0	280	< 1.0	23	22	< 4.0	< 2.0	0.425	< 10	11	< 0.20	4.9	7.52	7.8	< 1.0	19	180	56	< 1.0
CLc		75	< 2.0	< 3.0	1.8	56	< 1.0	280	< 1.0	23	22	< 4.0	< 2.0	0.426	< 10	12	< 0.20	4.7	7.62	7.4	< 1.0	19	160	54	< 1.0
CLd		80	< 2.0	< 3.0	1.8	54	< 1.0	270	< 1.0	23	23	< 4.0	< 2.0	0.421	< 10	12	< 0.20	4.8	7.30	7.5	< 1.0	20	170	54	< 1.0
GPa	Gypsum Stack Pond	4.0	< 2.0	< 3.0	4.7	120	2.6	59000	40	450	1900	< 4.0	52	42.7	300	1500	< 0.80	130	7.16	210	890	620	17000	17000	< 1.0
GPb		10	< 2.0	8.6	92	1100	< 20	97000	67	1400	2600	150	110	69.4	480	2500	27	140	6.65	360	1500	1000	28000	27000	< 4.0
GPc		5.5	< 2.0	< 6.0	4.4	110	2.6	72000	41	570	1800	< 4.0	54	49.2	300	1500	< 0.80	120	6.73	260	890	650	17000	20000	< 1.0
GPd		6.0	< 2.0	< 3.0	4.2	110	< 20	66000	38	560	1900	< 4.0	52	51.3	300	1500	< 0.80	120	6.73	230	800	660	16000	19000	< 1.0
RPa	Gypsum Recycle Pond	< 2.0	< 2.0	< 3.0	3.3	89	2.3	60000	37	380	1600	< 4.0	44	47.0	310	1200	< 0.20	63	6.70	190	840	450	16000	17000	< 1.0
RPb		< 2.0	< 2.0	< 3.0	2.8	90	2.1	56000	33	380	1800	< 4.0	45	44.4	310	1200	< 0.40	64	6.49	210	780	470	16000	18000	< 1.0
RPc		< 2.0	< 2.0	< 3.0	3.1	88	2.2	59000	37	380	2000	< 4.0	43	45.0	310	1200	< 0.20	64	6.32	200	830	440	16000	20000	< 1.0
RPd		< 2.0	< 2.0	< 3.0	3.4	89	2.4	59000	36	400	1600	< 4.0	45	51.2	310	1300	< 0.20	66	6.32	200	860	460	17000	16000	< 1.0

[O:MDM 12/2016, NRK 12/2016]

Natural Resource Technology

PDC Laboratories, Inc.

PROFESSIONAL • DEPENDABLE • COMMITTED

November 08, 2016

Rhonald Hasenyager
Hanson Professional Services, Inc.
1525 South Sixth Street
Springfield, IL 62703-2886

Dear Rhonald Hasenyager:

Please find enclosed the analytical results for the sample(s) the laboratory received on **10/25/16 7:45 am** and logged in under work order **6103663**. All testing is performed according to our current TNI certifications unless otherwise noted. This report cannot be reproduced, except in full, without the written permission of PDC Laboratories, Inc.

If you have any questions regarding your report, please contact your project manager. Quality and timely data is of the utmost importance to us.

PDC Laboratories, Inc. appreciates the opportunity to provide you with analytical expertise. We are always trying to improve our customer service and we welcome you to contact the Vice President , John LaPayne with any feedback you have about your experience with our laboratory.

Sincerely,

Gail J Schindler

Gail Schindler
Project Manager
(309) 692-9688 x1716
gschindler@pdclab.com

PDC Laboratories, Inc.
2231 West Altorfer Drive
Peoria, IL 61615
(800) 752-6651

ANALYTICAL RESULTS

Sample: **6103663-01**
Name: AP1a
Matrix: Surface Water - Grab

Sampled: 10/24/16 11:52
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	3.2	mg/L		10/25/16 11:16	10/25/16 11:16	TAS	EPA 300.0
Fluoride	< 0.250	mg/L		10/25/16 11:16	10/25/16 11:16	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 11:16	10/25/16 11:16	TAS	EPA 300.0
Sulfate	1500	mg/L		10/27/16 13:02	10/27/16 13:02	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.99	pH Units		10/24/16 11:52	10/24/16 11:52	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	90	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	1800	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	3.1	ug/L		10/26/16 13:38	11/02/16 12:10	JMW	SW 6020
Arsenic	7.2	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Barium	130	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Boron	3800	ug/L		10/26/16 13:38	11/03/16 07:54	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Calcium	380	mg/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Lithium	39	ug/L		10/26/16 13:38	10/27/16 11:24	KJP	SW 6010*
Magnesium	67	mg/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 13:53	JMW	SW 6020
Molybdenum	47	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Potassium	7.3	mg/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Selenium	3.0	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Sodium	33	mg/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:23	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-02**
Name: AP1b
Matrix: Surface Water - Grab

Sampled: 10/24/16 11:56
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	13	mg/L		10/27/16 13:20	10/27/16 13:20	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 12:45	10/25/16 12:45	TAS	EPA 300.0
Sulfate	1300	mg/L		10/27/16 13:38	10/27/16 13:38	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.01	pH Units		10/24/16 11:56	10/24/16 11:56	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	120	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	0.977	mg/L		10/27/16 13:26	10/27/16 13:26	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	1600	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	3.3	ug/L		10/26/16 13:38	11/02/16 12:23	JMW	SW 6020
Arsenic	17	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Barium	100	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Boron	3100	ug/L		10/26/16 13:38	11/03/16 07:59	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Calcium	320	mg/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Lithium	47	ug/L		10/26/16 13:38	10/27/16 11:33	KJP	SW 6010*
Magnesium	52	mg/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:06	JMW	SW 6020
Molybdenum	100	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Potassium	18	mg/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Selenium	6.9	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Sodium	53	mg/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:36	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-03**
Name: AP1c
Matrix: Surface Water - Grab

Sampled: 10/24/16 12:10
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	13	mg/L		10/27/16 13:55	10/27/16 13:55	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 13:21	10/25/16 13:21	TAS	EPA 300.0
Sulfate	1600	mg/L		10/27/16 14:13	10/27/16 14:13	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.05	pH Units		10/24/16 12:10	10/24/16 12:10	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	80	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	0.614	mg/L		10/27/16 13:30	10/27/16 13:30	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	1900	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:26	JMW	SW 6020
Arsenic	18	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Barium	130	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Boron	2900	ug/L		10/26/16 13:38	11/03/16 08:01	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Calcium	390	mg/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Lithium	51	ug/L		10/26/16 13:38	10/27/16 11:36	KJP	SW 6010*
Magnesium	49	mg/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:10	JMW	SW 6020
Molybdenum	81	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Potassium	18	mg/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Selenium	3.1	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Sodium	59	mg/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:39	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-04**
Name: AP1d
Matrix: Surface Water - Grab

Sampled: 10/24/16 12:15
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	18	mg/L		10/27/16 14:31	10/27/16 14:31	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 13:57	10/25/16 13:57	TAS	EPA 300.0
Sulfate	1000	mg/L		10/27/16 14:48	10/27/16 14:48	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.21	pH Units		10/24/16 12:15	10/24/16 12:15	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	90	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Alkalinity - carbonate as CaCO3	< 20	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Fluoride	1.08	mg/L		10/27/16 13:43	10/27/16 13:43	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	980	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:30	JMW	SW 6020
Arsenic	2.0	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Barium	200	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Boron	2000	ug/L		10/26/16 13:38	11/03/16 08:02	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Calcium	210	mg/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Lithium	55	ug/L		10/26/16 13:38	10/27/16 11:39	KJP	SW 6010*
Magnesium	35	mg/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:13	JMW	SW 6020
Molybdenum	31	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Potassium	26	mg/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Selenium	1.5	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Sodium	83	mg/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:43	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-05**
Name: AP1e
Matrix: Surface Water - Grab

Sampled: 10/24/16 12:01
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	18	mg/L		10/27/16 18:37	10/27/16 18:37	TAS	EPA 300.0
Fluoride	1.00	mg/L		10/25/16 13:26	10/25/16 13:26	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 13:26	10/25/16 13:26	TAS	EPA 300.0
Sulfate	960	mg/L		10/28/16 11:36	10/28/16 11:36	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.12	pH Units		10/24/16 12:01	10/24/16 12:01	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	80	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	1200	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:45	JMW	SW 6020
Arsenic	1.4	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Barium	160	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Boron	2100	ug/L		10/26/16 13:38	11/03/16 08:03	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Calcium	200	mg/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Lithium	55	ug/L		10/26/16 13:38	10/27/16 11:48	KJP	SW 6010*
Magnesium	34	mg/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:17	JMW	SW 6020
Molybdenum	30	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Potassium	26	mg/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Selenium	1.2	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Sodium	80	mg/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:46	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-06**
Name: AP1f
Matrix: Surface Water - Grab

Sampled: 10/24/16 12:40
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	17	mg/L		10/27/16 15:06	10/27/16 15:06	TAS	EPA 300.0
Fluoride	1.00	mg/L		10/25/16 14:03	10/25/16 14:03	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 14:03	10/25/16 14:03	TAS	EPA 300.0
Sulfate	1000	mg/L		10/27/16 15:23	10/27/16 15:23	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.20	pH Units		10/24/16 12:40	10/24/16 12:40	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	110	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Alkalinity - carbonate as CaCO3	< 20	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Solids - total dissolved solids (TDS)	1200	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:48	JMW	SW 6020
Arsenic	1.5	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Barium	150	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Boron	2100	ug/L		10/26/16 13:38	11/03/16 08:13	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Calcium	200	mg/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Lithium	57	ug/L		10/26/16 13:38	10/27/16 11:51	KJP	SW 6010*
Magnesium	35	mg/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:21	JMW	SW 6020
Molybdenum	31	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Potassium	26	mg/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Selenium	1.2	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Sodium	82	mg/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 11:50	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-07**
Name: AP1g
Matrix: Surface Water - Grab

Sampled: 10/24/16 12:50
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	17	mg/L		10/27/16 15:41	10/27/16 15:41	TAS	EPA 300.0
Fluoride	1.00	mg/L		10/25/16 15:34	10/25/16 15:34	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 15:34	10/25/16 15:34	TAS	EPA 300.0
Sulfate	970	mg/L		10/28/16 11:54	10/28/16 11:54	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.21	pH Units		10/24/16 12:50	10/24/16 12:50	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	75	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	1200	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:52	JMW	SW 6020
Arsenic	1.3	ug/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020
Barium	140	ug/L		10/26/16 13:38	11/01/16 14:37	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020
Boron	2100	ug/L		10/26/16 13:38	11/03/16 08:16	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020
Calcium	210	mg/L		10/26/16 13:38	11/02/16 12:52	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:37	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 12:52	JMW	SW 6020
Lithium	56	ug/L		10/26/16 13:38	10/27/16 11:54	KJP	SW 6010*
Magnesium	32	mg/L		10/26/16 13:38	11/01/16 14:37	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:37	JMW	SW 6020
Molybdenum	29	ug/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020
Potassium	26	mg/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020
Selenium	1.4	ug/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020
Sodium	100	mg/L		10/26/16 13:38	11/02/16 12:52	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:09	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-08**
Name: AP1h
Matrix: Surface Water - Grab

Sampled: 10/24/16 12:55
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	17	mg/L		10/27/16 16:51	10/27/16 16:51	TAS	EPA 300.0
Fluoride	0.980	mg/L		10/25/16 16:11	10/25/16 16:11	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 16:11	10/25/16 16:11	TAS	EPA 300.0
Sulfate	1000	mg/L		10/28/16 12:12	10/28/16 12:12	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.41	pH Units		10/24/16 12:55	10/24/16 12:55	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	90	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Alkalinity - carbonate as CaCO3	< 20	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Solids - total dissolved solids (TDS)	1200	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:55	JMW	SW 6020
Arsenic	1.5	ug/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020
Barium	180	ug/L		10/26/16 13:38	11/01/16 14:40	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020
Boron	2200	ug/L		10/26/16 13:38	11/03/16 08:18	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020
Calcium	230	mg/L		10/26/16 13:38	11/02/16 12:55	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:40	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 12:55	JMW	SW 6020
Lithium	55	ug/L		10/26/16 13:38	10/27/16 11:57	KJP	SW 6010*
Magnesium	30	mg/L		10/26/16 13:38	11/01/16 14:40	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:40	JMW	SW 6020
Molybdenum	31	ug/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020
Potassium	27	mg/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020
Selenium	1.2	ug/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020
Sodium	110	mg/L		10/26/16 13:38	11/02/16 12:55	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:12	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-09**
Name: AP2e
Matrix: Surface Water - Grab

Sampled: 10/24/16 11:30
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	< 5.0	mg/L		10/27/16 17:27	10/27/16 17:27	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 14:33	10/25/16 14:33	TAS	EPA 300.0
Sulfate	1500	mg/L		10/28/16 12:31	10/28/16 12:31	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.49	pH Units		10/24/16 11:30	10/24/16 11:30	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	55	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Alkalinity - carbonate as CaCO3	< 20	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Fluoride	0.438	mg/L		10/27/16 13:58	10/27/16 13:58	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	1700	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 12:59	JMW	SW 6020
Arsenic	23	ug/L		10/26/16 13:38	11/01/16 12:16	JMW	SW 6020
Barium	26	ug/L		10/26/16 13:38	11/01/16 14:44	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/02/16 12:59	JMW	SW 6020
Boron	5300	ug/L		10/26/16 13:38	11/03/16 08:19	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:16	JMW	SW 6020
Calcium	210	mg/L		10/26/16 13:38	11/02/16 12:59	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:44	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 12:59	JMW	SW 6020
Lithium	190	ug/L		10/26/16 13:38	10/27/16 12:00	KJP	SW 6010*
Magnesium	40	mg/L		10/26/16 13:38	11/01/16 14:44	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:44	JMW	SW 6020
Molybdenum	90	ug/L		10/26/16 13:38	11/01/16 12:16	JMW	SW 6020
Potassium	27	mg/L		10/26/16 13:38	11/01/16 12:16	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:16	JMW	SW 6020
Sodium	25	mg/L		10/26/16 13:38	11/02/16 12:59	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:16	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-10**
Name: AP2f
Matrix: Surface Water - Grab

Sampled: 10/24/16 11:20
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	< 5.0	mg/L		10/27/16 18:02	10/27/16 18:02	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 15:09	10/25/16 15:09	TAS	EPA 300.0
Sulfate	1500	mg/L		10/28/16 12:49	10/28/16 12:49	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.42	pH Units		10/24/16 11:20	10/24/16 11:20	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	100	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Alkalinity - carbonate as CaCO3	< 20	mg/L		10/25/16 09:29	10/25/16 09:29	CJN	SM 2320B*
Fluoride	0.398	mg/L		10/27/16 14:02	10/27/16 14:02	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	1700	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:03	JMW	SW 6020
Arsenic	1.2	ug/L		10/26/16 13:38	11/01/16 12:20	JMW	SW 6020
Barium	22	ug/L		10/26/16 13:38	11/01/16 14:47	JMW	SW 6020
Beryllium	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:54	JMW	SW 6020
Boron	2000	ug/L		10/26/16 13:38	11/03/16 08:20	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:20	JMW	SW 6020
Calcium	170	mg/L		10/26/16 13:38	11/02/16 13:54	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:47	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:03	JMW	SW 6020
Lithium	130	ug/L		10/26/16 13:38	10/27/16 12:03	KJP	SW 6010*
Magnesium	33	mg/L		10/26/16 13:38	11/01/16 14:47	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:47	JMW	SW 6020
Molybdenum	3.2	ug/L		10/26/16 13:38	11/01/16 12:20	JMW	SW 6020
Potassium	21	mg/L		10/26/16 13:38	11/01/16 12:20	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:20	JMW	SW 6020
Sodium	14	mg/L		10/26/16 13:38	11/02/16 13:03	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:20	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-11**
Name: AP2g
Matrix: Surface Water - Grab

Sampled: 10/24/16 11:10
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	< 5.0	mg/L		10/27/16 19:12	10/27/16 19:12	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 16:20	10/25/16 16:20	TAS	EPA 300.0
Sulfate	2300	mg/L		10/28/16 13:07	10/28/16 13:07	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.46	pH Units		10/24/16 11:10	10/24/16 11:10	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	4.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	0.506	mg/L		10/27/16 14:07	10/27/16 14:07	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	2400	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:06	JMW	SW 6020
Arsenic	5.5	ug/L		10/26/16 13:38	11/01/16 12:23	JMW	SW 6020
Barium	20	ug/L		10/26/16 13:38	11/01/16 14:51	JMW	SW 6020
Beryllium	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:57	JMW	SW 6020
Boron	4300	ug/L		10/26/16 13:38	11/03/16 08:22	JMW	SW 6020
Cadmium	4.6	ug/L		10/26/16 13:38	11/01/16 12:23	JMW	SW 6020
Calcium	410	mg/L		10/26/16 13:38	11/02/16 13:57	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:51	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:06	JMW	SW 6020
Lithium	180	ug/L		10/26/16 13:38	10/27/16 12:06	KJP	SW 6010*
Magnesium	51	mg/L		10/26/16 13:38	11/01/16 14:51	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:51	JMW	SW 6020
Molybdenum	41	ug/L		10/26/16 13:38	11/01/16 12:23	JMW	SW 6020
Potassium	29	mg/L		10/26/16 13:38	11/01/16 12:23	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:23	JMW	SW 6020
Sodium	27	mg/L		10/26/16 13:38	11/02/16 13:06	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:23	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-12**
Name: AP2h
Matrix: Surface Water - Grab

Sampled: 10/24/16 11:40
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1.7	mg/L		10/25/16 16:56	10/25/16 16:56	TAS	EPA 300.0
Fluoride	0.406	mg/L		10/25/16 16:56	10/25/16 16:56	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 16:56	10/25/16 16:56	TAS	EPA 300.0
Sulfate	1300	mg/L		10/28/16 14:57	10/28/16 14:57	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.17	pH Units		10/24/16 11:40	10/24/16 11:40	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	140	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	1500	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:10	JMW	SW 6020
Arsenic	75	ug/L		10/26/16 13:38	11/01/16 12:27	JMW	SW 6020
Barium	23	ug/L		10/26/16 13:38	11/01/16 14:55	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:27	JMW	SW 6020
Boron	14000	ug/L		10/26/16 13:38	11/03/16 08:23	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:27	JMW	SW 6020
Calcium	310	mg/L		10/26/16 13:38	11/02/16 13:10	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:55	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:10	JMW	SW 6020
Lithium	120	ug/L		10/26/16 13:38	10/27/16 12:09	KJP	SW 6010*
Magnesium	29	mg/L		10/26/16 13:38	11/01/16 14:55	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:55	JMW	SW 6020
Molybdenum	570	ug/L		10/26/16 13:38	11/01/16 12:27	JMW	SW 6020
Potassium	40	mg/L		10/26/16 13:38	11/03/16 08:23	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:27	JMW	SW 6020
Sodium	39	mg/L		10/26/16 13:38	11/02/16 13:10	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:27	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-13**
Name: CLa
Matrix: Surface Water - Grab

Sampled: 10/24/16 15:30
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	23	mg/L		10/27/16 20:41	10/27/16 20:41	TAS	EPA 300.0
Fluoride	0.443	mg/L		10/25/16 17:32	10/25/16 17:32	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 17:32	10/25/16 17:32	TAS	EPA 300.0
Sulfate	55	mg/L		10/25/16 17:50	10/25/16 17:50	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.22	pH Units		10/24/16 15:30	10/24/16 15:30	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	80	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	190	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:14	JMW	SW 6020
Arsenic	1.8	ug/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020
Barium	54	ug/L		10/26/16 13:38	11/01/16 14:58	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020
Boron	270	ug/L		10/26/16 13:38	11/03/16 08:24	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020
Calcium	23	mg/L		10/26/16 13:38	11/02/16 13:14	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 14:58	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:14	JMW	SW 6020
Lithium	< 10	ug/L		10/26/16 13:38	10/27/16 12:12	KJP	SW 6010*
Magnesium	12	mg/L		10/26/16 13:38	11/01/16 14:58	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 14:58	JMW	SW 6020
Molybdenum	5.0	ug/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020
Potassium	7.4	mg/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020
Sodium	19	mg/L		10/26/16 13:38	11/02/16 13:14	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:30	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-14**
Name: CLb
Matrix: Surface Water - Grab

Sampled: 10/24/16 13:35
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	22	mg/L		10/27/16 20:58	10/27/16 20:58	TAS	EPA 300.0
Fluoride	0.425	mg/L		10/25/16 18:08	10/25/16 18:08	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 18:08	10/25/16 18:08	TAS	EPA 300.0
Sulfate	56	mg/L		10/25/16 18:26	10/25/16 18:26	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.52	pH Units		10/24/16 13:35	10/24/16 13:35	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	80	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	180	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:17	JMW	SW 6020
Arsenic	1.8	ug/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020
Barium	52	ug/L		10/26/16 13:38	11/01/16 15:02	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020
Boron	280	ug/L		10/26/16 13:38	11/03/16 08:26	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020
Calcium	23	mg/L		10/26/16 13:38	11/02/16 13:17	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 15:02	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:17	JMW	SW 6020
Lithium	< 10	ug/L		10/26/16 13:38	10/27/16 12:15	KJP	SW 6010*
Magnesium	11	mg/L		10/26/16 13:38	11/01/16 15:02	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 15:02	JMW	SW 6020
Molybdenum	4.9	ug/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020
Potassium	7.8	mg/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020
Sodium	19	mg/L		10/26/16 13:38	11/02/16 13:17	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:34	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-15**
Name: CLc
Matrix: Surface Water - Grab

Sampled: 10/24/16 13:15
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	22	mg/L		10/27/16 21:16	10/27/16 21:16	TAS	EPA 300.0
Fluoride	0.426	mg/L		10/25/16 18:43	10/25/16 18:43	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 18:43	10/25/16 18:43	TAS	EPA 300.0
Sulfate	54	mg/L		10/25/16 19:01	10/25/16 19:01	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.62	pH Units		10/24/16 13:15	10/24/16 13:15	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	75	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	160	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:29	JMW	SW 6020
Arsenic	1.8	ug/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020
Barium	56	ug/L		10/26/16 13:38	11/01/16 15:05	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020
Boron	280	ug/L		10/26/16 13:38	11/03/16 08:27	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020
Calcium	23	mg/L		10/26/16 13:38	11/02/16 13:29	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 15:05	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:29	JMW	SW 6020
Lithium	< 10	ug/L		10/26/16 13:38	10/27/16 12:24	KJP	SW 6010*
Magnesium	12	mg/L		10/26/16 13:38	11/01/16 15:05	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 15:05	JMW	SW 6020
Molybdenum	4.7	ug/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020
Potassium	7.4	mg/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020
Sodium	19	mg/L		10/26/16 13:38	11/02/16 13:29	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:38	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-16**
Name: CLd
Matrix: Surface Water - Grab

Sampled: 10/24/16 15:55
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	23	mg/L		10/27/16 21:34	10/27/16 21:34	TAS	EPA 300.0
Fluoride	0.421	mg/L		10/25/16 19:55	10/25/16 19:55	TAS	EPA 300.0
Nitrite-N	< 0.15	mg/L		10/25/16 19:55	10/25/16 19:55	TAS	EPA 300.0
Sulfate	54	mg/L		10/25/16 20:13	10/25/16 20:13	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.30	pH Units		10/24/16 15:55	10/24/16 15:55	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	80	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Solids - total dissolved solids (TDS)	170	mg/L		10/25/16 14:59	10/25/16 15:33	DMB/ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:32	JMW	SW 6020
Arsenic	1.8	ug/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020
Barium	54	ug/L		10/26/16 13:38	11/01/16 15:09	JMW	SW 6020
Beryllium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020
Boron	270	ug/L		10/26/16 13:38	11/03/16 08:41	JMW	SW 6020
Cadmium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020
Calcium	23	mg/L		10/26/16 13:38	11/02/16 13:32	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 15:09	JMW	SW 6020
Cobalt	< 2.0	ug/L		10/26/16 13:38	11/02/16 13:32	JMW	SW 6020
Lithium	< 10	ug/L		10/26/16 13:38	10/27/16 12:27	KJP	SW 6010*
Magnesium	12	mg/L		10/26/16 13:38	11/01/16 15:09	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 13:38	11/01/16 15:09	JMW	SW 6020
Molybdenum	4.8	ug/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020
Potassium	7.5	mg/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020
Selenium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020
Sodium	20	mg/L		10/26/16 13:38	11/02/16 13:32	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 12:41	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-17**
Name: GPa
Matrix: Surface Water - Grab

Sampled: 10/24/16 14:00
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1900	mg/L		10/27/16 21:51	10/27/16 21:51	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 11:42	10/26/16 11:42	TAS	EPA 300.0
Sulfate	17000	mg/L		11/01/16 09:58	11/01/16 09:58	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	7.16	pH Units		10/24/16 14:00	10/24/16 14:00	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	4.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	42.7	mg/L		10/27/16 17:31	10/27/16 17:31	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	17000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:36	JMW	SW 6020
Arsenic	4.7	ug/L		10/26/16 13:38	11/02/16 15:00	JMW	SW 6020
Barium	120	ug/L		10/26/16 13:38	11/02/16 13:36	JMW	SW 6020
Beryllium	2.6	ug/L		10/26/16 13:38	11/02/16 14:16	JMW	SW 6020
Boron	59000	ug/L		10/26/16 13:38	11/03/16 08:44	JMW	SW 6020
Cadmium	40	ug/L		10/26/16 13:38	11/02/16 15:53	JMW	SW 6020
Calcium	450	mg/L		10/26/16 13:38	11/02/16 14:16	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 15:20	JMW	SW 6020
Cobalt	52	ug/L		10/26/16 13:38	11/02/16 15:00	JMW	SW 6020
Lithium	300	ug/L		10/26/16 13:38	10/27/16 12:30	KJP	SW 6010*
Magnesium	1500	mg/L		10/26/16 13:38	11/02/16 14:16	JMW	SW 6020
Mercury	< 0.80	ug/L		10/26/16 13:38	11/02/16 15:00	JMW	SW 6020
Molybdenum	130	ug/L		10/26/16 13:38	11/02/16 14:16	JMW	SW 6020
Potassium	210	mg/L		10/26/16 13:38	11/03/16 09:03	JMW	SW 6020
Selenium	890	ug/L		10/26/16 13:38	11/02/16 15:00	JMW	SW 6020
Sodium	620	mg/L		10/26/16 13:38	11/02/16 13:36	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 15:20	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-18**
Name: GPb
Matrix: Surface Water - Grab

Sampled: 10/24/16 14:10
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	2600	mg/L		10/27/16 22:26	10/27/16 22:26	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 12:00	10/26/16 12:00	TAS	EPA 300.0
Sulfate	27000	mg/L		10/28/16 14:39	10/28/16 14:39	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.65	pH Units		10/24/16 14:10	10/24/16 14:10	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	10	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	69.4	mg/L		10/27/16 15:56	10/27/16 15:56	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	28000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	8.6	ug/L		10/26/16 13:38	11/02/16 14:20	JMW	SW 6020
Arsenic	92	ug/L		10/26/16 13:38	11/02/16 15:03	JMW	SW 6020
Barium	1100	ug/L		10/26/16 13:38	11/02/16 14:20	JMW	SW 6020
Beryllium	< 20	ug/L		10/26/16 13:38	11/02/16 14:34	JMW	SW 6020
Boron	97000	ug/L		10/26/16 13:38	11/03/16 08:45	JMW	SW 6020
Cadmium	67	ug/L		10/26/16 13:38	11/02/16 15:55	JMW	SW 6020
Calcium	1400	mg/L		10/26/16 13:38	11/02/16 14:34	JMW	SW 6020
Chromium	150	ug/L		10/26/16 13:38	11/02/16 15:03	JMW	SW 6020
Cobalt	110	ug/L		10/26/16 13:38	11/02/16 15:03	JMW	SW 6020
Lithium	480	ug/L		10/26/16 13:38	10/27/16 12:33	KJP	SW 6010*
Magnesium	2500	mg/L		10/26/16 13:38	11/02/16 14:34	JMW	SW 6020
Mercury	27	ug/L		10/26/16 13:38	11/02/16 15:03	JMW	SW 6020
Molybdenum	140	ug/L		10/26/16 13:38	11/02/16 15:03	JMW	SW 6020
Potassium	360	mg/L		10/26/16 13:38	11/03/16 08:45	JMW	SW 6020
Selenium	1500	ug/L		10/26/16 13:38	11/02/16 15:03	JMW	SW 6020
Sodium	1000	mg/L		10/26/16 13:38	11/02/16 14:34	JMW	SW 6020
Thallium	< 4.0	ug/L		10/26/16 13:38	11/07/16 15:07	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-19**
Name: GPc
Matrix: Surface Water - Grab

Sampled: 10/24/16 14:20
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1800	mg/L		10/28/16 01:58	10/28/16 01:58	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 12:18	10/26/16 12:18	TAS	EPA 300.0
Sulfate	20000	mg/L		10/28/16 02:16	10/28/16 02:16	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.73	pH Units		10/24/16 14:20	10/24/16 14:20	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	5.5	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	49.2	mg/L		10/27/16 17:35	10/27/16 17:35	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	17000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 6.0	ug/L		10/26/16 13:38	11/02/16 14:23	JMW	SW 6020
Arsenic	4.4	ug/L		10/26/16 13:38	11/02/16 15:07	JMW	SW 6020
Barium	110	ug/L		10/26/16 13:38	11/02/16 13:43	JMW	SW 6020
Beryllium	2.6	ug/L		10/26/16 13:38	11/02/16 14:23	JMW	SW 6020
Boron	72000	ug/L		10/26/16 13:38	11/03/16 08:46	JMW	SW 6020
Cadmium	41	ug/L		10/26/16 13:38	11/02/16 15:56	JMW	SW 6020
Calcium	570	mg/L		10/26/16 13:38	11/02/16 14:38	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 15:27	JMW	SW 6020
Cobalt	54	ug/L		10/26/16 13:38	11/02/16 15:07	JMW	SW 6020
Lithium	300	ug/L		10/26/16 13:38	10/27/16 12:36	KJP	SW 6010*
Magnesium	1500	mg/L		10/26/16 13:38	11/02/16 14:23	JMW	SW 6020
Mercury	< 0.80	ug/L		10/26/16 13:38	11/02/16 15:07	JMW	SW 6020
Molybdenum	120	ug/L		10/26/16 13:38	11/02/16 14:23	JMW	SW 6020
Potassium	260	mg/L		10/26/16 13:38	11/03/16 08:46	JMW	SW 6020
Selenium	890	ug/L		10/26/16 13:38	11/02/16 15:07	JMW	SW 6020
Sodium	650	mg/L		10/26/16 13:38	11/02/16 13:43	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 15:27	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-20**
Name: GPd
Matrix: Surface Water - Grab

Sampled: 10/24/16 14:30
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1900	mg/L		10/28/16 03:09	10/28/16 03:09	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 12:36	10/26/16 12:36	TAS	EPA 300.0
Sulfate	19000	mg/L		10/28/16 03:26	10/28/16 03:26	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.73	pH Units		10/24/16 14:30	10/24/16 14:30	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	6.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	51.3	mg/L		10/27/16 17:39	10/27/16 17:39	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	16000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 13:38	11/02/16 13:47	JMW	SW 6020
Arsenic	4.2	ug/L		10/26/16 13:38	11/02/16 15:10	JMW	SW 6020
Barium	110	ug/L		10/26/16 13:38	11/02/16 13:47	JMW	SW 6020
Beryllium	< 20	ug/L		10/26/16 13:38	11/02/16 14:41	JMW	SW 6020
Boron	66000	ug/L		10/26/16 13:38	11/03/16 08:48	JMW	SW 6020
Cadmium	38	ug/L		10/26/16 13:38	11/02/16 15:57	JMW	SW 6020
Calcium	560	mg/L		10/26/16 13:38	11/02/16 14:41	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 13:38	11/01/16 15:31	JMW	SW 6020
Cobalt	52	ug/L		10/26/16 13:38	11/02/16 15:10	JMW	SW 6020
Lithium	300	ug/L		10/26/16 13:38	10/27/16 12:39	KJP	SW 6010*
Magnesium	1500	mg/L		10/26/16 13:38	11/02/16 14:27	JMW	SW 6020
Mercury	< 0.80	ug/L		10/26/16 13:38	11/02/16 15:10	JMW	SW 6020
Molybdenum	120	ug/L		10/26/16 13:38	11/02/16 14:27	JMW	SW 6020
Potassium	230	mg/L		10/26/16 13:38	11/03/16 08:48	JMW	SW 6020
Selenium	800	ug/L		10/26/16 13:38	11/01/16 15:31	JMW	SW 6020
Sodium	660	mg/L		10/26/16 13:38	11/02/16 13:47	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 13:38	11/01/16 15:31	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-21**
Name: RPb
Matrix: Surface Water - Grab

Sampled: 10/24/16 14:50
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1800	mg/L		10/28/16 03:44	10/28/16 03:44	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 12:53	10/26/16 12:53	TAS	EPA 300.0
Sulfate	18000	mg/L		10/28/16 04:01	10/28/16 04:01	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.49	pH Units		10/24/16 14:50	10/24/16 14:50	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	44.4	mg/L		10/27/16 17:44	10/27/16 17:44	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	16000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 11:03	11/01/16 09:42	JMW	SW 6020
Arsenic	2.8	ug/L		10/26/16 11:03	11/02/16 11:16	JMW	SW 6020
Barium	90	ug/L		10/26/16 11:03	11/01/16 09:42	JMW	SW 6020
Beryllium	2.1	ug/L		10/26/16 11:03	11/01/16 10:30	JMW	SW 6020
Boron	56000	ug/L		10/26/16 11:03	11/02/16 16:34	JMW	SW 6020
Cadmium	33	ug/L		10/26/16 11:03	11/02/16 11:32	JMW	SW 6020
Calcium	380	mg/L		10/26/16 11:03	11/01/16 10:30	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 11:03	11/01/16 09:42	JMW	SW 6020
Cobalt	45	ug/L		10/26/16 11:03	11/01/16 09:42	JMW	SW 6020
Lithium	310	ug/L		10/26/16 11:03	10/27/16 11:01	KJP	SW 6010*
Magnesium	1200	mg/L		10/26/16 11:03	11/01/16 10:30	JMW	SW 6020
Mercury	< 0.40	ug/L		10/26/16 11:03	11/02/16 11:16	JMW	SW 6020
Molybdenum	64	ug/L		10/26/16 11:03	11/01/16 10:30	JMW	SW 6020
Potassium	210	mg/L		10/26/16 11:03	11/02/16 11:32	JMW	SW 6020
Selenium	780	ug/L		10/26/16 11:03	11/02/16 11:16	JMW	SW 6020
Sodium	470	mg/L		10/26/16 11:03	11/01/16 09:42	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 11:03	11/01/16 09:42	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-22**
Name: RPc
Matrix: Surface Water - Grab

Sampled: 10/24/16 15:00
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	2000	mg/L		10/28/16 04:19	10/28/16 04:19	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 14:05	10/26/16 14:05	TAS	EPA 300.0
Sulfate	20000	mg/L		10/28/16 04:37	10/28/16 04:37	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.32	pH Units		10/24/16 15:00	10/24/16 15:00	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	45.0	mg/L		10/27/16 17:48	10/27/16 17:48	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	16000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 11:03	11/01/16 09:46	JMW	SW 6020
Arsenic	3.1	ug/L		10/26/16 11:03	11/02/16 11:20	JMW	SW 6020
Barium	88	ug/L		10/26/16 11:03	11/01/16 09:46	JMW	SW 6020
Beryllium	2.2	ug/L		10/26/16 11:03	11/01/16 10:34	JMW	SW 6020
Boron	59000	ug/L		10/26/16 11:03	11/02/16 16:36	JMW	SW 6020
Cadmium	37	ug/L		10/26/16 11:03	11/02/16 11:36	JMW	SW 6020
Calcium	380	mg/L		10/26/16 11:03	11/01/16 10:34	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 11:03	11/01/16 09:46	JMW	SW 6020
Cobalt	43	ug/L		10/26/16 11:03	11/01/16 09:46	JMW	SW 6020
Lithium	310	ug/L		10/26/16 11:03	10/27/16 11:04	KJP	SW 6010*
Magnesium	1200	mg/L		10/26/16 11:03	11/01/16 10:34	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 11:03	11/02/16 10:36	JMW	SW 6020
Molybdenum	64	ug/L		10/26/16 11:03	11/01/16 10:34	JMW	SW 6020
Potassium	200	mg/L		10/26/16 11:03	11/02/16 11:36	JMW	SW 6020
Selenium	830	ug/L		10/26/16 11:03	11/02/16 11:20	JMW	SW 6020
Sodium	440	mg/L		10/26/16 11:03	11/01/16 09:46	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 11:03	11/01/16 09:46	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: 6103663-23
Name: RPd
Matrix: Surface Water - Grab

Sampled: 10/24/16 15:05
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1600	mg/L		10/28/16 04:25	10/28/16 04:25	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 14:23	10/26/16 14:23	TAS	EPA 300.0
Sulfate	16000	mg/L		10/28/16 04:43	10/28/16 04:43	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.32	pH Units		10/24/16 15:05	10/24/16 15:05	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	51.2	mg/L		10/27/16 17:53	10/27/16 17:53	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	17000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 11:03	11/01/16 09:49	JMW	SW 6020
Arsenic	3.4	ug/L		10/26/16 11:03	11/02/16 11:23	JMW	SW 6020
Barium	89	ug/L		10/26/16 11:03	11/01/16 09:49	JMW	SW 6020
Beryllium	2.4	ug/L		10/26/16 11:03	11/01/16 10:37	JMW	SW 6020
Boron	59000	ug/L		10/26/16 11:03	11/02/16 16:37	JMW	SW 6020
Cadmium	36	ug/L		10/26/16 11:03	11/02/16 11:40	JMW	SW 6020
Calcium	400	mg/L		10/26/16 11:03	11/01/16 10:37	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 11:03	11/01/16 09:49	JMW	SW 6020
Cobalt	45	ug/L		10/26/16 11:03	11/01/16 09:49	JMW	SW 6020
Lithium	310	ug/L		10/26/16 11:03	10/27/16 11:13	KJP	SW 6010*
Magnesium	1300	mg/L		10/26/16 11:03	11/01/16 10:37	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 11:03	11/02/16 10:39	JMW	SW 6020
Molybdenum	66	ug/L		10/26/16 11:03	11/01/16 10:37	JMW	SW 6020
Potassium	200	mg/L		10/26/16 11:03	11/02/16 11:40	JMW	SW 6020
Selenium	860	ug/L		10/26/16 11:03	11/02/16 11:23	JMW	SW 6020
Sodium	460	mg/L		10/26/16 11:03	11/01/16 09:49	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 11:03	11/01/16 09:49	JMW	SW 6020

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ANALYTICAL RESULTS

Sample: **6103663-24**
Name: RPa
Matrix: Surface Water - Grab

Sampled: 10/24/16 14:40
Received: 10/25/16 07:45

Parameter	Result	Unit	Qualifier	Prepared	Analyzed	Analyst	Method
Anions - PIA							
Chloride	1600	mg/L		10/28/16 05:02	10/28/16 05:02	TAS	EPA 300.0
Nitrite-N	< 3.0	mg/L		10/26/16 13:11	10/26/16 13:11	TAS	EPA 300.0
Sulfate	17000	mg/L		10/28/16 05:20	10/28/16 05:20	TAS	EPA 300.0
Field - PIA							
pH, Field Measured	6.70	pH Units		10/24/16 14:40	10/24/16 14:40	FIELD	Field*
General Chemistry - PIA							
Alkalinity - bicarbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Alkalinity - carbonate as CaCO3	< 2.0	mg/L		10/31/16 13:36	10/31/16 13:36	LAM	SM 2320B*
Fluoride	47.0	mg/L		10/27/16 15:52	10/27/16 15:52	TTH	SM 4500-F C
Solids - total dissolved solids (TDS)	16000	mg/L		10/27/16 12:04	10/27/16 12:28	ARL	SM 2540C
Total Metals - PIA							
Antimony	< 3.0	ug/L		10/26/16 11:03	11/01/16 09:53	JMW	SW 6020
Arsenic	3.3	ug/L		10/26/16 11:03	11/02/16 11:27	JMW	SW 6020
Barium	89	ug/L		10/26/16 11:03	11/01/16 09:53	JMW	SW 6020
Beryllium	2.3	ug/L		10/26/16 11:03	11/01/16 10:41	JMW	SW 6020
Boron	60000	ug/L		10/26/16 11:03	11/02/16 16:38	JMW	SW 6020
Cadmium	37	ug/L		10/26/16 11:03	11/02/16 11:43	JMW	SW 6020
Calcium	380	mg/L		10/26/16 11:03	11/01/16 10:41	JMW	SW 6020
Chromium	< 4.0	ug/L		10/26/16 11:03	11/01/16 09:53	JMW	SW 6020
Cobalt	44	ug/L		10/26/16 11:03	11/01/16 09:53	JMW	SW 6020
Lithium	310	ug/L		10/26/16 11:03	10/27/16 11:16	KJP	SW 6010*
Magnesium	1200	mg/L		10/26/16 11:03	11/01/16 10:41	JMW	SW 6020
Mercury	< 0.20	ug/L		10/26/16 11:03	11/02/16 10:43	JMW	SW 6020
Molybdenum	63	ug/L		10/26/16 11:03	11/01/16 10:41	JMW	SW 6020
Potassium	190	mg/L		10/26/16 11:03	11/02/16 11:43	JMW	SW 6020
Selenium	840	ug/L		10/26/16 11:03	11/02/16 11:27	JMW	SW 6020
Sodium	450	mg/L		10/26/16 11:03	11/01/16 09:53	JMW	SW 6020
Thallium	< 1.0	ug/L		10/26/16 11:03	11/01/16 09:53	JMW	SW 6020

PDC Laboratories, Inc.
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Peoria, IL 61615
(800) 752-6651

NOTES

Specific method revisions used for analysis are available upon request.

Certifications

PIA - Peoria, IL
- TNI Accreditation for Drinking Water, Wastewater, Hazardous and Solid Wastes Fields of Testing through IL EPA Lab No. 100230
- Illinois Department of Public Health Bacteriological Analysis in Drinking Water Approved Laboratory Registry No. 17553
- Missouri Department of Natural Resources Certificate of Approval for Microbiological Laboratory Service No. 870
- Drinking Water Certifications: Iowa (240); Kansas (E-10338); Missouri (870)
- Wastewater Certifications: Arkansas (88-0677); Iowa (240); Kansas (E-10338)
- Hazardous/Solid Waste Certifications: Arkansas (88-0677); Iowa (240); Kansas (E-10338)

SPMO - Springfield, MO
- USEPA DMR-QA Program

STL - St. Louis, MO
- TNI Accreditation for Wastewater, Hazardous and Solid Wastes Fields of Testing through KS Lab No. E-10389
- Illinois Department of Public Health Bacteriological Analysis in Drinking Water Approved Laboratory Registry No. 171050
- Drinking Water Certifications: Missouri (1050)
- Missouri Department of Natural Resources

* Not a TNI accredited analyte

Gail J Schindler

Certified by: Gail Schindler, Project Manager

PDC LABORATORIES, INC.
2231 WEST ALTORFER DRIVE
PEORIA, IL 61615
PHONE # 309-692-9688
FAX # 309-692-9689

CHAIN OF CUSTODY RECORD

6DS 10-26-16

ALL SHADED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

(1) CLIENT: Hanson Professional Services COFFEEN ENERGY CENTER
PROJECT NUMBER:
P.O. NUMBER:
MEANS SHIPPED:
ADDRESS: 134 CIPS LANE
PHONE NUMBER:
FAX NUMBER:
DATE SHIPPED:
CITY STATE ZIP: COFFEEN IL 62017
SAMPLER (PLEASE PRINT): R. ZINSER
CONTACT PERSON: JOHN ROMANG
SAMPLER'S SIGNATURE:

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- SOLID
OTHER: _____

(3) ANALYSIS REQUESTED 6DS 10-26-16

(FOR LAB USE ONLY)
LOGIN # 6103663-24
LOGGED BY: KDM

NATURAL RESOURCE TECHNOLOGY
COFFEEN POND LAKE
GAIL J SCHINDLER

Custom list

(2) SAMPLE DESCRIPTION	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	TOTAL # OF CONT	SB,AS,BA,BE,ALKHCO3	B,CD,CA,ALK CO3, CL	CR,CR+6,CO,CU,ON,F	PE,PB,LI,MG,MN,HG,MO	NI,GRO,PHENOL,P,SE,	AG,NA,SO4,TL,TDS,ZN	TSS,NO2,NO3,NH3,TKN	REMARKS
AP1 a	10/24/16	11:52	X		SW	7	per chain							pH 6.99
AP1 b	10/24/16	11:56	X		SW	7		RUSH						pH 7.01
AP1 c	10/24/16	12:10	X		SW	7								pH 7.05
AP1 d	10/24/16	12:15	X		SW	7								pH 7.21
AP1 e	10/24/16	12:01	X		SW	7								pH 7.12
AP1 f	10/24/16	12:40	X		SW	7								pH 7.20
AP1 g	10/24/16	12:50	X		SW	7								pH 7.21
AP1 h	10/24/16	12:55	X		SW	7								pH 7.41
AP2 e	10/24/16	11:30	X		SW	7								pH 6.49
AP2 f	10/24/16	11:20	X		SW	7								pH 6.42
AP2 g	10/24/16	11:10	X		SW	7								pH 6.46

(5) TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
X(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) FAX PHONE
FAX # IF DIFFERENT FROM ABOVE:
PHONE # IF DIFFERENT FROM ABOVE:

(6) *The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature.*

(7) RELINQUISHED BY: (SIGNATURE) DATE 10/25/16 TIME 7:45
RECEIVED BY: (SIGNATURE) DATE TIME
RELINQUISHED BY: (SIGNATURE) DATE TIME
RECEIVED AT LAB BY: (SIGNATURE) DATE 10/25/16 TIME 7:45

(8) COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 6 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED TO APPROX. THE NECK Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) Y OR N

PDC LABORATORIES, INC.
2231 WEST ALTORFER DRIVE
PEORIA, IL 61615

PHONE # 309-692-9688
FAX # 309-692-9689

CHAIN OF CUSTODY RECORD

GJS 10-26-16

ALL SHADED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

(1) CLIENT: Hanson Professional Services
COFFEEN ENERGY CENTER

ADDRESS: 134 CIPS LANE

CITY / STATE / ZIP: COFFEEN IL 62017

CONTACT PERSON: JOHN ROMANG

PROJECT NUMBER | P.O. NUMBER | MEANS SHIPPED

PHONE NUMBER | FAX NUMBER | DATE SHIPPED

SAMPLER (PLEASE PRINT): R. ZINSER

SAMPLER'S SIGNATURE: [signature]

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- SOLID
OTHER: _____

(3) ANALYSIS REQUESTED: GJS 10-26-16

(FOR LAB USE ONLY)
LOGIN # _____
LOGGED BY: _____

NATURAL RESOURCE TECHNOLOGY
COFFEEN POND LAKE
GAIL J SCHINDLER

(2)

SAMPLE DESCRIPTION	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	TOTAL # OF CONT	SB,AS,BA,BE,ALKHCO3	B,CD,CA,ALK CO3, CL	CR,CR+6,CO,CU,CN,F	FE,PB,LI,MG,MN,HG,MO	NI,GEO,PHENOL,P,SE,	AG,NA,SO4,TL,TDS,ZN	TSS,NO2,NO3,NH3,TKN	REMARKS
AP2 h	10/24/16	11:40	X		SW	7	/	/	/	/	/	/	/	pH 7.17
CL a	10/24/16	15:30	X		SW	7	/	/	/	/	/	/	/	pH 7.22
CL b	10/24/16	13:35	X		SW	7	/	/	/	/	/	/	/	pH 7.52
CL c	10/24/16	13:15	X		SW	7	/	/	/	/	/	/	/	pH 7.62
CL d	10/24/16	15:55	X		SW	7	/	/	/	/	/	/	/	pH 7.30
GP a	10/24/16	14:00	X		SW	7	/	/	/	/	/	/	/	pH 7.16
GP b	10/24/16	14:10	X		SW	7	/	/	/	/	/	/	/	pH 6.65
GP c	10/24/16	14:20	X		SW	7	/	/	/	/	/	/	/	pH 6.73
GP d	10/24/16	14:30	X		SW	7	/	/	/	/	/	/	/	pH 6.73
RP b	10/24/16	14:50	X		SW	7	/	/	/	/	/	/	/	pH 6.49
RP c	10/24/16	15:00	X		SW	7	/	/	/	/	/	/	/	pH 6.32

(5) TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
X(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) FAX PHONE
FAX # IF DIFFERENT FROM ABOVE: PHONE # IF DIFFERENT FROM ABOVE:

(6) *The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature.*

(7) RELINQUISHED BY: (SIGNATURE) [signature] DATE 10/25/16 TIME 7:45
RECEIVED BY: (SIGNATURE) DATE TIME

RELINQUISHED BY: (SIGNATURE) DATE TIME
RECEIVED AT LAB BY: (SIGNATURE) [signature] DATE 10/25/16 TIME 745

(8) COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 6 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED TO APPROX. THE NECK Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) Y OR N

PDC LABORATORIES, INC.
2231 WEST ALTORFER DRIVE
PEORIA, IL 61615

PHONE # 309-692-9688
FAX # 309-692-9689

CHAIN OF CUSTODY RECORD

GJS 10-26-16

ALL SHADED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

(1) CLIENT: Hanson Professional Services
COFFEEN ENERGY CENTER

ADDRESS: 134 CIPS LANE

CITY / STATE / ZIP: COFFEEN IL 62017

CONTACT PERSON: JOHN ROMANG

PROJECT NUMBER | P.O. NUMBER | MEANS SHIPPED

PHONE NUMBER | FAX NUMBER | DATE SHIPPED

SAMPLER (PLEASE PRINT): R. ZINSER

SAMPLER'S SIGNATURE: [signature]

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- SOLID
OTHER: _____

(3) ANALYSIS REQUESTED: GJS 10-26-16

(FOR LAB USE ONLY)
LOGIN # _____
LOGGED BY: _____

NATURAL RESOURCE TECHNOLOGY
COFFEEN POND LAKE
GAIL J SCHINDLER

(2)

SAMPLE DESCRIPTION	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	TOTAL # OF CONT	SB,AS,BA,BE,ALKHCO3	B,CD,CA,ALK CO3, CL	CR,CR+6,CO,CU,CN,F	FE,PB,LI,MG,MN,HG,MO	NI,GRO,PHENOL,P,SE,	AG,NA,SO4,TL,TDS,ZN	TSS,NO2,NO3,NH3,TKN	REMARKS
RPd	10/24/16	15:05	X		SW	7	/	/	/	/	/	/	/	pH 6.32
RPa	10/24/16	14:40	X		SW	7	/	/	/	/	/	/	/	pH 6.70

(5) TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
X(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) FAX PHONE
FAX # IF DIFFERENT FROM ABOVE:
PHONE # IF DIFFERENT FROM ABOVE:

(6) *The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature.*

(7) RELINQUISHED BY: (SIGNATURE) [signature] DATE 10/25/16 TIME 7:45
RECEIVED BY: (SIGNATURE) DATE TIME

RELINQUISHED BY: (SIGNATURE) DATE TIME
RECEIVED AT LAB BY: (SIGNATURE) [signature] DATE 10/25/16 TIME 7:45

(8) COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 6 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED TO APPROX. THE NECK Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) Y OR N

Chain of Custody Parameters (as totals)

Antimony
Arsenic
Barium
Beryllium
Bicarbonate Alkalinity
Boron
Cadmium
Calcium
Carbonate Alkalinity
Chloride
Chromium
Cobalt
Fluoride
Lithium
Magnesium
Mercury
Molybdenum
Nitrite
pH
Potassium
Selenium
Sodium
Sulfate
Thallium
Total Dissolved Solids (TDS)

APPENDIX D
Geochemical Conceptual Site Model

Geosyntec consultants

engineers | scientists | innovators

Geochemical Conceptual Site Model

Coffeen Power Plant –Ash Pond No. 1

(CCR Unit #101)

Prepared for

Illinois Power Generating Company
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by

Geosyntec Consultants, Inc.
134 N. Lasalle Street, Suite 300
Chicago, Illinois 60602

Project Number: GLP8078

June 2024

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ACRONYMS AND ABBREVIATIONS

AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
bgs	below ground surface
CEC	cation exchange capacity
CCR	coal combustion residuals
COCs	constituents of concern
CPP	Coffeen Power Plant
DA	deep aquifer
DCU	deep confining unit
GCSM	geochemical conceptual site model
GWPS	groundwater protection standards
HSU	hydrostratigraphic unit
I.A.C.	Illinois Administrative Code
LCU	lower confining unit
LOI	loss on ignition
meq/100 g	milliequivalents per 100 grams
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
N&E	nature and extent
ORP	oxidation-reduction potential
PMP	potential migration pathway
SEP	sequential extraction procedure
SU	standard units
TDS	total dissolved solids
TOC	total organic carbon
UA	uppermost aquifer
UCU	upper confining unit
XRD	X-Ray diffraction
XRF	X-Ray fluorescence

1. EXECUTIVE SUMMARY

A geochemical conceptual site model (GCSM) has been developed to describe subsurface conditions at the Coffeen Power Plant Ash Pond No. 1 (AP1) coal combustion residuals unit (Unit #101). A GCSM describes the geochemical processes that contribute to the mobilization, distribution, and attenuation of constituents of concern (COCs) in the subsurface environment. This report describes the GCSM for parameters that have exceeded the GWPS in AP1 groundwater and which will be addressed in the corrective action plan. The exceedances detected at AP1 were boron, sulfate, and total dissolved solids (TDS). Exceedances of COCs are present in three hydrostratigraphic units at the Site: the uppermost aquifer (UA), comprised predominantly of sandy to gravelly silts with thin sand beds, the lower confining unit (LCU), comprised of primarily of sandy to silty till, with discontinuous sand lenses that have been identified as potential migration pathways, and a deep aquifer (DA), comprised of predominantly sand and sandy silt/clay that is discontinuous beneath AP1.

Coal combustion residual (CCR) materials are the primary source of constituent loading to the CCR contact water (i.e., CCR porewater or source water). Over an extended period (e.g., months to years), the CCR porewater (i.e., water contained within the interstitial pore spaces of the CCR that can be sampled by low-flow groundwater sampling methods) reaches equilibrium with the CCR materials. The porewater is therefore representative of the mobile phase constituents capable of migrating into the underlying materials and potentially downgradient in groundwater. The AP1 CCR contact water is therefore the primary indicator of boron and sulfate available to the groundwater and is considered as the primary source term for environmental investigation and fate and transport modeling. AP1 appears to be the primary source of boron and sulfate to downgradient groundwater. However, the poor correlation between boron and sulfate in groundwater and higher concentrations of sulfate in the LCU and DA than in AP1 indicate the potential for a secondary source of sulfate. TDS is a measure of inorganic and organic substances in solution. TDS trends are generally consistent with those of sulfate in the AP1 groundwater system.

Conditions within UA, LCU, and DA groundwater are predicted to favor amorphous iron oxide stability at some locations, and the presence of iron oxides in some site solids indicates a portion of the boron and sulfate in the groundwater system might be attenuated via surface complexation reactions. Boron may be further attenuated via interactions with clay minerals, which are present in solids across the UA, LCU, and DA. Attenuation of the constituents contributing to TDS, such as sulfate, will reduce TDS concentrations as well. Batch attenuation testing with solids from the Site indicate that chemical attenuation of boron is possible, while chemical attenuation of sulfate is expected to be limited.

2. INTRODUCTION

This report documents the development of a geochemical conceptual site model (GCSM) to describe subsurface conditions at the Coffeen Power Plant (CPP) Ash Pond No. 1 (AP1) coal combustion residuals (CCR) unit (Unit #101). A GCSM describes the environmental media and geochemical processes that contribute to the mobilization, distribution, and attenuation of constituents of concern (COCs) in the environment. The GCSM was prepared in support of an evaluation of the nature and extent of exceedances of COCs above the groundwater protection standards (GWPS) at AP1. The document has been prepared as an appendix to the CPP AP1 Nature and Extent (N&E) Report prepared by Ramboll Americas Engineering Solutions. Inc. (Ramboll).

Constituents with statistical exceedances above the GWPS at Coffeen AP1 for the second, third, and fourth quarters of 2023 (Q2 2023, Q3, 2023, and Q4 2023) monitoring events completed under Title 35 of the Illinois Administrative Code (35 I.A.C.) § Section 845.630 are boron, sulfate and total dissolved solids (TDS). For the 2023 events discussed above, an exceedance of boron was detected at compliance monitoring well G313; exceedances of sulfate were detected at G301, G303, G305, G307, G307D, G308, G310, G312, G313, G314, G314D, and G316; and exceedances of TDS were detected at G303, G305, G308, G310, G312, G313, G314, G314D, and G316. The boron exceedance is only present within the uppermost aquifer (UA), whereas sulfate and TDS exceedances were detected in the UA, lower confining unit (LCU), and deep aquifer (DA).

3. SITE BACKGROUND

3.1 Site Overview

An overview of Site characteristics and hydrogeology is presented in the CPP AP1 N&E Report. A Site layout figure is provided in Attachment A.[1] Briefly, the Coffeen AP1 impoundment is located to the south of the Ash Pond No. 2 (AP2) CCR unit (Unit #102). The CPP property is located approximately two miles south of the city of Coffeen, Illinois, and bordered by two lobes of Coffeen Lake to the west, east, and south, and by agricultural land to the north. AP1 is a 23-acre unlined surface impoundment that received bottom ash and other non-CCR waste streams prior to November 4, 2019, at which time sluicing of waste to AP1 ceased. Closure activities have not been initiated at AP1 to date.

A Hydrogeologic Site Characterization Report (Ramboll 2021a) has previously described the hydrostratigraphic units (HSUs) present in the vicinity of the CPP AP1, which consist of an Upper Confining Unit (UCU), UA, LCU, DA, and Deep Confining Unit (DCU). The UCU consists of the silt or clayey silt of the Loess Unit and the upper clayey portion of the Hagarstown Member. The UA is predominantly sandy to gravelly silts with thin sand beds, with lithology identified as the Hagarstown Member. The LCU, which contains the Vandalia Member, Mulberry Grove Member, and Smithboro Member, is comprised primarily of sandy to silty till, with discontinuous sand lenses that have been identified as potential migration pathways (PMPs). The DA is predominantly sand and sandy silt/clay units of the Yarmouth Soil and is discontinuous beneath the CPP.

Vertical gradients measured near the CPP indicate downward flow from the UA to the LCU and DA. Vertical gradients at the G307/G307D well nest, located south AP1, were consistently downward with an average vertical gradient of 0.13 feet per foot; vertical gradients at the G311/G311D well nest were consistently strongly downward with an average vertical gradient of 0.71 feet per foot (CPP GMF RP N&E Report). Both the DA and the LCU have been identified as PMPs due to the presence of these downward gradients.

3.2 Groundwater Monitoring Network

A groundwater monitoring network was proposed in accordance with 35 I.A.C. Section 845.630 to monitor groundwater quality which passes the waste boundary as part of the Operating Permit application to the Illinois Environmental Protection Agency for AP1. The proposed groundwater monitoring network is described in the Groundwater Monitoring Plan (Ramboll 2021b) and shown in Attachment B.[2] Well construction information is provided in Attachment C.[3]

Overall groundwater flow within the UA is divided towards the two lobes of Coffeen Lake. The groundwater divide runs approximately through the center of the CPP, with groundwater east of

[1] This figure is also provided as Figure 2-1 of the CPP AP1 N&E Report.
[2] This figure is also provided as Figure 2-2 of the CPP AP1 N&E Report.
[3] This table is also provided as Table 3-1 of the CPP AP1 N&E Report

the divide flowing east to southeast towards the Unnamed Tributary or the eastern lobe of Coffeen Lake and groundwater west of the divide flowing west to southwest towards the western lobe of Coffeen Lake. Groundwater flows north to northeast across AP1 toward the former discharge flume and Unnamed Tributary. Groundwater flow directions are generally consistent across seasons. A detailed discussion of the hydrology of the Site is presented in Section 2 of the CPP AP1 N&E Report.

4. GEOCHEMICAL SITE CONDITIONS

The general behavior of the COCs is discussed in Section 4.1. Summaries of Site solids and aqueous conditions within the relevant HSUs is provided in Section 4.2 and 4.3, respectively, with discussion of how groundwater both upgradient and downgradient of AP1 may interact with the Site solids to affect constituent behavior. This includes discussion of potential sorbing or precipitating phases and how the stability of those phases may be affected by variable groundwater pH and redox conditions.

4.1 Constituent Transport and Fate

Boron is primarily present in groundwater as boric acid ($H_3BO_3^o$) or borate ($B[OH]_4^-$) (Bolan et al. 2023). The speciation of boron depends on pH: at pH below 9.2 standard units (SU), H_3BO_3 is the dominant species (NCBI 2024). Boron is not subject to oxidation/reduction reactions (Lemarchand et al. 2015; Bolan et al. 2023). Boron primarily sorbs to positively charged sites on solid metal oxide phases, including iron and aluminum oxides (Goldberg and Glaubig 1985; Bolan et al. 2023). Boron sorbs most extensively to amorphous metal oxides between pH 7 SU and 8 SU (Goldberg and Glaubig, 1985). Boron can also sorbs to organic surfaces such as humic acids or coal under favorable conditions, most extensively between pH 8 and 10 SU (LeMarchand et al. 2015). Clay minerals have been correlated with boron sorption in soils (Goldberg 1997), with this sorption mechanism presenting an additional potential attenuation mechanism for boron under favorable geochemical conditions.

Sulfate is the primary form of oxidized sulfur (S(VI)) in the environment and is a divalent oxyanion at pH values greater than 2 SU (Stumm and Morgan 1996). Sulfate in groundwater may sorb onto positively charged sites on solid metal oxide phases, most commonly iron and manganese oxides (Brown et al. 1999). The extent and strength of sulfate sorption to metal oxide surfaces depends on pH, ionic strength, and oxide surface area available for sorption. Sulfate can also form insoluble complexes such as barite ($BaSO_4$) (NCBI 2024). Sulfate in groundwater may be reduced to elemental sulfur (S(0)) or sulfide (S(-II)) under sufficiently reducing conditions, a process governed by local microbial communities (Stumm and Morgan 1996). Generally, reduced sulfur is less mobile in groundwater than sulfate. Reduced sulfur readily precipitates as insoluble metal sulfides (Stumm and Morgan 1996).

TDS is a measure of the mass of dissolved material in water, rather than a specific chemical constituent. Individual constituent contributions to TDS depends on the concentration of that constituent. Typically, major ions (i.e., calcium, sodium, magnesium, potassium, chloride, sulfate, and carbonate species) represent the primary contributors to TDS. As such, TDS is often positively correlated with electrical conductivity and ionic strength (Rusydi 2018, Ghalib et al. 2020). TDS concentrations can be reduced by the removal from aqueous phases of the individual constituents that contribute to TDS.

4.2 Site Solids Characterization

Solid phase data was collected for the CCR source material within the AP1 unit during the installation of porewater monitoring locations XPW01 and XPW02 and analyzed to understand bulk geochemical characterization. Solids from HSUs across the CPP were characterized to determine the type and abundance of minerals present in the UA, LCU, and DA. Solids were characterized using a variety of analytical techniques to characterize their geochemical properties and to understand their effect on the geochemistry of the groundwater system.[4] The results of these analyses are presented in Tables 1 – 4. Solids were collected from six locations adjacent to the following existing wells in the AP1 monitoring network:

- G306, located upgradient of AP1 to the south and considered representative of background conditions, with solids collected within the UA.
- G307 and G307D, located upgradient of AP1 to the south, with solids collected within five intervals representing the UCU, UA, and LCU. Statistical exceedances of sulfate and TDS were determined at G307 during 2023.
- G311 and G311D, located downgradient of AP1 to the north, with solids collected within four intervals representing the UCU, UA, and LCU.
- G313, located downgradient of AP1 to the east, with solids collected within the UA. Statistical exceedances of sulfate and TDS were determined at G313 during 2023 and a statistical exceedance of boron above the GWPS was determined during the Q4 2023 statistical evaluation (Ramboll 2024).
- G314 and G314D, located downgradient of AP1 to the east, with solids collected within six intervals representing the UCU, UA, LCU, and DA. Statistical exceedances of sulfate and TDS were determined at G314 during the 2023 statistical evaluations.
- G316. Located downgradient of AP1 to the east, with solids collected within two intervals within the UA that were combined for analysis. Statistical exceedances of sulfate and TDS were determined at G316 during the 2023 statistical evaluations.

The monitoring well locations are shown on Attachment B. Boring logs for these locations are provided in Attachment D.

[4] Sequential extraction procedures are chemical extractions used to dissolve metals from specific solid-associated phases. While useful for solid phase characterization, reporting limits are often elevated for sulfate and boron and samples from the vicinity of CPP AP1 were not submitted for analysis via this technique.

Five additional locations across the site were analyzed as part of investigations at CPP AP2 but are representative of conditions within the same HSUs beneath AP1. These solids were collected adjacent to existing wells, specifically:

- G270, located upgradient of AP2 to the northwest. Solids were collected within the UA, and are considered representative of background conditions for AP2.
- G1001, located downgradient of AP2 to the east, with solids collected within the LCU.
- G401, located downgradient of AP2 to the south, with solids collected within the UA.
- G407, located side-gradient of AP2 to the west. Solids were collected within the UA.
- G410, located side-gradient of AP2 to the west, with solids collected within two intervals within the UA.

A map showing these monitoring well location and boring logs for these locations are provided in Attachment D.

4.2.1 Bulk Characterization: Organic Carbon, Loss on Ignition, Cation Exchange Capacity and Sulfur Content

Total organic carbon (TOC) represents only the carbon component of organic matter within a solid material, while loss on ignition (LOI) represents the combustible portions of a solid material and is often used as an approximation of organic matter in a sample. The cation exchange capacity (CEC) of a solid represents the total negative surface charge of that material, which is related to the material's surface potential to sorb cations. Amorphous iron hydroxides, organic matter, and clays at circumneutral pH all tend to possess high negative surface charges and therefore tend to contribute to higher CEC values.

The CEC, TOC, and LOI values for solids are presented in Table 1 and the analytical data is provided in Attachment E. CEC, in the vicinity of AP1 range from 3.32 – 31.02 milliequivalents per 100 g of sample [meq/100g]. TOC abundances range from 0.5 – 1.7 percent by dry weight [% wt] and LOI abundances range from 2.5 – 12.4 % wt. No clear patterns in CEC, TOC or LOI between lithologic units is observed for solids across the Site.

Total sulfur within Site solids was low across all lithologies, with all detections less than 0.15 % wt. Acid volatile sulfide (AVS) represents the portion of sulfide within a solid material that can be liberated to hydrogen sulfide (H_2S) gas after the acidification of the sample. Sulfide was only detected at one location (G1001 within the LCU at 0.05 % wt) and the highest detection of AVS was 0.28 milligrams per kilogram (mg/kg), indicating that sulfides have a limited abundance in the Site solids and sulfur is primarily present within other mineral phases. Sulfate concentrations, as measured in solid leachate after HCl digestion, were higher in solids at G307D (UCU and UA; 170-220 mg/kg) and G314D (UA/LCU, 210 mg/kg) compared to similar lithologic units (e.g.

G311D). Higher sulfate concentrations at these two locations are consistent with the highest sulfur wt % values detected for these intervals (0.09 – 0.14 wt %).

Samples of the CCR solid material within AP1 were collected at two locations (co-located with AP1 porewater wells XPW01 and XPW02), and analyzed for boron, total metals and bulk characterization. Ash material had low CEC values (0.28 to 2.26 meq/100g), consistent with ash particle surfaces that have limited additional capacity to sorb ions. TOC values for ash material were higher than detected in Site solids (3.8 – 4.0% wt), consistent with the coal source nature of the ash material. Sulfate concentrations of ash material ranged between 85 to 450 mg/kg, providing evidence that the ash material is a contributing source of sulfate to the AP1 porewater. Boron was present in the ash material, with concentrations ranging between 70 to 110 mg/kg, consistent with the expectation of boron presence within CCR materials (EPRI 2005) and providing evidence that the ash material is a contributing source of boron to AP1 porewater.

4.2.2 Total Metals and Boron via Bulk Characterization

Total metals were analyzed to determine the major and trace metal content of the solids. The abundance of total aluminum, iron, and manganese can provide insights into the potential presence of adsorbing phases, as oxyhydroxides of these metals can provide sorption capacity. The total metals results are presented in Table 2 and the analytical data is provided in Attachment E.

Total iron concentrations are generally consistent in both UA solids (4,900 milligrams per kilogram [mg/kg] to 22,000 mg/kg) and LCU solids (10,000 to 21,000 mg/kg) sampled from across the Site. Total manganese concentrations do not follow a similar pattern to iron, with a relatively larger concentration range in UA solids (34 mg/kg to 1,200 mg/kg) than in LCU solids (370 to 470 mg/kg). The abundance of iron within the bulk solids matrix of both the UA, and LCU indicates the likely presence of iron-bearing minerals within the system. The presence of iron-bearing minerals was confirmed via X-Ray diffraction (XRD) as discussed in Section 4.2.4. Aluminum concentrations in UA solids vary from 9,600 mg/kg at the AP2 background location G270 to 32,000 mg/kg at the downgradient location G316. Boron concentrations within HSU solids were analyzed in the vicinity of AP1, with concentrations not detected above reporting limits for any samples. Boron was detected in UA and LCU samples collected elsewhere at the CPP, with concentrations ranging from 4 to 6 mg/kg (Table 2).

X-Ray fluorescence (XRF) was conducted for identification of the bulk elemental composition of solids. The XRF data are presented in Table 3 and the analytical data is provided in Attachment F. Solids from across all HSUs at the Site are predominantly composed of silicon (61.7 to 84.6 wt%), followed by calcium (0.5 to 9.1 wt%) and aluminum (4.9 to 8.4 wt%), consistent with the sandy, silty, and clayey lithologies described for these units. Iron is detected in all Site solid samples, ranging from 1.69 to 3.71 wt %, with UA solids having lower wt % iron than LCU and DA solids. Manganese was detected in all Site solid samples with concentrations ranging from 0.03 to 0.13 wt %.

4.2.3 Mineralogical Analysis

X-Ray diffraction (XRD) with Rietveld refinement was conducted for identification of minerals in solid samples. XRD is an analytical technique that provides information about the identity of the crystalline material within a sample but does not provide information about non-crystalline or amorphous phases. XRD results are normalized to 100% of the total weight, meaning that material not characterized by XRD is ignored in the percent calculation.

The XRD data are presented in Table 4 and the analytical data is provided in Attachment G. Solids from all HSUs across the Site were predominantly composed of quartz, ranging from 46.3 to 73.5% of the minerals present. Feldspar minerals including albite (6.1 to 10.4%) and microcline (5.1 to 9.8%), carbonates such as dolomite (0.0 to 15.7 %) and calcite (0.4 to 4.2%) and a variety of clays (1.1 to 12.0% total) were detected as additional primary crystalline mineral phases. Low abundances of magnetite (detected up to 0.2%) were detected in UA, LCU and DA solids, but otherwise crystalline forms of iron oxides were not detected in Site solids. Ankerite, an iron-bearing carbonate mineral, was detected in all Site solids at abundances from 0.5 to 9.4%. Combined with XRF data detections of iron abundances between 1.7 to 3.7 wt %, these results indicate that the total iron within Site solids is largely associated with minerals other than crystalline iron oxides. No crystalline manganese oxide minerals were detected in Site solids. The manganese-bearing mineral kutnohorite (0.1 to 0.5 %) was detected at low abundances, consistent with the presence of dolomite-like carbonates.

Kaolinite, montmorillonite, and illite have been correlated with boron retention in soils (Goldberg 1997). Of those three clay types, illite has the greatest rate of boron adsorption, and was detected in solid samples from the UA, DA and LCU at abundances ranging from 1.7 to 4.0%. Montmorillonite and kaolinite were also present in a subset of solids from these units (1.0 to 3.2% and 0.6 to 1.1%, respectively). Chlorite was also identified at abundances ranging from 1.1 to 3.9%. The presence of clay minerals within solids presents an additional, if limited, potential attenuation mechanism for boron across the Site.

4.3 Aqueous Geochemistry

AP1 porewater and groundwater from wells across the UA, DA, and LCU were analyzed for a range of geochemical parameters and presented in Figures 1a – 9. For clarity in interpretation, the figures present data from the UA and both the LCU and DA well locations separately. UA well locations are shown with circular symbology on the figures, LCU locations are shown with triangular symbology, and DA locations are shown with square symbology. Background locations G281 and G306, both of which are screened in the UA, are shown with hollow symbology. The groundwater data used in the site evaluation is summarized in Attachment H.

CCR porewater is water “collected from the interstitial water between waste particles in surface impoundments as it occurs in the field” (USEPA, 2014) and represents the material potentially leached from impoundments. The CCR materials are the primary source of constituent loading to

the CCR porewater. Over an extended period (e.g., months to years), the CCR porewater (i.e., water) reaches equilibrium with the CCR materials. The concentrations within the porewater are "the most representative data available for impoundments because these data are field-measured concentrations of leachate" (USEPA 2014). Porewater is therefore the most appropriate source term for potential flux out of CCR impoundments. Porewater samples collected from locations XPW01 and XPW02 are presented in Figures 1a – 9 and the data is summarized in Attachment H.

4.3.1 Redox/pH Summary

The oxidation-reduction (redox) potential (ORP) and pH in aqueous systems are major controls on the speciation and mobility of reactive constituents such as iron, manganese, and sulfate.

AP1 CCR porewater pH values ranged from 7.0 to 8.5 standard units (SU) (Figures 1a & 1b). In wells across the groundwater monitoring network, pH values generally appear to be stable and circumneutral (Figures 1a & 1b). UA groundwater pH values largely range between 6.5 to 7.5 SU, consistent with the buffering capacity expected from the carbonate minerals present within the geologic units. Groundwater pH at downgradient well G312 is consistently between 6.0 and 6.5, although these levels do not represent a statistical exceedance. Groundwater within UA wells upgradient of AP1 and located to the southwest (G305, G307, G307D, and G308) generally have higher pH values than other compliance wells. LCU and DA groundwater pH values similarly ranged between 6.5 to 7.5 SU. Background well G281 has stable pH values through time between 6.8 to 7.25 SU, while G306 has a wider pH range, between 6.2 to 7.1 SU.

A range of ORP values are reported for groundwater across the Site, with some locations (e.g., G301, G314) observed to fluctuate between relatively more reducing and more oxidizing conditions (Figures 2a & 2b). Upgradient UA background wells G281 and G306 are consistently more oxidizing, while LCU wells G307D and G316 are consistently more reducing, although this trend does not extend to the LCU at G314. Groundwater within AP1 porewaters is relatively more reducing than ORP values detected in the groundwater of the monitoring network (Figures 2a & 2b). Many of the UA wells across the network (G301, G302, G303, and G313) appear to fluctuate seasonally between relatively more oxidizing (winter) and more reducing (summer) conditions, a pattern that is not consistently observed across the monitoring network and appears to have become prevalent after the cessation of material addition to AP1 in 2019.

4.3.2 Exceedance Parameters

Total boron concentrations in AP1 porewaters varied from 1.9 to 4.0 milligrams per liter (mg/L), with concentrations at XPW02 consistently detected below the site-specific GWPS for boron of 3.2 mg/L (Figures 3a and 3b). Total sulfate concentrations within AP1 porewater ranged between 175 to 860 mg/L and are typically above the GWPS of 400 mg/L (Figures 4a and 4b). TDS values within AP1 porewater ranged between 522 to 1,400 mg/L, near or below the GWPS of 1,200 mg/L (Figures 5a and 5b). XPW01 and XPW02 are both located on the western portion of AP1, and heterogeneity in ash composition across the former pond may result in the detection of all three exceedance parameter analytes with lower concentrations in AP1 porewater than downgradient groundwater. The porewater results from XPW01 and XPW02 are consistent with concentrations

observed in source water collected from test pits as part of the dewatering evaluation process at the pond between 2016-2017, which had detections of total sulfate from 1,200 to 1,600 mg/L and boron from 1.6 to 3.8 mg/L (data originally presented in the 2017 *Antidegradation Assessment for Management of Coal Combustion Residuals Impoundment Waters, Coffeen Power Station*; Attachment I). These concentrations ranges indicate that downgradient groundwater with COC exceedances may be reflective of past conditions within AP1 porewater.

4.3.2.1 UA

UA background wells G281 and G306 have differing ranges of boron concentrations in groundwater, with G281 boron concentrations below the GWPS (below detection limits to 0.04 mg/L), while G306 boron concentrations ranged between 2.2 to 3.5 mg/L, which has resulted in the GWPS of 3.2 mg/L for the AP1 (Figure 3a). Sulfate concentrations at these background wells are typically below the GWPS (G281: 140 to 380 mg/L; G306: 6 to 700 mg/L), as are TDS concentrations (G281: 700 to 1,000 mg/L; G306: 455 to 900 mg/L) (Figures 4a & 5a). For groundwaters at G306, the variable concentration of boron and depressed sulfate concentrations in relation to AP1 porewater concentrations indicates that AP1 porewaters may not be the sole boron source to AP1 groundwater.

The only well in the monitoring network with an exceedance above the GWPS for boron is G313, a downgradient UA compliance well with concentrations that range from 3.2 to 5.2 mg/L. Other UA compliance wells have boron concentrations between 1.1 to 3.5 mg/L, with this subset of UA compliance wells typically below the boron concentrations detected at the background UA well G306.

While there was only one statistical exceedance of boron, statistical exceedances of sulfate were widely distributed both spatially and within the different HSUs downgradient of AP1. The only UA compliance well without an exceedance for sulfate is G302. Sulfate concentrations at other UA compliance wells are typically greater than those detected at XPW02, with G305 and G308 typically detected above concentrations at XPW01 as well (710 to 1200 mg/L) (Figure 4a). G305 and G308 are both located side gradient of AP1 to the southwest, such that AP1 porewater, as represented by XPW01 and XPW02, may not be the only source of sulfate to the groundwater at these locations.

UA background wells G281 (700 to 1,000 mg/L) and G306 (455 to 900 mg/L) have a lower range of TDS concentrations relative to UA compliance wells (362 to 1,700 mg/L; excluding exceedance wells) (Figure 5a). TDS concentrations at wells with statistically significant exceedances of TDS are elevated (1,100 to 2,010 mg/L) compared to the range of values observed for AP1 porewaters (522 to 1,400 mg/L). Total sulfate concentrations are significantly positively linearly correlated with TDS concentrations across the UA monitoring network ($R^2 = 0.67$; Figure 6a), indicating that sulfate is a major contributor to TDS across the UA AP1 monitoring network.

4.3.2.2 LCU/DA

Boron concentrations in LCU and DA groundwaters are relatively lower than those detected in UA groundwaters, ranging from 0.12 to 2.5 mg/L, consistently below the GWPS at the Site (Figure 3b). Boron concentrations at G314 (0.12 to 0.24 mg/L) and G314D (0.14 to 0.24 mg/L) are equivalent to those detected at the background well G281. Unlike boron, sulfate concentrations in all LCU and DA groundwaters are above the GWPS, with concentrations notably higher in G314 (830 to 2,400 mg/L) (Figure 4b). Unlike the UA wells G305 and G308 that had higher sulfate concentrations and are located sidegradient to the southwest, G314 and G314D are downgradient of AP1 to the east, which indicates groundwater at these locations may be influenced by differing sulfate sources.

G307D is the only LCU or DA well without a statistically significant exceedance of TDS (1,040 to 1,500 mg/L) (Figure 5b). G314, G314D and G306 have higher TDS concentrations (1,100 to 4,000 mg/L), well above what is detected in UA wells or AP1 porewaters. Total sulfate concentrations are positively linearly correlated with TDS concentrations across the LCU and DA monitoring network (R^2 = 0.95; Figure 6b), indicating that sulfate is a major contributor to TDS across the LCU and DA AP1 monitoring network.

4.3.3 Pourbaix Diagrams

Eh-pH (Pourbaix) diagrams can be used to illustrate the predicted stability of specific phases at thermodynamic equilibrium under the conditions observed for a groundwater sample. Select crystalline mineral species were suppressed to be representative of anticipated groundwater conditions (e.g. mineral formation not anticipated to be kinetically favored for igneous and metamorphic minerals in the low temperature near-surface environment).

Using conditions detected at well G313 on 6 June 2023 to represent downgradient groundwater within the UA (Table 5), amorphous ferrihydrite is predicted to be stable under groundwater conditions at some locations, while at other locations solid phase iron minerals are not expected to be stable (Figure 7a).[5] However, the higher abundance of total iron at G313, which was used to inform the Eh-pH diagram generation, compared to dissolved iron at G313 (Table 6) may overestimate the stability of solid phase iron species.

Under the evaluated conditions, wells G301, G302, and G303 are all predicted to not favor solid phase iron minerals, while at G310 and G315 amorphous iron hydroxide stability is always favored. G301, G302, and G303 are also wells for which a seasonal fluctuation in ORP is observed, and the same process driving these seasonal fluctuations (possibly meteoric water recharge) may contribute to conditions that do not favor amorphous iron oxide stability. Wells G315 and G303 are located physically adjacent and sidegradient of AP1 to the south, while G310 and G301 are adjacent and downgradient of AP1, which indicates that solid phase iron stability is likely related

[5] Field ORP measurements were converted to Eh by adding +200 millivolts to correct for the Ag/AgCl electrode.

to localized conditions, rather than larger hydrologic forces. Conditions at most UA wells, including background wells G281 and G306, are poised on the redox boundary for solid phase iron stability. Ankerite, which is an analogous iron-bearing carbonate species to siderite, was identified via XRD but not expected to be thermodynamically stable within the UA based upon the detected pH and redox conditions. Dissolution of ankerite or magnetite (where present) may provide a source of iron for the subsequent formation of amorphous iron oxide coatings. Overall, these modeling results indicate that amorphous iron oxides (the formation of which is more kinetically favorable than crystalline iron oxides) might be present, although unstable, at some locations within the UA.

Similar aquifer conditions are predicted at locations within the LCU and DA, as modeled using groundwater conditions from G314 sampled on 1 June 2023 (Table 5; Figure 7b). All locations within the LCU and DA are observed to experience dynamic equilibrium conditions in which chemical reactions between dissolved iron and amorphous iron oxyhydroxides may occur, with the exception of G316, where conditions are not observed to favor iron oxide thermodynamic stability. Crystalline magnetite is expected to be thermodynamically stable at all LCU and DA locations (Figure 7c), which is consistent with the low abundances of magnetite detected via XRD near G314 (Table 4). Ankerite is not expected to be thermodynamically stable within the LCU or DA based upon the detected pH or redox conditions. As in the UA, dissolution of ankerite or magnetite may provide a source of iron for the subsequent formation of amorphous iron oxide coatings. Overall, these modeling results indicate that crystalline and amorphous iron oxides (the formation of which is more kinetically favorable than crystalline iron oxides) might be present at some locations within the LCU and DA.

The Eh-pH diagrams for manganese show that solid phase manganese oxides are not predicted to be stable under conditions within either the UA, LCU, or DA across the site (Figures 8a and 8b, respectively). However, rhodochrosite might be stable.

4.3.4 Total and Dissolved Iron and Manganese Concentrations

The distribution of iron and manganese between total and dissolved phases can provide insights on Site redox conditions and constituent behavior. Paired total and dissolved iron and manganese data are only available across the Site for the Q2 and Q3 2023 sampling events. A comparison of the total and dissolved iron and manganese data for these events is provided in Table 6.

Total iron concentrations ranged from 0.026 mg/L at UA well G310 on 9 August 2023 to 17 mg/L at downgradient LCU well G316 on 31 May 2023. Dissolved iron concentrations ranged from below reporting limits to 17 mg/L at downgradient LCU well G316 on 31 May 2023. Where dissolved iron was detected, the dissolved concentration was typically less than 50% of the total iron value, indicating that aqueous iron is largely associated with suspended particulates across the AP1 monitoring network. G302, G303, G314, G314D, and G316 all have higher fractions of dissolved iron concentrations in at least one monitoring event such that dissolved iron is the majority of total iron, consistent with Eh-pH modeling results for these locations indicating

geochemical conditions favoring the stability of dissolved iron. Generally, higher total and dissolved iron concentrations are observed in the LCU and DA.

Total manganese concentrations ranged from 0.078 mg/L at background UA well G306 on 5 June to 9.28 mg/L at downgradient LCU well G316 on 9 August 2023 (Table 6). Dissolved manganese concentrations ranged from 0.006 mg/L at background UA well G306 on 5 June to 9.82 mg/L at downgradient LCU well G316 on 9 August 2023. Dissolved manganese represents the majority of total manganese concentrations at all locations except for G306. This is consistent with the lack of manganese-bearing mineral stability based on the Pourbaix diagrams (Figures 8a and 8b), and the lack of detected crystalline manganese-bearing minerals (like rhodochrosite) across most of the Site (Table 4).

4.3.5 Major Ion Distribution and Groundwater Signatures

A Piper diagram was constructed using data from all HSUs to visualize major ion distributions in groundwater (Figure 9). Piper diagrams are a common tool for assessing geochemical similarities or differences between aqueous samples. The cation composition of AP1 porewater is dominated by calcium, with major anion compositions that span from evenly split between alkalinity-dominated to sulfate-dominated. Background wells G281 and G306 have compositions with lower contributions of sulfate, greater contributions of carbonate alkalinity and are dominated by calcium and magnesium. The higher relative abundance of alkalinity is consistent with the presence of carbonates in the UA solids. Groundwater from the compliance network wells spans the range between the background wells and AP1 porewater, with no clear patterns observed for UA, LCU, and DA groundwaters or spatially. These results provide further evidence for the influence of AP1 source water on compliance wells for the unit.

5. EVALUATION OF PARTITION COEFFICIENT RESULTS

Batch test studies combine soil and groundwater collected from the Site to evaluate the attenuation of chemical constituents. A draft memorandum discussing batch attenuation testing at the CPP AP1 was included as an appendix to the *Groundwater Modeling Report* (Ramboll 2022) and is provided as Attachment J to this document.

5.1 Batch Attenuation Testing

Batch attenuation testing was conducted for boron and sulfate to evaluate the potential for sorption and to attempt to generate site-specific distribution coefficients between the solid and aqueous phase. In 2021, Geosyntec conducted a field investigation at AP1 which included completion of four soil borings ranging in depth from 13 to 18 feet below ground surface. Two groundwater samples (G311 and G313) and three soil samples (SB-306, SB-311, and SB-313) representative of the UA were used for batch attenuation testing at five soil:solution ratios (Table 7), each ran in duplicate. G311 is not within the AP1 network but is located downgradient on the north side of the unit (Attachment A). Each microcosm was amended (i.e., spiked) with sodium sulfate (Na_2SO4), and microcosms with G313 groundwater were also amended with boric acid, to achieve target concentrations of sulfate and boron, respectively (Table 7). The G311 microcosm was not amended with boric acid because potential boron exceedances were not identified in the vicinity of G311. G313 groundwater was combined with aquifer solids both adjacent to downgradient location G311 and background location G306 to understand how partitioning behavior may be affected by position relative to AP1. After the end of the test, the samples were filtered through a 0.45-micron (µm) filter prior to analysis for dissolved concentrations of sulfate and/or boron. Analysis of the dissolved phase is important to adequately measure the partioning of mass between the solid and liquid fractions of the experiment.

5.2 Partition Coefficient Results

The mass of sulfate or boron in the water versus in the solids of each sample was plotted according to three sorption models: linear, Langmuir, and Freundlich (Tables 8a and 8b). Data obtained from the batch attenuation tests was used to calculate attenuation distribution coefficients (K_d) for each sorption model. The calculated linear, Langmuir, and Freundlich distribution coefficients (K_d, K_L, and K_F, respectively) values are shown in Tables 9a and 9b. The linear, Langmuir, and Freundlich isotherms for boron and sulfate are provided in Figures 10a – 10e.

A boron partition coefficient was not calculated for G311, since the microcosm was not amended with boric acid because potential boron exceedances were not identified in the vicinity. Given the negative values for the Langmuir isotherms, the Freundlich isotherm fit the data best for G313/SB-306 and G313/SB-313, yielding K_F values of 0.65 L/kg and 2.03 L/kg, respectively. Though slightly higher at G313/SB-313, these values are comparable to boron partition coefficients reported in the literature, which range from 0.19 to 1.3 L/kg depending on pH conditions and the amount of sorbent present (EPRI, 2005; Strenge & Peterson, 1989).

The G311 partition coefficient for sulfate ranged from -624 L/kg for the Langmuir isotherm to 10.11 L/kg for the linear isotherm, but the best-fitting Freundlich isotherm yielded a low K_F value of 9.2×10^{-12} L/kg. None of the isotherms showed a high goodness-of-fit (i.e., R^2) for either G313/SB-306 or G313/SB-313, with the highest correlation being 0.51, and were associated with erroneously high (1700 L/kg) and low (-690 L/kg) partition coefficients. An accurate sulfate partition coefficient could therefore not be calculated from any of the data.

6. GEOCHEMICAL CONCEPTUAL SITE MODEL

6.1 Source and Mobilization Mechanisms

Boron is naturally abundant in coals associated with organic matrices and is concentrated within CCR, primarily as polyborate (B_2O_3) surface coatings on particles (EPRI 1998; Izquierdo & Querol, 2012). Boron was identified in the CCR porewater at concentrations up to 4 mg/L. The likely primary source of boron to the UA is the AP1 CCR porewater based on boron concentrations within the source.

Reduced sulfur species (e.g. pyrite) can be naturally abundant in coals; after coal fly ash production, sulfate is the dominant sulfur species associated with fly ash. Sulfate is concentrated on the surface of fly ash particles and the majority of sulfate mineral phases are soluble under environmental conditions, such that sulfate associated with fly ash is leachable (Izquierdo & Querol, 2012). The primary source of sulfate to the UA and LCU/DA is AP1 CCR porewater. Sulfate was identified in the CCR leachate or porewater at concentrations up to 860 mg/L for recently collected samples, and up to 1,600 mg/L for historic samples.

The multiple instances of observations of groundwater locations where sulfate and boron concentrations appear uncoupled, the presence of elevated boron concentrations at background well G306, and the detection of sulfate concentrations higher than those observed in AP1 source water at downgradient wells indicate that the groundwater in the vicinity of AP1 is likely impacted by multiple potential sources.

6.2 Potential and Observed Attenuation Mechanisms

Boron exceedances were identified in the UA. Boron is anticipated to largely be present as the neutral $B(OH)_3^o$ boric acid species as groundwater pH values in the UA are below the pK_a for boric acid (9.2). The presence of iron oxides in some UA and LCU solids (Table 4), and the potential for amorphous ferrihydrite formation based on modeling of Eh-pH conditions indicates a portion of the boron in the groundwater system might be attenuated via surface complexation reactions within portions of the UA, LCU, and DA. Given the low abundance of total manganese in the solids (Table 2) and the predicted instability of solid manganese phases (Figures 8a and 8b), manganese oxides are not expected to be an important source of adsorption sites. Boron is also known to be attenuated via interactions with clay minerals (Goldberg 1997); the XRD results identified the presence of clay minerals across the UA, LCU, and DA (Table 4). These lines of evidence support the partition coefficient calculated from batch attenuation testing for boron, which indicated boron chemical attenuation is possible, if limited, at locations downgradient of AP1.

Sulfate exceedances were identified in the UA, LCU, and DA. Sulfate is typically considered to be a conservative species within groundwater at circumneutral pH conditions, although sorption onto mineral surfaces is a potential attenuation mechanism. Sulfate attenuation is expected to occur

largely as the result of sorption onto positively charged iron oxides and oxyhydroxides associated with solids under acidic conditions. XRD analyses (Table 4) support the presence of iron oxides crystalline phases across the Site in the UA, LCU, and DA, with the additional potential for amorphous phases to form at some locations based on modeled redox conditions. However, chemical attenuation of sulfate is anticipated to be limited, as batch attenuation testing was not able to determine a partition coefficient for sulfate at the Site. Any attenuation of sulfate will likely contribute to a reduction of TDS in the groundwater.

7. REFERENCES

Bolan, S., Wijesekara, H., Amarasiri, D., Zhang, T., Ragályi, P., Brdar-Jokanović, M., Rékási, M., Lin, J., Padhye, L., Zhao, H., Wang, L., Rinklebe, J., Wang, H., Siddique, K., Kirkhamn, M., Bolan, N. 2023. "Boron contamination and its risk management in terrestrial and aquatic environmental settings". *Science of the Total Environment*. 164744

Brown, G E J, V Henrich, W Casey, D Clark, C Eggleston, A Felmy, D W Goodman, M Gratzel, G Maciel, M I McCarthy, K H Nealson, D Sverjensky, M Toney, J M Zachara. 1999. "Metal Oxide Surfaces and Their Interactions with Aqueous Solutions and Microbial Organisms". *Chemical Reviews*, 99, p. 77-174.

EPRI. 1998. "Leaching of Inorganic Constituents from Coal Combustion By-Products Under Field and Laboratory Conditions, Volume 1." Final Report TR-111773-V1.

EPRI. 2005. "Chemical constituents in Coal Combustion Product Leachate: Boron." Final Report 1005258.

Maria Izquierdo, Xavier Querol. 2012. Leaching behaviour of elements from coal combustion fly ash: An overview. International Journal of Coal Geology, 194, 54-66.

Lemarchand, D, A D Jacobson, D Cividini, and F Chabaux. 2015. "The major ion, 87Sr/86Sr, and δ11B geochemistry of groundwater in the Wyodak-Anderson coal bed aquifer (Powder River Basin, Wyoming, USA)". Comptes Rendus Geoscience, 347, 348-357.

Ghalib, H B, M B Yaqoob, A M Al-Abadi. 2020. "Assessment of the Groundwater at Ali Al-Garbi Area, Iraq using Geochemical Modeling and Environmental Isotopes." Desalination Water Treat. 176, 114-122.

Goldberg, S. 1997. "Reactions of Boron with Soils". Plant and Soil, 193, 35-48.

Goldberg, S. and Glaubig, R.A. 1985. Boron Adsorption on Aluminum and Iron Oxide Minerals. *Soil Science Society of America Journal*, 49: 1374-1379.

National Center for Biotechnology Information (NCBI). 2024. PubChem Compound Summary for CID 24414, Barium Sulfate.. 2024

National Center for Biotechnology Information (NCBI). 2024. PubChem Compound Summary for CID 7628, Boric Acid. https://pubchem.ncbi.nlm.nih.gov/compound/Boric-Acid. Accessed Feb. 6, 2024.

Ramboll Americas Engineering Solutions, Inc. (Ramboll). 2021a. "*Hydrogeologic Site Characterization Report. Ash Pond No. 1. Coffeen Power Plant. Coffeen, Illinois*." October.

Ramboll. 2021b. "*Groundwater Monitoring Plan. Coffeen Power Plant, Ash Pond No.1, Coffeen, Illinois. Illinois Power Generating Company.*" October.

Ramboll. 2022. “Groundwater Modeling Report, Ash Pond No. 1 Coffeen Power Plant, Coffeen, Illinois.” May.

Ramboll. 2024. *35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances – 2023 Quarter 4. Ash Pond No.1, Coffeen Power Plant, Coffeen, Illinois*. Ramboll Americas Engineering Solutions, Inc. March.

Rusydi, A. 2018. “Correlation Between Conductivity and Total Dissolved Solids in Various Types of Water: A Review.” IOP Conference Series: Earth and Environmental Science. 118, 012019

Strenge, D. and Peterson, S. 1989. Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS) (No. PNL-7145). Pacific Northwest National Laboratory, Richland, WA (USA).

Stumm, W., J J Morgan. 1996. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, 3rd ed., Wiley-Interscience.

United States Environmental Protection Agency (USEPA). 2014. “Human and Ecological Risk Assessment of Coal Combustion Residuals (2050-AE81)”. December.

TABLES

Table 1. CEC and LOI of Site Solids
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Well ID	G270	G306	G311	G313	G316	G314	G314	G314	G401	G407	G410	G410	G307D	G307D
Depth (ft bgs)	(12-16)	(14-16)	(14-15)	(8-9)	(13-14, 15-16)	(13-18)	(18-23)	(38-43)	(16-20)	(10-13)	(11-12)	(12.5-13)	(4-12.8)	(12.8-14)
Well Characterization	AP2 Background	AP1 Background	AP1 Adjacent	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP2 Compliance	AP2 Compliance	AP2 Sidegradient	AP2 Sidegradient	AP1 Compliance	AP1 Compliance
Sampled Aquifer Unit	UA	UA	UA	UA	UA	LCU	LCU	DA	UA	UA	UA	UA	UCU	UA
Field Boring Log Description	Silty Sand	Sand	Sand	Sand	Sand	Sandy to silty till	Sandy to silty till	Sand and sandy silt/clay	Sand to Sandy Clay	Sandy to gravelly silt	Sandy to gravelly silt	Sandy to gravelly silt	Clay	Sand
CEC (meq/100 g solid)	-	-	-	-	-	17.84	18.95	14.39	-	11.41	15.39	31.02	18.82	3.32
LOI (%)	-	-	-	-	-	12.43	12.33	12.30	-	2.54	3.75	11.96	-	-
TOC (%)	0.14	0.41	0.77	0.78	0.26	-	-	-	0.08	-	-	-	0.06	1.12
AVS (mg/kg)	<0.19	<0.18	0.24	<0.16M	0.28	<0.22	<0.22	<0.22	<0.19	<0.23	<0.23	<0.21	-	-
Total Carbon (%)	-	1.65	2.76	3.26	0.46	-	-	-	-	-	-	-	-	-
Sulfur (%)	<0.005	0.01	0.01	0.01	0.01	-	-	-	0.01	-	-	-	0.01	<0.0066
Sulfide (%)	<0.04	<0.04	<0.04	<0.04	<0.04	-	-	-	<0.04	-	-	-	-	-

Well ID	G307D	G307D	G307D	G311D	G311D	G311D	G311D	G314D	G314D	G314D	G1001	XPW01	XPW02
Depth (ft bgs)	(18-34.9)	(40-54)	(54-60)	(4-12)	(12-14)	(18-42)	(44-52)	(4.2-17)	(17.3-21.6)	(21.8-45.5)	(6-11)	(0-8)	(0-8)
Well Characterization	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Adjacent	AP1 Adjacent	AP1 Adjacent	AP1 Adjacent	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP2 Compliance	CCR Material	CCR Material
Sampled Aquifer Unit	UA	LCU	LCU	UCU	UA	UA	LCU	UCU/UA	UA/LCU	LCU	LCU	-	-
Field Boring Log Description	Sandy to gravelly silt	Clay	Clay	Clay	Sand and sandy silt/clay	Clay	Clay	Clay with trace sand	Clay with trace sand	Clay	Clay with trace sand	Ash	Ash
CEC (meq/100 g solid)	3.91	8.31	17.24	9.36	9.23	9.61	13.05	9.44	9.72	12.45	-	2.26	0.28
LOI (%)	-	-	-	-	-	-	-	-	-	-	-	-	-
TOC (%)	1.67	1.24	0.11	<0.0318	1.15	1.48	0.06	<0.0498	1.74	0.85	0.85	4.02	3.84
AVS (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Carbon (%)	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur (%)	0.14	0.09	0.01	0.01	0.08	0.08	0.08	0.01	0.11	<0.008	0.03	0.05	0.01
Sulfide (%)	-	-	-	-	-	-	-	-	-	-	0.05	-	-

Notes
Sample depth is shown in feet below ground surface (ft bgs)
Dashes indicate sample was not analyzed for analyte
M - Reporting limit elevated due to matrix interference
meq/100 g solid: milliequivalents per 100 grams solids
LOI: loss on ignition
TOC: total organic carbon
AVS: acid volatile sulfides
mg/kg: milligrams per kilogram
AP1: Ash Pond 1
AP2: Ash Pond 2
CCR: Coal combustion residual
UCU: Upper Confining Unit
LCU: Lower Confining Unit
DA: Deep Aquifer
UA: Uppermost Aquifer

Table 2. Bulk Characterization of Site Solids
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Well ID	G270	G306	G311	G313	G316	G307D	G307D	G307D	G307D	G307D	G311D	G311D	G311D	G311D	G314D	G314D	G314D	G401	G1001	XPW01	XPW02
Depth (ft bgs)	(12-16)	(14-16)	(14-15)	(8-9)	(13-14, 15-16)	(4-12.8)	(12.8-14)	(18-34.9)	(40-54)	(54-60)	(4-12)	(12-14)	(18-42)	(44-52)	(4.2-17)	(17.3-21.6)	(21.8-45.5)	(16-20)	(6-11)	(0-8)	(0-8)
Well Characterization	AP2 Background	AP1 Background	AP1 Adjacent	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP1 Adjacent	AP1 Adjacent	AP1 Adjacent	AP1 Adjacent	AP1 Compliance	AP1 Compliance	AP1 Compliance	AP2 Compliance	AP2 Compliance	CCR Material	CCR Material
Sampled Aquifer Unit	UA	UA	UA	UA	UA	UCU	UA	UA	LCU	LCU	UCU	UA	UA	LCU	UCU/UA	UA/LCU	LCU	UA	LCU	-	-
Field Boring Log Description	Silty Sand	Sand	Sand	Sand	Sand	Clay	Sand	Sandy to gravelly silt	Clay	Clay	Clay	Sand and sandy silt/clay	Clay	Clay	Clay with trace cand	Clay with trace sand	Clay	Sand to Sandy Clay	Clay with trace sand	Ash	Ash
Analyte	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aluminum	9600	13000	11000	31000	32000	-	-	-	-	-	-	-	-	-	-	-	-	9700	8200	-	-
Antimony	<0.8	<0.8	<0.8	<0.8	<0.8	<2.6	<2	<2.6	<2.8	<2.4	<3	<3.2	<3	<2.8	<2.8	<3	<2.4	<0.8	<0.8	<2.7	<2.8
Arsenic	12	6.7	2.7	5.6	5.1	7.5	1.7	2.9	5.7	4.2	3.2	3.5	2.8	3.2	1.3	2.7	3.8	5.5	6.2	6.9	<0.93
Barium	210	98	58	310	320	150	10	20	93	110	57	44	69	90	63	27	140	190	120	710	850
Beryllium	0.48	0.5	0.4	0.7	0.7	<0.86	<0.66	<0.87	<0.93	<0.79	<1	<1.1	<1	<0.95	<0.93	<1	<0.8	0.35	0.45	1.9	1.6
Bismuth	0.18	0.1	0.1	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	0.25	0.23	-	-
Boron	5	-	-	-	-	<8.6	<6.6	<8.7	<9.3	<7.9	<10	<11	<10	<9.5	<9.3	<10	<8	4	6	110.0	70.0
Cadmium	0.12	0.1	0.1	0.2	0.1	1.2	<0.66	<0.87	<0.93	<0.79	<1	<1.1	<1	<0.95	<0.93	<1	<0.8	0.03	0.13	1.0	<0.93
Calcium	5000	35000	52000	69000	10000	-	-	-	-	-	-	-	-	-	-	-	-	1900	42000	-	-
Chloride	-	-	-	-	-	<10	19	<10	<10	<10	<1	<1	<1	<1	<10	<10	<10	-	-	<10	<10
Chromium	16	130.0	100.0	130.0	150.0	9.5	3.8	8.5	10.0	8.5	10.0	8.0	10.0	12.0	8.7	9.9	25.0	14	15	41.0	24.0
Cobalt	10	6.0	4.0	7.0	4.0	25.0	1.4	4.5	7.1	6.0	3.1	4.0	5.0	5.9	<1.9	5.2	10.0	6.1	8.8	4.8	4.3
Copper	12	14	10	12	10	-	-	-	-	-	-	-	-	-	-	-	-	7.8	11	-	-
Fluoride	-	-	-	-	-	3.1	<2.5	<2.5	4.2	6.8	<0.25	<0.25	<0.25	<0.25	<2.5	<2.5	3.1	-	-	<2.5	<2.5
Iron	22000	-	-	-	-	20000	4900	11000	10000	19000	10000	8600	11000	12000	4900	11000	21000	14000	16000	57000	50000
Lead	12	9.0	7.0	11.0	12.0	15.0	3.3	5.9	7.7	7.2	8.1	5.4	6.9	8.7	5.5	7.3	11.0	9.5	11	4.7	1.3
Lithium	11	11.0	11.0	19.0	14.0	<4.3	<3.3	10.0	7.1	6.8	<5	6.4	8.4	10.0	<4.6	9.1	28.0	7	9	18.0	20.0
Magnesium	4700	15000	27000	35000	6700	-	-	-	-	-	-	-	-	-	-	-	-	1600	18000	-	-
Manganese	1200	470	310	1200	260	3100	120	290	430	470	110	250	290	380	34	320	370	54	450	170	170
Mercury	-	-	-	-	-	<0.17	<0.13	<0.17	<0.19	<0.16	<0.2	<0.21	<0.2	<0.19	<0.19	<0.2	<0.16	-	-	<0.18	<0.19
Molybdenum	0.8	5.8	2.7	1.6	8.1	1.3	<0.66	<0.87	1.4	<0.79	<1	1.2	1.2	1.3	<0.93	1.2	<0.8	0.4	1.5	7.0	2.5
Nickel	20	15	11	17	13	-	-	-	-	-	-	-	-	-	-	-	-	10	15	-	-
Nitrogen (total)	-	-	-	-	-	160	<63	260	360	310	510	360	370	530	140	360	260	-	-	110	100
Potassium	1400	3700	3600	13000	14000	-	-	-	-	-	-	-	-	-	-	-	-	770	1100	-	-
Selenium	<0.7	<0.7	<0.7	<0.7	<0.7	<0.86	<0.66	<0.87	<0.93	<0.79	<1	<1.1	<1	<0.95	<0.93	<1	1.0	<0.7	<0.7	7.5	<0.93
Silver	< 0.05	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	< 0.05	< 0.05	-	-
Sodium	110	590	830	6000	6400	-	-	-	-	-	-	-	-	-	-	-	-	80	110	-	-
Strontium	10	26	35	100	89	-	-	-	-	-	-	-	-	-	-	-	-	9.1	35	-	-
Sulfate	-	-	-	-	-	220	170	30	<10	<10	2	<1	<1	<1	76	210	<10	-	-	450	85
Thallium	0.16	0.2	0.1	0.3	0.3	<0.86	<0.66	<0.87	<0.93	<0.79	<1	<1.1	<1	<0.95	<0.93	<1	<0.8	0.12	0.16	<0.91	<0.93
Tin	< 0.5	<6	<6	<6	<6	-	-	-	-	-	-	-	-	-	-	-	-	< 0.5	0.6	-	-
Titanium	230	370	320	1500	1200	-	-	-	-	-	-	-	-	-	-	-	-	65	170	-	-
Uranium	1.46	0.5	0.6	1.0	1.0	-	-	-	-	-	-	-	-	-	-	-	-	0.39	0.82	-	-
Vanadium	22	28	20	35	29	-	-	-	-	-	-	-	-	-	-	-	-	14	19	-	-
Yttrium	9.4	9	8	11	10	-	-	-	-	-	-	-	-	-	-	-	-	8.2	8.1	-	-
Zinc	50	35	27	41	34	-	-	-	-	-	-	-	-	-	-	-	-	28	35	-	-

Notes:
Sample depth is shown in feet below ground surface (ft bgs)
Dashes indicate analyte was not reported by lab for sample
Non-detect values are shown as less than the reporting limit
mg/kg: milligrams per kilogram
AP1: Ash Pond 1
AP2: Ash Pond 2
CCR: Coal Combustion Residual
UCU: Upper Confining Unit
LCU: Lower Confining Unit
UA: Uppermost Aquifer

Table 3. XRF Analysis of Site Solids
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Well ID	**G314**	**G314**	**G314**	**G407**	**G410**	**G410**
Depth (ft bgs)	**(13-18)**	**(18-23)**	**(38-43)**	**(10-13)**	**(11-12)**	**(12.5-13)**
Well Characterization	**AP1 Compliance**	**AP1 Compliance**	**AP1 Compliance**	**AP2 Compliance**	**AP2 Sidegradient**	**AP2 Sidegradient**
Sampled Aquifer Unit	**LCU**	**LCU**	**DA**	**UA**	**UA**	**UA**
Field Boring Log Description	**Sandy to silty till**	**Sandy to silty till**	**Sand and sandy silt/clay**	**Sandy to gravelly silt**	**Sandy to gravelly silt**	**Sandy to gravelly silt**
Analyte	(wt %)	(wt %)	(wt %)	(wt %)	(wt %)	(wt %)
Al_2O_3	8.36	8.41	8.35	6.73	8.14	4.92
CaO	6.73	6.72	6.69	0.52	1.04	9.10
Cr_2O_3	<0.01	0.02	0.02	0.01	<0.01	<0.01
Fe_2O_3	3.19	3.48	3.71	2.08	2.77	1.69
K_2O	1.88	1.88	1.89	2.01	2.42	1.59
MgO	3.71	3.66	3.62	0.54	0.77	4.44
Mn_3O_4	0.07	0.07	0.07	0.03	0.13	0.08
Na_2O	0.79	0.80	0.77	0.82	0.85	0.69
P_2O_5	0.07	0.08	0.08	0.06	0.06	0.05
SiO_2	62.07	61.80	61.72	84.59	80.21	64.55
TiO_2	0.49	0.50	0.50	0.36	0.40	0.26
V_2O_5	0.01	<0.01	0.01	<0.01	0.01	<0.01

Notes
Sample depth is shown in feet below ground surface (ft bgs).
Non-detect values are shown as less than the reporting limit.
Results are not normalized to 100%, with some portion of sample mass uncharacterized.
Analytes are presented as the respective oxide species of the element of interest, consistent with the sample processing prior to analysis.
wt %: percentage by weight
AP1: Ash Pond 1
AP2: Ash Pond 2
LCU: Lower Confining Unit
DA: Deep Aquifer
UA: Upper Aquifer

Table 4. XRD Analysis of Site Solids
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Well ID			**G306**	**G311**	**G313**	**G316**	**G314**	**G314**	**G314**
Depth (ft bgs)			**(14-16)**	**(14-15)**	**(8-9)**	**(13-14, 15-16)**	**(13-18)**	**(18-23)**	**(38-43)**
Well Characterization			**AP1 Background**	**AP1 Adjacent**	**AP1 Compliance**	**AP1 Compliance**	**AP1 Compliance**	**AP1 Compliance**	**AP1 Compliance**
Sampled Aquifer Unit			**UA**	**UA**	**UA**	**UA**	**LCU**	**LCU**	**DA**
Field Boring Log Description			**Sand**	**Sand**	**Sand**	**Sand**	**Sandy to silty till**	**Sandy to silty till**	**Sand and sandy silt/clay**
Mineral/Compound	**Formula**	**Mineral Type**	(wt %)	(wt %)	(wt %)	(wt %)	(wt %)	(wt %)	(wt %)
Quartz	SiO_2	Silicate	70.9	58.9	51.3	67.6	53.9	67.5	73.5
Dolomite	$CaMg(CO_3)_2$	Carbonate	3.5	12.1	15.7	1.9	13.3	0.5	0.0
Calcite	$CaCO_3$	Carbonate	0.5	2.5	4.1	-	4.1	0.4	-
Ankerite	$CaFe(CO_3)_2$	Carbonate	2.1	5.0	7.7	0.8	7.2	1.2	0.5
Kutnohorite	$CaMn(CO_3)_2$	Carbonate	-	-	-	-	0.5	0.3	0.2
Albite	$NaAlSi_3O_8$	Feldspar	9.6	8.6	7.9	9.6	6.1	8.3	8.2
Microcline	$KAlSi_3O_8$	Feldspar	8.5	7.4	7.6	9.8	5.1	9.7	7.8
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$	Amphibole	-	-	-	-	0.3	0.7	0.8
Diopside	$CaMgSi_2O_6$	Pyroxene	3.1	3.8	4.6	1.3	1.0	0.7	0.7
Magnetite	Fe_3O_4	Oxide	-	-	-	-	-	0.2	0.0
Pyrite	FeS_2	Sulfide	-	-	-	-	-	-	-
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$	Mica	-	-	-	-	-	-	-
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Mica	-	-	-	7.3	1.0	4.8	3.3
Clay Minerals									
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot 10H_2O$	Clay	-	-	-	-	1.1	1.0	1.1
Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$	Clay	-	-	-	-	4.0	2.0	1.7
Illite-Montmorillonite	$KAl_4(Si,Al)_8O_{20}(OH)_4 \cdot 8H_2O$	Clay	-	-	-	-	-	-	-
Kaolinite	$Al_2Si_2O_5(OH)_4$	Clay	-	-	-	-	0.7	1.1	0.7
Stilpnomelane	$K(Fe^{2+},Mg,Fe^{3+})_8(Si,Al)_{12}(O,OH)_{27} \cdot n(H_2O)$	Sheet silicate	-	-	-	-	-	-	-
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$	Sheet silicate	1.8	1.7	1.1	1.7	1.6	1.7	1.5
Clay Minerals Total			1.8	1.7	1.1	1.7	7.4	5.8	5.0

Notes
Dashes indicate mineral was not identified by lab
Sample depth is shown in feet below ground surface (ft bgs).
ft bgs: feet below ground surface
wt %: percentage by weight
AP1: Ash Pond 1
LCU: Lower Confining Unit
DA: Deep Aquifer
UA: Uppermost Aquifer

Table 4. XRD Analysis of Site Solids
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 2

Well ID			**G407**	**G410**	**G410**	**G1001**
Depth (ft bgs)			**(10-13)**	**(11-12)**	**(12.5-13)**	**(6-11)**
Well Characterization			**AP2 Compliance**	**AP2 Sidegradient**	**AP2 Sidegradient**	**AP2 Compliance**
Sampled Aquifer Unit			**UA**	**UA**	**UA**	**LCU**
Field Boring Log Description			**Sandy to gravelly silt**	**Sandy to gravelly silt**	**Sandy to gravelly silt**	**Clay with trace sand**
Mineral/Compound	**Formula**	**Mineral Type**	(wt %)	(wt %)	(wt %)	(wt %)
Quartz	SiO_2	Silicate	51.2	50.7	50.5	46.3
Dolomite	$CaMg(CO_3)_2$	Carbonate	6.0	7.6	8.1	11.3
Calcite	$CaCO_3$	Carbonate	2.4	2.6	2.8	4.2
Ankerite	$CaFe(CO_3)_2$	Carbonate	9.4	8.4	8.1	1.5
Kutnohorite	$CaMn(CO_3)_2$	Carbonate	0.1	-	0.2	-
Albite	$NaAlSi_3O_8$	Feldspar	6.8	7.4	7.5	10.4
Microcline	$KAlSi_3O_8$	Feldspar	7.2	5.9	5.8	7.8
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$	Amphibole	0.5	0.6	0.6	0.9
Diopside	$CaMgSi_2O_6$	Pyroxene	0.4	0.5	0.7	0.8
Magnetite	Fe_3O_4	Oxide	0.1	0.1	0.2	-
Pyrite	FeS_2	Sulfide	-	-	-	0.1
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$	Mica	-	-	-	2.4
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	Mica	5.5	4.4	4.3	10.3
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot 10H_2O$	Clay	3.2	3.2	2.9	-
Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$	Clay	3.3	3.0	2.9	-
Illite-Montmorillonite	$KAl_4(Si,Al)_8O_{20}(OH)_4 \cdot 8H_2O$	Clay	-	1.3	1.7	-
Kaolinite	$Al_2Si_2O_5(OH)_4$	Clay	0.9	0.6	0.6	-
Stilpnomelane	$K(Fe^{2+},Mg,Fe^{3+})_8(Si,Al)_{12}(O,OH)_{27} \cdot n(H_2O)$	Sheet silicate	-	-	-	2.6
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$	Sheet silicate	3.0	3.9	3.2	1.5
Clay Minerals Total			10.4	12.0	11.3	4.1

Notes
Dashes indicate mineral was not identified by lab
Sample depth is shown in feet below ground surface (ft bgs).
ft bgs: feet below ground surface
wt %: percentage by weight
AP1: Ash Pond 1
AP2: Ash Pond 2
LCU: Lower Confining Unit
DA: Deep Aquifer
UA: Uppermost Aquifer

Table 5. AP1 Eh-pH Diagram Inputs
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Well ID		**G313**	**G314**
Sample Date		**6/6/2023**	**6/1/2023**
Aquifer Unit		**UA**	**LCU**
Input Parameter	**Unit**		
Temperature	°C	18.3	16.1
pH	SU	6.94	6.78
Calcium	mg/L	200	250
Chloride	mg/L	23	30
Bicarbonate Alkalinity	mg/L	490	660
Magnesium	mg/L	100	83
Sodium	mg/L	150	390
Potassium	mg/L	0.93	3.1
Sulfate	mg/L	720	2000
Total Manganese	mg/L	0.37	1.1
Total Iron	mg/L	0.37	1.2

Notes
°C - degrees Celsius
mg/L - milligrams per liter
SU - standard units
UA - uppermost aquifer

Table 6. Total and Dissolved Aqueous Iron and Manganese Results
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Well ID	Well Characterization	Sampled Aquifer Unit	Date	Iron, total (mg/L)	Iron, dissolved (mg/L)	Manganese, total (mg/L)	Manganese, dissolved (mg/L)
G281	AP1 Background	UA	2023/06/08	0.88	0.016	0.7	0.31
			2023/08/14	0.194	<0.0175	0.352	0.291
G301	AP1 Compliance	UA	2023/06/06	0.84	0.17	2.3	2.3
			2023/08/09	0.394	0.0697	2.03	2.04
G302	AP1 Compliance	UA	2023/05/31	2.3	0.66	1.8	1
			2023/08/09	0.489	0.284	0.483	0.424
G303	AP1 Compliance	UA	2023/05/31	1	1.1	0.39	0.4
			2023/08/09	2.07	0.612	0.383	0.323
G305	AP1 Compliance	UA	2023/06/06	6.3	0.011	0.43	0.24
			2023/08/10	0.549	0.022	0.143	0.0984
G306	AP1 Background	UA	2023/06/05	0.91	0.0094	0.078	0.006
			2023/08/10	13.8	<0.0115	0.581	0.0833
G307	AP1 Compliance	UA	2023/06/05	0.15	0.015	1.8	1.8
G307D	AP1 Compliance	LCU	2023/06/05	4.1	0.2	0.63	0.58
			2023/08/10	3.05	0.99	0.324	0.417
G308	AP1 Compliance	UA	2023/06/01	0.38	0.0057	0.35	0.32
G310	AP1 Compliance	UA	2023/06/01	0.16	0.0021	0.34	0.31
			2023/08/09	0.0255	<0.0115	0.372	0.336
G312	AP1 Compliance	UA	2023/06/01	0.048	0.0062	2.4	3
			2023/08/09	0.2	0.024	5.74	4.68
G313	AP1 Compliance	UA	2023/06/06	0.37	0.068	0.37	0.37
			2023/08/09	0.289	0.0745	0.399	0.386
G314	AP1 Compliance	LCU	2023/06/01	1.2	0.34	1.1	1.1
			2023/08/09	6.31	6.3	1.84	2.54
G314D	AP1 Compliance	DA	2023/06/01	3.6	4.9	1.6	1.4
			2023/08/09	0.944	0.704	1.1	1.01
G315	AP1 Compliance	UA	2023/06/07	3	<0.01	0.4	0.24
			2023/08/10	0.258	0.012	0.395	0.306
G316	AP1 Compliance	LCU	2023/05/31	17	17	9	8.7
			2023/08/09	15.6	16.3	9.28	9.82
XPW01	AP1 Porewater	CCR	2023/06/06	2.8	0.87	0.098	0.093
			2023/08/10	1.77	1.06	0.124	0.115
XPW02	AP1 Porewater	CCR	2023/06/06	1.9	1.3	0.1	0.12
			2023/08/10	1.21	0.742	0.0903	0.0809

Notes
mg/L: milligrams per liter
Non-detect values are shown as less than the reporting limit.
CCR: Coal Combustion Residual
AP1: Ash Pond 1
LCU: Lower Confining Unit
UA: Uppermost Aquifer

Table 7. Batch Attenuation Testing Data Summary
Geochemical Conceptual Site Model
Coffeen Power Plant Ash Pond No. 1

Groundwater Sample ID	Soil Sample ID	Soil: Water Ratio	Amendment	Target Concentration
G311	SB-311 (14-15 ft bgs)	2:1.4	2.76 g of Na_2SO_4	1500 mg/L sulfate
		1:1.3		
		1:5.7		
		1:11.3		
		1:27.8		
G313	SB-306 (14-16 ft bgs)	2:1.5	19.73 mL of a 2 g/L H_3BO_3 & 2.98 g of Na_2SO_4	5 mg/L boron; 1500 mg/L sulfate
		1:1.3		
		1:6.0		
		1:11.7		
		1:28.8		
G313	SB-313 (8-9 ft bgs)	2:1.5	19.73 mL of a 2 g/L H_3BO_3 & 1.98 g of Na_2SO_4	5 mg/L boron; 1500 mg/L sulfate
		1:1.3		
		1:6.0		
		1:11.7		
		1:28.8		

Notes:
ft bgs: feet below ground surface
g: grams
mL: milliliters
mg/L: milligrams per liter
g/L: grams per liter
Na_2SO_4: sodium sulfate
H_3BO_3: boric acid

Table 8a. Batch Attenuation Testing Results, G311
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Groundwater Sample ID	Geologic Material Sample ID	Treatment	Date	Day	Replicate	Dissolved Sulfate	pH	ORP
						mg/L	SU	mV
G311	--	Groundwater Only Control	25-Jan-22	0	G311-1a	1,589	6.83	-62
					G311-2a	1,826	6.88	-66
					Average Concentration (mg/L)	**1,708**	**6.86**	**-64**
			1-Feb-22	7	G311-1	1,617	6.85	42
					G311-2	1,478	6.85	38
					Average Concentration (mg/L)	**1,548**	**6.85**	**40**
	G311 SB-311 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 2:1-1	1,321	6.92	50
					SB-311:G311 2:1-2	1,302	6.86	100
					Average Concentration (mg/L)	**1,311**	**6.89**	**75**
		1:1 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:1-1	1,727	6.92	51
					SB-311:G311 1:1-2	860	6.88	24
					Average Concentration (mg/L)	**1,294**	**6.90**	**38**
		1:5 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:5-1	1,326	6.87	93
					SB-311:G311 1:5-2	1,516	6.88	56
					Average Concentration (mg/L)	**1,421**	**6.88**	**75**
		1:10 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:10-1	1,570	6.89	27
					SB-311:G311 1:10-2	1,551	6.86	133
					Average Concentration (mg/L)	**1,560**	**6.88**	**80**
		1:20 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:20-1	1,511	6.88	88
					SB-311:G311 1:20-2	1,588	6.86	39
					Average Concentration (mg/L)	**1,550**	**6.87**	**64**

Notes:

mg/L - milligrams per liter
mV - millivolts
SU - Standard Units
ORP - oxidation/reduction potential

Table 8b. Batch Attenuation Testing Results, G313
Geochemical Conceptual Site Model
Coffeen Power Plant - Ash Pond No. 1

Groundwater Sample ID	Geologic Material Sample ID	Treatment	Date	Day	Replicate	Dissolved Boron	Dissolved Sulfate	pH	ORP
						mg/L	mg/L	SU	mV
G313	--	Groundwater Only Control	25-Jan-22	0	G313-1a	6.5	1,372	6.98	-60
					G313-2a	6.7	1,473	6.98	-21
					Average Concentration (mg/L)	**6.6**	**1,423**	**6.98**	**-41**
			1-Feb-22	7	G313-1	6.3	1,158	6.98	113
					G313-2	6.2	1,058	6.97	40
					Average Concentration (mg/L)	**6.2**	**1,108**	**6.98**	**77**
	G313 SB-306 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 2:1-1	4.5	884	6.95	46
					SB-306:G313 2:1-2	4.7	779	6.95	44
					Average Concentration (mg/L)	**4.6**	**831**	**6.95**	**45**
		1:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:1-1	5.3	1,049	6.94	75
					SB-306:G313 1:1-2	5.3	976	6.93	44
					Average Concentration (mg/L)	**5.3**	**1,012**	**6.94**	**60**
		1:5 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:5-1	5.8	243	6.95	80
					SB-306:G313 1:5-2	6.1	1,005	6.96	-5
					Average Concentration (mg/L)	**5.9**	**624**	**6.96**	**38**
		1:10 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:10-1	6.1	958	6.96	203
					SB-306:G313 1:10-2	6.1	832	6.97	90
					Average Concentration (mg/L)	**6.1**	**895**	**6.97**	**147**
		1:20 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:20-1	6.0	881	6.96	39
					SB-306:G313 1:20-2	6.0	1,409	6.94	81
					Average Concentration (mg/L)	**6.0**	**1,145**	**6.95**	**60**
	G313 SB-313 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 2:1-1	4.3	852	6.96	164
					SB-313:G313 2:1-2	4.6	900	6.93	143
					Average Concentration (mg/L)	**4.5**	**876**	**6.95**	**154**
		1:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:1-1	4.9	482	6.99	78
					SB-313:G313 1:1-2	5.0	1,000	6.95	39
					Average Concentration (mg/L)	**4.9**	**741**	**6.97**	**59**
		1:5 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:5-1	6.0	1,227	6.96	23
					SB-313:G313 1:5-2	6.2	837	6.97	25
					Average Concentration (mg/L)	**6.1**	**1,032**	**6.97**	**24**
		1:10 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:10-1	6.0	1,459	6.97	63
					SB-313:G313 1:10-2	5.8	2,105	6.98	85
					Average Concentration (mg/L)	**5.9**	**1,782**	**6.98**	**74**
		1:20 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:20-1	5.8	1,000	6.96	125
					SB-313:G313 1:20-2	6.0	1,043	6.97	47
					Average Concentration (mg/L)	**5.9**	**1,022**	**6.97**	**86**

Notes:
mg/L - milligrams per liter
mV - millivolts
SU - Standard Units
ORP - oxidation/reduction potential

Table 9a. Partition Coefficient Results, G311 Geochemical Conceptual Site Model Coffeen Power Plant - Ash Pond No. 1

Geosyntec Consultants

Analyte	Isotherm	Variable	Value
Sulfate	Linear	R^2	0.61
		K_D (L/kg)	10.11
	Langmuir	R^2	0.65
		q_m (mg/g)	-0.10
		K_L (L/kg)	-6.24E+02
	Freundlich	R^2	0.78
		1/n	10.27
		K_F (L/kg)	9.20E-12

Notes:

K_D - linear partition coefficient

K_L - Langmuir partition coefficient

K_F - Freundlich partition coefficient

q_m - inverse of the slope of the linearized Langmuir isotherm

n - non-linearity constant of the Freundlich isotherm

Table 9b. Partition Coefficient Results, G313 Geochemical Conceptual Site Model Coffeen Power Plant - Ash Pond No. 1

Geosyntec Consultants

Materials	Analyte	Isotherm	Variable	Value
G313/SB-306	Boron	Linear	R^2	0.37
			K_D (L/kg)	6.13
		Langmuir	R^2	0.76
			q_m (mg/g)	0.00
			K_L (L/kg)	-1.51E+05
		Freundlich	R^2	0.64
			1/n	6.65
			K_F (L/kg)	6.50E-01
	Sulfate	Linear	R^2	0.05
			K_D (L/kg)	3.97
		Langmuir	R^2	0.01
			q_m (mg/g)	2.20
			K_L (L/kg)	1.19E+03
		Freundlich	R^2	0.00
			1/n	-0.06
			K_F (L/kg)	1.70E+03
G313/SB-313	Boron	Linear	R^2	0.24
			K_D (L/kg)	5.68
		Langmuir	R^2	0.50
			q_m (mg/g)	0.00
			K_L (L/kg)	-1.43E+05
		Freundlich	R^2	0.46
			1/n	5.25
			K_F (L/kg)	2.03E+00
	Sulfate	Linear	R^2	0.21
			K_D (L/kg)	-6.50
		Langmuir	R^2	0.51
			q_m (mg/g)	-0.66
			K_L (L/kg)	-6.91E+02
		Freundlich	R^2	--
			1/n	--
			K_F (L/kg)	--

Notes:

The Freundlich isotherm was not calculated for G313/SB-313 because the data were not conducive to log transformation

K_D - linear partition coefficient

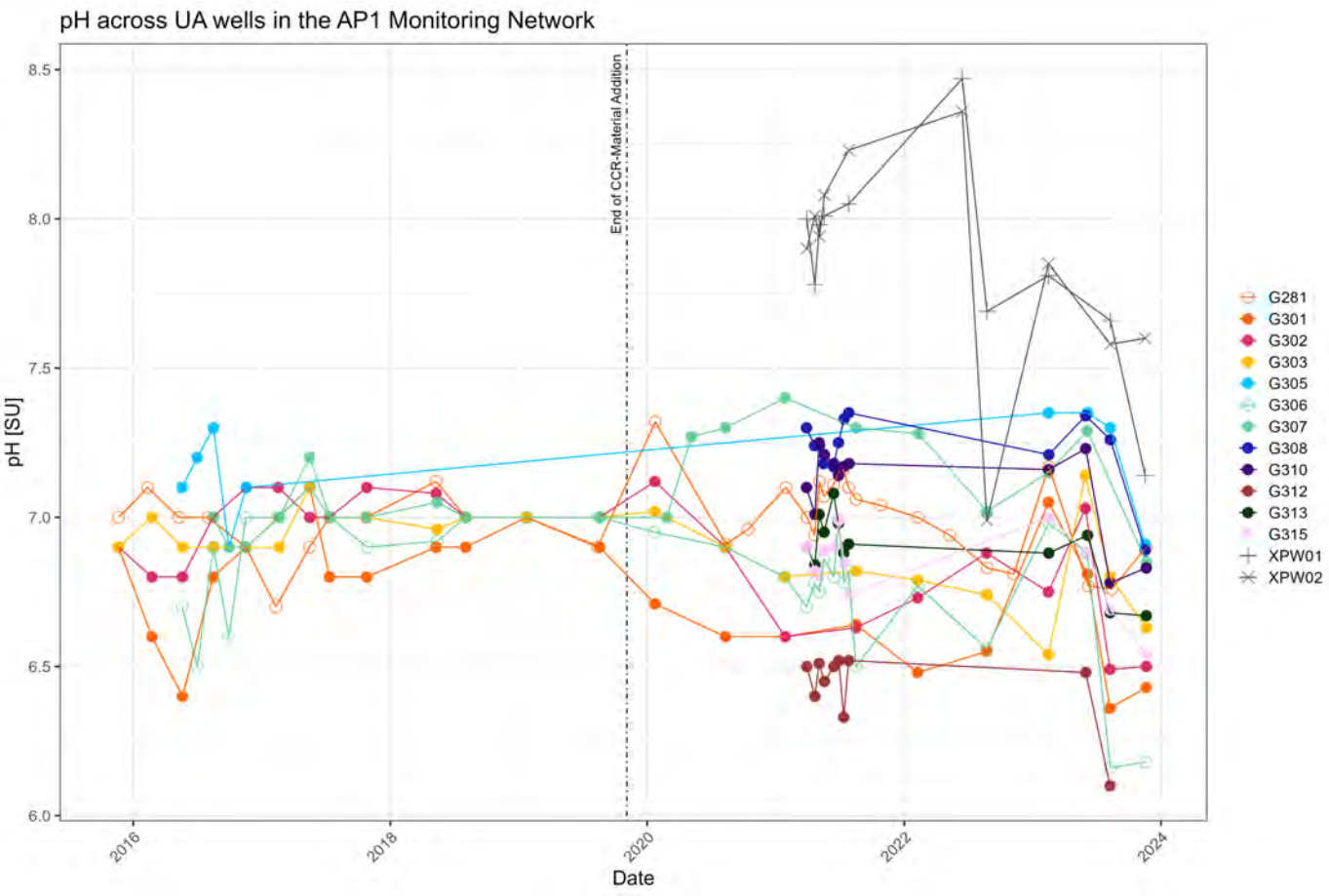
K_L - Langmuir partition coefficient

K_F - Freundlich partition coefficient

q_m - inverse of the slope of the linearized Langmuir isotherm

n - non-linearity constant of the Freundlich isotherm

FIGURES



Notes:
SU: Standard Units
Background wells shown with open symbols.

pH Time Series – Uppermost Aquifer

Coffeen Power Plant – Ash Pond No. 1

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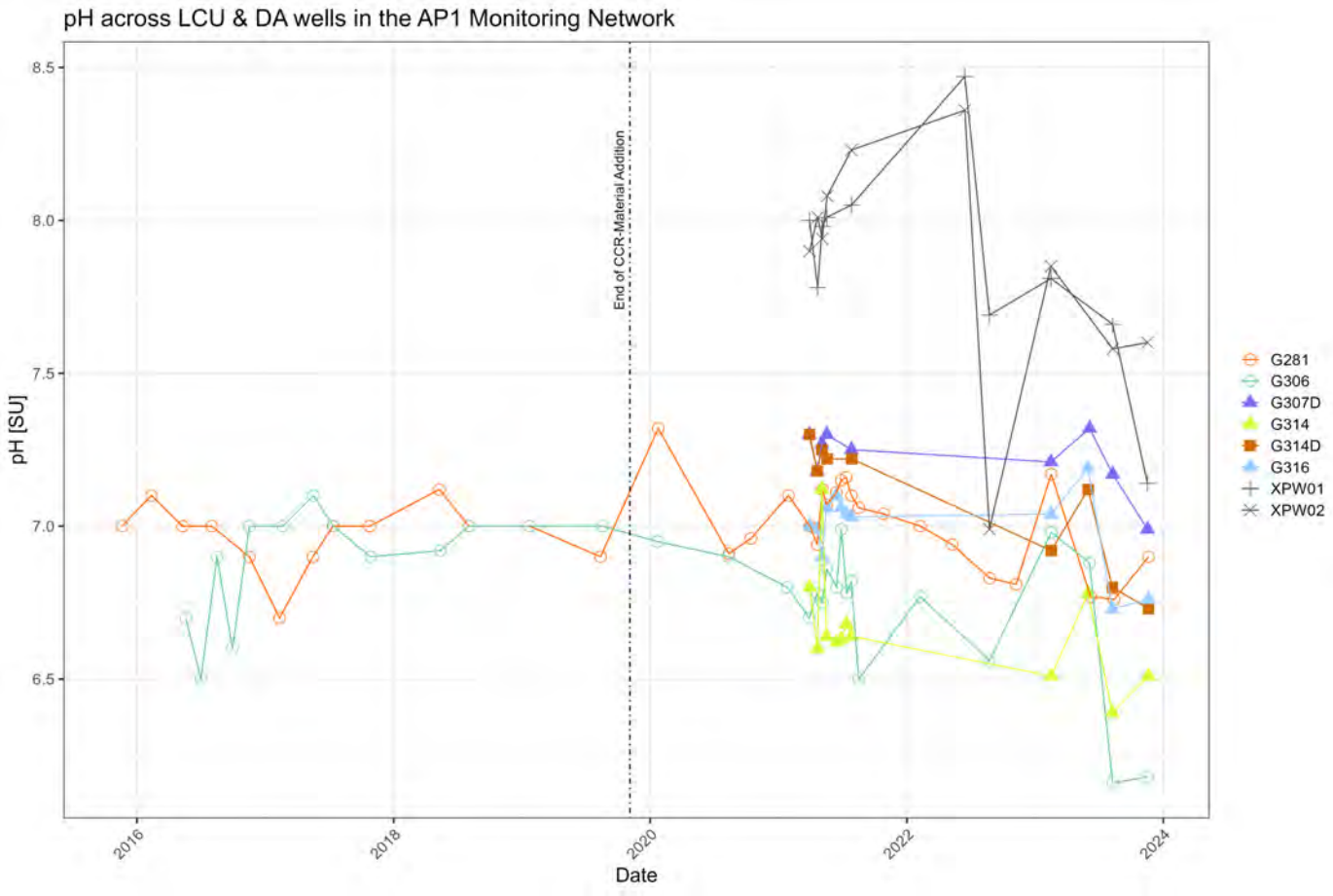
Figure **1a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
SU: Standard Units
Background wells shown with open symbols.

pH Time Series – Lower Confining Unit & Deep Aquifer

Coffeen Power Plant – Ash Pond No. 1

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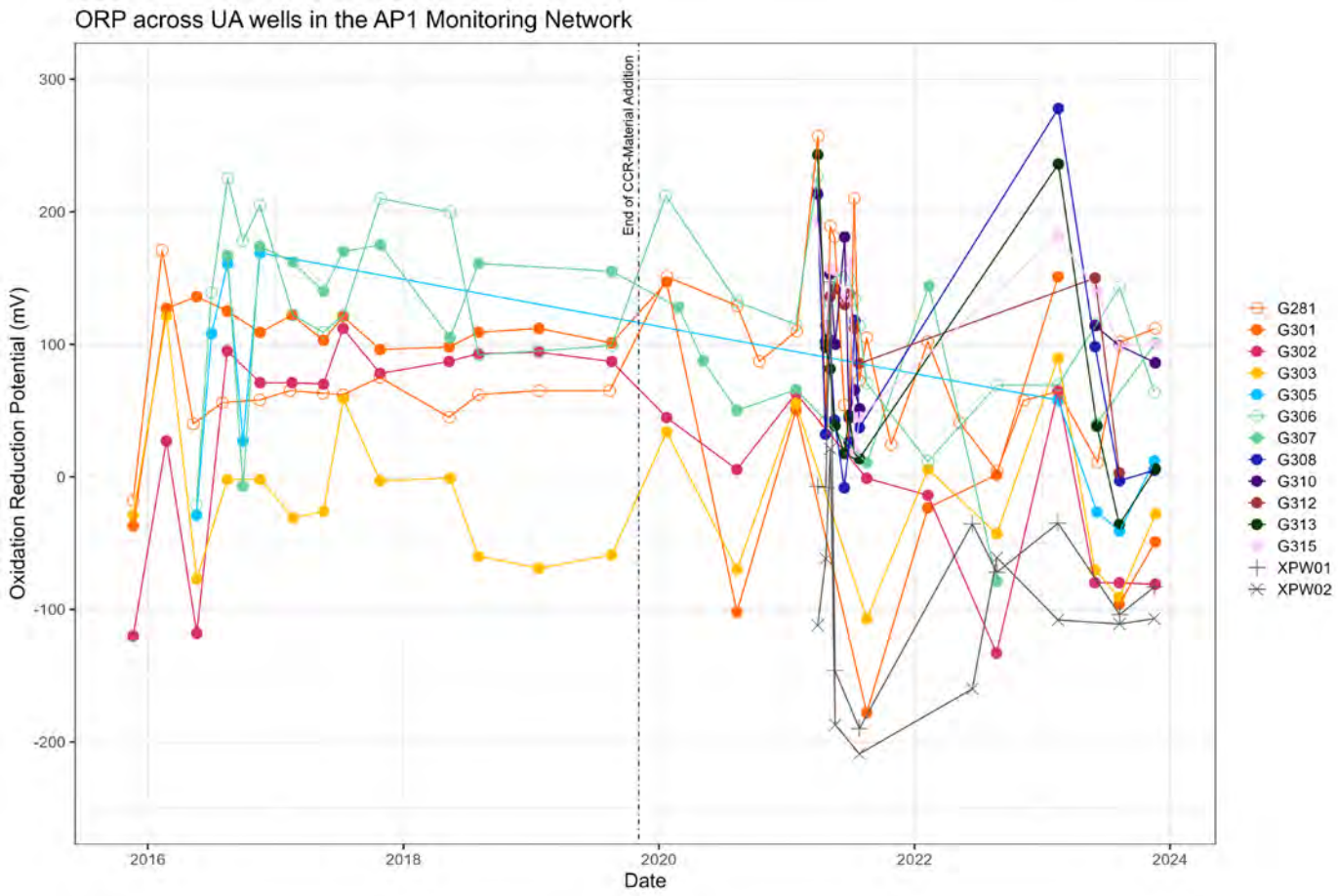
Figure **1b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mV: millivolts
Background wells shown with open symbols.

ORP Time Series – Uppermost Aquifer

Coffeen Power Plant – Ash Pond No. 1

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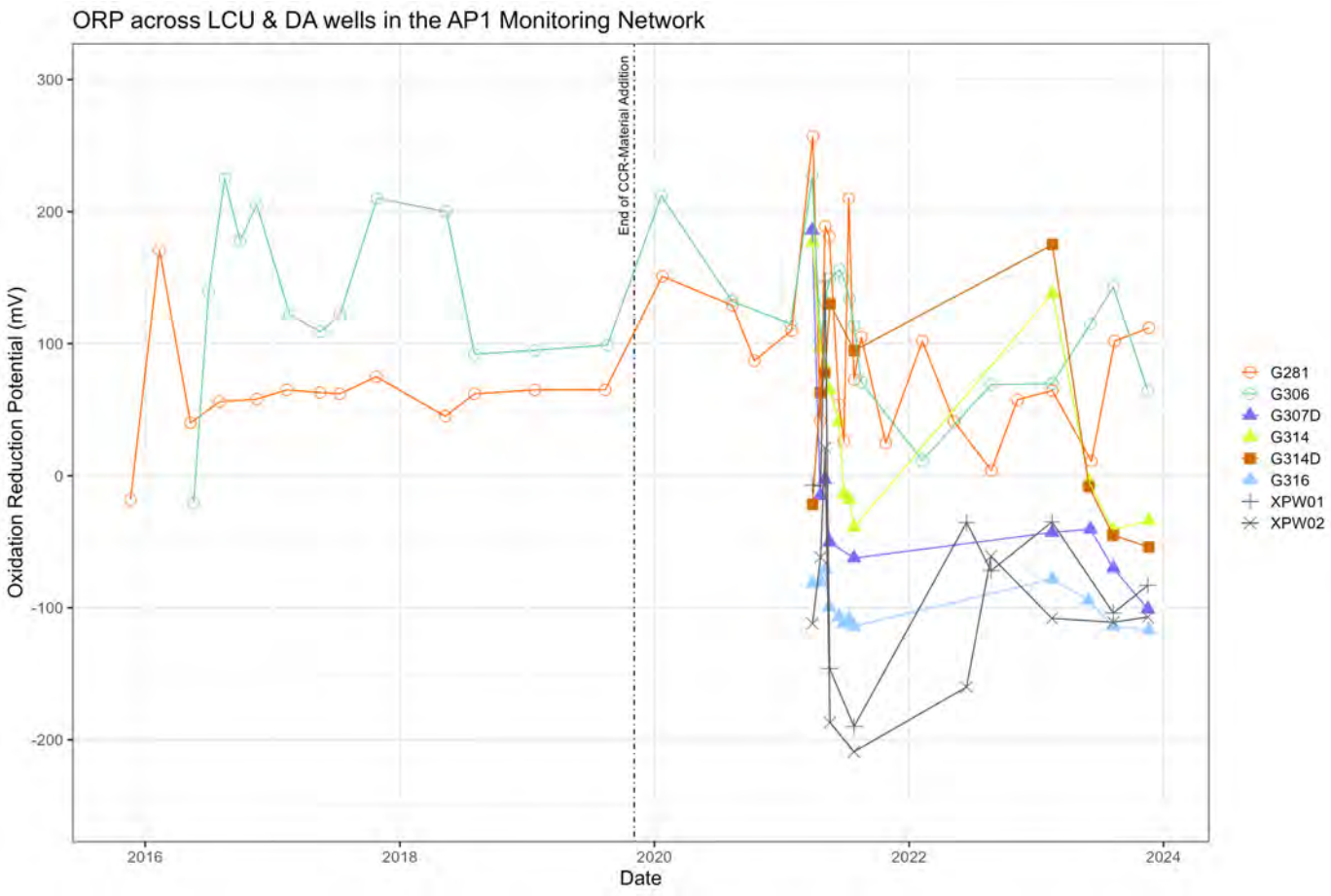
Figure **2a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mV: millivolts
Background wells shown with open symbols.

ORP Time Series – Lower Confining Unit & Deep Aquifer
Coffeen Power Plant – Ash Pond No. 1

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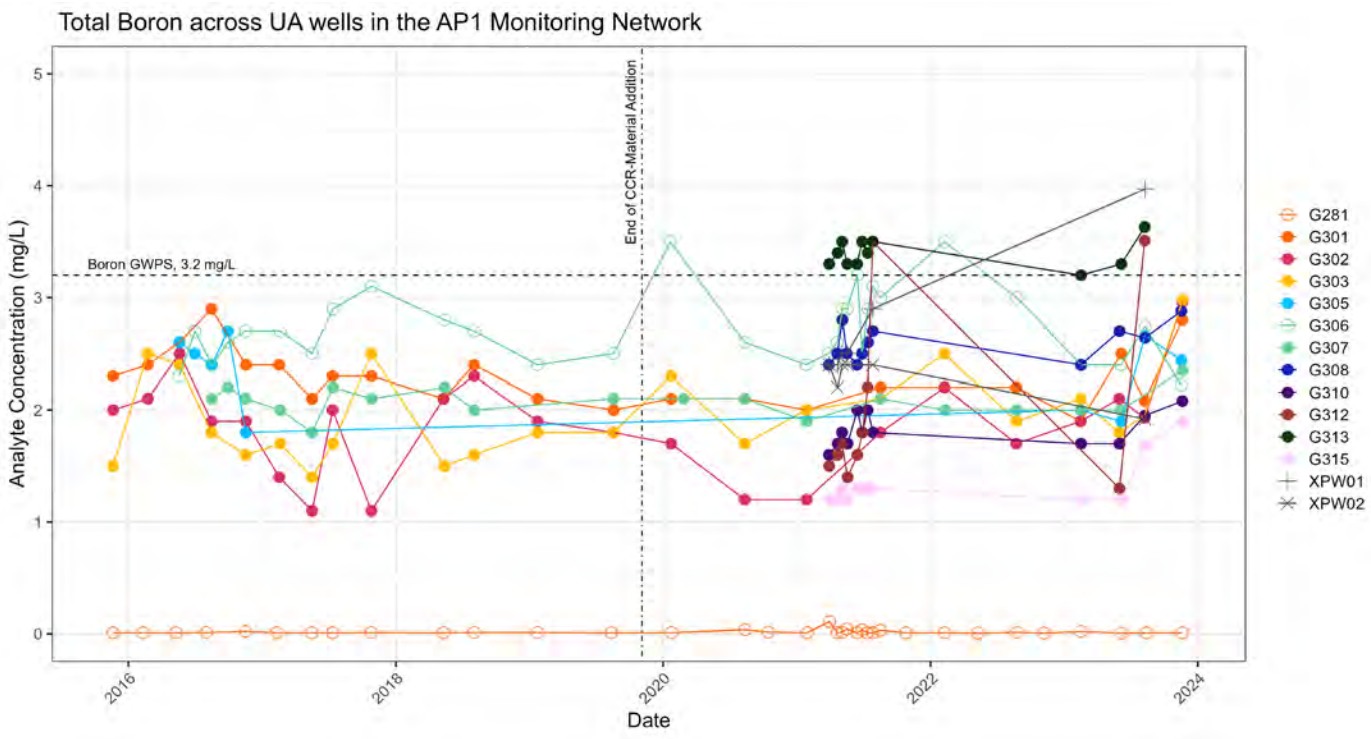
Figure **2b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
GWPS: Groundwater Protection Standard
Background wells shown with open symbols.

Boron Concentration Time Series – Uppermost Aquifer

Coffeen Power Plant – Ash Pond No. 1

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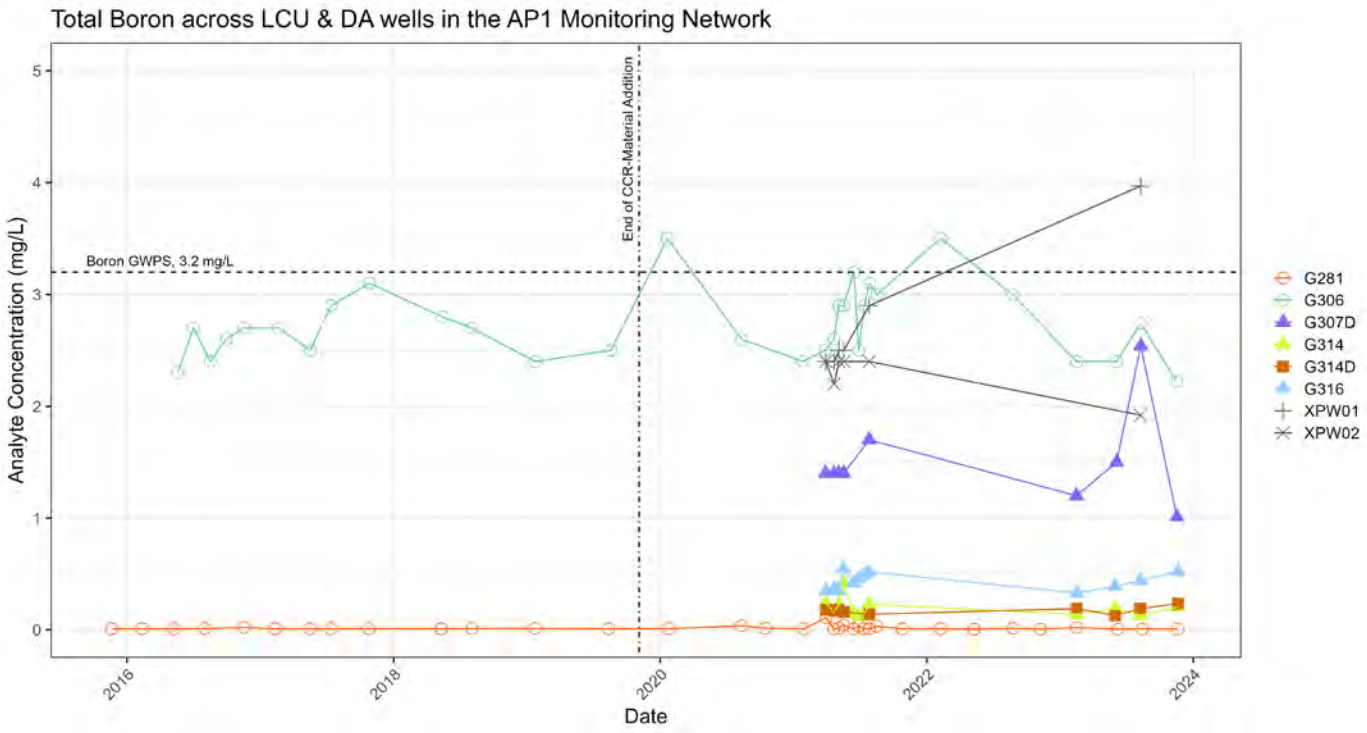
Figure **3a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
GWPS: Groundwater Protection Standard
Background wells shown with open symbols.

Boron Concentration Time Series – Lower Confining Unit & Deep Aquifer
Coffeen Power Plant – Ash Pond No. 1

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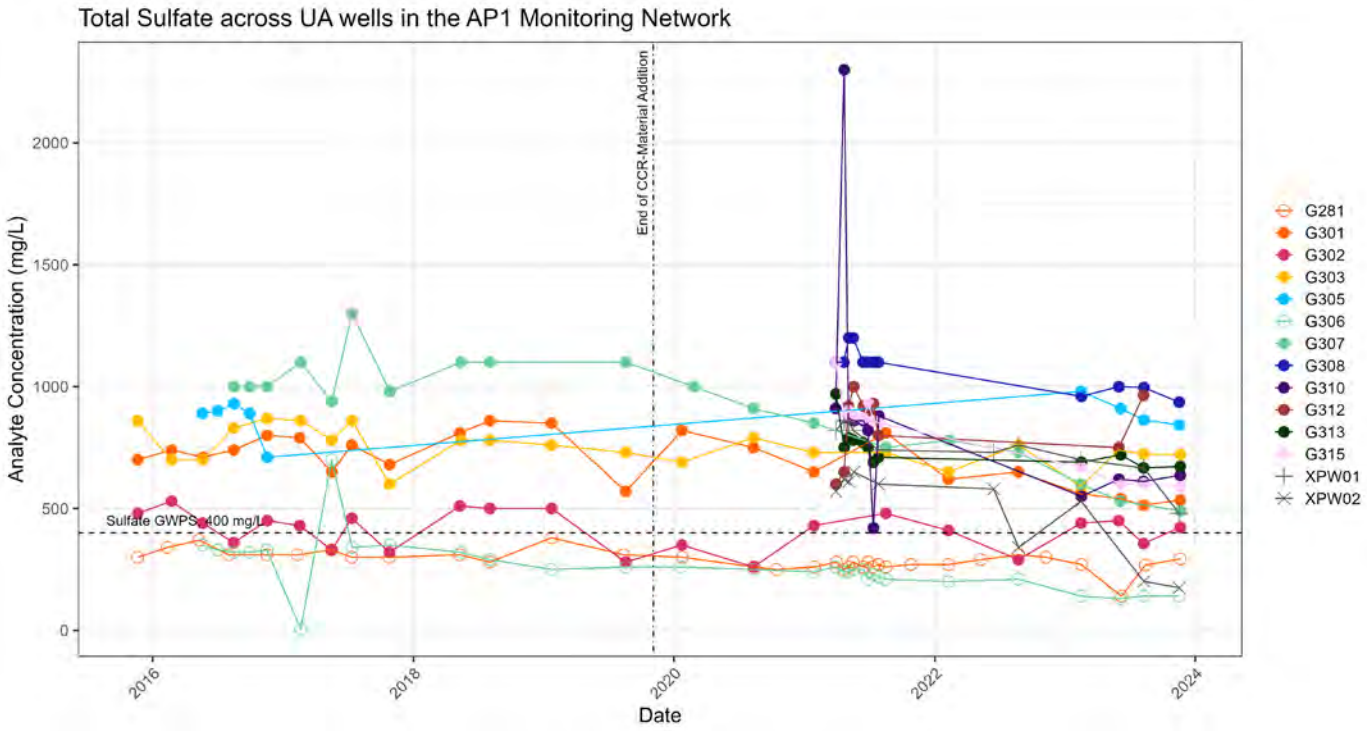
Figure **3b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
GWPS: Groundwater Protection Standard
Background wells shown with open symbols.

Sulfate Concentration Time Series – Uppermost Aquifer

Coffeen Power Plant – Ash Pond No. 1

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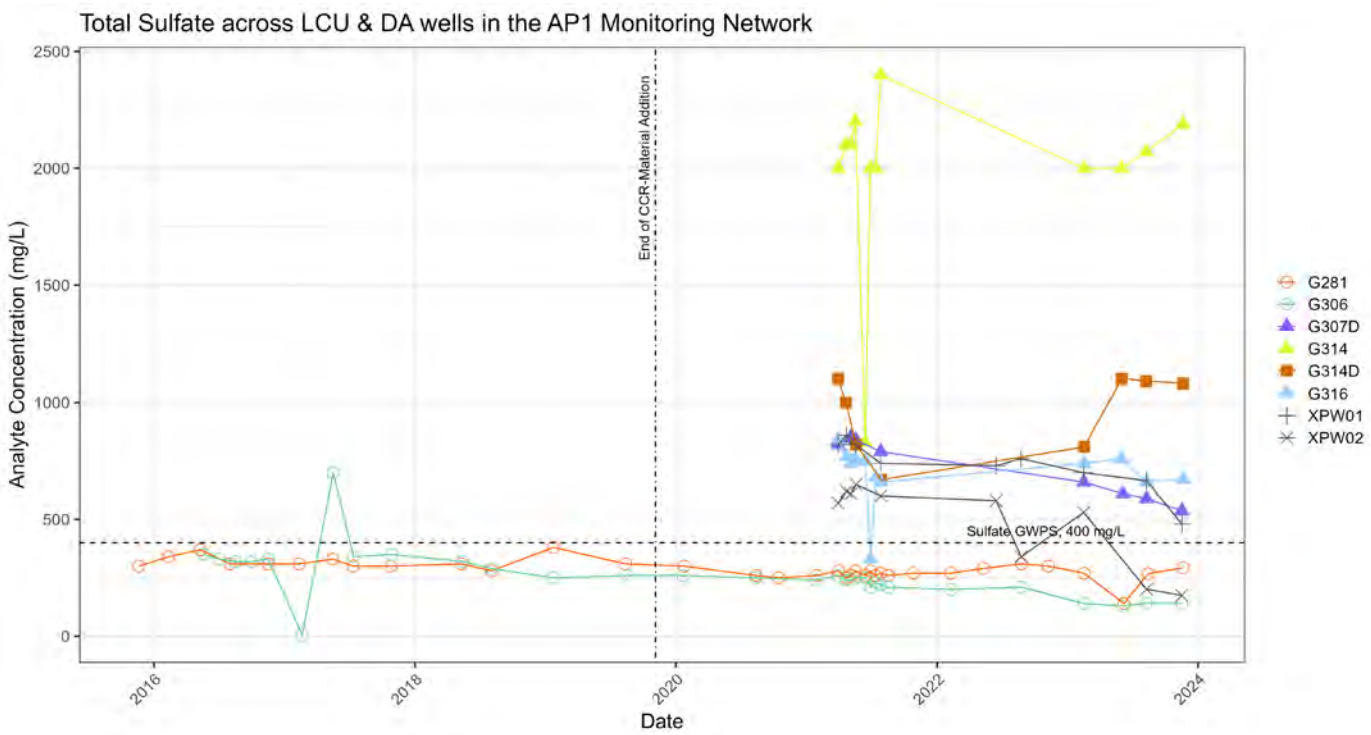
Figure **4a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
GWPS: Groundwater Protection Standard
Background wells shown with open symbols.

Sulfate Concentration Time Series – Lower Confining Unit & Deep Aquifer
Coffeen Power Plant – Ash Pond No. 1

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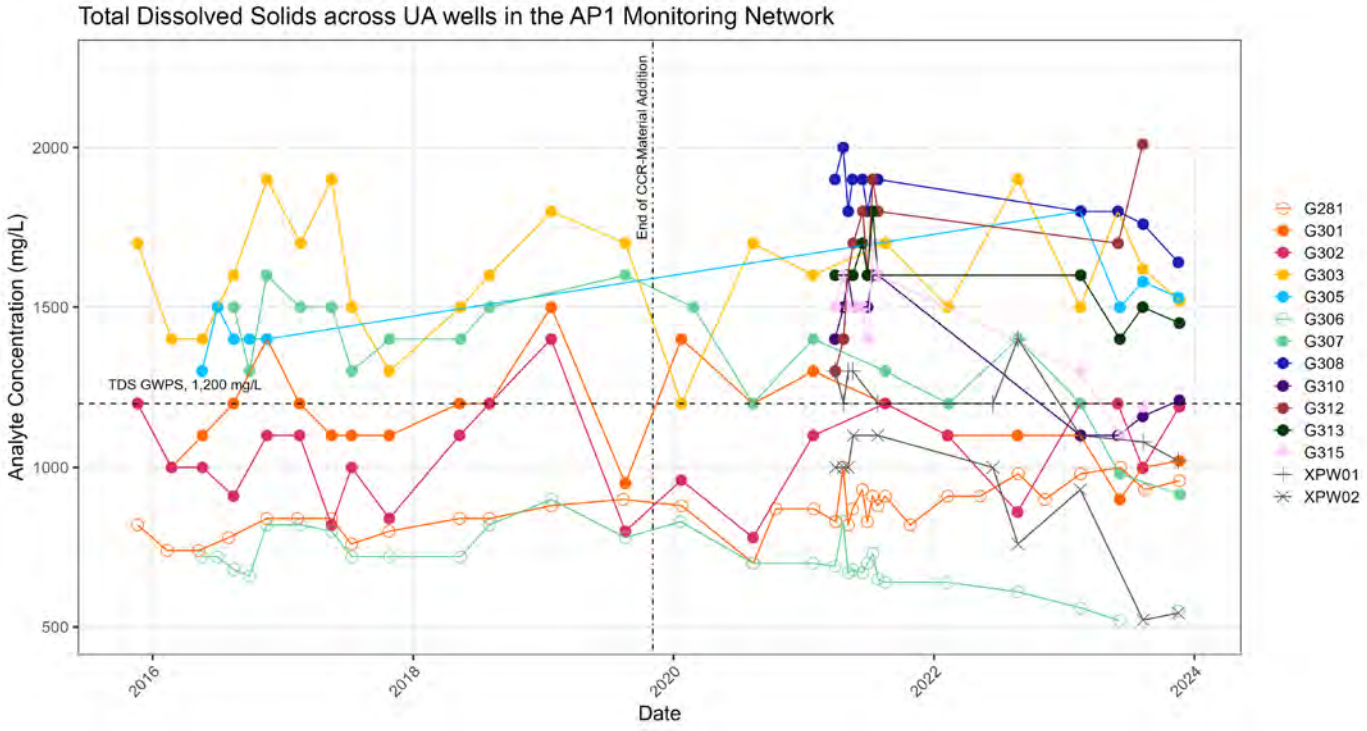
Figure **4b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
GWPS: Groundwater Protection Standard
Background wells shown with open symbols.

Total Dissolved Solids Concentration Time Series – Uppermost Aquifer
Coffeen Power Plant – Ash Pond No. 1

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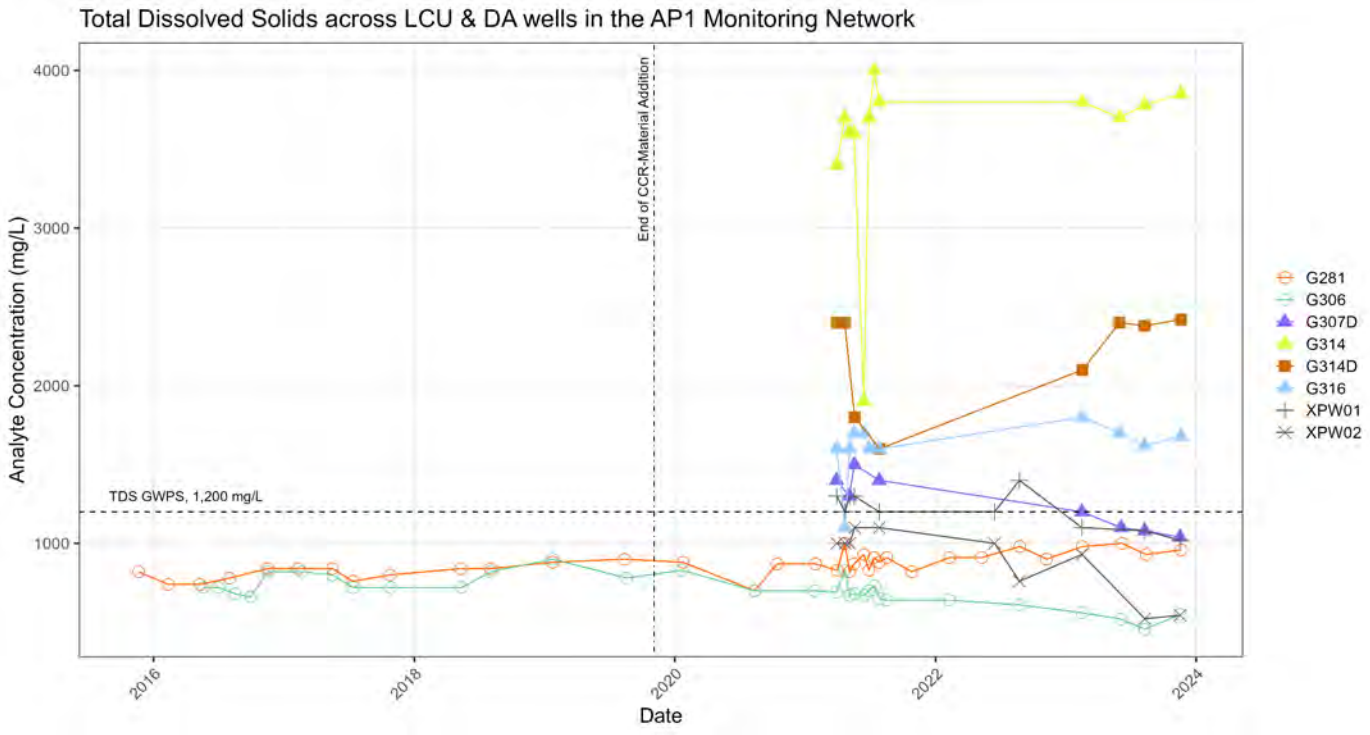
Figure **5a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
GWPS: Groundwater Protection Standard
Background wells shown with open symbols.

Total Dissolved Solids Concentration Time Series – Lower Confining Unit & Deep Aquifer
Coffeen Power Plant – Ash Pond No. 1

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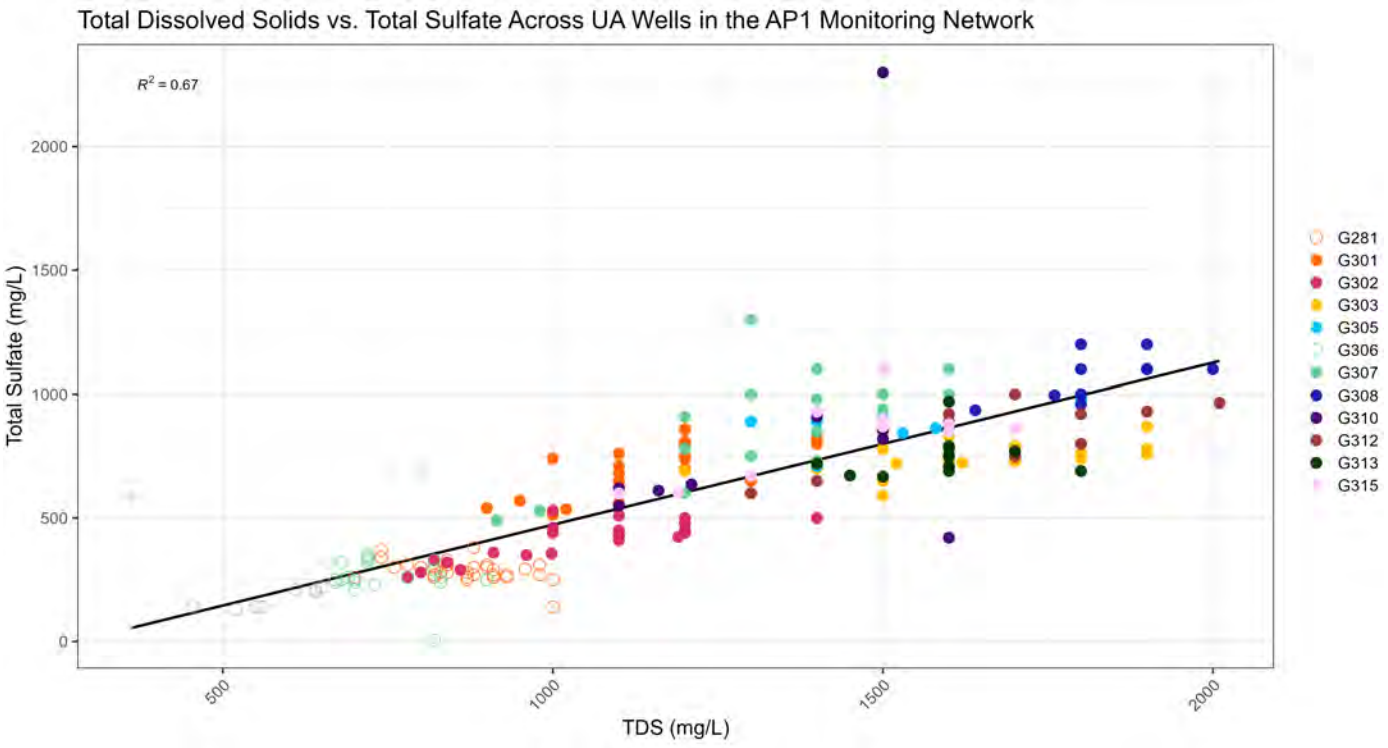
Figure **5b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
Background wells shown with open symbols.

TDS Concentration vs Sulfate Concentration – Uppermost Aquifer
Coffeen Power Plant – Ash Pond No. 1

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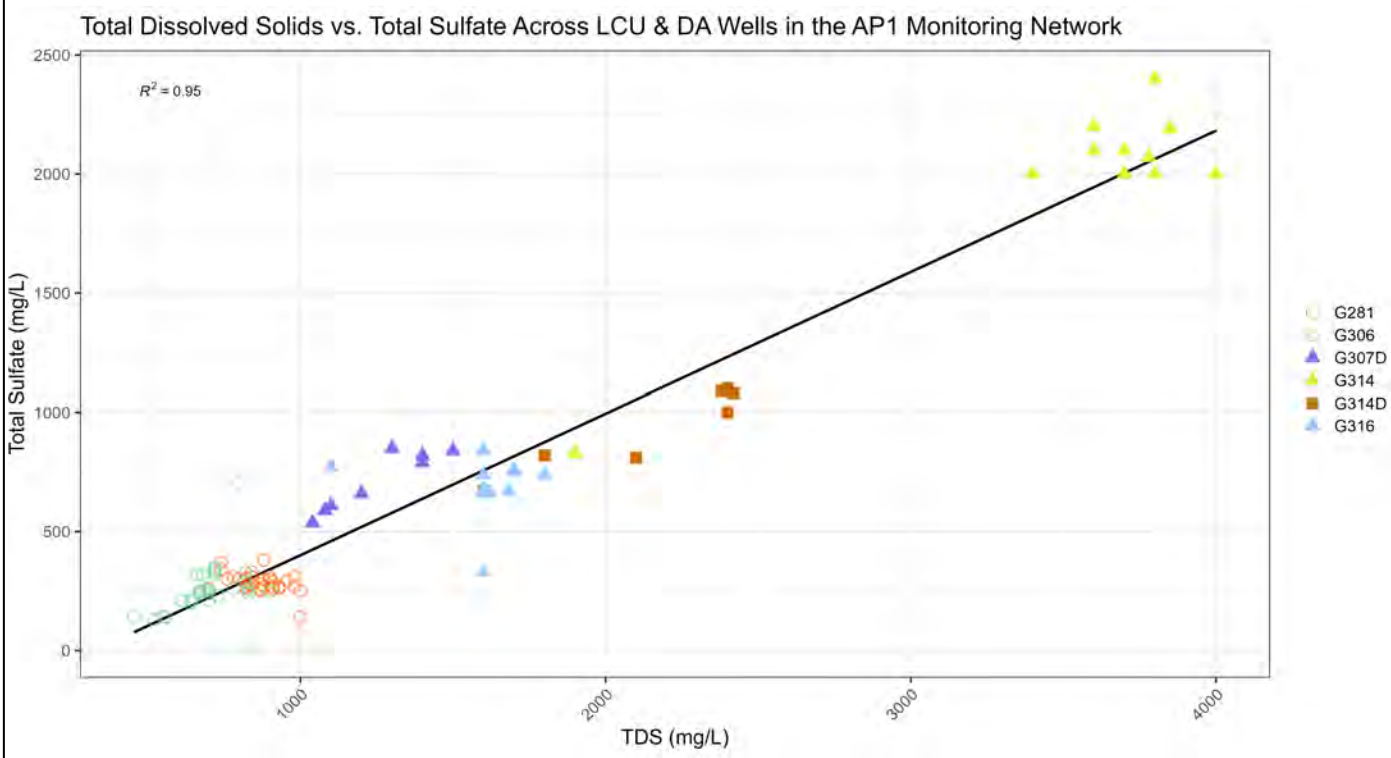
Figure **6a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:
mg/L: milligrams per liter
Background wells shown with open symbols.

TDS Concentration vs Sulfate Concentration – Lower Confining Unit & Deep Aquifer
Coffeen Power Plant – Ash Pond No. 1

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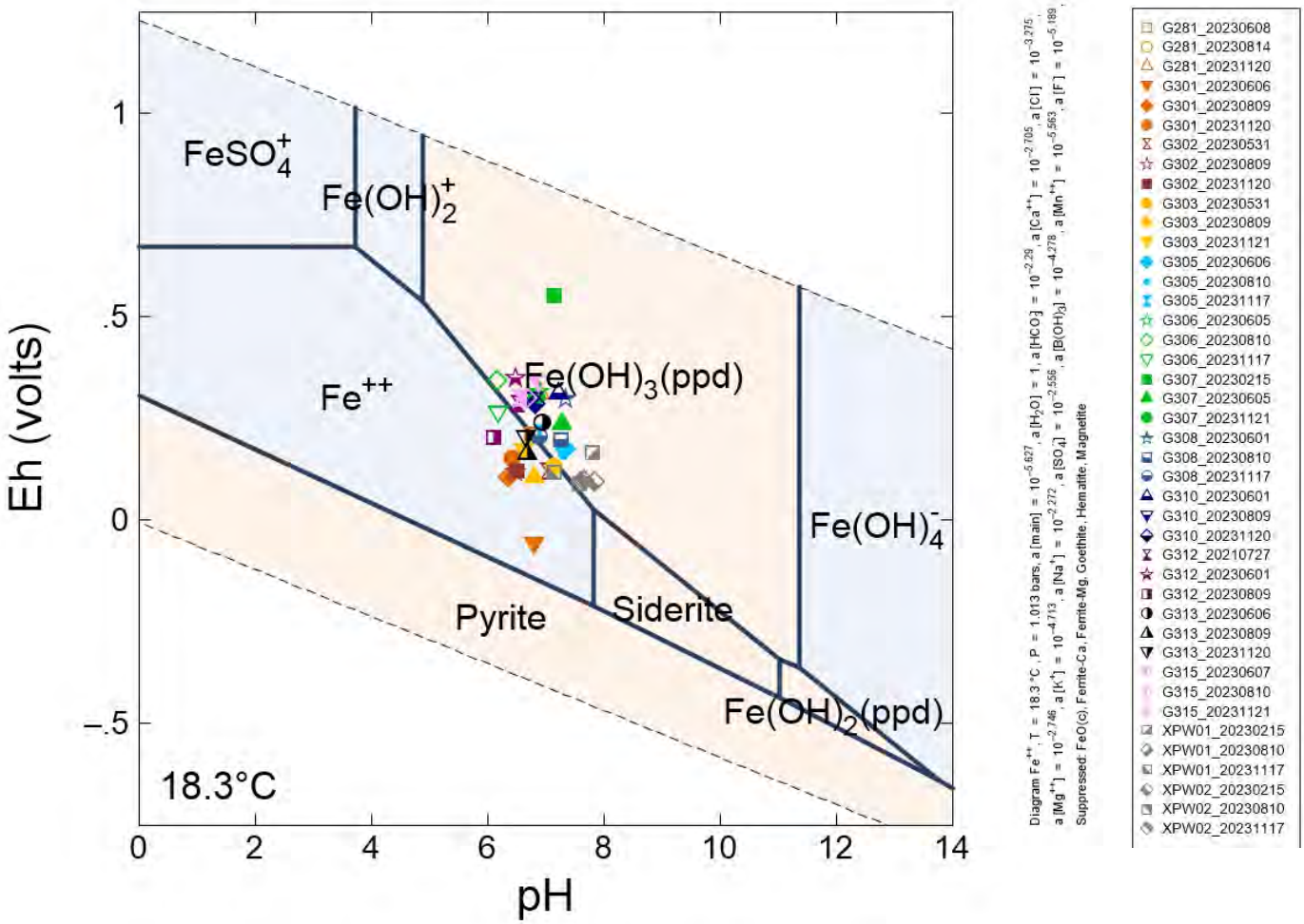
Figure **6b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:

1. Diagram was generated using conditions detected at well G313 on 6/6/2023.
2. Well G313 is screened within the uppermost aquifer.
3. The most recent available pH and ORP data for each location are displayed.
4. Hematite, ferrite-Ca, ferrite-Mg, goethite, crystalline iron oxide, and magnetite were suppressed during model generation.

Iron Pourbaix Diagram; Crystalline Phases Suppressed – Uppermost Aquifer

Coffeen Power Plant – Ash Pond No. 1

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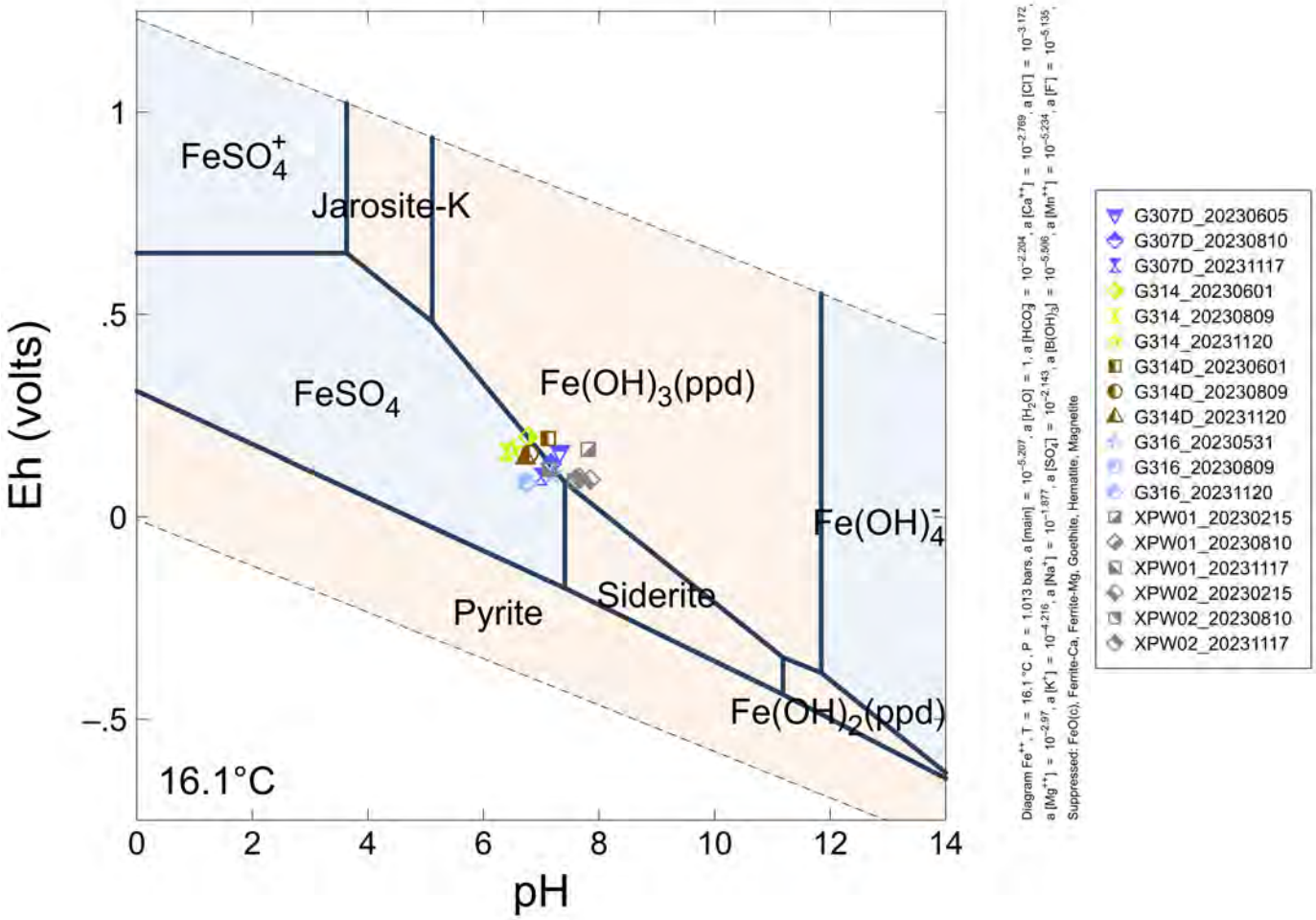
Figure **7a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:

1. Diagram was generated using conditions detected at well G314 on 6/1/2023.
2. Well G314 is screened in the lower confining unit.
3. The most recent available pH and ORP data for each location are displayed.
4. Hematite, ferrite-Ca, ferrite-Mg, goethite, crystalline iron oxide, and magnetite were suppressed during model generation.

Iron Pourbaix Diagram; Crystalline Phases Suppressed – Lower Confining Unit & Deep Aquifer

Coffeen Power Plant – Ash Pond No. 1

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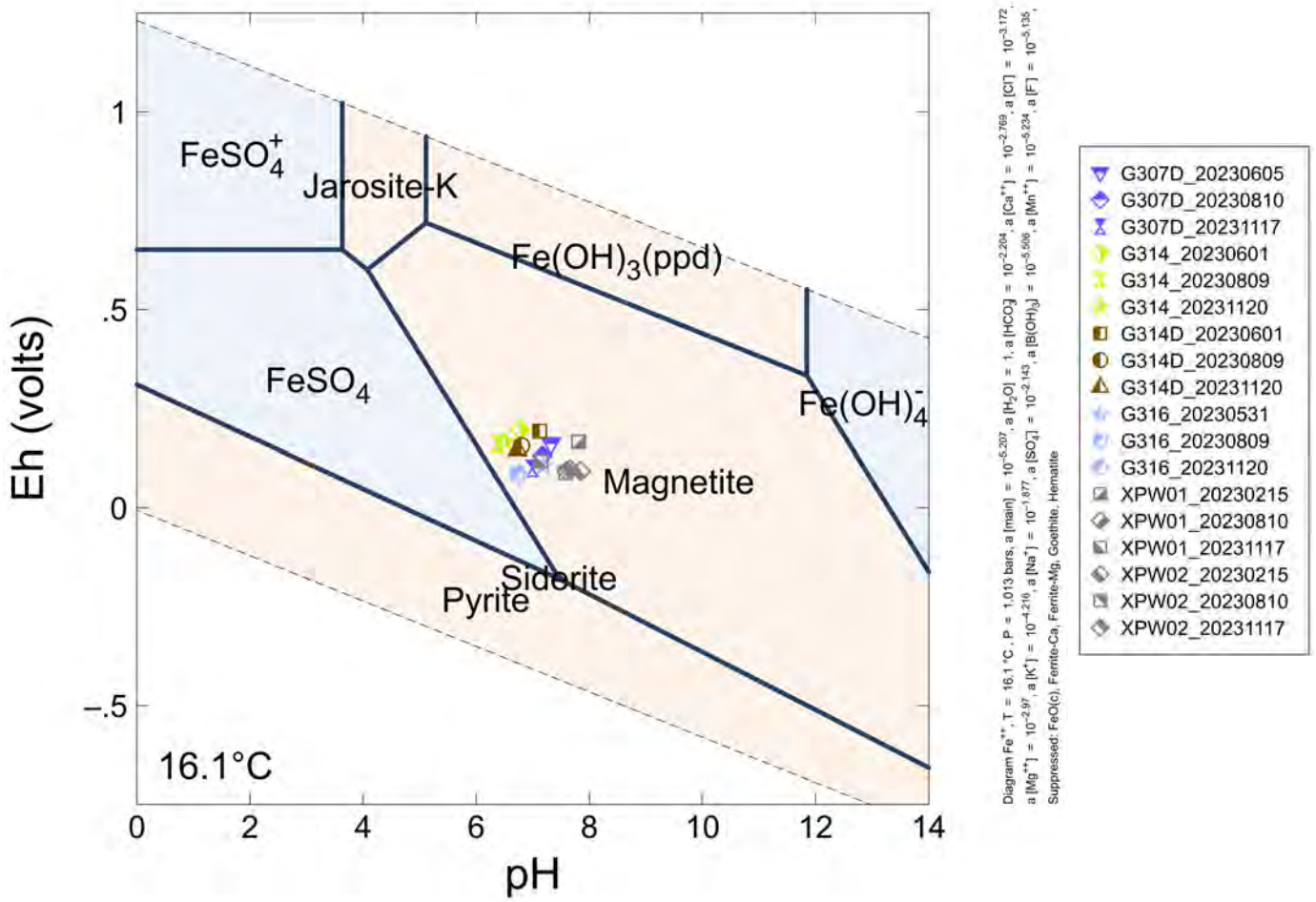
Figure **7b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:

1. Diagram was generated using conditions detected at well G314 on 6/1/2023.
2. Well G314 is screened in the lower confining unit.
3. The most recent available pH and ORP data for each location are displayed.
4. Ferrite-Ca, ferrite-Mg, goethite, crystalline iron oxide, and hematite were suppressed during model generation.

Iron Pourbaix Diagram –
Lower Confining Unit & Deep Aquifer
Coffeen Power Plant – Ash Pond No. 1

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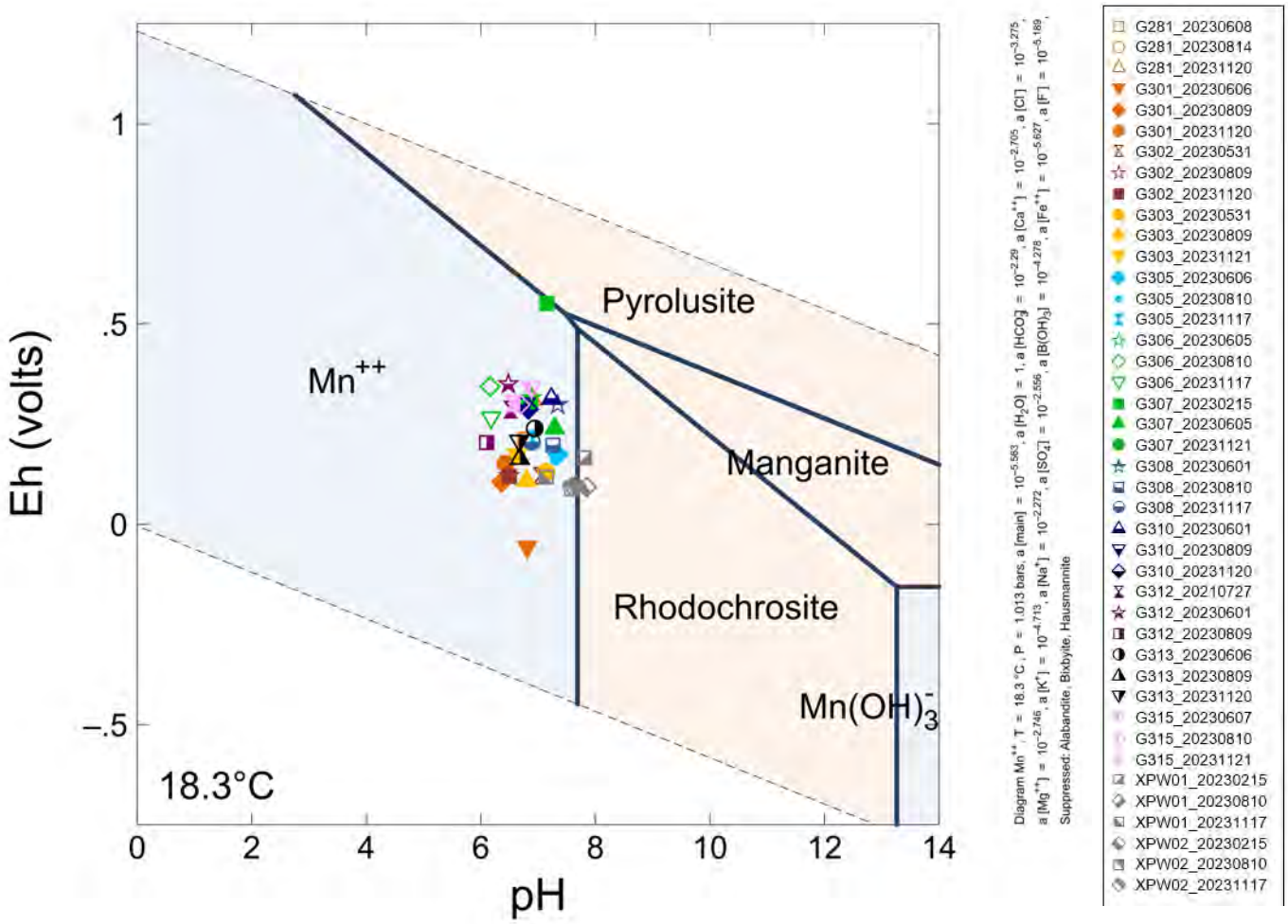
Figure **7c**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:

1. Diagram was generated using conditions detected at well G313 on 6/6/2023.
2. The most recent available pH and ORP data for each location are displayed.
3. Alabandite, bixbyite, and hausmannite were suppressed during model generation.

Manganese Pourbaix Diagram – Uppermost Aquifer

Coffeen Power Plant – Ash Pond No. 1

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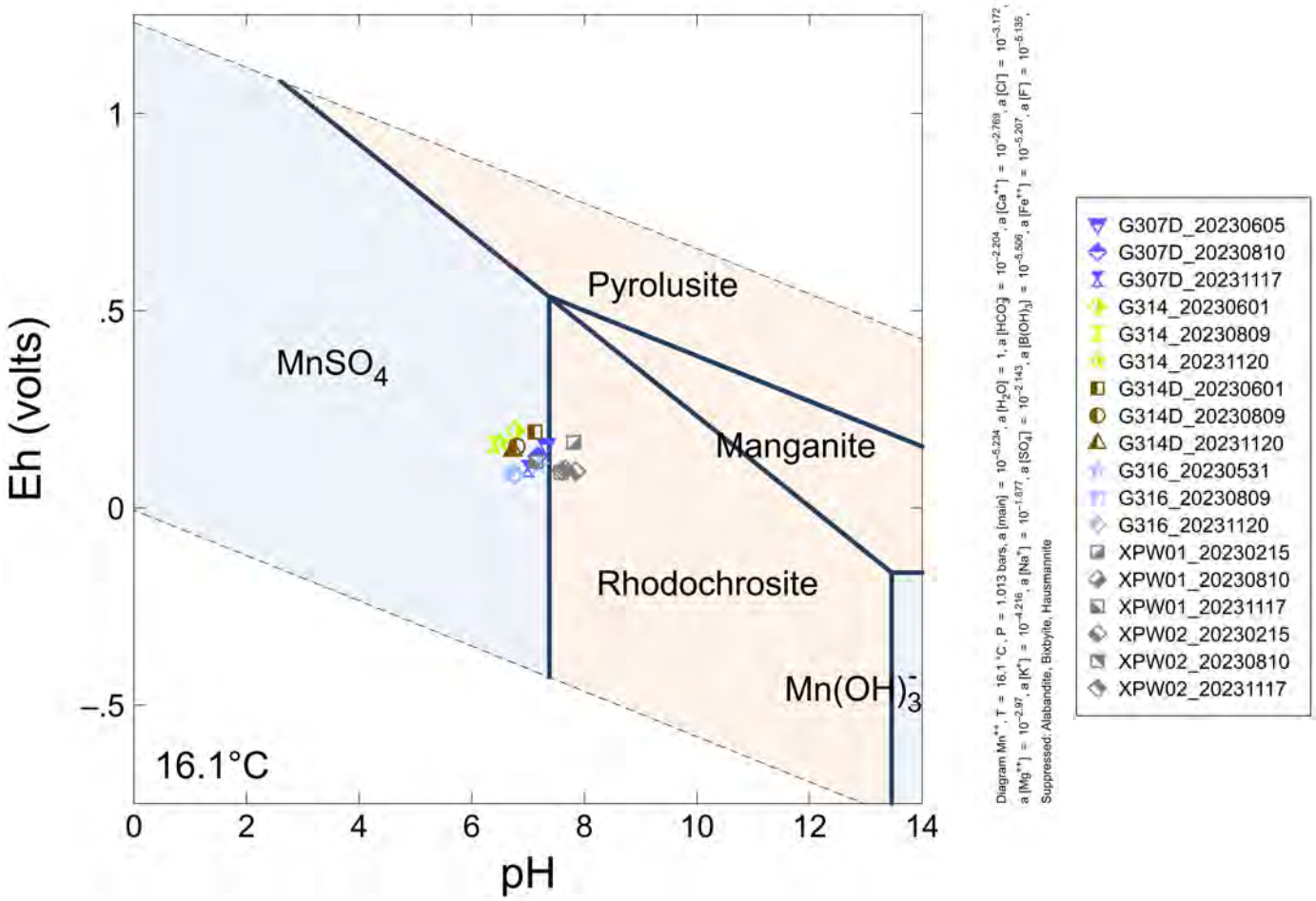
Figure **8a**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:

1. Diagram was generated using conditions detected at well G314 on 6/1/2023.
2. Well G314 is screened in the lower confining unit.
3. The most recent available pH and ORP data for each location are displayed.
4. Alabandite, bixbyite, and hausmannite were suppressed during model generation.

Manganese Pourbaix Diagram – Lower Confining Unit & Deep Aquifer

Coffeen Power Plant – Ash Pond No. 1

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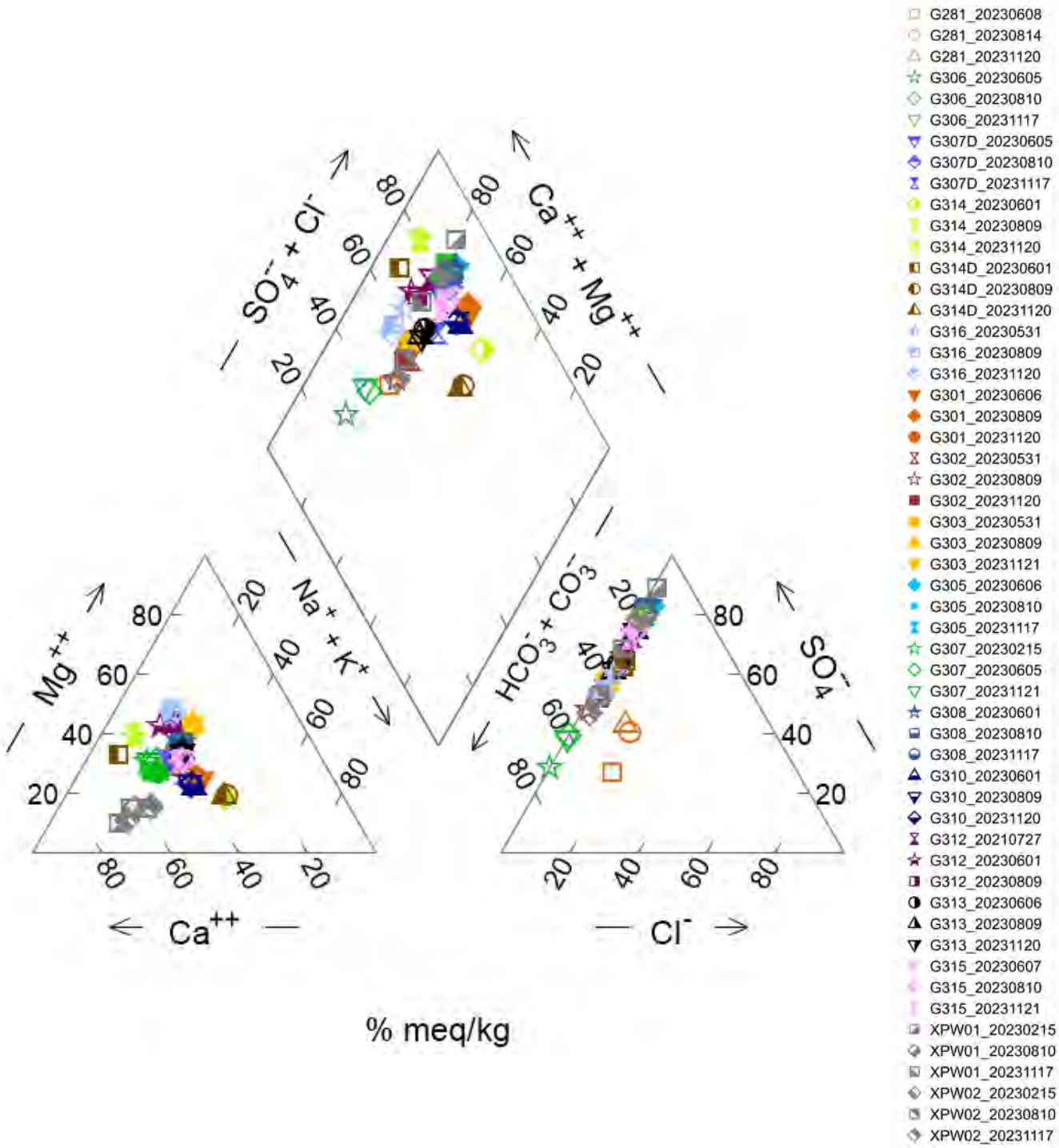
Figure **8b**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures



Notes:

1. The three most recent available data points for each location are displayed.

% meq/kg: percent milliequivalents per kilogram

Piper Diagram

Coffeen Power Plant – Ash Pond No. 1

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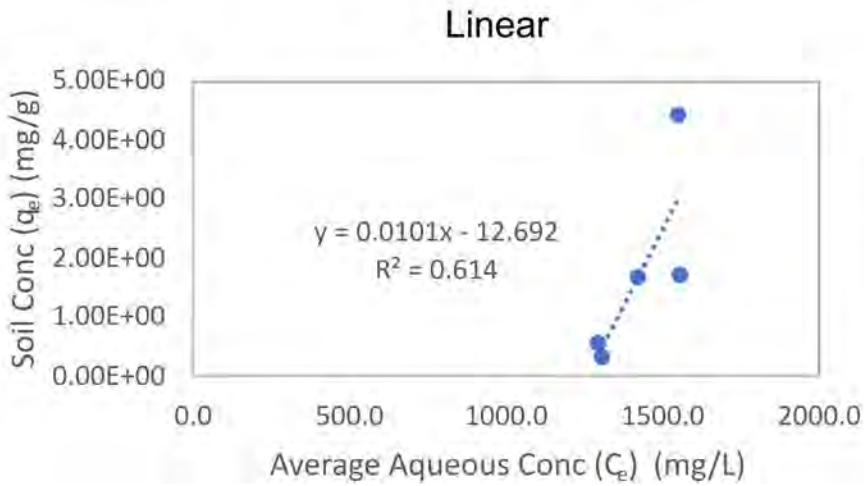
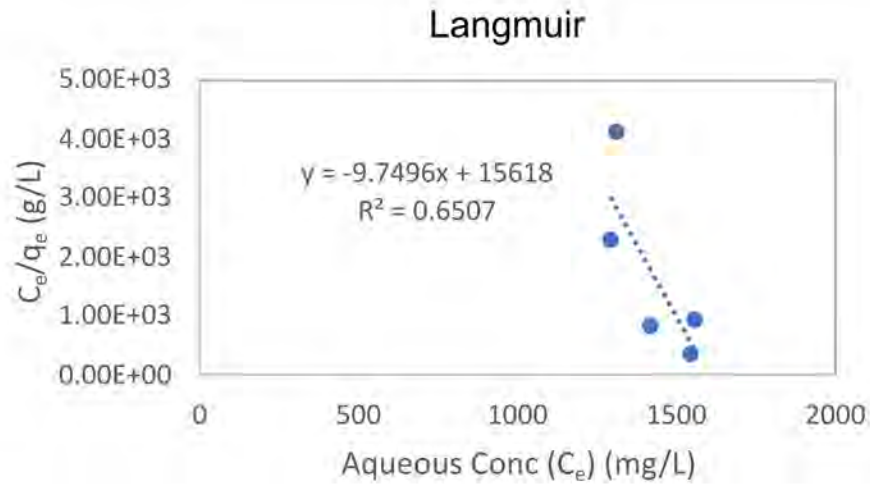
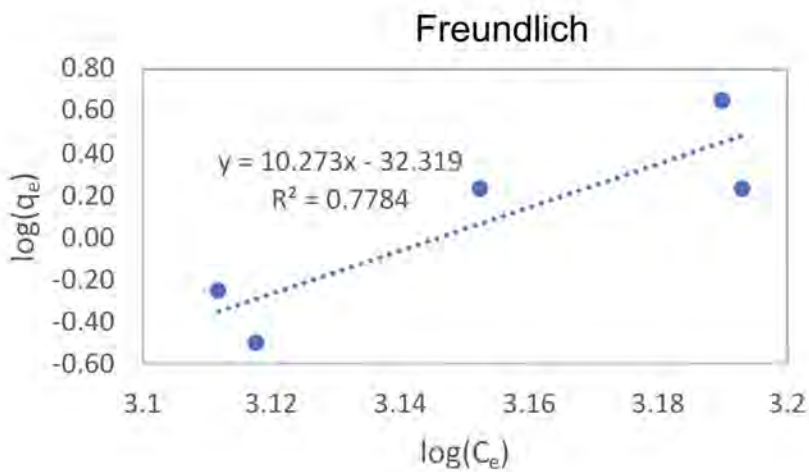
Figure **9**

Vistra - Groundwater Compliance - Documents\General\GCSM\Coffeen\Figures







Notes:
q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G311 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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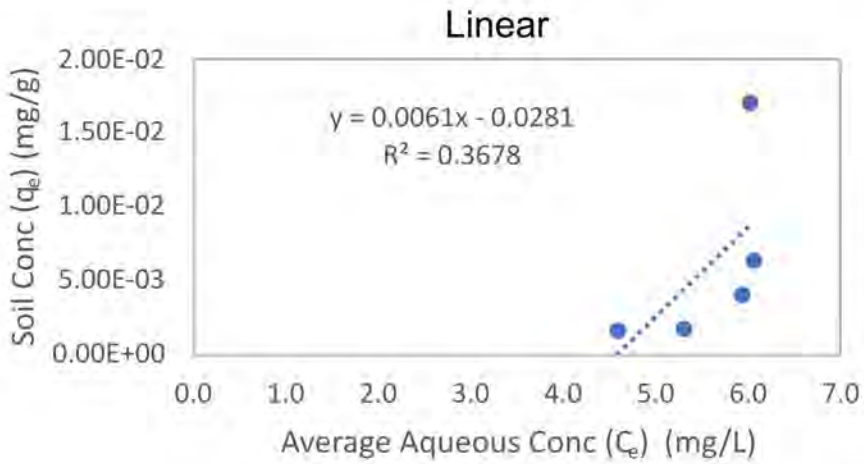
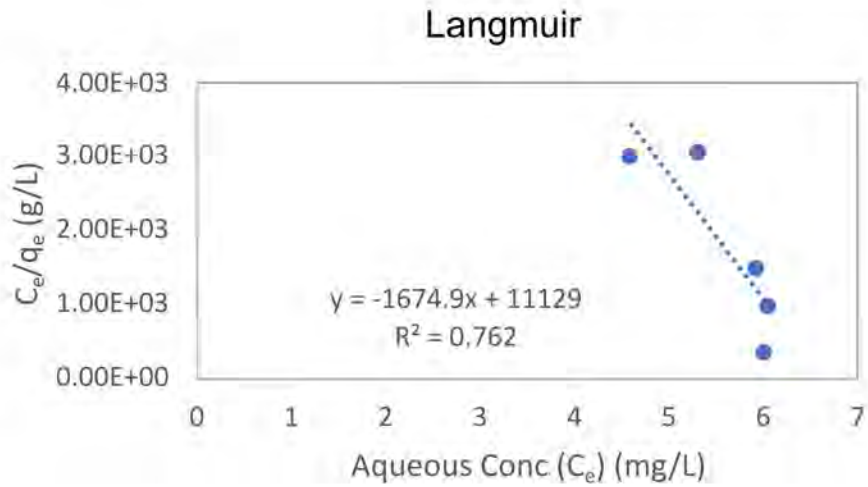
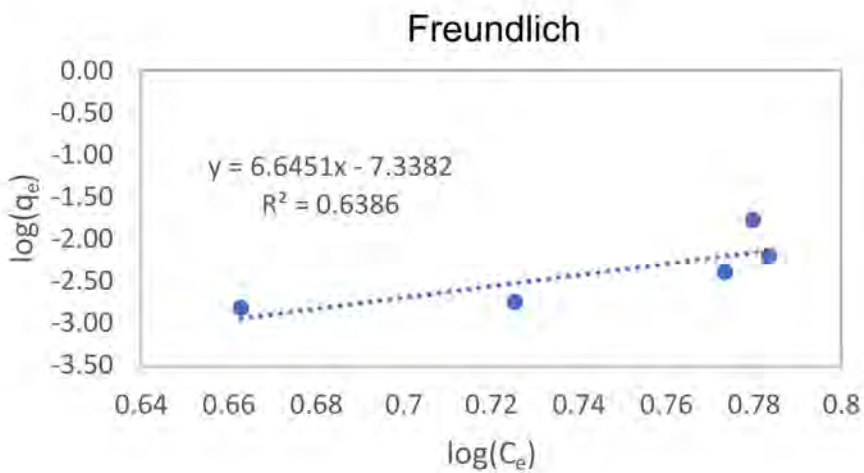
Columbus, OH | January 2024

Figure **10a**







Notes:

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-306 Boron Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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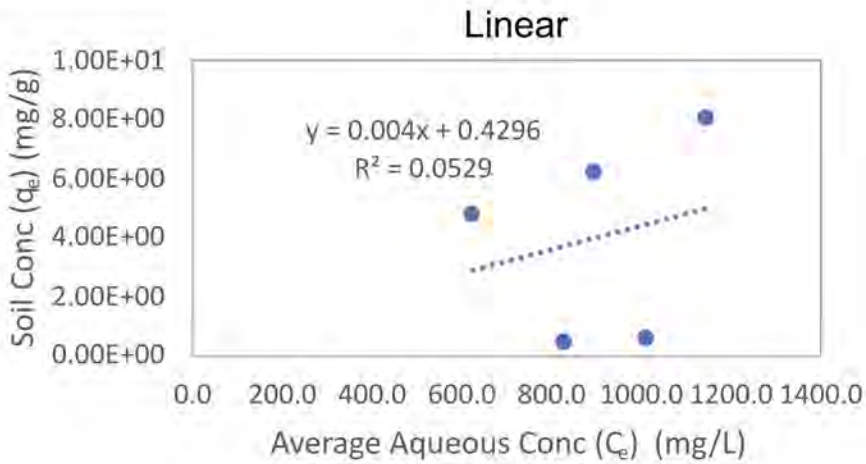
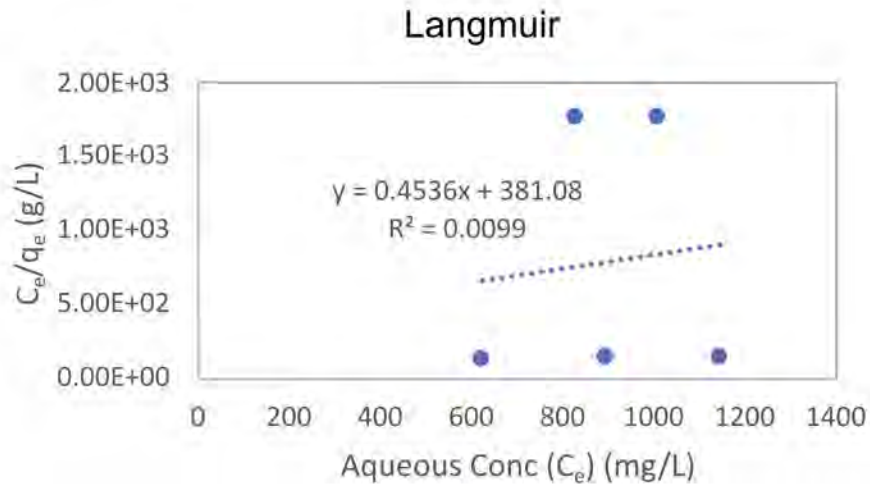
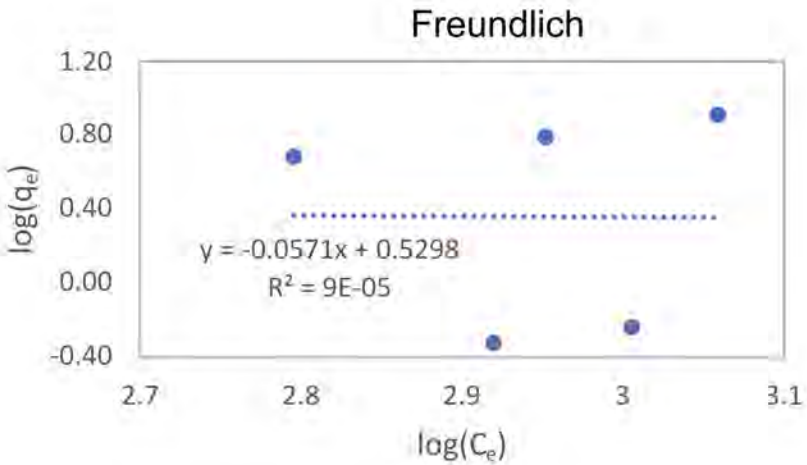
Figure **10b**







Notes:

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-306 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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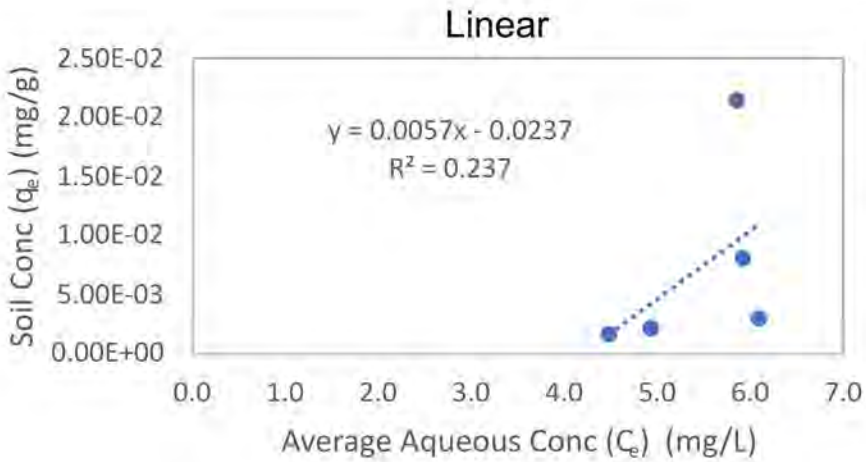
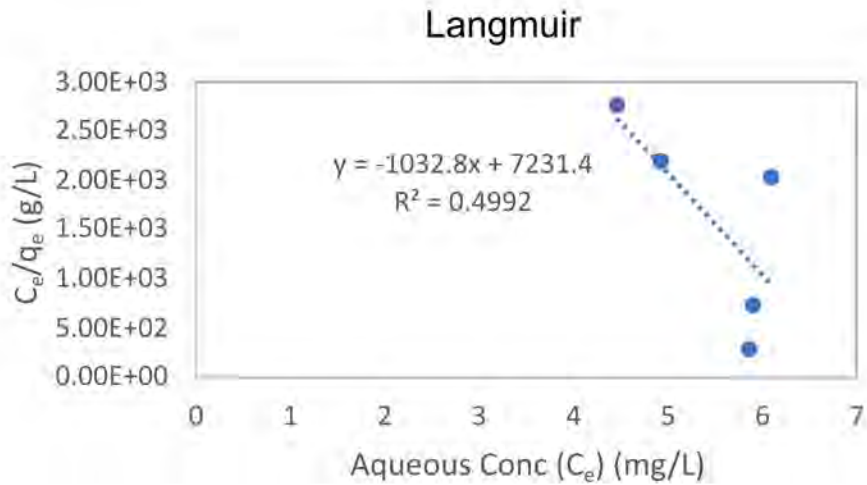
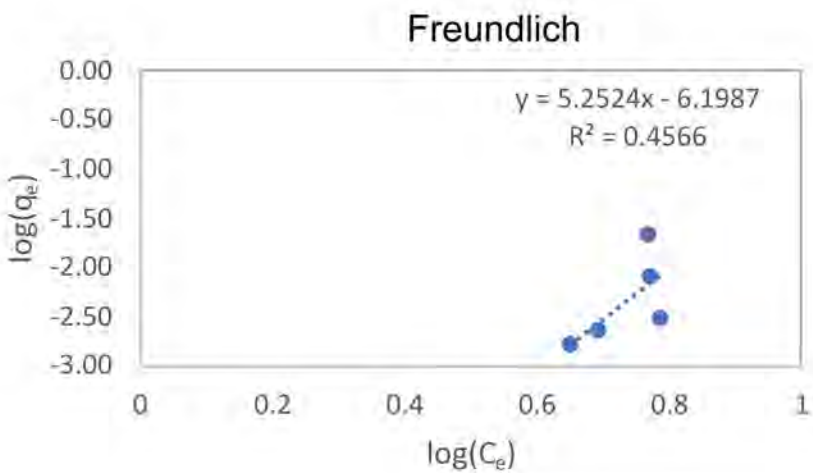
Columbus, OH | January 2024

Figure **10c**







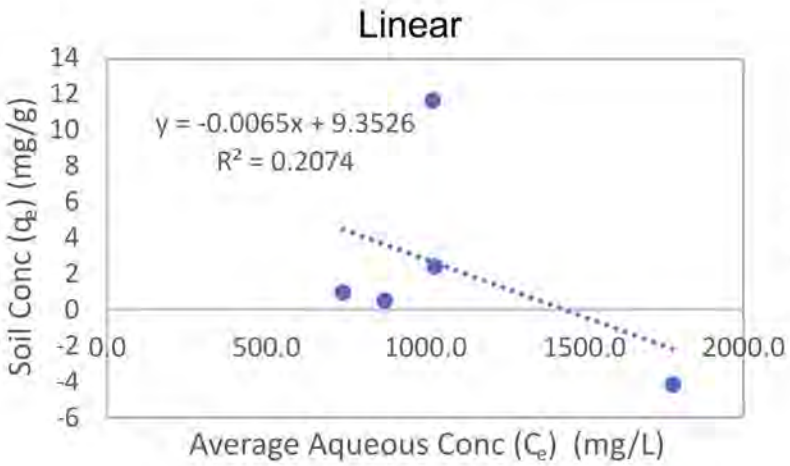
Notes:
q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

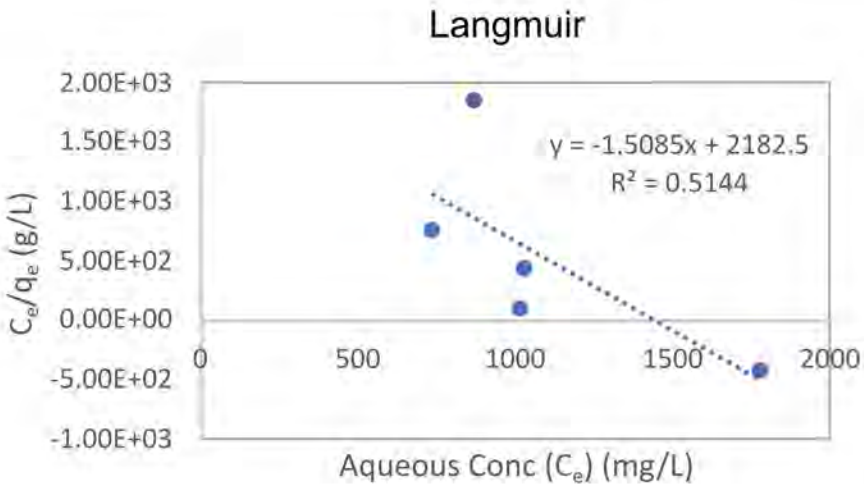
G313/SB-313 Boron Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

Geosyntec consultants

Columbus, OH | January 2024

Figure **10d**





Notes:

The Freundlich isotherm was not calculated because the data were not conducive to log transformation.

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-313 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

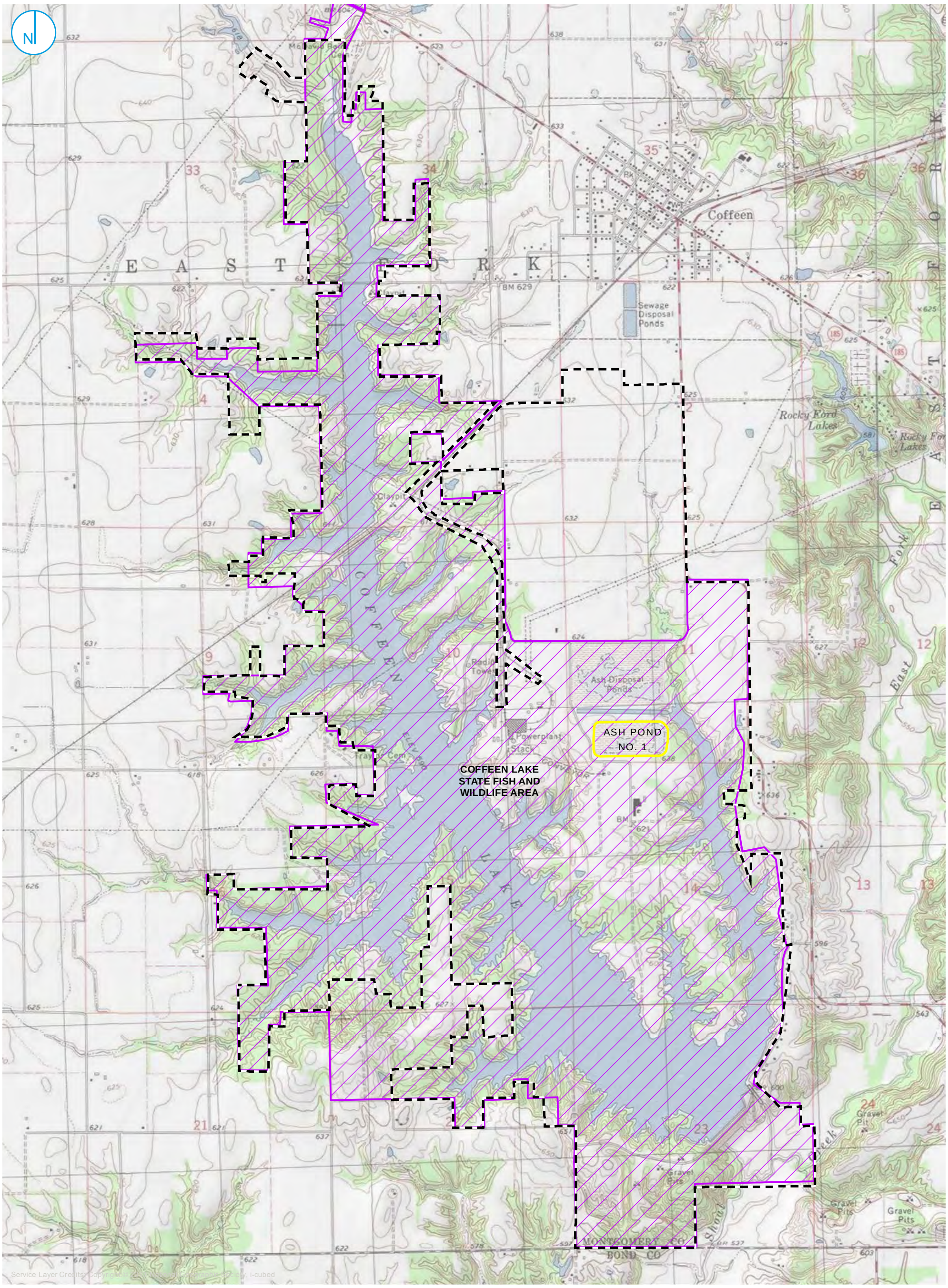
Geosyntec consultants

Columbus, OH | January 2024

Figure **10e**

Attachment A

Site Layout Figure



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
COFFEEN LAKE STATE FISH AND WILDLIFE AREA

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 2-1

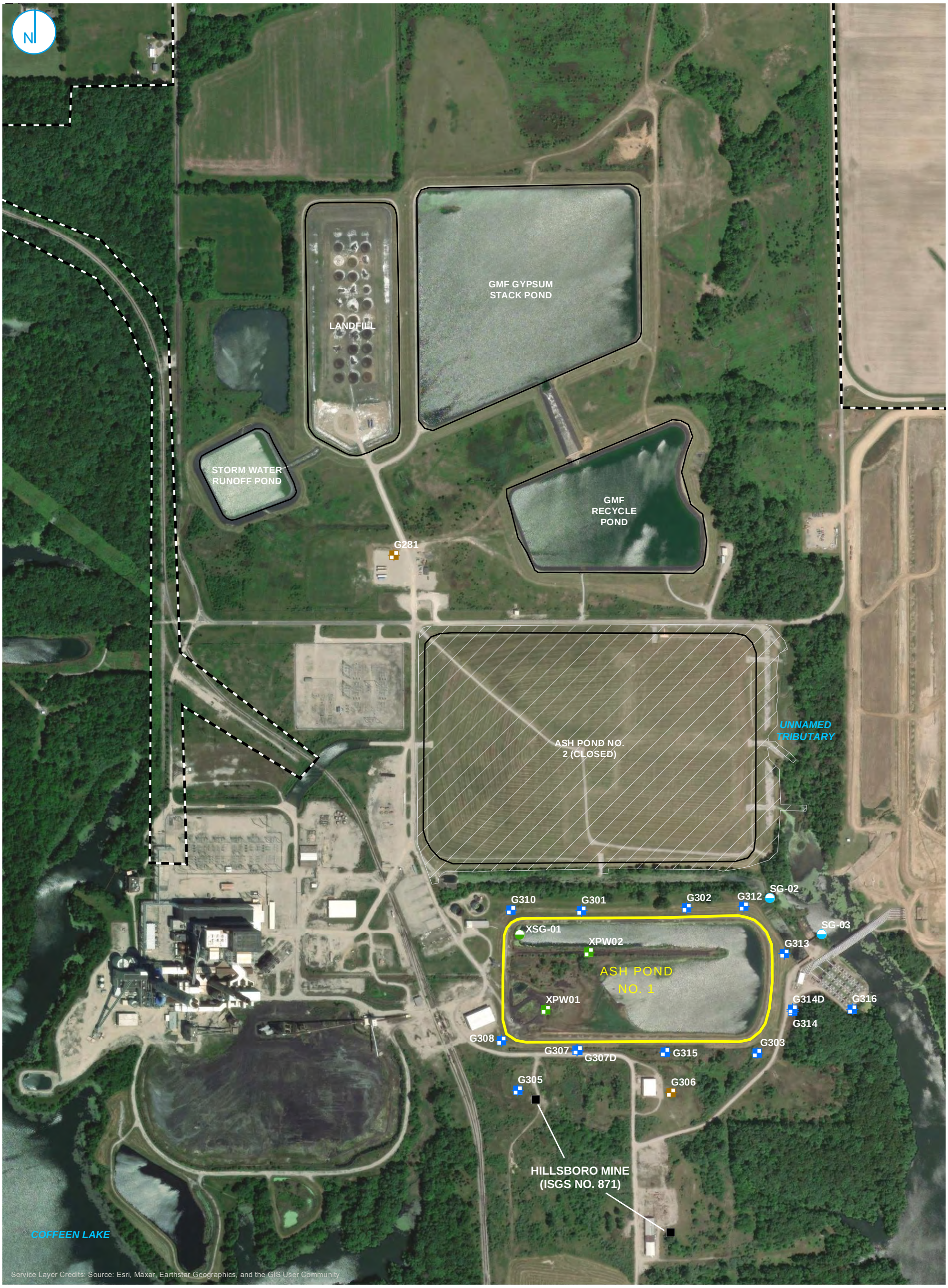
NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Attachment B

Proposed Part 845 Groundwater Monitoring Network



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

REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 275 550 Feet

MONITORING WELL LOCATION MAP

FIGURE 2-2

NATURE AND EXTENT REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

Attachment C
Monitoring Well Construction Information

Table 3-1. Monitoring Well Construction Details
Nature and Extent Report
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Location	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft bgs)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G281	UA	09/08/2015	--	626.43	Top of Disk	623.82	15.51	20.16	608.31	603.66	20.3	603.50	4.7	2	39.0654052	-89.3993221
G301	UA	09/04/2015	--	622.56	Top of Disk	620.88	11.31	15.96	608.96	604.31	16.21	604.10	4.7	2	39.05951	-89.395415
G302	UA	09/04/2015	--	619.95	Top of Disk	618.52	13.21	17.86	604.74	600.09	18.39	599.60	4.7	2	39.059544	-89.393192
G303	UA	08/26/2010	--	621.93	Top of Disk	619.33	10	20	609.07	599.07	20.4	598.70	10	2	39.057144	-89.391721
G305	UA	05/03/2016	625.67	625.84	Top of PVC	623.23	13.44	18.27	609.10	604.27	18.5	604.10	4.8	2	39.056558	-89.396798
G306	UA	05/03/2016	625.91	626.08	Top of PVC	623.57	13.07	17.68	609.77	605.16	17.9	604.80	4.6	2	39.056494	-89.393556
G307	UA	07/27/2016	624.60	624.60	Top of PVC	624.73	12.96	17.8	609.12	604.28	18.22	603.90	4.8	2	39.057214	-89.395545
G307D	LCU	01/19/2021	624.88	625.05	Top of PVC	622.51	48.98	58.75	573.53	563.76	59.6	562.50	9.8	2	39.05721	-89.39552
G308	UA	01/18/2021	624.59	624.76	Top of PVC	621.59	10.1	14.89	611.49	606.70	15.24	605.80	4.8	2	39.057379	-89.397134
G310	UA	02/09/2021	622.87	622.88	Top of PVC	619.89	10.24	15.03	609.65	604.86	15.38	604.00	4.8	2	39.059532	-89.396907
G312	UA	01/15/2021	619.78	619.95	Top of PVC	616.92	9.79	14.58	607.13	602.34	14.93	601.70	4.8	2	39.059558	-89.391983
G313	UA	02/05/2021	614.30	614.30	Top of PVC	611.51	6.3	11.11	605.21	600.40	11.46	599.50	4.8	2	39.058773	-89.391124
G314	LCU	02/05/2021	613.88	614.05	Top of PVC	611.11	14.56	19.58	596.55	591.53	20.02	591.10	5	2	39.05782	-89.390964
G314D	DA	02/04/2021	613.70	613.71	Top of PVC	610.87	39.34	49.11	571.53	561.76	49.47	510.60	9.8	2	39.057852	-89.390958
G315	UA	01/14/2021	623.52	623.69	Top of PVC	620.94	9.69	14.48	611.25	606.46	14.85	605.00	4.8	2	39.057165	-89.393667
G316	LCU	02/26/2021	602.59	602.59	Top of PVC	599.64	10.02	14.82	589.62	584.82	15.16	583.90	4.8	2	39.057847	-89.389698
XPW01	CCR	01/14/2021	634.57	634.36	Top of PVC	631.85	8.21	12.98	623.64	618.87	13.36	617.90	4.8	2	39.057878	-89.396196
XPW02	CCR	02/08/2021	639.69	639.86	Top of PVC	636.64	8.05	17.85	628.59	618.79	18.2	618.40	9.8	2	39.058828	-89.395267

Notes:
All elevation data are presented relative to the North American Vertical Datum of 1988 (NAVD88), GEOID 12A
-- = not measured/recorded
bgs = below ground surface
CCR = Coal Combustion Residuals
DA = Deep Aquifer
ft = foot or feet
HSU = Hydrostratigraphic Unit
LCU = Lower Confining Unit
PVC = polyvinyl chloride
UA = Uppermost Aquifer

Attachment D
Boring Logs

- COMPLIANCE MONITORING WELL
- BACKGROUND MONITORING WELL
- PORE WATER WELL
- LEACHATE WELL
- MONITORING WELL
- STAFF GAGE, CCR UNIT
- STAFF GAGE, RIVER
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- REGULATED UNIT (SUBJECT UNIT)
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY
- SITE FEATURE

0 325 650 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE MAP MAY 30, 2023 (E001)

FIGURE 2-8

NATURE AND EXTENT REPORT
ASH POND NO. 1

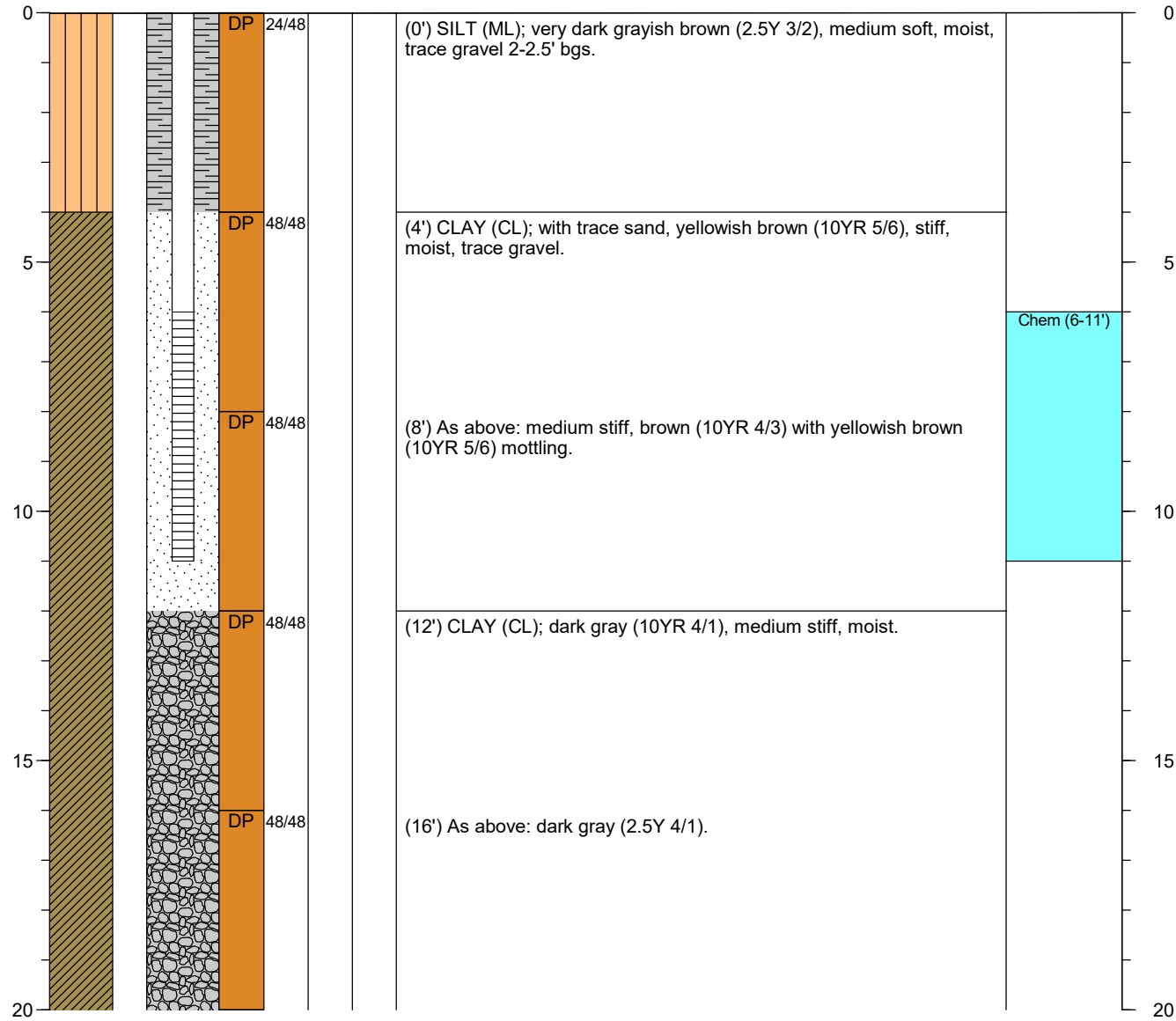
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Geosyntec consultants	Client: Dynegy Project: GLP8005, Coffeen Power Station Address: Coffeen, IL 62017	WELL LOG Well No. G1001 Page: 1 of 2

Drilling Start Date:	04/05/2021	Boring Depth (ft):	32	Well Depth (ft):	12
Drilling End Date:	04/05/2021	Boring Diameter (in):	6	Well Diameter (in):	1
Drilling Company:	Roberts Drilling	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Direct Push	DTW After Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	Geoprobe	Top of Casing Elev. (ft)		Screen Material:	Sch 40 PVC Slotted
Driller:		Ground Elev. (ft):		Seal Material(s):	Bentonite Chips
Logged By:	A. Toye	Northing, Easting (NAD83):		Filter Pack:	Sand



NOTES: No groundwater encountered.

Geosyntec consultants	Client: Dynegy Project: GLP8005, Coffeen Power Station Address: Coffeen, IL 62017	WELL LOG Well No. G1001 Page: 2 of 2

Drilling Start Date:	04/05/2021	Boring Depth (ft):	32	Well Depth (ft):	12
Drilling End Date:	04/05/2021	Boring Diameter (in):	6	Well Diameter (in):	1
Drilling Company:	Roberts Drilling	DTW During Drilling (ft):		Screen Slot (in):	0.010
Drilling Method:	Direct Push	DTW After Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	Geoprobe	Top of Casing Elev. (ft)		Screen Material:	Sch 40 PVC Slotted
Driller:		Ground Elev. (ft):		Seal Material(s):	Bentonite Chips
Logged By:	A. Toye	Northing, Easting (NAD83):		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)
20				DP	48/48			(20') As above: gravel at 1 ft.		20
				DP	48/48			(24') As above: dry pocket at 2.8 ft.		
25										25
				DP	18/48			(28') As above: trace gravel and silt at 2 ft.		
30										30
								(32') End of Boring.		
35										35

NOTES: No groundwater encountered.

FIELD BORING LOG

HANSON

CLIENT: AEG Coffeen Power Station
Site: CCB Management Facility
Location: Coffeen, Illinois
Project: 05S3004A
DATES: Start: 2/26/2008
Finish: 2/26/2008
WEATHER: Overcast, cold

CONTRACTOR: Testing Service Corp.
Rig mfg/model: CME-650 Track Drill
Drilling Method: 3¼" HSA w/SS & CME samplers
FIELD STAFF: Driller: B. Williamson
Helper: R. Keedy
Eng/Geo: .

BOREHOLE ID: G270
Well ID: G270
Surface Elev: 622.92 ft. MSL
Completion: 18.27 ft. BGS
Station: 874,801.92N
2,514,996.84E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 16.00 - While drilling
▼ = 5.62 - 3/12/08
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
	20/24 83%	ss	2-2 2-4 N=4			
1A				24		
2A	19/24 79%	ss	3-4 5-9 N=9	22		2.33 B
2B				20		5.04 Sh
3A	20/24 83%	ss	14-5 7-8 N=12	17		2.52 Sh
4A	24/24 100%	ss	8-6 7-5 N=13	21		1.24 BSh
4B				21		1.20 B
5A	22/24 92%	ss	2-3 4-4 N=7	21		1.36 B
6A	24/24 100%	ss	1-2 2-3 N=4	21		0.74 BSh
6B				24		0.78 B
7A	17/24 71%	ss	2-2 2-3 N=4	21		
8A				20		
8B	19/24 79%	ss	1-3 5-6 N=8	17		4.46 Sh
9A	24/24 100%	ss	6-8 30-35 N=38	20		
9B				8		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Dark grayish brown (10YR4/2), moist, firm, clayey SILT	622
	Dark grayish brown (10YR4/2), moist, firm, silty CLAY	
2	Dark grayish brown (10YR4/2) with 5% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY, slight trace sand	620
4	Gray (10YR5/1) with 70% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY, slight trace sand and gravel	618
6	Dark gray (10YR4/1) with 5% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY, trace sand, slight trace gravel	616
8	Gray (10YR5/1) with 10% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY, trace sand, slight trace gravel	614
10	Gray (10YR5/1) with 60% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY, trace sand, slight trace gravel	612
	Gray (10YR5/1), moist, soft, sandy CLAY	
12	Gray (10YR5/1), moist, soft, sandy CLAY, trace gravel	610
14	Gray (10YR5/1), moist, soft, fine- to coarse-grained SAND, trace gravel	
	Dark yellowish brown (10YR4/4), moist, soft, sandy CLAY	
	Gray (10YR5/1) with 10% yellowish brown (10YR5/8) mottles, moist, firm, silty CLAY, slight trace sand and gravel	608
16	Yellowish brown (10YR5/4), wet, soft, fine to coarse SAND	606
18	Gray (10YR5/1), moist, hard, silty CLAY, trace sand and gravel	

End of Boring = 18.27 ft. BGS

NOTE(S):

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Coffeen Power Station
Location: Coffeen, Illinois
Project: 15E0030
DATES: Start: 5/3/2016
Finish: 5/3/2016
WEATHER: Sunny, calm, warm, lo 60s

CONTRACTOR: Ramsey Geotechnical Engineering LLC
Rig mfg/model: D-50 Turbo Tracked MST 800ATV
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Keim

BOREHOLE ID: G306
Well ID: G306
Surface Elev: 622.84 ft. MSL
Completion: 18.00 ft. BGS
Station: 2,516,120.41N
871,140.98E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork
Section 14, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 5.50 - During Drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	12/24 50%	ss	1-3 3-4 N=6	14		
2A	24/24 100%	ss	5-4 5-4 N=9	21		
2B				19		
3A	22/24 92%	ss	2-2 3-3 N=5	30		
4A	20/24 83%	ss	3-4 6-6 N=10	26		
5A	24/24 100%	ss	2-2 3-3 N=5	23		
6A	22/24 92%	ss	1-2 3-4 N=5	20		
7A	20/24 83%	ss	5-6 6-6 N=12	21		
8A	20/24 83%	ss	2-2 8-14 N=10	15		
8B				12		
9A	23/24 96%	ss	14-17 28-50/5" N=45	10		
9B				13		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Very dark brown (10YR2/2), moist, medium, SILT with little clay and few very fine- to medium-grained sand, roots, trace coal fragments.	622
2	Dark gray (10YR4/1) with 5% dark yellowish brown (10YR3/6) mottles, moist, stiff, SILT with little clay and trace very fine- to medium-grained sand.	620
	Gray (10YR6/1) with 10% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT with little clay and trace very fine-grained sand.	
4		618
6	Gray (10YR6/1) with 20% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT with some clay and trace very fine-grained sand.	616
8		614
10	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, very stiff, silty CLAY with trace very fine- to coarse-grained sand.	612
12	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, stiff, silty CLAY with few very fine- to coarse-grained sand.	610
14	Yellowish brown (10YR5/6), wet, soft, very fine- to coarse-grained sandy CLAY with little silt.	608
	Yellowish brown (10YR5/6), wet, medium dense, silty, very fine- to medium-grained SAND with trace coarse-grained sand.	
16	Yellowish brown (10YR5/6), moist, dense, fine- to coarse-grained SAND with little silt, little very fine-grained sand, and trace small gravel.	606
	Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, hard, SILT with little clay, few very fine- to coarse-grained sand, and trace small gravel.	
18		

End of boring = 18.0 feet

NOTE(S): G306 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Power Station Ash Pond 1
Location: Coffeen, Illinois
Project: 16E0108
DATES: Start: 07/26/2016
Finish: 07/27/2016
WEATHER: Overcast, warm & humid (mid-80s)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME 55LC Track Drill
Drilling Method: 4¼" Hollow Stem Auger w/Continuous Split Spoon
FIELD STAFF: Driller: J. Gates
Helper: C. Clines
Eng/Geo: R. Hasenyager

BOREHOLE ID: G307
Well ID: G307
Surface Elev: 622.08 ft. MSL
Completion: 18.22 ft. BGS
Station: 871,398.55N
2,515,553.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen
Township: East Fork
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 14.00 - during drilling
▼ = -1.76 - 7/27/2016 @ 07:30
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	18/24 75%	SS	1-3 3-2 N=6	22		
2A	22/24 92%	SS	2-1 3-3 N=4	28		
3A	24/24 100%	SS	1-2 3-4 N=5	26		
4A	24/24 100%	SS	1-3 3-3 N=6	18		
5A	24/24 100%	SS	3-3 4-5 N=7	19		
6A	24/24 100%	SS	3-3 4-5 N=7	20		
7A	24/24 100%	SS	woh-2 5-13 N=7	20		
7B				11		
8A	24/24 100%	SS	12-9 6-9 N=15	20		
9A	18/18 100%	SS	8-30 50 N=80	8		
	0/9 0%	BD				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Brown (10YR5/3), moist, stiff, SILT with few clay, trace sand, gravel and roots.	
2	Gray (10YR5/1), moist, soft, CLAY, with some silt, trace sand, gravel and roots.	620
4	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand, gravel and roots.	618
6		616
8	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium CLAY,with some silt, few very fine- to medium-grained sand, and trace gravel.	614
10		612
12	Gray (10YR5/1), moist, medium, CLAY with little silt and very fine to very coarse sand, trace gravel.	610
	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand and gravel.	
14	Gray (10YR6/1), wet, medium dense, very fine- to very coarse-grained SAND with few silt and trace clay.	608
	Yellow brown (10YR5/6), wet. medium dense, very fine- to very coarse-grained SAND, with little silt and trace gravel.	
16	Yellowish brown (10YR5/8), moist, hard, SILT with some clay, little very fine- to very coarse-grained sand and trace gravel.	606
	Gray (10YR5/1), moist, hard, SILT with some clay, little very fine- to very coarse-grained sand and trace gravel.	
18		604

End of boring = 18.2 feet

NOTE(S):

FIELD BORING LOG

HANSON

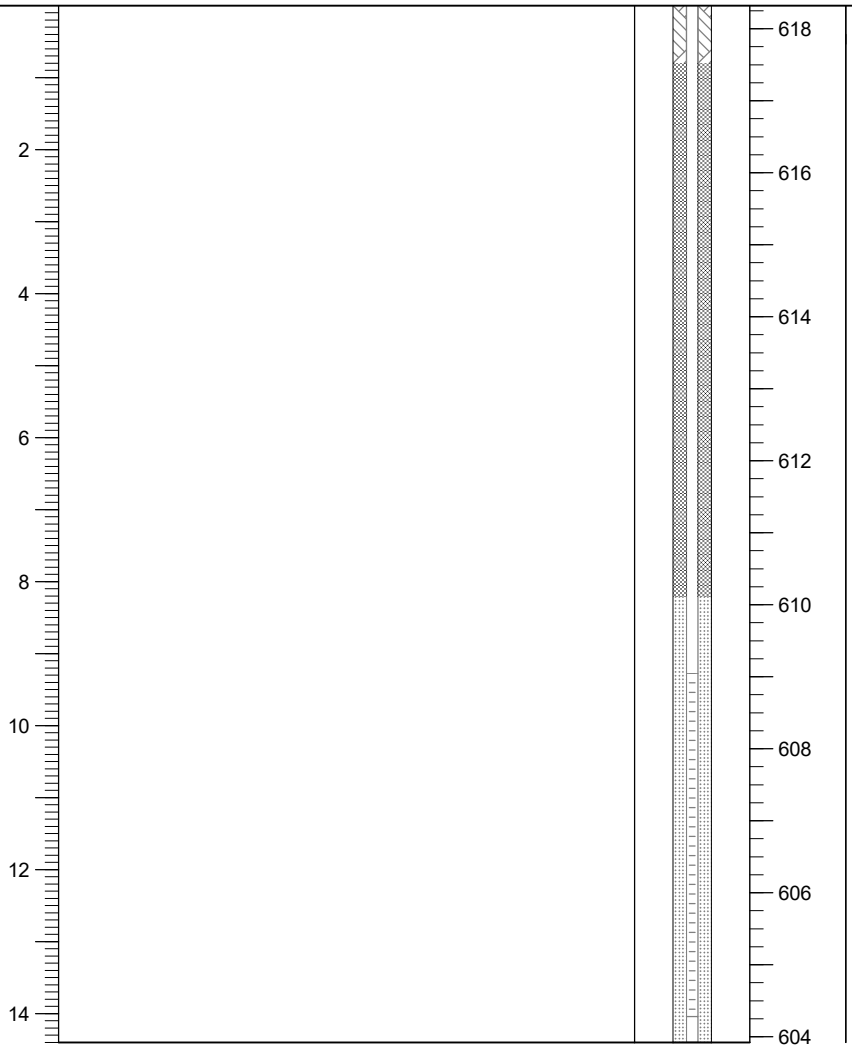
CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model:
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311
Well ID: G311
Surface Elev: 618.32 ft. MSL
Completion: 14.40 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork
Section 11, **Tier** 7N; **Range** 3W

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks



NOTE(S): G311 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
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SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	13/24 54%	SS	0-4 4-4 N=8					Yellowish brown (10YR5/6), moist, stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	618	
							2			
2A	24/24 100%	SS	3-4 5-6 N=9					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, stiff, lean CLAY, with some silt, trace very fine- to fine-grained sand, and small gravel.	616	
							4			
3A	24/24 100%	SS	2-4 5-7 N=9					Very dark grayish brown (10YR3/2) with 10% gray (10YR5/1) mottles, moist, stiff, lean CLAY, with some silt, trace very fine- to fine-grained sand, and small gravel.	614	
4A	24/24 100%	SH					6		612	
							8	Gray (10YR5/1) with 15% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, few small gravel.	610	
5A	18/24 75%	SS	1-2 4-5 N=6							
							10		608	
6A	24/24 100%	SS	1-3 3-4 N=6					Gray (10YR5/1) with 10% yellowish brown (10YR5/6) mottles, moist to wet, medium stiff, lean CLAY, with some very fine- to fine-grained sand, little silt, few small gravel.		
							12	Yellowish brown (10YR5/6), moist to wet, medium stiff, lean CLAY, with some very fine- to fine-grained sand, little silt, few small gravel.	606	
7A	24/24 100%	SS	2-6 12-13 N=18					Gray (10YR5/1), moist to wet, medium stiff, SILT, with some very fine- to fine-grained sand, few clay, trace small gravel.		1" wet, SAND at 13.5 ft.
							14		604	
8A	24/24 100%	SS	2-6 12-13 N=18							
							16	Yellowish brown (10YR5/6), moist, hard, SILT, with some clay, some to little sand, few small gravel.	602	
9A	24/24 100%	SS	6-15 18-22 N=33							Vertical fracture with very fine- to fine-grained sand from 16.9 to 18 ft.
							18		600	
10A	24/24 100%	SS	6-13 16-22 N=29					Dark grayish brown (10YR4/2) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.		
							20			

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A	24/24 *100%*	SS	*5-15* *20-26* N=35						598	
							22		596	No oxidation below 22 ft.
12A	12/24 *50%*	SS	*2-3* *14-17* N=17							
							24		594	Trace medium gravel below 24 ft.
13A	24/24 *100%*	SS	*6-11* *14-20* N=25							
14A	24/24 *100%*	SS	*4-8* *11-16* N=19				26		592	
							28		590	
15A	24/24 *100%*	SH						Dark gray (10YR4/1) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.		
							30		588	
16A	24/24 *100%*	SS	*0-3* *5-8* N=8							
							32		586	
17A	24/24 *100%*	SS	*2-4* *6-8* N=10							
							34		584	Gravel plugged shoe in Run 18.
18A	24/24 *100%*	SS	*2-5* *7-7* N=12							Trace large gravel from 35 to 36 ft.
							36		582	Trace lignite and wood fragments below 36 ft.
19A	13/24 *54%*	SS	*2-7* *8-11* N=15							
							38		580	
20A	24/24 *100%*	SS	*2-6* *10-8* N=16				40			

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler

FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
21A	16/24 67%	SS	3-3 6-8 N=9					Dark gray (10YR4/1) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel. *[Continued from previous page]*	578	
22A							42	Greenish gray (GLEY15/1) with 20% dark reddish brown (10YR3/2) mottles, moist, medium stiff, lean CLAY, with some silt.	576	
22B	24/24 100%	SS	3-4 7-8 N=11				44		574	
23A	24/24 100%	SS	1-3 5-7 N=8				46		572	
24A	20/24 83%	SS	3-4 10-8 N=14				48	Dark grayish brown (10YR4/1) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small to large gravel.	570	
25A	24/24 100%	SS	3-5 8-13 N=13				50		568	
26A	24/24 100%	SS	2-5 10-12 N=15				52		566	
27A	24/24 100%	SS	2-6 10-14 N=16				54	Dark gray (10YR4/1) with 20% greenish gray (GLEY15/1) and 5% yellowish brown (10YR5/6) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.	564	Trace small gravel below 54.3 ft.
28A	24/24 100%	SS	4-7 7-11 N=14				56	Greenish gray (GLEY16/1) with 40% yellowish brown (10YR5/6) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.	562	
29A	24/24 100%	SS	2-5 9-11 N=14				58		560	0.5" small to medium GRAVEL.
30A	24/24 100%	SS	3-7 10-13 N=17				60	Yellowish brown (10YR5/6) with 30% greenish gray (GLEY16/1) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.		

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler

FIELD STAFF: **Driller:** Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								End of boring = 60.0 feet			

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/14/2021
Finish: 1/14/2021
WEATHER: Overcast, cool (40s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler

FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G313
Well ID: G313
Surface Elev: 611.51 ft. MSL
Completion: 12.00 ft. BGS
Station: 871,976.80N
2,516,803.70E

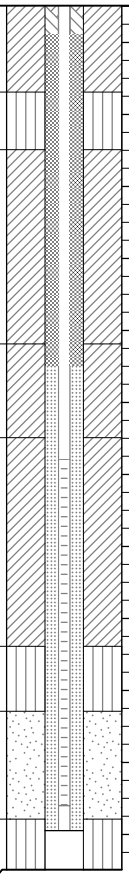
TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = 9.80 - During Drilling
▽ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A, 1B	17/24 *71%*	SS	*0-2* *3-3* N=5			
2A	13/24 *54%*	SS	*0-2* *2-3* N=4			
3A	19/24 *79%*	SS	*2-3* *5-5* N=8			
4A	22/24 *92%*	SS	*2-3* *4-5* N=7			
5A	22/24 *92%*	SS	*2-5* *9-12* N=14			
6A, 6B	21/24 *88%*	SS	*9-12* *21-22* N=33			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Dark yellowish brown (10YR4/4), wet, stiff, lean CLAY, with some silt, few roots, trace small gravel.	
	Gray (10YR6/1) with 15% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT, with little clay, few roots.	610
2	Dark gray (10YR4/1) with 5% black (10YR2/1) mottles, moist, stiff, lean CLAY, with some silt.	608
4	Dark gray (10YR4/1) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.	606
6	Very dark gray (10YR3/1), moist, stiff, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	604
8	Yellowish brown (10YR5/6) with 10% very dark gray (10YR3/1) mottles, moist, stiff SILT, with some very fine- to fine-grained sand and clay, few small gravel.	602
▽ 10	Yellowish brown (10YR5/4), wet, medium dense, very fine- to medium-grained SAND, with some silt, few small gravel.	
12	Dark grayish brown (10YR4/2) with 10% yellowish brown (10YR5/6) mottles, moist, hard, SILT, with some very fine- to fine-grained sand, few clay and small gravel, trace medium gravel.	600

Borehole Detail



Remarks

End of boring = 12.0 feet

NOTE(S): G313 installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	4/24 17%	SS	13-7 4-5 N=11					Moist, dense, small to large GRAVEL. [FILL]	610	
	1/24 4%	SS	3-4 5-5 N=9				2	Gray (10YR6/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	608	
3A	24/24 100%	SS	1-3 4-5 N=7				4		606	
4A	24/24 100%	SS	2-5 15-17 N=20				6		604	
5A	24/24 100%	SS	4-10 12-16 N=22				8	Yellowish brown (10YR5/6) with occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	602	
6A	24/24 100%	SS	4-5 14-18 N=19				10		600	1" wet, SAND, with some silt at 11.6 ft.
7A	24/24 100%	SS	3-11 14-18 N=25				12	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	598	
8A	24/24 100%	SS	3-9 13-18 N=22				14		596	
9A	24/24 100%	SS	1-7 9-13 N=16				16	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) and 10% dark yellowish brown (10YR4/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	594	
							18	Dark grayish brown (10YR4/2) with 15% yellowish brown (10YR5/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	592	
							20			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= During Drilling
=
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SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
10A	24/24 100%	SS	1-5 10-13 N=15							1" wet, SAND, with some silt at 20 ft.
									590	
							22	Dark grayish brown (10YR4/2) with 15% yellowish brown (10YR5/6) and 5% dark yellowish brown (10YR4/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel. *[Continued from previous page]*		Frequent oxidation below 21.7 ft.
11A	24/24 100%	SS	1-6 9-12 N=15						588	
							24			
12A	24/24 100%	SS	4-7 10-13 N=17						586	
							26			
13A	24/24 100%	SS	3-7 10-13 N=17						584	
							28			1 ft vertical fracture with yellowish red (5YR4/6) oxidation at 28.3 ft.
14A	24/24 100%	SS	4-6 10-10 N=16					Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	582	
							30			
15A	24/24 100%	SS	3-9 10-12 N=19						580	
							32			
16A	24/24 100%	SS	2-3 7-8 N=10						578	
							34			Trace roots below 34 ft.
17A	24/24 100%	SS	2-4 7-9 N=11					Gray (GLEY15/), moist, stiff, lean CLAY, with some silt.	576	
							36			
18A	21/24 88%	SH						Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel and roots.	574	
							38			
									572	
			2-5				40			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= During Drilling
=
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SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
19A	24/24 100%	SS	7-12 N=12			
20A	24/24 100%	SS	4-8 10-14 N=18			
21A	24/24 100%	SS	3-9 13-16 N=22			
22A 22B	24/24 100%	SS	12-31 14-11 N=45			
23A	24/24 100%	SS	3-4 6-9 N=10			
24A	24/24 100%	SS	5-11 14-17 N=25			
25A	24/24 100%	SS	4-6 11-15 N=17			
26A	20/24 83%	SS	4-5 18-30 N=23			
27A	20/24 83%	SS	9-22 33-33 N=55			
28A	24/24 100%	SS	7-19 29-43			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
		570	Trace medium gravel below 41.3 ft.
42	Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel and roots. *[Continued from previous page]*	568	
44		566	
46	Gray (10YR5/1), wet, dense, SAND, with some silt, few small gravel.	564	
48	Gray (GLEY15/) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	562	1" SILT, with some sand at 48.2 ft.
50		560	
52	Yellowish brown (10YR5/6) with 20% gray (GLEY15/) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	558	
54		556	
56	Yellowish brown (10YR5/6), moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	554	
58	Yellowish brown (10YR5/6) with 20% gray (GLEY15/) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	552	
60	Yellowish brown (10YR5/6) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.		

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
			N=48								
29A	20/24 83%	SS	13-20 30-38 N=50				62			550	
30A	24/24 100%	SS	8-15 30-34 N=45				64	Yellowish brown (10YR5/6) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel. *[Continued from previous page]*		548	
31A	24/24 100%	SS	5-17 28-29 N=45				66			546	
32A	24/24 100%	SS	7-18 29-43 N=47				68	Yellowish brown (10YR5/6) with 10% gray (GLEY15/), 5% dark yellowish brown (10YR4/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.		544	
33A	24/24 100%	SS	5-14 32-26 N=46				70	Dark grayish brown (10YR4/2) with 5% gray (GLEY15/), 5% yellowish brown (10YR5/6), and 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, little sand and gravel.		542	
34A	24/24 100%	SS	8-17 26-38 N=43				72	Yellowish brown (10YR5/6) with 5% gray (GLEY15/), 5% dark grayish brown (10YR4/2), and 5% light gray (10YR7/1) mottles.		540	
35A	24/24 100%	SS	5-12 24-24 N=36				74	Dark grayish brown (10YR4/2) with 5% gray (GLEY15/), 5% yellowish brown (10YR5/6), and 5% light gray (10YR7/1) mottles.		538	
36A	24/24 100%	SS	14-24 20-33 N=44				76	Dark grayish brown (10YR5/2) with 20% reddish brown (5YR4/4) and 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.		536	
37A	24/24 100%	SS	6-14 17-31 N=31				78	Dark gray (10YR4/1) with 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.		534	
							80			532	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
38A	24/24 100%	SS	7-17 21-29 N=38				82	Dark gray (10YR4/1) with 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel. *[Continued from previous page]*	530	Trace roots at 82 ft.
39A	24/24 100%	SS	8-24 26-27 N=50				84	Very dark gray (10YR3/1), moist, hard, lean CLAY, with some silt.	528	
40A	24/24 100%	SS	5-9 10-13 N=19				86	Dark gray (10YR4/1) with 5% black (10YR2/1) mottles, moist, hard, lean CLAY, with some silt.	526	
41A	24/24 100%	SS	6-10 25-33 N=35				88	Dark greenish gray (GLEY14/1) with 5% yellowish brown (10YR5/6) mottles, moist, hard, lean CLAY, with some silt.	524	Few very fine- to fine-grained sand below 88 ft.
42A	11/11 100%	SS	3-50/5"				90	Light reddish brown (2.5YR6/3) with 10% gray (GLEY15/), dry, hard, SILT, with few clay and very fine-grained sand.	522	
43A	5/5 100%	SS	50/5"				92		520	
44A	5/5 100%	SS	50/5"				94		518	
45A	8/8 100%	SS	49-50/2"				96		516	
46A	11/11 100%	SS	25-50/5"				98	Light reddish brown (2.5YR6/3) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, dry, hard, SILT, with few clay and very fine-grained sand.	514	
							100		512	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: **Driller:** Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
47A	3/3 *100%*	SS	*50/3"*								
								End of boring = 100.3 feet			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/14/2021
Finish: 1/14/2021
WEATHER: Overcast, cold (30s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G316
Well ID: G316
Surface Elev: 599.64 ft. MSL
Completion: 15.75 ft. BGS
Station: 871,643.10N
2,517,211.60E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 8.60 - During Drilling
= 13.80 - During Drilling
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A	15/24 *63%*	SS	*10-9 5-4* N=14			
2A	10/24 *42%*	SS	*1-3 4-6* N=7			
3A	14/24 *58%*	SS	*2-2 3-3* N=5			
4A	10/24 *42%*	SS	*0-1 1-2* N=2			
5A						
5B	22/24 *92%*	SS	*1-1 1-2* N=2			
6A	20/24 *83%*	SS	*1-2 4-7* N=6			
7A	22/24 *92%*	SS	*0-2 3-3* N=5			
8A	21/17 *124%*	SS	*2-2 26-50/3"* N=28			
8B						

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Brown (10YR5/3), moist, medium dense, small to large GRAVEL, with some clay and fine to coarse grained sand. [FILL]	
2	Gray (10YR5/1), moist, hard, lean CLAY, with some silt, few small gravel and very fine- to fine-grained sand.	598
4	Gray (10YR5/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few small gravel and very fine- to fine-grained sand.	596
6	Gray (10YR5/1) with 30% black (10YR2/1) mottles, moist, stiff, lean CLAY, with some silt, few very fine-grained sand, organics and wood fragments.	594
8	Very dark gray (10YR3/1), wet, medium stiff to stiff, SILT, with some clay and very fine- to fine-grained sand.	592
10	Brown (10YR4/3), moist, very stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, few small gravel.	590
12	Dark gray (10YR4/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium stiff to stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, few small gravel.	588
14	Brown (10YR4/3), wet, loose, very fine- to fine-grained SAND, with some silt, trace clay.	586
	Yellowish brown (10YR5/6), moist, hard, SILT, with some very fine- to fine-grained sand, trace small gravel.	584

End of boring = 15.75 feet

NOTE(S): G316 installed in borehole.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Coffeen Energy Center
Location: Coffeen, Illinois
Project: 15E0030
DATES: Start: 9/14/2015
Finish: 9/14/2015
WEATHER: Sunny, hi 60's

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: D-50 Turbo Tracked MST 800ATV
Drilling Method: Hollow Stem Auger (3¼"overdrill / 4¼")
FIELD STAFF: Driller: D. Crump
Helper: D. Groves
Eng/Geo: R. Hasenyager

BOREHOLE ID: G401
Well ID: G401
Surface Elev: 623.03 ft. MSL
Completion: 19.30 ft. BGS
Station: 2,515,614.84N
872,510.57E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = Dry - During Drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	16/24 67%	ss	2-2 3-7 N=5	17		
2A	21/24 88%	ss	8-11 8-9 N=19	17		1.80
2B				25		
3A	23/24 96%	ss	3-4 7-8 N=11	23		2.50
4A	24/24 100%	ss	8-9 12-14 N=21	21		3.30
4B				19		2.80
5A	24/24 100%	ss	2-3 4-5 N=7	21		1.30
6A	24/24 100%	ss	2-4 5-6 N=9	17		2.50
7A	24/24 100%	ss	9-7 8-9 N=15	21		1.40
8A	24/24 100%	ss	2-3 2-4 N=5	17		1.30
8B				19		
9A	20/24 83%	ss	5-4 5-10 N=9	21		
9B				16		
10A	12/16 75%	ss	23-41 50/4"	6		4.50

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Dark grayish brown (10YR4/2), moist, soft, CLAY with little silt and trace very fine- to fine-grained sand - FILL.	
	Yellowish brown (10YR5/6) moist, medium, CLAY with some silt and trace very fine- to coarse-grained sand - FILL.	622
2	Dark gray (10YR4/1), moist, stiff, SILT with little clay and trace very fine-grained sand.	
	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace very fine- to fine-grained sand.	620
4	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace very fine- to fine-grained sand.	618
6		616
8	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) mottles, moist, stiff, SILT and very fine-grained SAND with trace clay.	614
10	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace very fine- to fine-grained sand.	612
12		610
14		608
	Gray (10YR6/1), moist soft, CLAY with very fine- to fine-grained sand and little silt.	
16	Yellowish brown (10YR5/6), wet, loose, very fine- to fine-grained SAND with trace silt.	
	Yellowish brown (10YR5/6), wet medium, SILT with some very fine-grained sand and little clay.	606
	Yellowish brown (10YR5/6), wet, loose, very fine- to medium-grained SAND with trace silt.	
18	Gray (10YR5/1), moist, very hard, SILT with few clay and little very fine- to very coarse sand.	604

End of boring = 19.3 feet

NOTE(S): G401 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Natural Resources Technology, Inc.
Site: Coffeen Power Station - Ash Pond 2
Location: 134 CIPS Lane, Coffeen, IL 62017
Project: 16E0080
DATES: Start: 8/16/2016
Finish: 8/16/2016
WEATHER: Rain, (mid-70s)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 1/4" Hollow Stem Auger
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: K. Theesfeld

BOREHOLE ID: G407
Well ID: G407
Surface Elev: 618.35 ft. MSL
Completion: 20.00 ft. BGS
Station: 2,513,705.87N
2,513,705.87E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen
Township: East Fork
Section 10, **Tier** 7 N.; **Range** 3 W.

WATER LEVEL INFORMATION:
▼ = 16.00 - During Drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	12/24 50%	ss	4-3 3-3 N=6	14		3.50
2A	20/24 83%	ss	2-2 4-4 N=6	18		1.50
3A	23/24 96%	ss	1-2 3-4 N=5	19		1.75
4A	24/24 100%	ss	1-3 3-5 N=6	19		1.50
5A	21/24 88%	ss	1-2 4-4 N=6	19		0.50
6A	22/24 92%	ss	1-2 2-1 N=4	17		
7A	24/24 100%	ss	7-29 33-17 N=62	8		
8A	24/24 100%	ss	3-7 12-17 N=19	12		4.50
9A	24/24 100%	ss	4-9 14-20 N=23	13		4.00
10A	24/24 100%	ss	2-8 14-19 N=22	14		4.50

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	Very dark gray (10YR3/1), wet, medium, SILT with some organics. [Fill]	618	
	Gray (10YR6/1), wet, loose, SAND with some gravel and little clay. [Fill]		
2	Yellowish brown (10YR5/6) with 5% dark yellowish brown (10YR3/6) mottles, moist, very stiff, SILT with some clay and trace very fine- to fine-grained sand.	616	
	Brown (10YR5/3) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with some clay, little fine- to coarse-grained sand, and trace small gravel.		
4	Brown (10YR5/3) with 25% yellowish brown (10YR5/6) mottles, moist, stiff, CLAY with some silt, trace fine-grained sand and trace small gravel.	614	
6	Brown (10YR5/3) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, CLAY with some silt, little fine- to coarse-grained sand and trace small gravel.	612	
8	Yellowish brown (10YR5/6) with 25% brown (10YR5/3) mottles, moist, medium, CLAY with few silt, few fine-grained sand, and trace small gravel.	610	
10	Yellowish brown (10YR5/8) with 5% gray (10YR5/1) mottles, moist, very loose, fine-grained SAND with some clay and trace small gravel.	608	
12	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, moist, very dense, fine-grained SAND	606	
14	Brown (10YR5/3), moist, hard, SILT with some clay and little fine- to coarse-grained sand.	604	
	Yellowish brown (10YR5/4) with 5% yellowish brown (10YR5/6) and 5% black (10YR2/1) mottles, SILT with some clay and little fine- to coarse-grained sand.		
▼ 16	Yellowish brown (10YR5/4) with 5% yellowish brown (10YR5/6), 5% dark gray (10YR4/1) and 5% black (10YR2/1) mottles, moist, hard, SILT with little fine- to coarse-grained sand and trace small gravel.	602	
18	Yellowish brown (10YR5/4) with 5% yellowish brown (10YR5/6), 5% dark gray (10YR4/1) and 5% black (10YR2/1) mottles, wet, stiff, SILT with little fine- to coarse-grained sand and little small gravel.	600	
20	Dark grayish brown (10YR4/2) with 10% dark yellowish brown (10YR3/6) mottles, moist, hard, CLAY with some silt, little fine- to coarse-grained sand and trace small gravel.		

End of Boring = 20.0 ft. BGS

NOTE(S): G407 installed in boring.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company
Site: Coffeen Power Station - Ash Pond 2
Location: Coffeen, Illinois
Project: 16E0031A
DATES: Start: 2/23/2018
Finish: 2/23/2018
WEATHER: Overcast, mild (mid-40s)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4¼" HSA with continuous split spoon

FIELD STAFF: Driller: C. Dutton
Helper: M. Baetje
Eng/Geo: R. Hasenyager

BOREHOLE ID: G410
Well ID: G410
Surface Elev: 617.21 ft. MSL
Completion: 14.09 ft. BGS
Station: 872,968.54N
2,513,206.33E

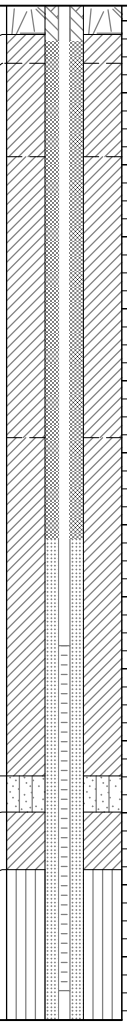
TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen
Township: East Fork
Section 10, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 11.00 - During drilling
▼ = 13.30 - Upon completion
▽ = 4.82 - 1 March 2018

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A	14/24 *58%*	SS	*2-3 1-5* N=4	26.7		
2A	15/24 *63%*	SS	*4-4 4-5* N=8	25.2		
3A	17/24 *71%*	SS	*2-3 4-6* N=7	17.9		
4A	20/24 *83%*	SS	*3-4 5-6* N=9	17.2		
5A	11/24 *46%*	SS	*3-3 5-6* N=8	17.5		
6A	22/24 *92%*	SS	*2-3 4-6* N=7	16.9		
6B				16.8		
7A	24/24 *100%*	SS	*6-28 36-42* N=64	10.3		
	0/1 *0%*	BD				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	FILL - Light gray (10YR7/1), moist, loose, very fine- to very coarse-grained SAND with few small to medium gravel.	
	Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace very fine- to fine-grained sand.	
	Yellowish brown (10YR5/4), moist, soft, CLAY with some silt and trace very fine- to fine-grained sand.	616
2		
	Gray (10YR6/1) with 25% yellowish brown (10YR5/6) mottles, moist, medium,CLAY with some silt and trace very fine- to fine-grained sand.	614
4		
		612
6		
	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) mottles, moist, medium, CLAY with some silt, little very fine- to very coarse-grained sand, and trace small to medium gravel.	610
8		
		608
10		
	Gray (10YR6/1), moist, loose, very fine- to medium-grained SAND with few silt and few clay.	606
	Yellowish brown (10YR5/8) with 10% gray (10YR5/1) mottles, moist, medium, CLAY with some silt, little very fine- to very coarse-grained sand, and trace small to medium gravel.	
12		
	Yellowish brown (10YR5/6), moist, hard, SILT with some clay, few very fine- to very coarse-grained sand, and trace small to medium gravel.	604
14		

Borehole Detail



Remarks

End of Boring = 14.09 ft bgs

NOTE(S):

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/8/2021
Finish: 2/8/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler

FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: XPW01
Well ID: XPW01
Surface Elev: 631.85 ft. MSL
Completion: 14.00 ft. BGS
Station: 871,638.70N
2,515,366.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = 5.00 - Approx. During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL
1A	19/24 *79%*	SS	*11-20* *21-13* N=41					Black (10YR2/1), moist, BOTTOM ASH, fine- to coarse-grained, cohesionless. [FILL]	630
2A	24/24 *100%*	SS	*3-6* *8-6* N=14				2		
3A	0/24 *0%*	SH					4	Black (10YR2/1), moist, BOTTOM ASH, very fine- to fine-grained, cohesive. [FILL]	628
4A	24/24 *100%*	SS	*1-5* *7-8* N=12				6		626
5A	19/24 *79%*	SS	*1-1* *1-6* N=2				8	Black (10YR2/1), wet, BOTTOM ASH, fine- to coarse-grained. [FILL]	624
6A	15/24 *63%*	SS	*4-5* *4-4* N=9				10		622
7A	18/24 *75%*	SS	*1-3* *5-6* N=8				12		620
7B							14	Gray (10YR5/1) with 20% yellowish brown (10YR5/6), moist, stiff, lean CLAY, some silt, trace very fine grained sand.	618

End of boring = 14.0 feet

NOTE(S): XPW01 installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/8/2021
Finish: 2/8/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: XPW02
Well ID: XPW02
Surface Elev: 636.64 ft. MSL
Completion: 18.00 ft. BGS
Station: 871,987.10N
2,515,627.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 6.00 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A	19/24 *79%*	SS	*5-5 10-15* N=15			
2A	21/24 *88%*	SS	*5-14 17-18* N=31			
3A	24/24 *100%*	SS	*4-13 15-14* N=28			
	24/24 *100%*	SS	*4-9 13-15* N=22			
5A	22/24 *92%*	SS	*3-4 7-12* N=11			
6A	23/24 *96%*	SS	*1-9 14-14* N=23			
7A	24/24 *100%*	SS	*5-7 7-7* N=14			
8A	21/24 *88%*	SS	*4-4 5-4* N=9			
9A 9B	24/24 *100%*	SS	*0-1 1-2* N=2			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0	Black (10YR2/1), moist, BOTTOM ASH, fine- to coarse-grained, cohesionless. [FILL]	636
2		634
4		632
6		630
8		628
10	Black (10YR2/1), wet, BOTTOM ASH, fine- to coarse-grained, cohesionless. [FILL]	626
12		624
14		622
16		620
18	Dark gray (10YR4/1), moist, very soft, SILT, some clay.	

End of boring = 18.0 feet

Borehole Detail

Remarks

NOTE(S): XPW02 installed in borehole.

Attachment E

Site Solids Bulk Characterization Analytical Data

PDC Laboratories, Inc.

PROFESSIONAL • DEPENDABLE • COMMITTED

March 09, 2021

Rhonald Hasenyager
Hanson Professional Services, Inc.
1525 South Sixth Street
Springfield, IL 62703-2886

RE: HANSON VISTRA SOIL

Dear Rhonald Hasenyager:

Please find enclosed the analytical results for the **14** sample(s) the laboratory received on **2/12/21 3:12 pm** and logged in under work order **EB02539**. All testing is performed according to our current TNI accreditations unless otherwise noted. This report cannot be reproduced, except in full, without the written permission of PDC Laboratories, Inc.

If you have any questions regarding your report, please contact your project manager. Quality and timely data is of the utmost importance to us.

PDC Laboratories, Inc. appreciates the opportunity to provide you with analytical expertise. We are always trying to improve our customer service and we welcome you to contact the Director of Client Services, Lisa Grant, with any feedback you have about your experience with our laboratory at 309-683-1764 or lgrant@pdclab.com.

Sincerely,

Gail J Schindler

Gail Schindler
Project Manager
(309) 692-9688 x1716
gschindler@pdclab.com

SAMPLE RECEIPT CHECK LIST

Items not applicable will be marked as in compliance

Work Order EB02539

YES	Samples received within temperature compliance when applicable
YES	COC present upon sample receipt
YES	COC completed & legible
YES	Sampler name & signature present
YES	Unique sample IDs assigned
YES	Sample collection location recorded
YES	Date & time collected recorded on COC
YES	Relinquished by client signature on COC
YES	COC & labels match
YES	Sample labels are legible
YES	Appropriate bottle(s) received
YES	Sufficient sample volume received
YES	Sample containers recieved undamaged
YES	Zero headspace, <6 mm present in VOA vials
NO	Trip blank(s) received
YES	All non-field analyses received within holding times
NO	Short hold time analysis
YES	Current PDC COC submitted
NO	Case narrative provided

ANALYTICAL RESULTS

Sample: EB02539-01
Name: G314D - S1
Matrix: Soil - Composite

Sampled: 02/10/21 15:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.44	meq/100g			1	1			Subcontracted

Sample: EB02539-02
Name: G314D - S2
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.72	meq/100g			1	1			Subcontracted

Sample: EB02539-03
Name: G314D - S3
Matrix: Soil - Composite

Sampled: 02/11/21 14:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	12.45	meq/100g			1	1			Subcontracted

Sample: EB02539-04
Name: G314D - S2 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.15	meq/100g			1	1			Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-05
Name: G307D - S1
Matrix: Soil - Composite

Sampled: 02/09/21 10:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	18.82	meq/100g			1	1			Subcontracted

Sample: EB02539-06
Name: G307D - S2
Matrix: Soil - Composite

Sampled: 02/09/21 10:40
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	3.32	meq/100g			1	1			Subcontracted

Sample: EB02539-07
Name: G307D - S3
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	3.91	meq/100g			1	1			Subcontracted

Sample: EB02539-08
Name: G307D - S4
Matrix: Soil - Composite

Sampled: 02/09/21 16:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	8.31	meq/100g			1	1			Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-09
Name: G307D - S5
Matrix: Soil - Composite

Sampled: 02/09/21 16:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	17.24	meq/100g			1	1			Subcontracted

Sample: EB02539-10
Name: G307D - S3 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	6.05	meq/100g			1	1			Subcontracted

Sample: EB02539-11
Name: XPW - 01 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 11:15
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	2.26	meq/100g			1	1			Subcontracted

Sample: EB02539-12
Name: XPW - 01 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	1.57	meq/100g			1	1			Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-13
Name: XPW - 02 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	0.28	meq/100g			1	1			Subcontracted

Sample: EB02539-14
Name: XPW - 02 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	0.38	meq/100g			1	1			Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-01
Name: G314D - S1
Matrix: Soil - Composite

Sampled: 02/10/21 15:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	342 J	mg/kg			1.66	498	02/20/21 14:30		SM 5310C 2000

Sample: EB02539-02
Name: G314D - S2
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	17400	mg/kg			4.81	1440	02/20/21 14:42		SM 5310C 2000

ANALYTICAL RESULTS

Sample: EB02539-03
Name: G314D - S3
Matrix: Soil - Composite

Sampled: 02/11/21 14:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	8540	mg/kg			2.49	747	02/20/21 14:55		SM 5310C 2000

Sample: EB02539-04
Name: G314D - S2 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	12900	mg/kg			4.81	1440	02/20/21 13:52		SM 5310C 2000

Sample: EB02539-05
Name: G307D - S1
Matrix: Soil - Composite

Sampled: 02/09/21 10:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	553	mg/kg			1.01	303	02/22/21 13:56		SM 5310C 2000

Sample: EB02539-06
Name: G307D - S2
Matrix: Soil - Composite

Sampled: 02/09/21 10:40
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	11200	mg/kg			6.39	1920	02/20/21 15:20		SM 5310C 2000

Sample: EB02539-07
Name: G307D - S3
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	16700	mg/kg			4.81	1440	02/20/21 15:58		SM 5310C 2000

ANALYTICAL RESULTS

Sample: EB02539-08
Name: G307D - S4
Matrix: Soil - Composite

Sampled: 02/09/21 16:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	12400	mg/kg			4.91	1470	02/20/21 16:11		SM 5310C 2000

Sample: EB02539-09
Name: G307D - S5
Matrix: Soil - Composite

Sampled: 02/09/21 16:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	1070	mg/kg			1.97	591	02/20/21 16:24		SM 5310C 2000

Sample: EB02539-10
Name: G307D - S3 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	24900 F1	mg/kg			4.98	1490	02/20/21 17:02		SM 5310C 2000

Sample: EB02539-11
Name: XPW - 01 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 11:15
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	40200	mg/kg			95.24	28600	02/20/21 16:36		SM 5310C 2000

Sample: EB02539-12
Name: XPW - 01 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	9400 F1 F2	mg/kg			1.69	507	02/22/21 14:21		SM 5310C 2000

ANALYTICAL RESULTS

Sample: EB02539-13
Name: XPW - 02 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	38400	mg/kg			1.37	411	02/22/21 14:09		SM 5310C 2000

Sample: EB02539-14
Name: XPW - 02 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	3150	mg/kg			1.76	528	02/22/21 15:00		SM 5310C 2000

ANALYTICAL RESULTS

Sample: EB02539-01
Name: G314D - S1
Matrix: Soil - Composite

Sampled: 02/10/21 15:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.54	pCi/g dry wt			1		03/03/21 14:23		Subcontracted
Radium 228 - subcontracted	-0.0977	pCi/g dry wt	U		1		03/05/21 09:17		Subcontracted

Sample: EB02539-02
Name: G314D - S2
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.592	pCi/g dry wt			1		03/03/21 14:23		Subcontracted
Radium 228 - subcontracted	0.988	pCi/g dry wt			1		03/05/21 09:17		Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-03
Name: G314D - S3
Matrix: Soil - Composite

Sampled: 02/11/21 14:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.583	pCi/g dry wt			1		03/03/21 14:23		Subcontracted
Radium 228 - subcontracted	0.158 U	pCi/g dry wt			1		03/05/21 09:17		Subcontracted

Sample: EB02539-04
Name: G314D - S2 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.513	pCi/g dry wt			1		03/03/21 14:23		Subcontracted
Radium 228 - subcontracted	0.587	pCi/g dry wt			1		03/05/21 09:17		Subcontracted

Sample: EB02539-05
Name: G307D - S1
Matrix: Soil - Composite

Sampled: 02/09/21 10:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.413	pCi/g dry wt			1		03/08/21 17:06		Subcontracted
Radium 228 - subcontracted	0.809	pCi/g dry wt			1		03/05/21 09:17		Subcontracted

Sample: EB02539-06
Name: G307D - S2
Matrix: Soil - Composite

Sampled: 02/09/21 10:40
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.398	pCi/g dry wt			1		03/03/21 14:23		Subcontracted
Radium 228 - subcontracted	0.129 U	pCi/g dry wt			1		03/05/21 09:17		Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-07
Name: G307D - S3
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.374	pCi/g dry wt			1		03/03/21 14:23		Subcontracted
Radium 228 - subcontracted	-0.223	pCi/g dry wt	U		1		03/05/21 09:17		Subcontracted

Sample: EB02539-08
Name: G307D - S4
Matrix: Soil - Composite

Sampled: 02/09/21 16:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.565	pCi/g dry wt			1		03/03/21 15:52		Subcontracted
Radium 228 - subcontracted	0.776	pCi/g dry wt			1		03/05/21 13:45		Subcontracted

Sample: EB02539-09
Name: G307D - S5
Matrix: Soil - Composite

Sampled: 02/09/21 16:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.569	pCi/g dry wt			1		03/03/21 15:52		Subcontracted
Radium 228 - subcontracted	-0.145	pCi/g dry wt	U		1		03/05/21 13:45		Subcontracted

Sample: EB02539-10
Name: G307D - S3 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.492	pCi/g dry wt			1		03/03/21 15:52		Subcontracted
Radium 228 - subcontracted	0.307 J	pCi/g dry wt			1		03/05/21 13:45		Subcontracted

ANALYTICAL RESULTS

Sample: EB02539-11
Name: XPW - 01 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 11:15
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	1.04	pCi/g dry wt			1		03/03/21 15:52		Subcontracted
Radium 228 - subcontracted	0.701	pCi/g dry wt			1		03/05/21 13:45		Subcontracted

Sample: EB02539-12
Name: XPW - 01 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	1.89	pCi/g dry wt			1		03/03/21 15:52		Subcontracted
Radium 228 - subcontracted	0.888	pCi/g dry wt			1		03/05/21 13:45		Subcontracted

Sample: EB02539-13
Name: XPW - 02 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	2.19	pCi/g dry wt			1		03/03/21 15:53		Subcontracted
Radium 228 - subcontracted	1.56	pCi/g dry wt			1		03/05/21 13:45		Subcontracted

Sample: EB02539-14
Name: XPW - 02 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	2.1	pCi/g dry wt			1		03/03/21 15:53		Subcontracted
Radium 228 - subcontracted	0.836	pCi/g dry wt			1		03/05/21 13:45		Subcontracted

ANALYTICAL RESULTS

ANALYTICAL RESULTS

Sample: EB02539-01
Name: G314D - S1
Matrix: Soil - Composite

Sampled: 02/10/21 15:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 17:19	1	10	02/16/21 17:19	CRD	EPA 9056A
Sulfate	76	mg/kg		02/16/21 17:19	1	10	02/16/21 17:19	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	< 2.5	mg/kg		02/17/21 14:01	1	2.5	02/17/21 14:01	TTH	SM 4500F C 1997
Solids - total solids (TS)	88	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	140	mg/kg dry		02/17/21 11:37	1	57	02/18/21 10:31	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	7000	mg/kg		02/16/21 14:27	10	40	02/23/21 08:25	JMW	calculated
Manganese as MnO2	54	mg/kg		02/16/21 14:27	10	1.5	02/18/21 09:58	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.30	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:07	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	120	mg/kg		02/16/21 09:26	1	50	02/18/21 10:31	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.8	mg/kg		02/16/21 14:27	10	2.8	02/18/21 09:58	JMW	EPA 6020A
Arsenic	1.3	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Barium	63	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Beryllium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Boron	< 9.3	mg/kg		02/16/21 14:27	10	9.3	02/18/21 09:58	JMW	EPA 6020A*
Cadmium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Chromium	8.7	mg/kg		02/16/21 14:27	10	3.7	02/18/21 09:58	JMW	EPA 6020A
Cobalt	< 1.9	mg/kg		02/16/21 14:27	10	1.9	02/18/21 09:58	JMW	EPA 6020A
Iron	4900	mg/kg		02/16/21 14:27	10	28	02/23/21 08:25	JMW	EPA 6020A*
Lead	5.5	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Manganese	34	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Molybdenum	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Selenium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Thallium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 09:58	JMW	EPA 6020A
Mercury	< 0.19	mg/kg		02/16/21 14:27	10	0.19	02/18/21 09:58	JMW	EPA 6020A
Lithium	< 4.6	mg/kg		02/16/21 14:27	1	4.6	02/18/21 09:27	TJJ	EPA 6010B*
Sulfur	100	mg/kg		02/16/21 14:27	10	93	02/17/21 14:52	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-02
Name: G314D - S2
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 17:38	1	10	02/16/21 17:38	CRD	EPA 9056A
Sulfate	210	mg/kg		02/17/21 17:41	5	50	02/17/21 17:41	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	< 2.5	mg/kg		02/17/21 14:03	1	2.5	02/17/21 14:03	TTH	SM 4500F C 1997
Solids - total solids (TS)	86	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	360	mg/kg dry		02/17/21 11:37	1	58	02/18/21 10:32	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	16000	mg/kg		02/16/21 14:27	10	43	02/23/21 10:46	JMW	calculated
Manganese as MnO2	500	mg/kg		02/16/21 14:27	10	1.6	02/18/21 10:02	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:07	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	310	mg/kg		02/16/21 09:26	1	50	02/18/21 10:32	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/16/21 14:27	10	3.0	02/18/21 10:02	JMW	EPA 6020A
Arsenic	2.7	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Barium	27	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Beryllium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Boron	< 10	mg/kg		02/16/21 14:27	10	10	02/18/21 10:02	JMW	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Chromium	9.9	mg/kg		02/16/21 14:27	10	4.0	02/18/21 10:02	JMW	EPA 6020A
Cobalt	5.2	mg/kg		02/16/21 14:27	10	2.0	02/18/21 10:02	JMW	EPA 6020A
Iron	11000	mg/kg		02/16/21 14:27	10	30	02/23/21 10:46	JMW	EPA 6020A*
Lead	7.3	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Manganese	320	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Molybdenum	1.2	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Selenium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Thallium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:02	JMW	EPA 6020A
Mercury	< 0.20	mg/kg		02/16/21 14:27	10	0.20	02/18/21 10:02	JMW	EPA 6020A
Lithium	9.1	mg/kg		02/16/21 14:27	1	5.0	02/18/21 09:29	TJJ	EPA 6010B*
Sulfur	1100	mg/kg		02/16/21 14:27	10	100	02/17/21 14:54	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-03
Name: G314D - S3
Matrix: Soil - Composite

Sampled: 02/11/21 14:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 17:56	1	10	02/16/21 17:56	CRD	EPA 9056A
Sulfate	< 10	mg/kg		02/16/21 17:56	1	10	02/16/21 17:56	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	3.1	mg/kg		02/17/21 14:10	1	2.5	02/17/21 14:10	TTH	SM 4500F C 1997
Solids - total solids (TS)	88	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	260	mg/kg dry		02/17/21 11:37	1	57	02/18/21 10:32	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	30000	mg/kg		02/16/21 14:27	100	340	02/23/21 10:50	JMW	calculated
Manganese as MnO2	590	mg/kg		02/16/21 14:27	10	1.3	02/18/21 10:06	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.48	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:08	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	230	mg/kg		02/16/21 09:26	1	50	02/18/21 10:32	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.4	mg/kg		02/16/21 14:27	10	2.4	02/18/21 10:06	JMW	EPA 6020A
Arsenic	3.8	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Barium	140	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Beryllium	< 0.80	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Boron	< 8.0	mg/kg		02/16/21 14:27	10	8.0	02/18/21 10:06	JMW	EPA 6020A*
Cadmium	< 0.80	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Chromium	25	mg/kg		02/16/21 14:27	10	3.2	02/18/21 10:06	JMW	EPA 6020A
Cobalt	10	mg/kg		02/16/21 14:27	10	1.6	02/18/21 10:06	JMW	EPA 6020A
Iron	21000	mg/kg		02/16/21 14:27	100	240	02/23/21 10:50	JMW	EPA 6020A*
Lead	11	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Manganese	370	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Molybdenum	< 0.80	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Selenium	0.98	mg/kg		02/16/21 14:27	10	0.80	02/24/21 11:51	JMW	EPA 6020A
Thallium	< 0.80	mg/kg		02/16/21 14:27	10	0.80	02/18/21 10:06	JMW	EPA 6020A
Mercury	< 0.16	mg/kg		02/16/21 14:27	10	0.16	02/18/21 10:06	JMW	EPA 6020A
Lithium	28	mg/kg		02/16/21 14:27	1	4.0	02/18/21 09:31	TJJ	EPA 6010B*
Sulfur	< 80	mg/kg		02/16/21 14:27	10	80	02/17/21 14:56	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-04
Name: G314D - S2 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/11/21 11:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg	Q2	02/16/21 18:14	1	10	02/16/21 18:14	CRD	EPA 9056A
Sulfate	95	mg/kg	Q4	02/16/21 18:14	1	10	02/16/21 18:14	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	2.8	mg/kg		02/17/21 14:05	1	2.5	02/17/21 14:05	TTH	SM 4500F C 1997
Solids - total solids (TS)	86	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	360	mg/kg dry		02/17/21 11:37	1	58	02/18/21 10:37	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	19000	mg/kg		02/16/21 14:27	100	430	02/23/21 10:54	JMW	calculated
Manganese as MnO2	990	mg/kg		02/16/21 14:27	10	1.6	02/18/21 10:29	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.68	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:04	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	310	mg/kg		02/16/21 09:26	1	50	02/18/21 10:37	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/16/21 14:27	10	3.0	02/18/21 10:29	JMW	EPA 6020A
Arsenic	5.8	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Barium	80	mg/kg	Q3	02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Beryllium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Boron	< 10	mg/kg	Q3	02/16/21 14:27	10	10	02/18/21 10:29	JMW	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Chromium	22	mg/kg	Q3	02/16/21 14:27	10	4.0	02/18/21 10:29	JMW	EPA 6020A
Cobalt	9.8	mg/kg		02/16/21 14:27	10	2.0	02/18/21 10:29	JMW	EPA 6020A
Iron	14000	mg/kg		02/16/21 14:27	100	300	02/23/21 10:54	JMW	EPA 6020A*
Lead	14	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Manganese	620	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Molybdenum	1.9	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Selenium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/24/21 11:55	JMW	EPA 6020A
Thallium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:29	JMW	EPA 6020A
Mercury	< 0.20	mg/kg		02/16/21 14:27	10	0.20	02/18/21 10:29	JMW	EPA 6020A
Lithium	9.9	mg/kg		02/16/21 14:27	1	5.0	02/18/21 09:33	TJJ	EPA 6010B*
Sulfur	770	mg/kg	Q3	02/16/21 14:27	10	100	02/17/21 14:58	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-05
Name: G307D - S1
Matrix: Soil - Composite

Sampled: 02/09/21 10:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 19:08	1	10	02/16/21 19:08	CRD	EPA 9056A
Sulfate	220	mg/kg		02/17/21 17:59	5	50	02/17/21 17:59	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	3.1	mg/kg		02/17/21 14:11	1	2.5	02/17/21 14:11	TTH	SM 4500F C 1997
Solids - total solids (TS)	83	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	160	mg/kg dry		02/17/21 11:37	1	60	02/18/21 10:39	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	28000	mg/kg		02/16/21 14:27	100	370	02/23/21 12:02	JMW	calculated
Manganese as MnO2	4900	mg/kg		02/16/21 14:27	10	1.4	02/18/21 10:41	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:09	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	140	mg/kg		02/16/21 09:26	1	50	02/18/21 10:39	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.6	mg/kg		02/16/21 14:27	10	2.6	02/18/21 10:41	JMW	EPA 6020A
Arsenic	7.5	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Barium	150	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Beryllium	< 0.86	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Boron	< 8.6	mg/kg		02/16/21 14:27	10	8.6	02/18/21 10:41	JMW	EPA 6020A*
Cadmium	1.2	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Chromium	9.5	mg/kg		02/16/21 14:27	10	3.4	02/18/21 10:41	JMW	EPA 6020A
Cobalt	25	mg/kg		02/16/21 14:27	10	1.7	02/18/21 10:41	JMW	EPA 6020A
Iron	20000	mg/kg		02/16/21 14:27	100	260	02/23/21 12:02	JMW	EPA 6020A*
Lead	15	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Manganese	3100	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Molybdenum	1.3	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Selenium	< 0.86	mg/kg		02/16/21 14:27	10	0.86	02/24/21 12:29	JMW	EPA 6020A
Thallium	< 0.86	mg/kg		02/16/21 14:27	10	0.86	02/18/21 10:41	JMW	EPA 6020A
Mercury	< 0.17	mg/kg		02/16/21 14:27	10	0.17	02/18/21 10:41	JMW	EPA 6020A
Lithium	< 4.3	mg/kg		02/16/21 14:27	1	4.3	02/18/21 09:41	TJJ	EPA 6010B*
Sulfur	100	mg/kg		02/16/21 14:27	10	86	02/17/21 15:03	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-06
Name: G307D - S2
Matrix: Soil - Composite

Sampled: 02/09/21 10:40
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	19	mg/kg		02/16/21 20:02	1	10	02/16/21 20:02	CRD	EPA 9056A
Sulfate	170	mg/kg		02/22/21 19:38	5	50	02/22/21 19:38	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	< 2.5	mg/kg		02/17/21 14:13	1	2.5	02/17/21 14:13	TTH	SM 4500F C 1997
Solids - total solids (TS)	79	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	< 63	mg/kg dry		02/17/21 11:37	1	63	02/18/21 10:40	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	7100	mg/kg		02/16/21 14:27	10	28	02/23/21 11:09	JMW	calculated
Manganese as MnO2	190	mg/kg		02/16/21 14:27	10	1.0	02/18/21 10:45	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:10	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	< 50	mg/kg		02/16/21 09:26	1	50	02/18/21 10:40	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.0	mg/kg		02/16/21 14:27	10	2.0	02/18/21 10:45	JMW	EPA 6020A
Arsenic	1.7	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Barium	10	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Beryllium	< 0.66	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Boron	< 6.6	mg/kg		02/16/21 14:27	10	6.6	02/18/21 10:45	JMW	EPA 6020A*
Cadmium	< 0.66	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Chromium	3.8	mg/kg		02/16/21 14:27	10	2.6	02/18/21 10:45	JMW	EPA 6020A
Cobalt	1.4	mg/kg		02/16/21 14:27	10	1.3	02/18/21 10:45	JMW	EPA 6020A
Iron	4900	mg/kg		02/16/21 14:27	10	20	02/23/21 11:09	JMW	EPA 6020A*
Lead	3.3	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Manganese	120	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Molybdenum	< 0.66	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Selenium	< 0.66	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Thallium	< 0.66	mg/kg		02/16/21 14:27	10	0.66	02/18/21 10:45	JMW	EPA 6020A
Mercury	< 0.13	mg/kg		02/16/21 14:27	10	0.13	02/18/21 10:45	JMW	EPA 6020A
Lithium	< 3.3	mg/kg		02/16/21 14:27	1	3.3	02/18/21 09:43	TJJ	EPA 6010B*
Sulfur	< 66	mg/kg		02/16/21 14:27	10	66	02/17/21 15:05	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-07
Name: G307D - S3
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 20:21	1	10	02/16/21 20:21	CRD	EPA 9056A
Sulfate	30	mg/kg		02/16/21 20:21	1	10	02/16/21 20:21	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	< 2.5	mg/kg		02/17/21 14:14	1	2.5	02/17/21 14:14	TTH	SM 4500F C 1997
Solids - total solids (TS)	92	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	260	mg/kg dry		02/17/21 11:37	1	54	02/18/21 10:41	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	15000	mg/kg		02/16/21 14:27	10	37	02/23/21 11:39	JMW	calculated
Manganese as MnO2	450	mg/kg		02/16/21 14:27	10	1.4	02/18/21 10:49	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.25	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:11	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	240	mg/kg		02/16/21 09:26	1	50	02/18/21 10:41	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.6	mg/kg		02/16/21 14:27	10	2.6	02/18/21 10:49	JMW	EPA 6020A
Arsenic	2.9	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Barium	20	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Beryllium	< 0.87	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Boron	< 8.7	mg/kg		02/16/21 14:27	10	8.7	02/18/21 10:49	JMW	EPA 6020A*
Cadmium	< 0.87	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Chromium	8.5	mg/kg		02/16/21 14:27	10	3.5	02/18/21 10:49	JMW	EPA 6020A
Cobalt	4.5	mg/kg		02/16/21 14:27	10	1.7	02/18/21 10:49	JMW	EPA 6020A
Iron	11000	mg/kg		02/16/21 14:27	10	26	02/23/21 11:39	JMW	EPA 6020A*
Lead	5.9	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Manganese	290	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Molybdenum	< 0.87	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Selenium	< 0.87	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Thallium	< 0.87	mg/kg		02/16/21 14:27	10	0.87	02/18/21 10:49	JMW	EPA 6020A
Mercury	< 0.17	mg/kg		02/16/21 14:27	10	0.17	02/18/21 10:49	JMW	EPA 6020A
Lithium	10	mg/kg		02/16/21 14:27	1	4.4	02/18/21 09:45	TJJ	EPA 6010B*
Sulfur	1400	mg/kg		02/16/21 14:27	10	87	02/17/21 15:07	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-08
Name: G307D - S4
Matrix: Soil - Composite

Sampled: 02/09/21 16:00
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 20:39	1	10	02/16/21 20:39	CRD	EPA 9056A
Sulfate	< 10	mg/kg		02/16/21 20:39	1	10	02/16/21 20:39	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	4.2	mg/kg		02/17/21 14:16	1	2.5	02/17/21 14:16	TTH	SM 4500F C 1997
Solids - total solids (TS)	86	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	360	mg/kg dry		02/17/21 11:37	1	58	02/18/21 10:42	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	14000	mg/kg		02/16/21 14:27	10	40	02/23/21 11:43	JMW	calculated
Manganese as MnO2	670	mg/kg		02/16/21 14:27	10	1.5	02/18/21 10:52	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.32	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:17	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	310	mg/kg		02/16/21 09:26	1	50	02/18/21 10:42	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.8	mg/kg		02/16/21 14:27	10	2.8	02/18/21 10:52	JMW	EPA 6020A
Arsenic	5.7	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Barium	93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Beryllium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Boron	< 9.3	mg/kg		02/16/21 14:27	10	9.3	02/18/21 10:52	JMW	EPA 6020A*
Cadmium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Chromium	10	mg/kg		02/16/21 14:27	10	3.7	02/18/21 10:52	JMW	EPA 6020A
Cobalt	7.1	mg/kg		02/16/21 14:27	10	1.9	02/18/21 10:52	JMW	EPA 6020A
Iron	10000	mg/kg		02/16/21 14:27	10	28	02/23/21 11:43	JMW	EPA 6020A*
Lead	7.7	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Manganese	430	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Molybdenum	1.4	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Selenium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Thallium	< 0.93	mg/kg		02/16/21 14:27	10	0.93	02/18/21 10:52	JMW	EPA 6020A
Mercury	< 0.19	mg/kg		02/16/21 14:27	10	0.19	02/18/21 10:52	JMW	EPA 6020A
Lithium	7.1	mg/kg		02/16/21 14:27	1	4.7	02/18/21 09:46	TJJ	EPA 6010B*
Sulfur	850	mg/kg		02/16/21 14:27	10	93	02/17/21 15:13	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-09
Name: G307D - S5
Matrix: Soil - Composite

Sampled: 02/09/21 16:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/16/21 20:57	1	10	02/16/21 20:57	CRD	EPA 9056A
Sulfate	< 10	mg/kg		02/16/21 20:57	1	10	02/16/21 20:57	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	6.8	mg/kg		02/17/21 14:23	1	2.5	02/17/21 14:23	TTH	SM 4500F C 1997
Solids - total solids (TS)	81	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	310	mg/kg dry		02/17/21 11:37	1	61	02/18/21 10:43	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	28000	mg/kg		02/16/21 14:27	100	340	02/23/21 12:06	JMW	calculated
Manganese as MnO2	740	mg/kg		02/16/21 14:27	10	1.2	02/18/21 10:56	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	1.5	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:17	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	250	mg/kg		02/16/21 09:26	1	50	02/18/21 10:43	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.4	mg/kg		02/16/21 14:27	10	2.4	02/18/21 10:56	JMW	EPA 6020A
Arsenic	4.2	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Barium	110	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Beryllium	< 0.79	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Boron	< 7.9	mg/kg		02/16/21 14:27	10	7.9	02/18/21 10:56	JMW	EPA 6020A*
Cadmium	< 0.79	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Chromium	8.5	mg/kg		02/16/21 14:27	10	3.2	02/18/21 10:56	JMW	EPA 6020A
Cobalt	6.0	mg/kg		02/16/21 14:27	10	1.6	02/18/21 10:56	JMW	EPA 6020A
Iron	19000	mg/kg		02/16/21 14:27	100	240	02/23/21 12:06	JMW	EPA 6020A*
Lead	7.2	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Manganese	470	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Molybdenum	< 0.79	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Selenium	< 0.79	mg/kg		02/16/21 14:27	10	0.79	02/24/21 12:33	JMW	EPA 6020A
Thallium	< 0.79	mg/kg		02/16/21 14:27	10	0.79	02/18/21 10:56	JMW	EPA 6020A
Mercury	< 0.16	mg/kg		02/16/21 14:27	10	0.16	02/18/21 10:56	JMW	EPA 6020A
Lithium	6.8	mg/kg		02/16/21 14:27	1	4.0	02/18/21 09:48	TJJ	EPA 6010B*
Sulfur	85	mg/kg		02/16/21 14:27	10	79	02/17/21 15:15	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-10
Name: G307D - S3 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/09/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg	Q3	02/16/21 21:15	1	10	02/16/21 21:15	CRD	EPA 9056A
Sulfate	45	mg/kg	Q3	02/16/21 21:15	1	10	02/16/21 21:15	CRD	EPA 9056A
General Chemistry - PIA									
Fluoride	< 2.5	mg/kg		02/17/21 14:28	1	2.5	02/17/21 14:28	TTH	SM 4500F C 1997
Solids - total solids (TS)	90	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	250	mg/kg dry		02/17/21 11:37	1	55	02/18/21 10:44	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	13000	mg/kg		02/16/21 14:27	10	43	02/23/21 11:51	JMW	calculated
Manganese as MnO2	420	mg/kg		02/16/21 14:27	10	1.6	02/18/21 11:00	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:19	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	220	mg/kg		02/16/21 09:26	1	50	02/18/21 10:44	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/16/21 14:27	10	3.0	02/18/21 11:00	JMW	EPA 6020A
Arsenic	3.2	mg/kg	Q1	02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Barium	17	mg/kg		02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Beryllium	< 1.0	mg/kg	Q1	02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Boron	< 10	mg/kg	Q1, R	02/16/21 14:27	10	10	02/18/21 11:00	JMW	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Chromium	7.3	mg/kg	Q1	02/16/21 14:27	10	4.0	02/18/21 11:00	JMW	EPA 6020A
Cobalt	4.2	mg/kg	Q1	02/16/21 14:27	10	2.0	02/18/21 11:00	JMW	EPA 6020A
Iron	9100	mg/kg		02/16/21 14:27	10	30	02/23/21 11:51	JMW	EPA 6020A*
Lead	5.2	mg/kg		02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Manganese	270	mg/kg		02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Molybdenum	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Selenium	< 1.0	mg/kg	Q1	02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Thallium	< 1.0	mg/kg		02/16/21 14:27	10	1.0	02/18/21 11:00	JMW	EPA 6020A
Mercury	< 0.20	mg/kg		02/16/21 14:27	10	0.20	02/18/21 11:00	JMW	EPA 6020A
Lithium	8.1	mg/kg		02/16/21 14:27	1	5.0	02/18/21 09:50	TJJ	EPA 6010B*
Sulfur	1400	mg/kg	Q3	02/16/21 14:27	10	100	02/17/21 15:17	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-11
Name: XPW - 01 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 11:15
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/17/21 14:40	1	10	02/17/21 14:40	CRD	EPA 9056A
Fluoride	< 2.5	mg/kg		02/17/21 14:40	1	2.5	02/17/21 14:40	CRD	EPA 9056A
Sulfate	450	mg/kg		02/22/21 19:56	10	100	02/22/21 19:56	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	78	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	110	mg/kg dry		02/17/21 11:37	1	64	02/18/21 10:50	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	81000	mg/kg		02/23/21 09:23	100	390	02/26/21 11:05	JMW	calculated
Manganese as MnO2	270	mg/kg		02/23/21 09:23	10	1.4	02/24/21 12:52	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:18	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	85	mg/kg		02/16/21 09:26	1	50	02/18/21 10:50	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.7	mg/kg		02/23/21 09:23	10	2.7	02/25/21 10:07	JMW	EPA 6020A
Arsenic	6.9	mg/kg		02/23/21 09:23	10	0.91	02/24/21 12:52	JMW	EPA 6020A
Barium	710	mg/kg		02/23/21 09:23	10	0.91	02/25/21 10:07	JMW	EPA 6020A
Beryllium	1.9	mg/kg		02/23/21 09:23	10	0.91	03/02/21 09:19	JMW	EPA 6020A
Boron	110	mg/kg		02/23/21 09:23	10	9.1	03/02/21 09:19	JMW	EPA 6020A*
Cadmium	0.96	mg/kg		02/23/21 09:23	10	0.91	02/25/21 10:07	JMW	EPA 6020A
Chromium	41	mg/kg		02/23/21 09:23	10	3.6	02/24/21 12:52	JMW	EPA 6020A
Cobalt	4.8	mg/kg		02/23/21 09:23	10	1.8	02/24/21 12:52	JMW	EPA 6020A
Iron	57000	mg/kg		02/23/21 09:23	100	270	02/26/21 11:05	JMW	EPA 6020A*
Lead	4.7	mg/kg		02/23/21 09:23	10	0.91	02/25/21 10:07	JMW	EPA 6020A
Manganese	170	mg/kg	Q2	02/23/21 09:23	10	0.91	02/24/21 12:52	JMW	EPA 6020A
Molybdenum	7.0	mg/kg		02/23/21 09:23	10	0.91	02/25/21 10:07	JMW	EPA 6020A
Selenium	7.5	mg/kg		02/23/21 09:23	10	0.91	02/24/21 12:52	JMW	EPA 6020A
Thallium	< 0.91	mg/kg		02/23/21 09:23	10	0.91	02/25/21 10:07	JMW	EPA 6020A
Mercury	< 0.18	mg/kg		02/23/21 09:23	10	0.18	02/25/21 10:07	JMW	EPA 6020A
Lithium	18	mg/kg		02/23/21 09:23	1	4.6	02/24/21 09:59	AMB	EPA 6010B*
Sulfur	480	mg/kg		02/23/21 09:23	1	9.1	02/23/21 15:16	TJJ	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-12
Name: XPW - 01 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:45
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg	Q3	02/17/21 14:58	1	10	02/17/21 14:58	CRD	EPA 9056A
Fluoride	< 2.5	mg/kg	Q3	02/17/21 14:58	1	2.5	02/17/21 14:58	CRD	EPA 9056A
Sulfate	230	mg/kg		02/22/21 20:14	10	100	02/22/21 20:14	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	82	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	160	mg/kg dry		02/17/21 11:37	1	61	02/18/21 10:51	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	61000	mg/kg		02/23/21 09:23	100	400	02/26/21 11:09	JMW	calculated
Manganese as MnO2	210	mg/kg		02/23/21 09:23	10	1.5	02/24/21 13:27	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:22	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	130	mg/kg		02/16/21 09:26	1	50	02/18/21 10:51	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.8	mg/kg		02/23/21 09:23	10	2.8	02/25/21 08:39	JMW	EPA 6020A
Arsenic	2.3	mg/kg		02/23/21 09:23	10	0.93	02/24/21 13:27	JMW	EPA 6020A
Barium	680	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:39	JMW	EPA 6020A
Beryllium	1.5	mg/kg		02/23/21 09:23	10	0.93	03/02/21 09:21	JMW	EPA 6020A
Boron	71	mg/kg		02/23/21 09:23	10	9.3	03/02/21 09:21	JMW	EPA 6020A*
Cadmium	< 0.93	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:39	JMW	EPA 6020A
Chromium	29	mg/kg		02/23/21 09:23	10	3.7	02/24/21 13:27	JMW	EPA 6020A
Cobalt	4.7	mg/kg		02/23/21 09:23	10	1.9	02/24/21 13:27	JMW	EPA 6020A
Iron	43000	mg/kg		02/23/21 09:23	100	280	02/26/21 11:09	JMW	EPA 6020A*
Lead	1.7	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:39	JMW	EPA 6020A
Manganese	140	mg/kg		02/23/21 09:23	10	0.93	02/24/21 13:27	JMW	EPA 6020A
Molybdenum	2.4	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:39	JMW	EPA 6020A
Selenium	1.4	mg/kg		02/23/21 09:23	10	0.93	02/24/21 13:27	JMW	EPA 6020A
Thallium	< 0.93	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:39	JMW	EPA 6020A
Mercury	< 0.19	mg/kg		02/23/21 09:23	10	0.19	02/25/21 08:39	JMW	EPA 6020A
Lithium	16	mg/kg		02/23/21 09:23	1	4.6	02/24/21 10:01	AMB	EPA 6010B*
Sulfur	220	mg/kg	Q3	02/23/21 09:23	1	9.3	02/23/21 15:18	TJJ	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-13
Name: XPW - 02 - S1
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg		02/17/21 15:16	1	10	02/17/21 15:16	CRD	EPA 9056A
Fluoride	< 2.5	mg/kg		02/17/21 15:16	1	2.5	02/17/21 15:16	CRD	EPA 9056A
Sulfate	85	mg/kg		02/17/21 15:16	1	10	02/17/21 15:16	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	88	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	100	mg/kg dry		02/17/21 16:56	1	57	02/18/21 10:56	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	72000	mg/kg		02/23/21 09:23	100	400	02/26/21 11:12	JMW	calculated
Manganese as MnO2	270	mg/kg		02/23/21 09:23	10	1.5	02/24/21 13:35	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:22	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	89	mg/kg		02/17/21 16:56	1	50	02/18/21 10:56	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.8	mg/kg		02/23/21 09:23	10	2.8	02/25/21 08:50	JMW	EPA 6020A
Arsenic	< 0.93	mg/kg		02/23/21 09:23	10	0.93	02/24/21 13:35	JMW	EPA 6020A
Barium	850	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:50	JMW	EPA 6020A
Beryllium	1.6	mg/kg		02/23/21 09:23	10	0.93	03/02/21 09:30	JMW	EPA 6020A
Boron	70	mg/kg		02/23/21 09:23	10	9.3	03/02/21 09:30	JMW	EPA 6020A*
Cadmium	< 0.93	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:50	JMW	EPA 6020A
Chromium	24	mg/kg		02/23/21 09:23	10	3.7	02/24/21 13:35	JMW	EPA 6020A
Cobalt	4.3	mg/kg		02/23/21 09:23	10	1.9	02/24/21 13:35	JMW	EPA 6020A
Iron	50000	mg/kg		02/23/21 09:23	100	280	02/26/21 11:12	JMW	EPA 6020A*
Lead	1.3	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:50	JMW	EPA 6020A
Manganese	170	mg/kg		02/23/21 09:23	10	0.93	02/24/21 13:35	JMW	EPA 6020A
Molybdenum	2.5	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:50	JMW	EPA 6020A
Selenium	< 0.93	mg/kg		02/23/21 09:23	10	0.93	02/24/21 13:35	JMW	EPA 6020A
Thallium	< 0.93	mg/kg		02/23/21 09:23	10	0.93	02/25/21 08:50	JMW	EPA 6020A
Mercury	< 0.19	mg/kg		02/23/21 09:23	10	0.19	02/25/21 08:50	JMW	EPA 6020A
Lithium	20	mg/kg		02/23/21 09:23	1	4.7	02/24/21 10:06	AMB	EPA 6010B*
Sulfur	130	mg/kg		02/23/21 09:23	1	9.3	02/23/21 15:24	TJJ	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB02539-14
Name: XPW - 02 - S1 DUPLICATE
Matrix: Soil - Composite

Sampled: 02/08/21 14:30
Received: 02/12/21 15:12

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 10	mg/kg	Q3	02/17/21 16:11	1	10	02/17/21 16:11	CRD	EPA 9056A
Fluoride	< 2.5	mg/kg		02/17/21 16:11	1	2.5	02/17/21 16:11	CRD	EPA 9056A
Sulfate	120	mg/kg		02/22/21 20:32	5	50	02/22/21 20:32	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	85	%		02/15/21 13:07	1	0.050	02/15/21 15:17	BMA/BCR	SM 2540G*
Total Nitrogen	130	mg/kg dry		02/17/21 16:56	1	59	02/18/21 11:01	BMS	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	24000	mg/kg		02/23/21 09:23	10	40	02/24/21 13:39	JMW	calculated
Manganese as MnO2	95	mg/kg		02/23/21 09:23	10	1.5	02/24/21 13:39	JMW	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/17/21 11:37	1	0.20	02/17/21 12:26	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	110	mg/kg		02/17/21 16:56	1	50	02/18/21 11:01	BMS	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.8	mg/kg	Q1, R	02/23/21 09:23	10	2.8	02/25/21 09:53	JMW	EPA 6020A
Arsenic	1.4	mg/kg	Q1, R	02/23/21 09:23	10	0.92	02/24/21 13:39	JMW	EPA 6020A
Barium	290	mg/kg		02/23/21 09:23	10	0.92	02/25/21 09:53	JMW	EPA 6020A
Beryllium	< 0.92	mg/kg		02/23/21 09:23	10	0.92	03/02/21 09:33	JMW	EPA 6020A
Boron	49	mg/kg	Q2, R	02/23/21 09:23	10	9.2	03/02/21 09:33	JMW	EPA 6020A*
Cadmium	< 0.92	mg/kg	Q1, R	02/23/21 09:23	10	0.92	02/25/21 09:53	JMW	EPA 6020A
Chromium	9.9	mg/kg	Q1, R	02/23/21 09:23	10	3.7	02/24/21 13:39	JMW	EPA 6020A
Cobalt	< 1.8	mg/kg	Q1, R	02/23/21 09:23	10	1.8	02/24/21 13:39	JMW	EPA 6020A
Iron	17000	mg/kg		02/23/21 09:23	10	28	02/24/21 13:39	JMW	EPA 6020A*
Lead	< 0.92	mg/kg	Q1, R	02/23/21 09:23	10	0.92	02/25/21 09:53	JMW	EPA 6020A
Manganese	60	mg/kg	Q3, R	02/23/21 09:23	10	0.92	02/24/21 13:39	JMW	EPA 6020A
Molybdenum	1.4	mg/kg	Q1, R	02/23/21 09:23	10	0.92	02/25/21 09:53	JMW	EPA 6020A
Selenium	< 0.92	mg/kg	Q1, R	02/23/21 09:23	10	0.92	02/24/21 13:39	JMW	EPA 6020A
Thallium	< 0.92	mg/kg	Q1, R	02/23/21 09:23	10	0.92	02/25/21 09:53	JMW	EPA 6020A
Mercury	< 0.18	mg/kg	Q1, R	02/23/21 09:23	10	0.18	02/25/21 09:53	JMW	EPA 6020A
Lithium	7.4	mg/kg		02/23/21 09:23	1	4.6	02/24/21 10:08	AMB	EPA 6010B*
Sulfur	250	mg/kg	Q3	02/23/21 09:23	1	9.2	02/24/21 15:05	TJJ	EPA 6010B*

NOTES

Specifications regarding method revisions and method modifications used for analysis are available upon request. Please contact your project manager.

* Not a TNI accredited analyte

Certifications

CHI - McHenry, IL - 4314-A W. Crystal Lake Road, McHenry, IL 60050
TNI Accreditation for Drinking Water and Wastewater Fields of Testing through IL EPA Accreditation No. 100279
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory Registry No. 17556

PIA - Peoria, IL - 2231 W. Altorfer Drive, Peoria, IL 61615
TNI Accreditation for Drinking Water, Wastewater, Solid and Hazardous Material Fields of Testing through IL EPA Accreditation No. 100230
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory Registry No. 17553
Drinking Water Certifications/Accreditations: Iowa (240); Kansas (E-10338); Missouri (870)
Wastewater Certifications/Accreditations: Arkansas (88-0677); Iowa (240); Kansas (E-10338)
Solid and Hazardous Material Certifications/Accreditations: Arkansas (88-0677); Iowa (240); Kansas (E-10338)

SPMO - Springfield, MO - 1805 W Sunset Street, Springfield, MO 65807
USEPA DMR-QA Program

STL - Hazelwood, MO - 944 Anglum Rd, Hazelwood, MO 63042
TNI Accreditation for Wastewater, Solid and Hazardous Material Fields of Testing through KS KDHE Certification No. E-10389
TNI Accreditation for Wastewater, Solid and Hazardous Material Fields of Testing through IL EPA Accreditation No. - 200080
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory, Registry No. 171050
Missouri Department of Natural Resources - Certificate of Approval for Microbiological Laboratory Service - No. 1050

Qualifiers

Q1	Matrix Spike failed % recovery acceptance limits. The associated blank spike recovery was acceptable.
Q2	Matrix Spike Duplicate failed % recovery acceptance limits. The associated blank spike recovery was acceptable.
Q3	Matrix Spike/Matrix Spike Duplicate both failed % recovery acceptance limits. The associated blank spike recovery was acceptable.
Q4	The matrix spike recovery result is unusable since the analyte concentration in the sample is greater than four times the spike level. The associated blank spike was acceptable.
R	Matrix Spike/Matrix Spike Duplicate Failed %Relative Percent Difference criterion.

Gail J Schindler

Certified by: Gail Schindler, Project Manager

September 15, 2021

Michael Healy
SiREM
130 Stone Road West
Guelph, Ontario, Canada N1G 3Z2

RE: Report of Findings, Measurement of AVS
Client ID: Coffeen AP1 MNA
PRIMA ID: Sirem 08312021-Coffeen AP1

Dear Mr. Healy:

This letter report describes the results of analyses conducted on four soil samples. Each soil was analyzed for acid volatile sulfide (AVS). Results are reported herein.

Sample Receipt and Preparation

Samples were received on August 31, 2021. The samples were placed in an anaerobic glovebox upon receipt. All sample preparation was conducted in the glove box.

Procedures

AVS was measured via sequential extraction of soil based on methods provided by Microseeps, Inc. In order to minimize exposure of the soil or extraction fluid to oxygen, the soil samples were transferred to the extraction vessel while in the glove box and the extractions were carried out on the bench top under a flow of nitrogen. A brief description of the extraction procedure is provided below.

WAS-Fe. Approximately 10 g of soil is extracted with 1 N hydrochloric acid (HCl) for 30 minutes at room temperature (approximately 20° C), after which an aliquot of the HCl is withdrawn and analyzed for ferrous iron and total iron colorimetrically using a Hach DR2800 spectrophotometer and appropriate Hach test kit reagents. Dilutions are made as needed using deoxygenated, deionized (DO/DI) water.

AVS. Hydrogen sulfide generated during the WAS extraction step is collected in a trap filled with 1.25 N sodium hydroxide (NaOH). After collection of the WAS Fe sample, concentrated HCl is added to the soil and the mixture is heated for 30 minutes. The concentration of sulfide in trap is then measured using the methylene blue method via a

Hach DR2800 spectrophotometer and appropriate Hach test kit reagents. Dilutions are made as needed using DO/DI water.

Results

The amount of AVS in each sample is shown in **Table 1** (attached). QC results are given in **Table 2** (attached).

If you have any questions regarding these results, please give me a call at 916-939-7300. Thank you for the opportunity to be of service.

Sincerely,
PRIMA Environmental, Inc.

Cindy G. Schreier

Cindy G. Schreier, Ph.D.
President

Attachments

Table 1. AVS Results.

Sample	AVS, mg/kg
SB-306-(14-16)	< 0.18
SB-311-(14-15)	0.24
SB-313-(8-9)	< 1.6 M
SB-316-(13-14, 15-16)	0.28

M Reporting limit elevated due to matrix interference

Table 2. QC Results for AVS.

Sample ID	Result	Units
Blank *		
AVS	< 0.025	mg/L
FeS standard		
Sulfide concentration	365	g/kg
AVS	378	g/kg
% Recovered as AVS	104	%

* A blank was run in the absence of a solid material. Therefore, values are concentrations in the extraction fluids or traps.

5070 Robert J Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
916-939-7300
www.primaenvironmental.com

Sample Receipt Summary

Date/Time: 8/31/21 10:40

Client/Company: SiRem - AVS 08312021

Project: Coffeen AP1 MNA

	Yes	No	N/A
Custody seals intact?	☐	☐	☒
Chain of custody Present?	☒	☐	☐
If no, list number of samples and Sample ID			
Ice present?	☒ Blue ice	☐	☐
If no, what is temperature? _____			
Samples in good condition?	☒	☐	☐
If no, explain:			
Do sample IDs on containers match IDs on COC?	☒	☐	☐
If no, explain:			

Other Comments:
electrical tape around lids.
Store in glovebox

PRIMA ENVIRONMENTAL INC.
Mathews Parkway, Suite 300 El Dorado Hills, CA 95762
(916) 939-7300; (916) 939-7398 Fax
www.primaenvironmental.com

CHAIN of CUSTODY

Project Manager: Michael Healey
Project Name: Coffeen AP1 MNA
Job Number:
Sampler Signature:

Phone: (519) 822-2265
Fax: (519) 822-3151
Email: mhealey@siremlab.com
TAT: 1 week

SAMPLE ID	Date	Time	Matrix	# Containers	Acid Volatile Sulfide										Comments
SB-306-(14-16)	26-Aug-21	12:15	S	1	X										
SB-311-(14-15)	26-Aug-21	12:30	S	1	X										
SB-313-(8-9)	26-Aug-21	12:45	S	1	X										
SB-316-(13-14,15-16)	26-Aug-21	1:00	S	1	X										

Special Instructions	Relinquished by:		Received by:
	Company SiREM	Date 26 Aug 21	Company
	Printed Name Rachel Hallman	Time 12:00 pm.	Printed Name
	Signature		Signature
	Relinquished by:		**Received by:**
	Company	Date 8/31/21	Company PRIMA
	Printed Name	Time 10:40	Printed Name Molly Scott
	Signature		Signature

Matrix key: S - soil/sediment; W - water; OT - other

September 1, 2021

Michael Healy
SiREM
130 Stone Road West
Guelph, Ontario, Canada N1G 3Z2

RE: Report of Findings, Measurement of AVS
Client ID: Coffeen MNA
PRIMA ID: Sirem 08202021-Coffeen

Dear Mr. Healy:

This letter report describes the results of analyses conducted on two soil samples. Each soil was analyzed for acid volatile sulfide (AVS). Results are reported herein.

Sample Receipt and Preparation

Samples were received on August 20, 2021. The samples were frozen upon receipt, then thawed in a nitrogen-filled glove box. All sample preparation was conducted in the glove box.

Procedures

AVS was measured via sequential extraction of soil based on methods provided by Microseeps, Inc. In order to minimize exposure of the soil or extraction fluid to oxygen, the soil samples were transferred to the extraction vessel while in the glove box and the extractions were carried out on the bench top under a flow of nitrogen. A brief description of the extraction procedure is provided below.

WAS-Fe. Approximately 10 g of soil is extracted with 1 N hydrochloric acid (HCl) for 30 minutes at room temperature (approximately 20° C), after which an aliquot of the HCl is withdrawn and analyzed for ferrous iron and total iron colorimetrically using a Hach DR2800 spectrophotometer and appropriate Hach test kit reagents. Dilutions are made as needed using deoxygenated, deionized (DO/DI) water.

AVS. Hydrogen sulfide generated during the WAS extraction step is collected in a trap filled with 1.25 N sodium hydroxide (NaOH). After collection of the WAS Fe sample, concentrated HCl is added to the soil and the mixture is heated for 30 minutes. The

concentration of sulfide in trap is then measured using the methylene blue method via a Hach DR2800 spectrophotometer and appropriate Hach test kit reagents. Dilutions are made as needed using DO/DI water.

Results

The amount of AVS in each sample is shown in **Table 1** (attached). QC results are given in **Table 2** (attached).

If you have any questions regarding these results, please give me a call at 916-939-7300. Thank you for the opportunity to be of service.

Sincerely,
PRIMA Environmental, Inc.

Cindy G. Schreier

Cindy G. Schreier, Ph.D.
President

Attachments

Table 1. AVS Results.

Sample	AVS, mg/kg
401B-(16-20)	< 0.19
270A-(12-16)	< 0.19

Table 2. QC Results for AVS.

Sample ID	Result	Units
Blank *		
AVS	< 0.025	mg/L
FeS standard		
Sulfide concentration	365	g/kg
AVS	364	g/kg
% Recovered as AVS	100	%

* A blank was run in the absence of a solid material. Therefore, values are concentrations in the extraction fluids or traps.

5070 Robert J Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
916-939-7300
www.primaenvironmental.com

Sample Receipt Summary

Date/Time: 8/20/21 10:00 AM

Client/Company: S. Rem lab - Michael Healey

Project: Coffeen MNA (2)
Miami Fort MNA (4)
Vermillion MNA (5)

	Yes	No	N/A
Custody seals intact?	☐	☐	☒
Chain of custody Present?	☒	☐	☐

If no, list number of samples and Sample ID

Ice present?	☒	☐	☐

If no, what is temperature? _____

Samples in good condition?	☒	☐	☐

If no, explain:

Ice appears melted.

Do sample IDs on containers match IDs on COC?	☒	☐	☐

If no, explain:

3 Chains of custody
11 soil Jars Total

Other Comments:

PRIMA ENVIRONMENTAL INC
Mathews Parkway, Suite 300 El Dorado Hills, CA 95762
(916) 939-7300; (916) 939-7398 Fax
www.primaenvironmental.com

CHAIN of CUSTODY

Project Manager: Michael Healey
Project Name: Coffeen MNA
Job Number:
Sampler Signature:

Phone: (519) 822-2265
Fax: (519) 822-3151
Email: mhealey@siremlab.com
TAT: 1 week

SAMPLE ID	Date	Time	Matrix	# Containers	Acid Volatile Sulfide										Comments
401B-(16-20)	18-Aug-21	3:00	S	1	X										
270A-(12-16)	18-Aug-21	3:15	S	1	X										

Analysis

Special Instructions	Relinquished by:			Received by:	
	Company	SiREM Labs	Date 18 Aug 21	Company PRIMA	8/20/21
	Printed Name	Rachel Hallman	Time 5:30 pm.	Printed Name Chris B.	10:00 AM
	Signature			Signature	
	Relinquished by:			Received by:	
	Company		Date	Company	
	Printed Name		Time	Printed Name	
	Signature			Signature	

Matrix key: S - soil/sediment; W - water; OT - other

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

13-September-2021

SiREM Laboratory
Attn : Michael Healey

130 Stone Road W, Guelph
Canada, N1G 3Z2
Phone: 519-822-2265, Fax:519-822-3151

Date Rec. : 13 September 2021
LR Report: **CA15261-SEP21**
Reference: P.O# 800003210A

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	S %
1: Analysis Start Date		13-Sep-21
2: Analysis Start Time		15:44
3: Analysis Completed Date		13-Sep-21
4: Analysis Completed Time		17:17
5: G1001-(6-11)	17-May-21 10:00	0.031
6: 401B-(16-20)	17-May-21 10:15	0.008
7: 270A-(12-16)	17-May-21 10:30	< 0.005

Catharine Arnold

CHARTERED CATHARINE ARNOLD CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002638711

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Test method information available upon request. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.
SGS Canada Inc. Environment-Health & Safety statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : Coffeen AP1 MNA, PO# 800003210A

21-December-2021

SiREM Laboratory
Attn : Michael Healey

130 Stone Road W, Guelph
Canada, N1G 3Z2
Phone: 519-822-2265, Fax:519-822-3151

Date Rec. : 16 November 2021
LR Report: **CA14794-NOV21**
Reference: Project Name: Coffeen AP1 MNA, PO# 800003210A

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	B g/t
5: SB-306-(14-16)	26-Aug-21 10:00	< 40
6: SB-311-(14-15)	26-Aug-21 10:15	< 40
7: SB-313-(8-9)	26-Aug-21 10:30	< 40
8: SB-316-(13-14,15-16)	26-Aug-21 10:45	< 40

Catharine Arnold

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002751323

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Test method information available upon request. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.
SGS Canada Inc. Environment-Health & Safety statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

13-September-2021

SiREM Laboratory
Attn : Michael Healey

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

Phone: 519-822-2265
Fax:519-822-3151

Date Rec. : 31 August 2021
LR Report: **CA19062-AUG21**
Reference: Project Name: Coffeen AP1 MNA, PO# 800003210A

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-306-(14-16)	6: SB-311-(14-15)	7: SB-313-(8-9)	8: SB-316-(13-14,15-16)
Sample Date & Time					26-Aug-21 10:00	26-Aug-21 10:15	26-Aug-21 10:30	26-Aug-21 10:45
Ag [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	< 0.5	< 0.5	< 0.5	< 0.5
Al [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	13000	11000	31000	32000
As [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	6.7	2.7	5.6	5.1
Ba [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	98	58	310	320
Be [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	0.45	0.37	0.73	0.69
Bi [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	0.10	0.10	0.11	0.12
Ca [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	35000	52000	69000	10000
Cd [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	0.11	0.08	0.20	0.06
Co [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	6	4	7	4
Cr [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	130	100	130	150
Cu [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	14	10	12	10
Fe [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	20000	12000	27000	17000
K [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	3700	3600	13000	14000
Li [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	11	11	19	14
Mg [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	15000	27000	35000	6700
Mn [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	470	310	1200	260
Mo [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	5.8	2.7	1.6	8.1
Na [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	590	830	6000	6400
Ni [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	15	11	17	13
P [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	230	200	250	230
Pb [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	9	7	11	12
Sb [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	< 0.8	< 0.8	< 0.8	< 0.8
Se [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	< 0.7	< 0.7	< 0.7	< 0.7
Sn [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	< 6	< 6	< 6	< 6
Sr [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	26	35	100	89
Ti [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	370	320	1500	1200
Tl [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	0.15	0.13	0.26	0.31
U [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	0.54	0.55	1.0	1.0
V [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	28	20	35	29
Y [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	9.1	8.2	11	10
Zn [µg/g]	09-Sep-21	19:00	10-Sep-21	10:47	35	27	41	34
C [%]	10-Sep-21	08:20	10-Sep-21	14:51	1.65	2.76	3.26	0.457

OnLine LIMS

0002638704

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA19062-AUG21**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SB-306-(14-16)	6: SB-311-(14-15)	7: SB-313-(8-9)	8: SB-316-(13-14,15-16)
S [%]	10-Sep-21	08:20	10-Sep-21	14:51	0.005	0.014	0.007	0.012
TOC [%]	10-Sep-21	14:26	10-Sep-21	16:31	0.413	0.772	0.775	0.257
Sulphide [%]	10-Sep-21	18:37	13-Sep-21	09:15	< 0.04	< 0.04	< 0.04	< 0.04

Catharine Arnold

CHARTERED CATHARINE ARNOLD CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002638704

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Project : Coffeen MNA

09-June-2021

SiREM Laboratory
Attn : Michael Healey

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

Phone: 519-822-2265
Fax:519-822-3151

Date Rec. : 18 May 2021
LR Report: **CA12646-MAY21**
Reference: P.O# 800003210A

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: G1001-(6-11)	6: 401B-(16-20)	7: 270A-(12-16)
Sample Date & Time					17-May-21 10:00	17-May-21 10:15	17-May-21 10:30
Temp Upon Receipt [°C]	---	---	---	---	5.0	5.0	5.0
Sulphide1 [%]	03-Jun-21	15:12	03-Jun-21	16:31	0.05	< 0.04	< 0.04
TOC [%]	07-Jun-21	09:12	07-Jun-21	15:08	0.852	0.082	0.138
Ag [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	< 0.05	< 0.05	< 0.05
Al [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	8200	9700	9600
As [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	6.2	5.5	12
Ba [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	120	190	210
Be [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.45	0.35	0.48
B [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	6	4	5
Bi [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.23	0.25	0.18
Ca [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	42000	1900	5000
Cd [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.13	0.03	0.12
Co [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	8.8	6.1	10
Cr [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	15	14	16
Cu [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	11	7.8	12
Fe [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	16000	14000	22000
K [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	1100	770	1400
Li [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	9	7	11
Mg [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	18000	1600	4700
Mn [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	450	540	1200
Mo [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	1.5	0.4	0.8
Na [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	110	80	110
Ni [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	15	10	20
Pb [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	11	9.5	12
Sb [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	< 0.8	< 0.8	< 0.8
Se [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	< 0.7	< 0.7	< 0.7
Sn [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.6	< 0.5	< 0.5
Sr [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	35	9.1	10
Ti [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	170	65	230
Tl [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.16	0.12	0.16
U [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.82	0.39	0.46
V [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	19	14	22
W [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	0.07	0.04	0.13

OnLine LIMS

0002522990

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Project : Coffeen MNA

LR Report : **CA12646-MAY21**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: G1001-(6-11)	6: 401B-(16-20)	7: 270A-(12-16)
Y [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	8.1	8.2	9.4
Zn [µg/g]	04-Jun-21	15:33	07-Jun-21	10:42	35	28	50

Catharine Arnold

CHARTERED CATHARINE ARNOLD CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0002522990

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ANALYTICAL REPORT

Eurofins Lancaster Laboratories Env, LLC
2425 New Holland Pike
Lancaster, PA 17601
Tel: (717)656-2300

Laboratory Job ID: 410-29682-1
Client Project/Site: EB02539

For:
PDC Laboratories, Inc.
2231 W. Altorfer Drive
Peoria, Illinois 61615

Attn: Gail Schindler

Authorized for release by:
2/23/2021 11:07:33 AM

Marrissa Williams, Project Manager
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LINKS

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Results relate only to the items tested and the sample(s) as received by the laboratory.

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Analytical test results meet all requirements of the associated regulatory program (e.g., NELAC (TNI), DoD, and ISO 17025) unless otherwise noted under the individual analysis. Data qualifiers are applied to note exceptions. Noncompliant quality control (QC) is further explained in narrative comments.
· QC results that exceed the upper limits and are associated with non-detect samples are qualified but further narration is not required since the bias is high and does not change a non-detect result. Further narration is also not required with QC blank detection when the associated sample concentration is non-detect or more than ten times the level in the blank.
· Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD is performed, unless otherwise specified in the method.
· Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.
Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Measurement uncertainty values, as applicable, are available upon request.

Test results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. Times are local to the area of activity. Parameters listed in the 40 CFR Part 136 Table II as "analyze immediately" and tested in the laboratory are not performed within 15 minutes of collection.

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Marrissa Williams

Marrissa Williams
Project Manager
2/23/2021 11:07:33 AM

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Qualifiers

General Chemistry

Qualifier	Qualifier Description
F1	MS and/or MSD recovery exceeds control limits.
F2	MS/MSD RPD exceeds control limits
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
1C	Result is from the primary column on a dual-column method.
2C	Result is from the confirmation column on a dual-column method.
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Case Narrative

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Job ID: 410-29682-1

Laboratory: Eurofins Lancaster Laboratories Env, LLC

Narrative

Job Narrative
410-29682-1

Receipt
The samples were received on 2/18/2021 8:37 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperature of the cooler at receipt time was -0.6°C

General Chemistry
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Detection Summary

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Client Sample ID: EB02539-01 — Lab Sample ID: 410-29682-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	342	J	498	166	mg/Kg	1.66		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-02 — Lab Sample ID: 410-29682-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	17400		1440	481	mg/Kg	4.81		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-03 — Lab Sample ID: 410-29682-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	8540		747	249	mg/Kg	2.49		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-04 — Lab Sample ID: 410-29682-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	12900		1440	481	mg/Kg	4.81		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-05 — Lab Sample ID: 410-29682-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	553		303	101	mg/Kg	1.01		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-06 — Lab Sample ID: 410-29682-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	11200		1920	639	mg/Kg	6.39		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-07 — Lab Sample ID: 410-29682-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	16700		1440	481	mg/Kg	4.81		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-08 — Lab Sample ID: 410-29682-8

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	12400		1470	491	mg/Kg	4.91		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-09 — Lab Sample ID: 410-29682-9

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	1070		591	197	mg/Kg	1.97		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-10 — Lab Sample ID: 410-29682-10

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	24900	F1	1490	498	mg/Kg	4.98		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-11 — Lab Sample ID: 410-29682-11

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	40200		28600	9520	mg/Kg	95.24		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-12 — Lab Sample ID: 410-29682-12

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	9400	F2 F1	507	169	mg/Kg	1.69		Lloyd Kahn	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Client Sample ID: EB02539-13 — Lab Sample ID: 410-29682-13

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	3840		411	137	mg/Kg	1.37		Lloyd Kahn	Total/NA

Client Sample ID: EB02539-14 — Lab Sample ID: 410-29682-14

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	3150		528	176	mg/Kg	1.76		Lloyd Kahn	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: EB02539-01 — Lab Sample ID: 410-29682-1

Date Collected: 02/10/21 15:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	342	J	498	166	mg/Kg			02/20/21 14:30	1.66
Percent Moisture	11.2		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	88.8		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-02 — Lab Sample ID: 410-29682-2

Date Collected: 02/11/21 11:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	17400		1440	481	mg/Kg			02/20/21 14:42	4.81
Percent Moisture	14.0		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	86.0		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-03 — Lab Sample ID: 410-29682-3

Date Collected: 02/11/21 14:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	8540		747	249	mg/Kg			02/20/21 14:55	2.49
Percent Moisture	11.7		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	88.3		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-04 — Lab Sample ID: 410-29682-4

Date Collected: 02/11/21 11:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	12900		1440	481	mg/Kg			02/20/21 13:52	4.81
Percent Moisture	11.9		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	88.1		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-05 — Lab Sample ID: 410-29682-5

Date Collected: 02/09/21 10:30 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	553		303	101	mg/Kg			02/22/21 13:56	1.01
Percent Moisture	25.3		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	74.7		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-06 — Lab Sample ID: 410-29682-6

Date Collected: 02/09/21 10:40 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	11200		1920	639	mg/Kg			02/20/21 15:20	6.39
Percent Moisture	15.0		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-06 — Lab Sample ID: 410-29682-6

Date Collected: 02/09/21 10:40 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	85.0		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-07 — Lab Sample ID: 410-29682-7

Date Collected: 02/09/21 14:45 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	16700		1440	481	mg/Kg			02/20/21 15:58	4.81
Percent Moisture	7.6		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	92.4		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-08 — Lab Sample ID: 410-29682-8

Date Collected: 02/09/21 16:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	12400		1470	491	mg/Kg			02/20/21 16:11	4.91
Percent Moisture	13.6		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	86.4		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-09 — Lab Sample ID: 410-29682-9

Date Collected: 02/09/21 16:30 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	1070		591	197	mg/Kg			02/20/21 16:24	1.97
Percent Moisture	16.6		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	83.4		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-10 — Lab Sample ID: 410-29682-10

Date Collected: 02/09/21 14:45 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	24900	F1	1490	498	mg/Kg			02/20/21 17:02	4.98
Percent Moisture	8.3		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	91.7		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-11 — Lab Sample ID: 410-29682-11

Date Collected: 02/08/21 11:15 — **Matrix: Solid**
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	40200		28600	9520	mg/Kg			02/20/21 16:36	95.24
Percent Moisture	32.9		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	67.1		1.0	1.0	%			02/19/21 12:49	1

Client Sample Results

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Client Sample ID: EB02539-12

Lab Sample ID: 410-29682-12

Date Collected: 02/09/21 14:45
Matrix: Solid
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	9400	F2 F1	507	169	mg/Kg			02/22/21 14:21	1.69
Percent Moisture	19.4		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	80.6		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-13

Lab Sample ID: 410-29682-13

Date Collected: 02/08/21 14:30
Matrix: Solid
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	3840		411	137	mg/Kg			02/22/21 14:09	1.37
Percent Moisture	16.1		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	83.9		1.0	1.0	%			02/19/21 12:49	1

Client Sample ID: EB02539-14

Lab Sample ID: 410-29682-14

Date Collected: 02/08/21 14:30
Matrix: Solid
Date Received: 02/18/21 08:37

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	3150		528	176	mg/Kg			02/22/21 15:00	1.76
Percent Moisture	12.7		1.0	1.0	%			02/19/21 12:49	1
Percent Solids	87.3		1.0	1.0	%			02/19/21 12:49	1

Method: Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: MB 410-96043/3 — **Client Sample ID: Method Blank**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96043

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	ND		300	100	mg/Kg			02/20/21 13:26	1

Lab Sample ID: LCS 410-96043/4 — **Client Sample ID: Lab Control Sample**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96043

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	4300	2985		mg/Kg		69	47 - 143

Lab Sample ID: 410-29682-4 MS — **Client Sample ID: EB02539-04**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96043

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	12900		14500	24610		mg/Kg		81	47 - 143

Lab Sample ID: 410-29682-4 MSD — **Client Sample ID: EB02539-04**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96043

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	12900		14400	28590		mg/Kg		109	47 - 143	15	20

Lab Sample ID: 410-29682-10 MS — **Client Sample ID: EB02539-10**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96043

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	24900	F1	14600	48940	F1	mg/Kg		165	47 - 143

Lab Sample ID: 410-29682-10 MSD — **Client Sample ID: EB02539-10**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96043

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	24900	F1	14700	40150		mg/Kg		104	47 - 143	20	20

Lab Sample ID: MB 410-96500/3 — **Client Sample ID: Method Blank**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96500

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	ND		300	100	mg/Kg			02/22/21 13:18	1

Lab Sample ID: LCS 410-96500/4 — **Client Sample ID: Lab Control Sample**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96500

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	4300	3376		mg/Kg		79	47 - 143

Method: Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: 410-29682-12 MS — **Client Sample ID: EB02539-12**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96500

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Total Organic Carbon	9400	F2 F1	10100	30830	F1	mg/Kg		211	47 - 143		

Lab Sample ID: 410-29682-12 MSD — **Client Sample ID: EB02539-12**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96500

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	9400	F2 F1	5120	15800	F2	mg/Kg		125	47 - 143	64	20

Lab Sample ID: 410-29682-14 MS — **Client Sample ID: EB02539-14**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96500

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Total Organic Carbon	3150		5190	6849		mg/Kg		71	47 - 143		

Lab Sample ID: 410-29682-14 MSD — **Client Sample ID: EB02539-14**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 96500

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	3150		5420	7503		mg/Kg		80	47 - 143	9	20

QC Association Summary

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

General Chemistry

Analysis Batch: 95659

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-29682-1	EB02539-01	Total/NA	Solid	Moisture	
410-29682-2	EB02539-02	Total/NA	Solid	Moisture	
410-29682-3	EB02539-03	Total/NA	Solid	Moisture	
410-29682-4	EB02539-04	Total/NA	Solid	Moisture	
410-29682-5	EB02539-05	Total/NA	Solid	Moisture	
410-29682-6	EB02539-06	Total/NA	Solid	Moisture	
410-29682-7	EB02539-07	Total/NA	Solid	Moisture	
410-29682-8	EB02539-08	Total/NA	Solid	Moisture	
410-29682-9	EB02539-09	Total/NA	Solid	Moisture	
410-29682-10	EB02539-10	Total/NA	Solid	Moisture	
410-29682-11	EB02539-11	Total/NA	Solid	Moisture	
410-29682-12	EB02539-12	Total/NA	Solid	Moisture	
410-29682-13	EB02539-13	Total/NA	Solid	Moisture	
410-29682-14	EB02539-14	Total/NA	Solid	Moisture	

Analysis Batch: 96043

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-29682-1	EB02539-01	Total/NA	Solid	Lloyd Kahn	
410-29682-2	EB02539-02	Total/NA	Solid	Lloyd Kahn	
410-29682-3	EB02539-03	Total/NA	Solid	Lloyd Kahn	
410-29682-4	EB02539-04	Total/NA	Solid	Lloyd Kahn	
410-29682-6	EB02539-06	Total/NA	Solid	Lloyd Kahn	
410-29682-7	EB02539-07	Total/NA	Solid	Lloyd Kahn	
410-29682-8	EB02539-08	Total/NA	Solid	Lloyd Kahn	
410-29682-9	EB02539-09	Total/NA	Solid	Lloyd Kahn	
410-29682-10	EB02539-10	Total/NA	Solid	Lloyd Kahn	
410-29682-11	EB02539-11	Total/NA	Solid	Lloyd Kahn	
MB 410-96043/3	Method Blank	Total/NA	Solid	Lloyd Kahn	
LCS 410-96043/4	Lab Control Sample	Total/NA	Solid	Lloyd Kahn	
410-29682-4 MS	EB02539-04	Total/NA	Solid	Lloyd Kahn	
410-29682-4 MSD	EB02539-04	Total/NA	Solid	Lloyd Kahn	
410-29682-10 MS	EB02539-10	Total/NA	Solid	Lloyd Kahn	
410-29682-10 MSD	EB02539-10	Total/NA	Solid	Lloyd Kahn	

Analysis Batch: 96500

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-29682-5	EB02539-05	Total/NA	Solid	Lloyd Kahn	
410-29682-12	EB02539-12	Total/NA	Solid	Lloyd Kahn	
410-29682-13	EB02539-13	Total/NA	Solid	Lloyd Kahn	
410-29682-14	EB02539-14	Total/NA	Solid	Lloyd Kahn	
MB 410-96500/3	Method Blank	Total/NA	Solid	Lloyd Kahn	
LCS 410-96500/4	Lab Control Sample	Total/NA	Solid	Lloyd Kahn	
410-29682-12 MS	EB02539-12	Total/NA	Solid	Lloyd Kahn	
410-29682-12 MSD	EB02539-12	Total/NA	Solid	Lloyd Kahn	
410-29682-14 MS	EB02539-14	Total/NA	Solid	Lloyd Kahn	
410-29682-14 MSD	EB02539-14	Total/NA	Solid	Lloyd Kahn	

Lab Chronicle

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Client Sample ID: EB02539-01 — Lab Sample ID: 410-29682-1

Date Collected: 02/10/21 15:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.66	96043	02/20/21 14:30	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-02 — Lab Sample ID: 410-29682-2

Date Collected: 02/11/21 11:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		4.81	96043	02/20/21 14:42	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-03 — Lab Sample ID: 410-29682-3

Date Collected: 02/11/21 14:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		2.49	96043	02/20/21 14:55	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-04 — Lab Sample ID: 410-29682-4

Date Collected: 02/11/21 11:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		4.81	96043	02/20/21 13:52	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-05 — Lab Sample ID: 410-29682-5

Date Collected: 02/09/21 10:30 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.01	96500	02/22/21 13:56	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-06 — Lab Sample ID: 410-29682-6

Date Collected: 02/09/21 10:40 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		6.39	96043	02/20/21 15:20	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-07 — Lab Sample ID: 410-29682-7

Date Collected: 02/09/21 14:45 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		4.81	96043	02/20/21 15:58	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-08 — Lab Sample ID: 410-29682-8

Date Collected: 02/09/21 16:00 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		4.91	96043	02/20/21 16:11	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-09 — Lab Sample ID: 410-29682-9

Date Collected: 02/09/21 16:30 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.97	96043	02/20/21 16:24	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-10 — Lab Sample ID: 410-29682-10

Date Collected: 02/09/21 14:45 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		4.98	96043	02/20/21 17:02	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-11 — Lab Sample ID: 410-29682-11

Date Collected: 02/08/21 11:15 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		95.24	96043	02/20/21 16:36	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-12 — Lab Sample ID: 410-29682-12

Date Collected: 02/09/21 14:45 — **Matrix: Solid**
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.69	96500	02/22/21 14:21	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Lab Chronicle

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Client Sample ID: EB02539-13

Lab Sample ID: 410-29682-13

Date Collected: 02/08/21 14:30
Matrix: Solid
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.37	96500	02/22/21 14:09	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Client Sample ID: EB02539-14

Lab Sample ID: 410-29682-14

Date Collected: 02/08/21 14:30
Matrix: Solid
Date Received: 02/18/21 08:37

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.76	96500	02/22/21 15:00	NKL9	ELLE
Total/NA	Analysis	Moisture		1	95659	02/19/21 12:49	UVJN	ELLE

Laboratory References:

ELLE = Eurofins Lancaster Laboratories Env, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Accreditation/Certification Summary

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Laboratory: Eurofins Lancaster Laboratories Env, LLC

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Illinois	NELAP	004559	01-31-22

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
Lloyd Kahn		Solid	Total Organic Carbon
Moisture		Solid	Percent Moisture
Moisture		Solid	Percent Solids

Method Summary

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Method	Method Description	Protocol	Laboratory
Lloyd Kahn	Organic Carbon, Total (TOC)	EPA	ELLE
Moisture	Percent Moisture	EPA	ELLE

Protocol References:

EPA = US Environmental Protection Agency

Laboratory References:

ELLE = Eurofins Lancaster Laboratories Env, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Sample Summary

Client: PDC Laboratories, Inc.
Project/Site: EB02539

Job ID: 410-29682-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
410-29682-1	EB02539-01	Solid	02/10/21 15:00	02/18/21 08:37	
410-29682-2	EB02539-02	Solid	02/11/21 11:00	02/18/21 08:37	
410-29682-3	EB02539-03	Solid	02/11/21 14:00	02/18/21 08:37	
410-29682-4	EB02539-04	Solid	02/11/21 11:00	02/18/21 08:37	
410-29682-5	EB02539-05	Solid	02/09/21 10:30	02/18/21 08:37	
410-29682-6	EB02539-06	Solid	02/09/21 10:40	02/18/21 08:37	
410-29682-7	EB02539-07	Solid	02/09/21 14:45	02/18/21 08:37	
410-29682-8	EB02539-08	Solid	02/09/21 16:00	02/18/21 08:37	
410-29682-9	EB02539-09	Solid	02/09/21 16:30	02/18/21 08:37	
410-29682-10	EB02539-10	Solid	02/09/21 14:45	02/18/21 08:37	
410-29682-11	EB02539-11	Solid	02/08/21 11:15	02/18/21 08:37	
410-29682-12	EB02539-12	Solid	02/09/21 14:45	02/18/21 08:37	
410-29682-13	EB02539-13	Solid	02/08/21 14:30	02/18/21 08:37	
410-29682-14	EB02539-14	Solid	02/08/21 14:30	02/18/21 08:37	

410-29682 Chain of Custody

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Eurofins Eaton Analytical, Inc. - Lancaster, PA
2425 New Holland Pike
Lancaster, PA 17601
(717) 656-2300

Sample: EB02539-01
Name: G314D - S1
Sampled: 02/10/21 15:00
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/10/21 15:00	

Sample: EB02539-02
Name: G314D - S2
Sampled: 02/11/21 11:00
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/11/21 11:00	

Sample: EB02539-03
Name: G314D - S2
Sampled: 02/11/21 14:00
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/11/21 14:00	

Sample: EB02539-04
Name: G314D - S2 DUPLICATE
Sampled: 02/11/21 11:00
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/11/21 11:00	MS/MSD

Sample: EB02539-05
Name: G307D - S1
Sampled: 02/09/21 10:30
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 10:30	

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Eurofins Eaton Analytical, Inc. - Lancaster, PA
2425 New Holland Pike
Lancaster, PA 17601
(717) 656-2300

Sample: EB02539-06
Name: G307D - S2
Sampled: 02/09/21 10:40
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 10:40	

Sample: EB02539-07
Name: G307D - S3
Sampled: 02/09/21 14:45
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 14:45	

Sample: EB02539-08
Name: G307D - S4
Sampled: 02/09/21 16:00
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 16:00	

Sample: EB02539-09
Name: G307D - S5
Sampled: 02/09/21 16:30
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 16:30	

Sample: EB02539-10
Name: G307D - S3 DUPLICATE
Sampled: 02/09/21 14:45
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 14:45	MS/MSD

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Eurofins Eaton Analytical, Inc. - Lancaster, PA
2425 New Holland Pike
Lancaster, PA 17601
(717) 656-2300

Sample: EB02539-11
Name: XPW - 01 - S1

Sampled: 02/08/21 11:15
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/08/21 11:15	

Sample: EB02539-12
Name: XPW - 01 - S1 DUPLICATE

Sampled: 02/09/21 14:45
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/09/21 14:45	MS/MSD

Sample: EB02539-13
Name: XPW - 02 - S1

Sampled: 02/08/21 14:30
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/08/21 14:30	

Sample: EB02539-14
Name: XPW - 02 - S1 DUPLICATE

Sampled: 02/08/21 14:30
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/23/21 16:00	03/08/21 14:30	MS/MSD

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

Please email results to Gail Schindler at gschindler@pdclab.com

Date Shipped: 2/16/21 Total # of Containers: 14 Sample Origin (State): IL PO #: 11506

Turn-Around Time Requested ☒ NORMAL ☐ RUSH Date Results Needed: _____

Relinquished By	Date/Time	Received By	Date/Time
[signature]	2/16/21 1015		
		[signature]	2/18/21 08:37

Sample Temperature Upon Receipt	____ °C
Sample(s) Received on Ice	Y or N
Proper Bottles Received in Good Condition	Y or N
Bottles Filled with Adequate Volume	Y or N
Samples Received Within Hold Time	Y or N
Date/Time Taken From Sample Bottle	Y or N

THR

Login Sample Receipt Checklist

Client: PDC Laboratories, Inc.

Job Number: 410-29682-1

Login Number: 29682
List Number: 1
Creator: Rivera, Tatiana

List Source: Eurofins Lancaster Laboratories Env

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal is intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable (</=6C, not frozen).	True	
Cooler Temperature is recorded.	True	
WV: Container Temperature is acceptable (</=6C, not frozen).	N/A	
WV: Container Temperature is recorded.	N/A	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses.	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	N/A	
Is the Field Sampler's name present on COC?	False	Received project as a subcontract.
Sample Preservation Verified.	N/A	
Residual Chlorine Checked.	N/A	
Sample custody seals are intact.	N/A	

Report Number
F21048-0023
Account Number
67045

a&lgreatlakes LABORATORIES
Scientists who don't mind getting dirty.™

3505 Conestoga Dr.
Fort Wayne, IN 46808
260.483.4759
algreatlakes.com

To: PDC LABORATORIES, INC.
2231 W ALTORFER DR
PEORIA, IL 61615-1807

For: EB02539

P.O. Number: 12450

Attn: JANET CLUTTERS

REPORT OF ANALYSIS

Date Received: 02/17/2021
Date Reported: 02/24/2021

Lab Number	Sample ID	Analysis	Result	Unit	Method
20308	01	Cation Exchange Capacity (NH4-Sat.)	9.44	meq/100g	MSA Part 3 (1996) pp 1220-1221
20309	02	Cation Exchange Capacity (NH4-Sat.)	9.72	meq/100g	MSA Part 3 (1996) pp 1220-1221
20310	03	Cation Exchange Capacity (NH4-Sat.)	12.45	meq/100g	MSA Part 3 (1996) pp 1220-1221
20311	04	Cation Exchange Capacity (NH4-Sat.)	9.15	meq/100g	MSA Part 3 (1996) pp 1220-1221
20312	05	Cation Exchange Capacity (NH4-Sat.)	18.82	meq/100g	MSA Part 3 (1996) pp 1220-1221
20313	06	Cation Exchange Capacity (NH4-Sat.)	3.32	meq/100g	MSA Part 3 (1996) pp 1220-1221
20314	07	Cation Exchange Capacity (NH4-Sat.)	3.91	meq/100g	MSA Part 3 (1996) pp 1220-1221
20315	08	Cation Exchange Capacity (NH4-Sat.)	8.31	meq/100g	MSA Part 3 (1996) pp 1220-1221
20316	09	Cation Exchange Capacity (NH4-Sat.)	17.24	meq/100g	MSA Part 3 (1996) pp 1220-1221
20317	10	Cation Exchange Capacity (NH4-Sat.)	6.05	meq/100g	MSA Part 3 (1996) pp 1220-1221
20318	11	Cation Exchange Capacity (NH4-Sat.)	2.26	meq/100g	MSA Part 3 (1996) pp 1220-1221
20319	12	Cation Exchange Capacity (NH4-Sat.)	1.57	meq/100g	MSA Part 3 (1996) pp 1220-1221

Report reviewed and approved by our professional agronomy staff.

SOILMISC

Report Number
F21048-0023
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3505 Conestoga Dr.
Fort Wayne, IN 46808
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To: PDC LABORATORIES, INC.
2231 W ALTORFER DR
PEORIA, IL 61615-1807

For: EB02539

P.O. Number: 12450

Date Received: 02/17/2021
Date Reported: 02/24/2021

Attn: JANET CLUTTERS

REPORT OF ANALYSIS

Lab Number	Sample ID	Analysis	Result	Unit	Method
20320	13	Cation Exchange Capacity (NH4-Sat.)	0.28	meq/100g	MSA Part 3 (1996) pp 1220-1221
20321	14	Cation Exchange Capacity (NH4-Sat.)	0.38	meq/100g	MSA Part 3 (1996) pp 1220-1221

Report reviewed and approved by our professional agronomy staff.

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ANALYTICAL REPORT

March 09, 2021

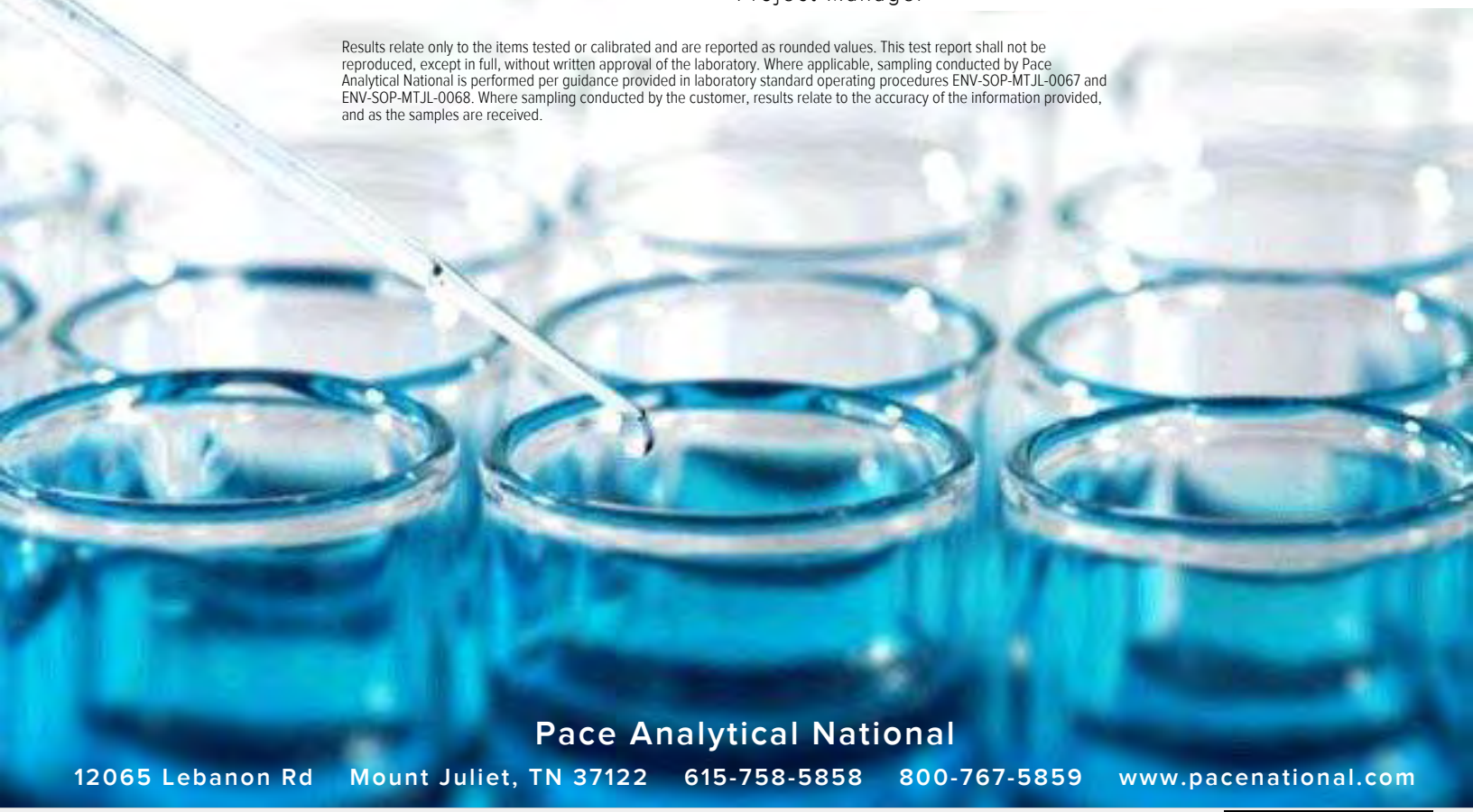
PDC Laboratory, Inc.

Sample Delivery Group:	L1319216
Samples Received:	02/23/2021
Project Number:	EB02539
Description:	
Report To:	Gail Schindler 2231 W. Altorfer Drive Peoria, IL 61615

Entire Report Reviewed By:

Mark W. Beasley
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace Analytical National is performed per guidance provided in laboratory standard operating procedures ENV-SOP-MTJL-0067 and ENV-SOP-MTJL-0068. Where sampling conducted by the customer, results relate to the accuracy of the information provided, and as the samples are received.



Pace Analytical National
12065 Lebanon Rd Mount Juliet, TN 37122 615-758-5858 800-767-5859 www.pacenational.com

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1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

EB02539-01 L1319216-01 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/10/21 15:00	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 09:17	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 09:17	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 14:23	RGT	Mt. Juliet, TN

EB02539-02 L1319216-02 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/11/21 11:00	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 09:17	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 09:17	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 14:23	RGT	Mt. Juliet, TN

EB02539-03 L1319216-03 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/11/21 14:00	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 09:17	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 09:17	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 14:23	RGT	Mt. Juliet, TN

EB02539-04 L1319216-04 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/11/21 11:00	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 09:17	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 09:17	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 14:23	RGT	Mt. Juliet, TN

EB02539-05 L1319216-05 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 10:30	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 09:17	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/08/21 17:06	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/08/21 17:06	RGT	Mt. Juliet, TN

EB02539-06 L1319216-06 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 10:40	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 09:17	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 09:17	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 14:23	RGT	Mt. Juliet, TN

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

EB02539-07 L1319216-07 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 14:45	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 14:23	RGT	Mt. Juliet, TN

EB02539-08 L1319216-08 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 16:00	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:52	RGT	Mt. Juliet, TN

EB02539-09 L1319216-09 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 16:30	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:52	RGT	Mt. Juliet, TN

EB02539-10 L1319216-10 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 14:45	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:52	RGT	Mt. Juliet, TN

EB02539-11 L1319216-11 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/08/21 11:15	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:52	RGT	Mt. Juliet, TN

EB02539-12 L1319216-12 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/09/21 14:45	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:52	RGT	Mt. Juliet, TN

EB02539-13 L1319216-13 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/08/21 14:30	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:53	RGT	Mt. Juliet, TN

EB02539-14 L1319216-14 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/08/21 14:30	02/23/21 17:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1626465	1	02/26/21 14:04	03/05/21 13:45	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1627415	1	03/01/21 09:01	03/05/21 13:45	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1627415	1	03/01/21 09:01	03/03/21 15:53	RGT	Mt. Juliet, TN

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Project Manager

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	-0.0977	U	0.276	0.517	03/05/2021 09:17	WG1626465
(T) Barium	*104*			*62.0-143*	*03/05/2021 09:17*	WG1626465
(T) Yttrium	*104*			*79.0-136*	*03/05/2021 09:17*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.540	J	0.443	0.625	03/05/2021 09:17	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.540		0.167	0.108	03/03/2021 14:23	WG1627415
(T) Barium-133	*82.2*			*30.0-143*	*03/03/2021 14:23*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.988		0.252	0.439	03/05/2021 09:17	WG1626465
(T) Barium	*104*			*62.0-143*	*03/05/2021 09:17*	WG1626465
(T) Yttrium	*101*			*79.0-136*	*03/05/2021 09:17*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.58		0.416	0.514	03/05/2021 09:17	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.592		0.164	0.0751	03/03/2021 14:23	WG1627415
(T) Barium-133	*86.1*			*30.0-143*	*03/03/2021 14:23*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.158	U	0.253	0.46	03/05/2021 09:17	WG1626465
(T) Barium	*97.0*			*62.0-143*	*03/05/2021 09:17*	WG1626465
(T) Yttrium	*92.1*			*79.0-136*	*03/05/2021 09:17*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.741		0.403	0.513	03/05/2021 09:17	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.583		0.150	0.0526	03/03/2021 14:23	WG1627415
(T) Barium-133	*98.3*			*30.0-143*	*03/03/2021 14:23*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.587		0.239	0.422	03/05/2021 09:17	WG1626465
(T) Barium	*106*			*62.0-143*	*03/05/2021 09:17*	WG1626465
(T) Yttrium	*105*			*79.0-136*	*03/05/2021 09:17*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.10		0.381	0.498	03/05/2021 09:17	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.513		0.142	0.0755	03/03/2021 14:23	WG1627415
(T) Barium-133	*92.4*			*30.0-143*	*03/03/2021 14:23*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.809		0.206	0.353	03/05/2021 09:17	WG1626465
(T) Barium	*102*			*62.0-143*	*03/05/2021 09:17*	WG1626465
(T) Yttrium	*107*			*79.0-136*	*03/05/2021 09:17*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.22		0.337	0.428	03/08/2021 17:06	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.413		0.131	0.0754	03/08/2021 17:06	WG1627415
(T) Barium-133	*94.8*			*30.0-143*	*03/08/2021 17:06*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.129	U	0.253	0.46	03/05/2021 09:17	WG1626465
(T) Barium	*94.4*			*62.0-143*	*03/05/2021 09:17*	WG1626465
(T) Yttrium	*105*			*79.0-136*	*03/05/2021 09:17*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.527	J	0.388	0.547	03/05/2021 09:17	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.398		0.135	0.087	03/03/2021 14:23	WG1627415
(T) Barium-133	*96.5*			*30.0-143*	*03/03/2021 14:23*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	-0.223	U	0.235	0.452	03/05/2021 13:45	WG1626465
(T) Barium	*99.6*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*109*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.374	J	0.373	0.534	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.374		0.138	0.0823	03/03/2021 14:23	WG1627415
(T) Barium-133	*84.6*			*30.0-143*	*03/03/2021 14:23*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.776		0.233	0.42	03/05/2021 13:45	WG1626465
(T) Barium	*95.3*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*104*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.34		0.376	0.473	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.565		0.143	0.0533	03/03/2021 15:52	WG1627415
(T) Barium-133	*93.2*			*30.0-143*	*03/03/2021 15:52*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	-0.145	U	0.208	0.402	03/05/2021 13:45	WG1626465
(T) Barium	*97.3*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*98.2*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.569		0.365	0.483	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.569		0.157	0.0806	03/03/2021 15:52	WG1627415
(T) Barium-133	*87.8*			*30.0-143*	*03/03/2021 15:52*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.307	J	0.300	0.562	03/05/2021 13:45	WG1626465
(T) Barium	*95.8*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*99.5*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.799		0.433	0.611	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.492		0.133	0.0485	03/03/2021 15:52	WG1627415
(T) Barium-133	*91.8*			*30.0-143*	*03/03/2021 15:52*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.701		0.263	0.479	03/05/2021 13:45	WG1626465
(T) Barium	*96.3*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*102*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.74		0.444	0.544	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	1.04		0.181	0.0645	03/03/2021 15:52	WG1627415
(T) Barium-133	*101*			*30.0-143*	*03/03/2021 15:52*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.888		0.329	0.599	03/05/2021 13:45	WG1626465
(T) Barium	*106*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*93.6*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	2.78		0.592	0.686	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	1.89		0.263	0.0874	03/03/2021 15:52	WG1627415
(T) Barium-133	*103*			*30.0-143*	*03/03/2021 15:52*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	1.56		0.270	0.462	03/05/2021 13:45	WG1626465
(T) Barium	*101*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*94.2*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	3.75		0.544	0.528	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	2.19		0.274	0.0662	03/03/2021 15:53	WG1627415
(T) Barium-133	*97.9*			*30.0-143*	*03/03/2021 15:53*	WG1627415

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.836		0.244	0.439	03/05/2021 13:45	WG1626465
(T) Barium	*94.1*			*62.0-143*	*03/05/2021 13:45*	WG1626465
(T) Yttrium	*102*			*79.0-136*	*03/05/2021 13:45*	WG1626465

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	2.93		0.516	0.53	03/05/2021 13:45	WG1627415

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	2.10		0.272	0.0906	03/03/2021 15:53	WG1627415
(T) Barium-133	*99.0*			*30.0-143*	*03/03/2021 15:53*	WG1627415

Method Blank (MB)

(MB) R3628725-1 03/05/21 09:17

Analyte	MB Result pCi/l	MB Qualifier	MB MDA pCi/l
Radium-228	-0.541	U	0.418
(T) Barium	*99.7*		
(T) Yttrium	*104*		

Laboratory Control Sample (LCS)

(LCS) R3628725-2 03/05/21 09:17

Analyte	Spike Amount pCi/l	LCS Result pCi/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-228	5.00	5.28	106	80.0-120	
(T) Barium			*103*		
(T) Yttrium			*108*		

L1319216-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-04 03/05/21 09:17 • (MS) R3628725-3 03/05/21 09:17 • (MSD) R3628725-6 03/05/21 09:17

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.93	0.587	5.01	4.63	89.7	82.0	1	70.0-130			7.85		20
(T) Barium		*106*			*100*	*99.6*							
(T) Yttrium		*105*			*105*	*103*							

L1319216-10 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-10 03/05/21 13:45 • (MS) R3628725-4 03/05/21 09:17 • (MSD) R3628725-7 03/05/21 09:17

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.93	0.307	6.33	5.81	122	112	1	70.0-130			8.63		20
(T) Barium		*95.8*			*100*	*100*							
(T) Yttrium		*99.5*			*101*	*108*							

L1319216-13 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-13 03/05/21 13:45 • (MS) R3628725-5 03/05/21 09:17 • (MSD) R3628725-8 03/05/21 09:17

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.93	1.56	6.17	6.22	93.4	94.5	1	70.0-130			0.872		20
(T) Barium		*101*			*115*	*110*							

L1319216-13 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-13 03/05/21 13:45 • (MS) R3628725-5 03/05/21 09:17 • (MSD) R3628725-8 03/05/21 09:17

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
(T) Yttrium		*94.2*			*104*	*100*							

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3628801-1 03/03/21 11:58

Analyte	MB Result pCi/g	MB Qualifier	MB MDA pCi/g
Radium-226	0.111		0.0551
(T) Barium-133	*88.4*		

Laboratory Control Sample (LCS)

(LCS) R3628801-2 03/03/21 14:22

Analyte	Spike Amount pCi/g	LCS Result pCi/g	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-226	5.02	5.95	119	60.0-144	
(T) Barium-133			*85.3*		

L1319216-10 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-10 03/03/21 15:52 • (MS) R3628801-3 03/03/21 14:22 • (MSD) R3628801-11 03/09/21 07:42

Analyte	Spike Amount pCi/g	Original Result pCi/g	MS Result pCi/g	MSD Result pCi/g	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	5.01	0.492	5.30	5.02	96.0	90.4	1	65.0-135			5.45		20
(T) Barium-133		*91.8*			*84.9*	*102*							

L1319216-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-04 03/03/21 14:23 • (MS) R3628801-9 03/08/21 17:06 • (MSD) R3628801-5 03/03/21 14:22

Analyte	Spike Amount pCi/g	Original Result pCi/g	MS Result pCi/g	MSD Result pCi/g	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	5.01	0.513	4.99	5.25	89.3	94.6	1	65.0-135			5.10		20
(T) Barium-133		*92.4*			*97.4*	*96.7*							

L1319216-13 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1319216-13 03/03/21 15:53 • (MS) R3628801-10 03/08/21 17:06 • (MSD) R3628801-7 03/03/21 14:22

Analyte	Spike Amount pCi/g	Original Result pCi/g	MS Result pCi/g	MSD Result pCi/g	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	5.01	2.19	5.54	6.23	66.7	80.5	1	65.0-135			11.7		20
(T) Barium-133		*97.9*			*102*	*98.1*							

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Results Disclaimer - Information that may be provided by the customer, and contained within this report, include Permit Limits, Project Name, Sample ID, Sample Matrix, Sample Preservation, Field Blanks, Field Spikes, Field Duplicates, On-Site Data, Sampling Collection Dates/Times, and Sampling Location. Results relate to the accuracy of this information provided, and as the samples are received.

Abbreviations and Definitions

MDA	Minimum Detectable Activity.
Rec.	Recovery.
RER	Replicate Error Ratio.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(T)	Tracer - A radioisotope of known concentration added to a solution of chemically equivalent radioisotopes at a known concentration to assist in monitoring the yield of the chemical separation.
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.
U	Below Detectable Limits: Indicates that the analyte was not detected.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

Pace Analytical National 12065 Lebanon Rd Mount Juliet, TN, 37122

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN000032021-1
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	TN00003
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	KY90010	South Carolina	84004002
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana	LA018	Texas	T104704245-20-18
Maine	TN00003	Texas [5]	LAB0152
Maryland	324	Utah	TN000032021-11
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	110033
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	998093910
Montana	CERT0086	Wyoming	A2LA
A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

SUBCONTRACT ORDER
Transfer Chain of Custody

H185

PDC Laboratories, Inc.

EB02539

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Pace Analytical - Mt Juliet, Tn
12065 Lebanon Rd
Mt Juliet, TN 37122
(615) 758-5858

1319216

Sample: EB02539-01 -01
Name: G314D - S1

Sampled: 02/10/21 15:00
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/09/21 15:00	

Sample: EB02539-02 02
Name: G314D - S2

Sampled: 02/11/21 11:00
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/10/21 11:00	

Sample: EB02539-03 03
Name: G314D - S2

Sampled: 02/11/21 14:00
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/10/21 14:00	

Sample: EB02539-04 04
Name: G314D - S2 DUPLICATE

Sampled: 02/11/21 11:00
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/10/21 11:00	MS/MSD

Sample: EB02539-05 05
Name: G307D - S1

Sampled: 02/09/21 10:30
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 10:30	

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Pace Analytical - Mt Juliet, Tn
12065 Lebanon Rd
Mt Juliet, TN 37122
(615) 758-5858

1319214

Sample: EB02539-06
Name: G307D - S2

06

Sampled: 02/09/21 10:40
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 10:40	

Sample: EB02539-07
Name: G307D - S3

07

Sampled: 02/09/21 14:45
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 14:45	

Sample: EB02539-08
Name: G307D - S4

08

Sampled: 02/09/21 16:00
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 16:00	

Sample: EB02539-09
Name: G307D - S5

09

Sampled: 02/09/21 16:30
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 16:30	

Sample: EB02539-10
Name: G307D - S3 DUPLICATE

10

Sampled: 02/09/21 14:45
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 14:45	MS/MSD

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

1319216

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Pace Analytical - Mt Juliet, Tn
12065 Lebanon Rd
Mt Juliet, TN 37122
(615) 758-5858

Sample: EB02539-11
Name: XPW - 01 - S1

Sampled: 02/08/21 11:15
Matrix: Soil
Preservative: Cool <6

11

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/07/21 11:15	

Sample: EB02539-12
Name: XPW - 01 - S1 DUPLICATE

Sampled: 02/09/21 14:45
Matrix: Soil
Preservative: Cool <6

12

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/08/21 14:45	MS/MSD

13

Sample: EB02539-13
Name: XPW - 02 - S1

Sampled: 02/08/21 14:30
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/07/21 14:30	

Sample: EB02539-14
Name: XPW - 02 - S1 DUPLICATE

Sampled: 02/08/21 14:30
Matrix: Soil
Preservative: Cool <6

14

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/23/21 16:00	08/07/21 14:30	MS/MSD

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB02539

1319216

7729 1192 2915/2926/3110/3505 All Cont <500 CPM

Sample Receipt Checklist

COC Seal Present/Intact:	Y ✓ N	If Applicable	
COC Signed/Accurate:	✓ Y __ N	VOA Zero Headspace:	__ Y __ N
Bottles arrive intact:	✓ Y __ N	Pres.Correct/Check:	__ Y __ N
Correct bottles used:	✓ Y __ N		
Sufficient volume sent:	✓ Y __ N		
RAD Screen <0.5 mR/hr:	✓ Y __ N		

14 total

MPA1 1.37.2=15

Please email results to Gail Schindler at gschindler@pdclab.com

Date Shipped: 2-15-21 Total # of Containers: 14 Sample Origin (State): IL PO #: 11508

Turn-Around Time Requested ☑ NORMAL ☐ RUSH Date Results Needed: _____

Relinquished By	Date/Time	Received By	Date/Time
[signature]	2-15-21 16:30		
		[signature]	2-23-21 930

Relinquished By	Date/Time	Received By	Date/Time

Sample Temperature Upon Receipt	____ °C
Sample(s) Received on Ice	Y or N
Proper Bottles Received in Good Condition	Y or N
Bottles Filled with Adequate Volume	Y or N
Samples Received Within Hold Time	Y or N
Date/Time Taken From Sample Bottle	Y or N

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REGULATORY PROGRAM (CIRCLE):	NPDES
MORBCA	RCRA
CCDD	TACO: RES OR IND/COMM

CHAIN OF CUSTODY RECORD

STATE WHERE SAMPLE COLLECTED IL

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

1 CLIENT: HANSON PROFESSIONAL SERVICES
PROJECT NUMBER: COFFEEN AP1
PROJECT LOCATION:
PURCHASE ORDER #:
ADDRESS: 1525 S 6TH STREET
PHONE NUMBER:
E-MAIL:
DATE SHIPPED:
CITY / STATE / ZIP: SPRINGFIELD IL 62703-6801
SAMPLER (PLEASE PRINT): COLIN WINTER
CONTACT PERSON: MR RHON HASENYAGER
SAMPLER'S SIGNATURE:

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- NON AQUEOUS SOLID
LCHT-LEACHATE
OIL-OIL
SO-SOIL
SOL-SOLID

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN # EB02539
LOGGED BY:
CLIENT: HANSON PROFESSIONAL SERVICES
PROJECT: HANSON VISTRA COFFEEN AP1 SOIL
PROJ. MGR.: GJ SCHINDLER

2 SAMPLE DESCRIPTION (UNIQUE DESCRIPTION AS IT WILL APPEAR ON THE ANALYTICAL REPORT)	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	PRES CODE CLIENT PROVIDED	SB, AS, BA, BE, B, CD, CA, CR,	CO, FE, PB, LI, MG, MN, MO, K	SE, NA, S, TL, CL, F, SO4, TN	FE OXIDE, MN OXIDE	RAD 226/228	TOC	CEC	REMARKS
G314D-S1	2/10/21	1:30-3		X	SO	SEE JARS									
G314D-S2	2/11/21	8-11AM		X	SO	3									
G314D-S3	2/11/21	11-2PM		X	SO	4									
G314DS2 (MS/MSD/FIELD DUP)	2/11/21	8-11AM		X	SO	2									
G314-S31 (EQUIP BLANK)	2/11/21	1:30PM		X	N/A	8									
G307D-S1	2/9/21	10-10:30		X	SO	3									
G307D-S2	2/9/21	10:30-40		X	SO	2									
G307D-S3	2/9/21	10:40-2:45		X	SO	SEE JARS									

CHEMICAL PRESERVATION CODES: 1 – HCL | 2 – H2SO4 | 3 – HNO3 | 4 – NAOH | 5 – NA2S2O3 | 6 – UNPRESERVED | 7 – OTHER

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) EMAIL PHONE
DATE RESULTS NEEDED:
EMAIL IF DIFFERENT FROM ABOVE:
PHONE # IF DIFFERENT FROM ABOVE:

6 *I understand that by initialing this box I give the lab permission to proceed with analysis, even though it may not meet all sample conformance requirements as defined in the receiving facility's Sample Acceptance Policy and the data will be qualified. Qualified data may NOT be acceptable to report to all regulatory authorities.*
PROCEED WITH ANALYSIS AND QUALIFY RESULTS: (INITIALS) _____

7 RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME
	2/12/21 9:30AM		2-12-21 9:00
RELINQUISHED BY: (SIGNATURE)	2-12-21 15:12	RECEIVED BY: (SIGNATURE)	
RELINQUISHED BY: (SIGNATURE)		RECEIVED BY: (SIGNATURE)	2/12/21 1512

8 COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 2.5 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
SAMPLE ACCEPTANCE NONCONFORMANT REPORT IS NEEDED Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE _____

PDC LABORATORIES, INC.
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REGULATORY PROGRAM (CIRCLE):	NPDES
MORBCA	RCRA
CCDD	TACO: RES OR IND/COMM

CHAIN OF CUSTODY RECORD

STATE WHERE SAMPLE COLLECTED IL

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

1 CLIENT: HANSON PROFESSIONAL SERVICES

ADDRESS: 1525 S 6TH STREET

CITY STATE ZIP: SPRINGFIELD IL 62703-6801

CONTACT PERSON: MR RHON HASENYAGER

PROJECT NUMBER: COFFEEN AP1

PROJECT LOCATION:

PURCHASE ORDER #:

PHONE NUMBER:

E-MAIL:

DATE SHIPPED:

SAMPLER (PLEASE PRINT): COLIN WINTER

SAMPLER'S SIGNATURE:

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- NON AQUEOUS SOLID
LCHT-LEACHATE
OIL-OIL
SO-SOIL
SOL-SOLID

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN # GB02539
LOGGED BY:
CLIENT: HANSON PROFESSIONAL SERVICES
PROJECT: HANSON VISTRA COFFEEN AP1 SOIL
PROJ. MGR.: GJ SCHINDLER

2 SAMPLE DESCRIPTION (UNIQUE DESCRIPTION AS IT WILL APPEAR ON THE ANALYTICAL REPORT)	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	PRES CODE CLIENT PROVIDED	SB, AS, BA, BE, B, CD, CA, CR,	CO, FE, PB, LI, MG, MN, MO, K	SE, NA, S, TL, CL, F, SO4, TN	FE OXIDE, MN OXIDE	RAD 226/228	TOC	CEC	REMARKS
G307D-S4	2/9/21	2:45-4		X	SO	4									
G307D-S5	2/9/21	4-4:30		X	SO	3									
G307D-S3 (MS/MSD & FIELD DUP)	2/9/21	10:40-2:45		X	SO	SEE JARS									
G307D-S11 (EQUIP BLANK)	2/9/21	[illegible]	SEE JARS		N/A	8									
XPW-01-S1	2/8/21	10:45-11:15		X	SOL	3									
XPW-01-S1 (MS/MSD/FIELD DUP)	2/8/21	10:45-11:15		X	SOL	3									
XPW-01- EQUIP BLANK	2/8/21	[illegible]	SEE JARS	[illegible]	[illegible]	8									

CHEMICAL PRESERVATION CODES: 1 – HCL | 2 – H2SO4 | 3 – HNO3 | 4 – NAOH | 5 – NA2S2O3 | 6 – UNPRESERVED | 7 – OTHER

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) EMAIL PHONE
EMAIL IF DIFFERENT FROM ABOVE: PHONE # IF DIFFERENT FROM ABOVE:
DATE RESULTS NEEDED

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PROCEED WITH ANALYSIS AND QUALIFY RESULTS: (INITIALS) _____

7	DATE	TIME		DATE	TIME
RELINQUISHED BY: (SIGNATURE)	2/12/21	9:30AM	RECEIVED BY: (SIGNATURE)		
RELINQUISHED BY: (SIGNATURE)	2-12-21	15:12	RECEIVED BY: (SIGNATURE)		
RELINQUISHED BY: (SIGNATURE)			RECEIVED BY: (SIGNATURE)	2/12/21	1512

8 COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 2.5 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
SAMPLE ACCEPTANCE NONCONFORMANT REPORT IS NEEDED Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE _____

PDC LABORATORIES, INC.
WWW.PDCLAB.COM

REGULATORY PROGRAM (CIRCLE):	NPDES
MORBCA	RCRA
CCDD	TACO: RES OR IND/COMM

CHAIN OF CUSTODY RECORD

STATE WHERE SAMPLE COLLECTED IL

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

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CITY STATE ZIP: SPRINGFIELD IL 62703-6801

CONTACT PERSON: MR RHON HASENYAGER

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PURCHASE ORDER #:

PHONE NUMBER:

E-MAIL:

DATE SHIPPED:

SAMPLER (PLEASE PRINT): COLIN WINTER

SAMPLER'S SIGNATURE:

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- NON AQUEOUS SOLID
LCHT-LEACHATE
OIL-OIL
SO-SOIL
SOL-SOLID

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN # EB07539
LOGGED BY:
CLIENT: HANSON PROFESSIONAL SERVICES
PROJECT: HANSON VISTRA COFFEEN AP1 SOIL
PROJ. MGR.: GJ SCHINDLER

2 SAMPLE DESCRIPTION (UNIQUE DESCRIPTION AS IT WILL APPEAR ON THE ANALYTICAL REPORT)	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	PRES CODE CLIENT PROVIDED	SB, AS, BA, BE, B, CD, CA, CR,	CO, FE, PB, LI, MG, MN, MO, K	SE, NA, S, TL, CL, F, SO4, TN	FE OXIDE, MN OXIDE	RAD 226/228	TOC	CEC	REMARKS
XPW-02-S1	2/8/21	1:30-2:30		X	SOL	See									
XPW-02-S1 (MS/MSD / FIELD DUP)	2/8/21	1:30-2:30		X	SOL	Jars									
XPW-02-S4 (EQUIP BLANK)	2/8/21	See Jars		N/A	N/A	8									

CHEMICAL PRESERVATION CODES: 1 – HCL | 2 – H2SO4 | 3 – HNO3 | 4 – NAOH | 5 – NA2S2O3 | 6 – UNPRESERVED | 7 – OTHER

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) EMAIL PHONE
EMAIL IF DIFFERENT FROM ABOVE: PHONE # IF DIFFERENT FROM ABOVE:
DATE RESULTS NEEDED

6 *I understand that by initialing this box I give the lab permission to proceed with analysis, even though it may not meet all sample conformance requirements as defined in the receiving facility's Sample Acceptance Policy and the data will be qualified. Qualified data may NOT be acceptable to report to all regulatory authorities.*
PROCEED WITH ANALYSIS AND QUALIFY RESULTS: (INITIALS) _____

7

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME
	2/12/21 9:30AM		2-12-21 9:00
RELINQUISHED BY: (SIGNATURE)	2-12-21 15:12	RECEIVED BY: (SIGNATURE)	
RELINQUISHED BY: (SIGNATURE)		RECEIVED BY: (SIGNATURE)	2/12/21 15:12

8 COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 2.5 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
SAMPLE ACCEPTANCE NONCONFORMANT REPORT IS NEEDED Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE _____

PDC Laboratories, Inc.

PROFESSIONAL • DEPENDABLE • COMMITTED

March 01, 2021

Rhonald Hasenyager
Hanson Professional Services, Inc.
1525 South Sixth Street
Springfield, IL 62703-2886

RE: HANSON VISTRA SOIL

Dear Rhonald Hasenyager:

Please find enclosed the analytical results for the **6** sample(s) the laboratory received on **2/5/21 4:00 pm** and logged in under work order **EB01458**. All testing is performed according to our current TNI accreditations unless otherwise noted. This report cannot be reproduced, except in full, without the written permission of PDC Laboratories, Inc.

If you have any questions regarding your report, please contact your project manager. Quality and timely data is of the utmost importance to us.

PDC Laboratories, Inc. appreciates the opportunity to provide you with analytical expertise. We are always trying to improve our customer service and we welcome you to contact the Director of Client Services, Lisa Grant, with any feedback you have about your experience with our laboratory at 309-683-1764 or lgrant@pdclab.com.

Sincerely,

Gail J Schindler

Gail Schindler
Project Manager
(309) 692-9688 x1716
gschindler@pdclab.com

NELAP ACCREDITED TNI LABORATORY

SAMPLE RECEIPT CHECK LIST

Items not applicable will be marked as in compliance

Work Order EB01458

NO	Samples received within temperature compliance when applicable
YES	COC present upon sample receipt
YES	COC completed & legible
YES	Sampler name & signature present
YES	Unique sample IDs assigned
YES	Sample collection location recorded
YES	Date & time collected recorded on COC
YES	Relinquished by client signature on COC
YES	COC & labels match
YES	Sample labels are legible
YES	Appropriate bottle(s) received
YES	Sufficient sample volume received
YES	Sample containers recieved undamaged
NO	Zero headspace, <6 mm present in VOA vials
NO	Trip blank(s) received
YES	All non-field analyses received within holding times
NO	Short hold time analysis
YES	Current PDC COC submitted
NO	Case narrative provided

Case Narrative

EB01458 was received February 5, 2021 at 6.9oC.
Sample(s) did not meet regulatory thermal preservation requirement.
Sample(s) were:
1. Received on the same day of collection, above allowable maximum temperature, and not received on ice.
OR
2. Received after the day of collection and were above the allowable maximum temperature.

PLEASE NOTE: Results **MAY** not be acceptable to report to a regulatory authority.
Analyses that do not require thermal preservation are Radiochemistry, Drinking Water Bacteriology, Fluoride, Chloride, Bromide, Mercury 245.1/7470, metals methods 200.7/200.8 and 6010/6020.

ANALYTICAL RESULTS

Sample: EB01458-01
Name: G289-S4 (COFFEEN GMF)
Matrix: Soil - Composite
Sampled: 02/01/21 14:00
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	19.81	meq/100g			1	1			Subcontracted

Sample: EB01458-02
Name: G311D-S1 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 08:30
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.36	meq/100g			1	1			Subcontracted

Sample: EB01458-03
Name: G311D-S2 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 09:15
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.23	meq/100g			1	1			Subcontracted

Sample: EB01458-04
Name: G311D-S3 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.61	meq/100g			1	1			Subcontracted

ANALYTICAL RESULTS

Sample: EB01458-05
Name: G311D-S4 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	13.05	meq/100g			1	1			Subcontracted

Sample: EB01458-06
Name: G311D-S2 (COFFEEN AP1) DUPCLIATE
Matrix: Soil - Composite
Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - A & L Great Lakes Laboratory									
Cation Exchange Capacity - subcontracted	9.63	meq/100g			1	1			Subcontracted

ANALYTICAL RESULTS

Sample: EB01458-01
Name: G289-S4 (COFFEEN GMF)
Matrix: Soil - Composite
Sampled: 02/01/21 14:00
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	1800	mg/kg			1.98	594	02/12/21 15:42		SM 5310C 2000

Sample: EB01458-02
Name: G311D-S1 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 08:30
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	118 J	mg/kg			1.06	318	02/17/21 12:58		SM 5310C 2000

ANALYTICAL RESULTS

Sample: EB01458-03
Name: G311D-S2 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 09:15
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	11500	mg/kg			5.02	1510	02/16/21 18:26		SM 5310C 2000

Sample: EB01458-04
Name: G311D-S3 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	14800	mg/kg			10.03	3010	02/17/21 13:49		SM 5310C 2000

Sample: EB01458-05
Name: G311D-S4 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	563	mg/kg			1.03	309	02/17/21 14:01		SM 5310C 2000

Sample: EB01458-06
Name: G311D-S2 (COFFEEN AP1) DUPCLIATE
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
General Chemistry - Eurofins Eaton Analytical, Inc. - Lancaster, PA									
Total Organic Carbon (TOC)	17100	mg/kg			4.55	1370	02/16/21 19:30		SM 5310C 2000

ANALYTICAL RESULTS

ANALYTICAL RESULTS

Sample: EB01458-01
Name: G289-S4 (COFFEEN GMF)
Matrix: Soil - Composite
Sampled: 02/01/21 14:00
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.529	pCi/g dry wt			1	0.0612	02/22/21 14:02		Subcontracted
Radium 228 - subcontracted	0.195 U	pCi/g dry wt			1	0.451	02/24/21 09:05		Subcontracted

Sample: EB01458-02
Name: G311D-S1 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 08:30
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.78	pCi/g dry wt			1	0.0752	02/22/21 14:02		Subcontracted
Radium 228 - subcontracted	0.278	pCi/g dry wt			1	0.399	02/24/21 09:05		Subcontracted

Sample: EB01458-03
Name: G311D-S2 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 09:15
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.742	pCi/g dry wt			1	0.0569	02/22/21 14:02		Subcontracted
Radium 228 - subcontracted	0.281 J	pCi/g dry wt			1	0.425	02/24/21 09:05		Subcontracted

Sample: EB01458-04
Name: G311D-S3 (COFFEEN AP1)
Matrix: Soil - Composite
Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.693	pCi/g dry wt			1	0.0694	02/22/21 14:02		Subcontracted
Radium 228 - subcontracted	0.621	pCi/g dry wt			1	0.42	02/24/21 09:05		Subcontracted

ANALYTICAL RESULTS

Sample: EB01458-05
Name: G311D-S4 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.518	pCi/g dry wt			1	0.0824	02/22/21 14:02		Subcontracted
Radium 228 - subcontracted	0.946	pCi/g dry wt			1	0.359	02/24/21 09:05		Subcontracted

Sample: EB01458-06
Name: G311D-S2 (COFFEEN AP1) DUPCLIATE
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Miscellaneous - Pace Analytical - Mt Juliet, Tn									
Radium 226 - subcontracted	0.429	pCi/g dry wt			1	0.0532	02/22/21 14:02		Subcontracted
Radium 228 - subcontracted	-0.41	pCi/g dry wt	U		1	0.372	02/24/21 09:05		Subcontracted

ANALYTICAL RESULTS

ANALYTICAL RESULTS

Sample: EB01458-01
Name: G289-S4 (COFFEEN GMF)
Matrix: Soil - Composite

Sampled: 02/01/21 14:00
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 1.0	mg/kg		02/08/21 17:41	1	1.0	02/08/21 17:41	CRD	EPA 9056A
Fluoride	< 0.25	mg/kg		02/08/21 17:41	1	0.25	02/08/21 17:41	CRD	EPA 9056A
Sulfate	< 1.0	mg/kg		02/08/21 17:41	1	1.0	02/08/21 17:41	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	82	%		02/08/21 15:14	1	0.050	02/08/21 15:57	BMA/BCR	SM 2540G*
Total Nitrogen	410	mg/kg dry		02/10/21 14:37	1	61	02/11/21 11:09	CRS1	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	19000	mg/kg		02/09/21 14:58	10	43	02/10/21 10:55	wjm	calculated
Manganese as MnO2	740	mg/kg		02/09/21 14:58	10	1.6	02/10/21 10:55	wjm	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.51	mg/kg		02/10/21 14:37	1	0.20	02/10/21 14:37	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	340	mg/kg		02/08/21 08:02	1	50	02/11/21 11:09	CRS1	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/09/21 14:58	10	3.0	02/10/21 10:55	wjm	EPA 6020A
Arsenic	2.3	mg/kg		02/09/21 14:58	20	2.0	02/10/21 11:37	wjm	EPA 6020A
Barium	86	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:55	wjm	EPA 6020A
Beryllium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:21	KMC	EPA 6020A
Boron	< 10	mg/kg		02/09/21 14:58	10	10	02/10/21 13:21	KMC	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:55	wjm	EPA 6020A
Chromium	13	mg/kg		02/09/21 14:58	10	4.0	02/10/21 10:55	wjm	EPA 6020A
Cobalt	6.2	mg/kg		02/09/21 14:58	10	2.0	02/10/21 10:55	wjm	EPA 6020A
Iron	13000	mg/kg		02/09/21 14:58	10	30	02/10/21 10:55	wjm	EPA 6020A*
Lead	9.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:21	KMC	EPA 6020A
Manganese	470	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:55	wjm	EPA 6020A
Molybdenum	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:55	wjm	EPA 6020A
Selenium	< 2.0	mg/kg		02/09/21 14:58	20	2.0	02/10/21 11:37	wjm	EPA 6020A
Thallium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:21	KMC	EPA 6020A
Mercury	< 0.20	mg/kg		02/09/21 14:58	10	0.20	02/10/21 13:21	KMC	EPA 6020A
Lithium	8.8	mg/kg		02/09/21 14:58	1	5.0	02/10/21 09:53	TJJ	EPA 6010B*
Sulfur	130	mg/kg		02/09/21 14:58	1	10	02/11/21 15:08	tjj	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB01458-02
Name: G311D-S1 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 08:30
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 1.0	mg/kg		02/08/21 18:17	1	1.0	02/08/21 18:17	CRD	EPA 9056A
Fluoride	< 0.25	mg/kg		02/08/21 18:17	1	0.25	02/08/21 18:17	CRD	EPA 9056A
Sulfate	2.3	mg/kg		02/08/21 18:17	1	1.0	02/08/21 18:17	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	84	%		02/10/21 14:48	1	0.050	02/10/21 15:26	BMA/BCR	SM 2540G*
Total Nitrogen	510	mg/kg dry		02/10/21 14:38	1	59	02/11/21 11:10	CRS1	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	14000	mg/kg		02/09/21 14:58	10	43	02/10/21 10:58	wjm	calculated
Manganese as MnO2	180	mg/kg		02/09/21 14:58	10	1.6	02/10/21 10:58	wjm	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.29	mg/kg		02/10/21 14:38	1	0.20	02/10/21 14:38	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	430	mg/kg		02/08/21 08:02	1	50	02/11/21 11:10	CRS1	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/09/21 14:58	10	3.0	02/10/21 10:58	wjm	EPA 6020A
Arsenic	3.2	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:58	wjm	EPA 6020A
Barium	57	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:58	wjm	EPA 6020A
Beryllium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:24	KMC	EPA 6020A
Boron	< 10	mg/kg		02/09/21 14:58	10	10	02/10/21 13:24	KMC	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:58	wjm	EPA 6020A
Chromium	10	mg/kg		02/09/21 14:58	10	4.0	02/10/21 10:58	wjm	EPA 6020A
Cobalt	3.1	mg/kg		02/09/21 14:58	10	2.0	02/10/21 10:58	wjm	EPA 6020A
Iron	10000	mg/kg		02/09/21 14:58	10	30	02/10/21 10:58	wjm	EPA 6020A*
Lead	8.1	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:24	KMC	EPA 6020A
Manganese	110	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:58	wjm	EPA 6020A
Molybdenum	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:58	wjm	EPA 6020A
Selenium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 10:58	wjm	EPA 6020A
Thallium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:24	KMC	EPA 6020A
Mercury	< 0.20	mg/kg		02/09/21 14:58	10	0.20	02/10/21 13:24	KMC	EPA 6020A
Lithium	< 5.0	mg/kg		02/09/21 14:58	1	5.0	02/10/21 10:00	TJJ	EPA 6010B*
Sulfur	65	mg/kg		02/09/21 14:58	1	10	02/11/21 15:09	tjj	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB01458-03
Name: G311D-S2 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 09:15
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 1.0	mg/kg		02/08/21 18:35	1	1.0	02/08/21 18:35	CRD	EPA 9056A
Fluoride	< 0.25	mg/kg		02/08/21 18:35	1	0.25	02/08/21 18:35	CRD	EPA 9056A
Sulfate	< 1.0	mg/kg		02/08/21 18:35	1	1.0	02/08/21 18:35	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	87	%		02/10/21 14:48	1	0.050	02/10/21 15:26	BMA/BCR	SM 2540G*
Total Nitrogen	360	mg/kg dry		02/10/21 14:38	1	58	02/11/21 11:11	CRS1	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	12000	mg/kg		02/09/21 14:58	10	45	02/10/21 11:02	wjm	calculated
Manganese as MnO2	400	mg/kg		02/09/21 14:58	10	1.7	02/10/21 11:02	wjm	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.21	mg/kg		02/10/21 14:38	1	0.20	02/10/21 14:38	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	310	mg/kg		02/08/21 08:02	1	50	02/11/21 11:11	CRS1	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.2	mg/kg		02/09/21 14:58	10	3.2	02/10/21 11:02	wjm	EPA 6020A
Arsenic	3.5	mg/kg		02/09/21 14:58	10	1.1	02/10/21 11:02	wjm	EPA 6020A
Barium	44	mg/kg		02/09/21 14:58	10	1.1	02/10/21 11:02	wjm	EPA 6020A
Beryllium	< 1.1	mg/kg		02/09/21 14:58	10	1.1	02/10/21 13:28	KMC	EPA 6020A
Boron	< 11	mg/kg		02/09/21 14:58	10	11	02/10/21 13:28	KMC	EPA 6020A*
Cadmium	< 1.1	mg/kg		02/09/21 14:58	10	1.1	02/10/21 11:02	wjm	EPA 6020A
Chromium	8.0	mg/kg		02/09/21 14:58	10	4.2	02/10/21 11:02	wjm	EPA 6020A
Cobalt	4.0	mg/kg		02/09/21 14:58	10	2.1	02/10/21 11:02	wjm	EPA 6020A
Iron	8600	mg/kg		02/09/21 14:58	10	32	02/10/21 11:02	wjm	EPA 6020A*
Lead	5.4	mg/kg		02/09/21 14:58	10	1.1	02/10/21 13:28	KMC	EPA 6020A
Manganese	250	mg/kg		02/09/21 14:58	10	1.1	02/10/21 11:02	wjm	EPA 6020A
Molybdenum	1.2	mg/kg		02/09/21 14:58	10	1.1	02/10/21 11:02	wjm	EPA 6020A
Selenium	< 1.1	mg/kg		02/09/21 14:58	10	1.1	02/10/21 11:02	wjm	EPA 6020A
Thallium	< 1.1	mg/kg		02/09/21 14:58	10	1.1	02/10/21 13:28	KMC	EPA 6020A
Mercury	< 0.21	mg/kg		02/09/21 14:58	10	0.21	02/10/21 13:28	KMC	EPA 6020A
Lithium	6.4	mg/kg		02/09/21 14:58	1	5.3	02/10/21 10:02	TJJ	EPA 6010B*
Sulfur	780	mg/kg		02/09/21 14:58	1	11	02/11/21 15:11	tjj	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB01458-04
Name: G311D-S3 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 1.0	mg/kg		02/08/21 18:53	1	1.0	02/08/21 18:53	CRD	EPA 9056A
Fluoride	< 0.25	mg/kg		02/08/21 18:53	1	0.25	02/08/21 18:53	CRD	EPA 9056A
Sulfate	< 1.0	mg/kg		02/08/21 18:53	1	1.0	02/08/21 18:53	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	88	%		02/10/21 14:48	1	0.050	02/10/21 15:26	BMA/BCR	SM 2540G*
Total Nitrogen	370	mg/kg dry		02/10/21 14:42	1	57	02/11/21 11:11	CRS1	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	15000	mg/kg		02/11/21 07:32	10	43	02/11/21 15:33	wjm	calculated
Manganese as MnO2	460	mg/kg		02/11/21 07:32	10	1.6	02/11/21 15:33	wjm	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/10/21 14:42	1	0.20	02/10/21 14:42	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	330	mg/kg		02/08/21 08:02	1	50	02/11/21 11:11	CRS1	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/11/21 07:32	10	3.0	02/11/21 15:33	wjm	EPA 6020A
Arsenic	2.8	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Barium	69	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Beryllium	< 1.0	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Boron	< 10	mg/kg		02/11/21 07:32	10	10	02/11/21 15:33	wjm	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Chromium	10	mg/kg		02/11/21 07:32	10	4.0	02/11/21 15:33	wjm	EPA 6020A
Cobalt	5.0	mg/kg		02/11/21 07:32	10	2.0	02/11/21 15:33	wjm	EPA 6020A
Iron	11000	mg/kg		02/11/21 07:32	10	30	02/11/21 15:33	wjm	EPA 6020A*
Lead	6.9	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Manganese	290	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Molybdenum	1.2	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Selenium	< 1.0	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Thallium	< 1.0	mg/kg		02/11/21 07:32	10	1.0	02/11/21 15:33	wjm	EPA 6020A
Mercury	< 0.20	mg/kg		02/11/21 07:32	10	0.20	02/11/21 15:33	wjm	EPA 6020A
Lithium	8.4	mg/kg		02/11/21 07:32	1	5.0	02/12/21 11:46	AMB	EPA 6010B*
Sulfur	760	mg/kg		02/11/21 07:32	1	10	02/15/21 16:02	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB01458-05
Name: G311D-S4 (COFFEEN AP1)
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 1.0	mg/kg		02/08/21 19:48	1	1.0	02/08/21 19:48	CRD	EPA 9056A
Fluoride	< 0.25	mg/kg		02/08/21 19:48	1	0.25	02/08/21 19:48	CRD	EPA 9056A
Sulfate	< 1.0	mg/kg		02/08/21 19:48	1	1.0	02/08/21 19:48	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	80	%		02/10/21 14:48	1	0.050	02/10/21 15:26	BMA/BCR	SM 2540G*
Total Nitrogen	530	mg/kg dry		02/10/21 14:43	1	63	02/11/21 11:12	CRS1	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	17000	mg/kg		02/11/21 07:32	10	41	02/11/21 15:37	wjm	calculated
Manganese as MnO2	600	mg/kg		02/11/21 07:32	10	1.5	02/11/21 15:37	wjm	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	< 0.20	mg/kg		02/10/21 14:43	1	0.20	02/10/21 14:43	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	420	mg/kg		02/08/21 08:02	1	50	02/11/21 11:12	CRS1	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 2.8	mg/kg		02/11/21 07:32	10	2.8	02/11/21 15:37	wjm	EPA 6020A
Arsenic	3.2	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Barium	90	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Beryllium	< 0.95	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Boron	< 9.5	mg/kg		02/11/21 07:32	10	9.5	02/11/21 15:37	wjm	EPA 6020A*
Cadmium	< 0.95	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Chromium	12	mg/kg		02/11/21 07:32	10	3.8	02/11/21 15:37	wjm	EPA 6020A
Cobalt	5.9	mg/kg		02/11/21 07:32	10	1.9	02/11/21 15:37	wjm	EPA 6020A
Iron	12000	mg/kg		02/11/21 07:32	10	28	02/11/21 15:37	wjm	EPA 6020A*
Lead	8.7	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Manganese	380	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Molybdenum	1.3	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Selenium	< 0.95	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Thallium	< 0.95	mg/kg		02/11/21 07:32	10	0.95	02/11/21 15:37	wjm	EPA 6020A
Mercury	< 0.19	mg/kg		02/11/21 07:32	10	0.19	02/11/21 15:37	wjm	EPA 6020A
Lithium	10	mg/kg		02/11/21 07:32	1	4.7	02/12/21 11:48	AMB	EPA 6010B*
Sulfur	820	mg/kg		02/11/21 07:32	1	9.5	02/15/21 16:04	AMB	EPA 6010B*

ANALYTICAL RESULTS

Sample: EB01458-06
Name: G311D-S2 (COFFEEN AP1) DUPCLIATE
Matrix: Soil - Composite

Sampled: 02/05/21 11:45
Received: 02/05/21 15:34

Parameter	Result	Unit	Qualifier	Prepared	Dilution	MRL	Analyzed	Analyst	Method
Anions - PIA									
Chloride	< 1.0	mg/kg	Q2	02/08/21 20:06	1	1.0	02/08/21 20:06	CRD	EPA 9056A
Fluoride	< 0.25	mg/kg		02/08/21 20:06	1	0.25	02/08/21 20:06	CRD	EPA 9056A
Sulfate	< 1.0	mg/kg	Q2	02/08/21 20:06	1	1.0	02/08/21 20:06	CRD	EPA 9056A
General Chemistry - PIA									
Solids - total solids (TS)	84	%		02/10/21 14:48	1	0.050	02/10/21 15:26	BMA/BCR	SM 2540G*
Total Nitrogen	390	mg/kg dry		02/10/21 14:21	1	60	02/11/21 11:06	CRS1	(calc)
Metals by ICP-MS - PIA									
Iron as Fe2O3	15000	mg/kg		02/09/21 14:58	10	43	02/10/21 11:06	wjm	calculated
Manganese as MnO2	420	mg/kg		02/09/21 14:58	10	1.6	02/10/21 11:06	wjm	calculated
Nutrients - PIA									
Nitrate/Nitrite-N	0.41	mg/kg		02/10/21 14:21	1	0.20	02/10/21 14:21	CJP	EPA 353.2 REV 2
Total Kjeldahl Nitrogen (TKN)	330	mg/kg		02/08/21 08:02	1	50	02/11/21 11:06	CRS1	EPA 351.2 REV 2*
Total Metals - PIA									
Antimony	< 3.0	mg/kg		02/09/21 14:58	10	3.0	02/10/21 11:06	wjm	EPA 6020A
Arsenic	2.5	mg/kg	Q3	02/09/21 14:58	10	1.0	02/10/21 11:06	wjm	EPA 6020A
Barium	54	mg/kg		02/09/21 14:58	10	1.0	02/10/21 11:06	wjm	EPA 6020A
Beryllium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:32	KMC	EPA 6020A
Boron	< 10	mg/kg		02/09/21 14:58	10	10	02/10/21 13:32	KMC	EPA 6020A*
Cadmium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 11:06	wjm	EPA 6020A
Chromium	8.2	mg/kg		02/09/21 14:58	10	4.0	02/10/21 11:06	wjm	EPA 6020A
Cobalt	4.6	mg/kg		02/09/21 14:58	10	2.0	02/10/21 11:06	wjm	EPA 6020A
Iron	10000	mg/kg	Q4	02/09/21 14:58	10	30	02/10/21 11:06	wjm	EPA 6020A*
Lead	6.5	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:32	KMC	EPA 6020A
Manganese	260	mg/kg	Q4	02/09/21 14:58	10	1.0	02/10/21 11:06	wjm	EPA 6020A
Molybdenum	1.1	mg/kg		02/09/21 14:58	10	1.0	02/10/21 11:06	wjm	EPA 6020A
Selenium	< 1.0	mg/kg	Q3	02/09/21 14:58	10	1.0	02/10/21 11:06	wjm	EPA 6020A
Thallium	< 1.0	mg/kg		02/09/21 14:58	10	1.0	02/10/21 13:32	KMC	EPA 6020A
Mercury	< 0.20	mg/kg		02/09/21 14:58	10	0.20	02/10/21 13:32	KMC	EPA 6020A
Lithium	7.3	mg/kg		02/09/21 14:58	1	5.0	02/10/21 10:03	TJJ	EPA 6010B*
Sulfur	940	mg/kg		02/09/21 14:58	1	10	02/11/21 15:13	tjj	EPA 6010B*

NOTES

Specifications regarding method revisions and method modifications used for analysis are available upon request. Please contact your project manager.

* Not a TNI accredited analyte

Certifications

CHI - McHenry, IL - 4314-A W. Crystal Lake Road, McHenry, IL 60050
TNI Accreditation for Drinking Water and Wastewater Fields of Testing through IL EPA Accreditation No. 100279
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory Registry No. 17556

PIA - Peoria, IL - 2231 W. Altorfer Drive, Peoria, IL 61615
TNI Accreditation for Drinking Water, Wastewater, Solid and Hazardous Material Fields of Testing through IL EPA Accreditation No. 100230
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory Registry No. 17553
Drinking Water Certifications/Accreditations: Iowa (240); Kansas (E-10338); Missouri (870)
Wastewater Certifications/Accreditations: Arkansas (88-0677); Iowa (240); Kansas (E-10338)
Solid and Hazardous Material Certifications/Accreditations: Arkansas (88-0677); Iowa (240); Kansas (E-10338)

SPMO - Springfield, MO - 1805 W Sunset Street, Springfield, MO 65807
USEPA DMR-QA Program

STL - Hazelwood, MO - 944 Anglum Rd, Hazelwood, MO 63042
TNI Accreditation for Wastewater, Solid and Hazardous Material Fields of Testing through KS KDHE Certification No. E-10389
TNI Accreditation for Wastewater, Solid and Hazardous Material Fields of Testing through IL EPA Accreditation No. - 200080
Illinois Department of Public Health Bacterial Analysis in Drinking Water Approved Laboratory, Registry No. 171050
Missouri Department of Natural Resources - Certificate of Approval for Microbiological Laboratory Service - No. 1050

Qualifiers

Q2 Matrix Spike Duplicate failed % recovery acceptance limits. The associated blank spike recovery was acceptable.
Q3 Matrix Spike/Matrix Spike Duplicate both failed % recovery acceptance limits. The associated blank spike recovery was acceptable.
Q4 The matrix spike recovery result is unusable since the analyte concentration in the sample is greater than four times the spike level. The associated blank spike was acceptable.

Gail J Schindler

Certified by: Gail Schindler, Project Manager

Report Number
F21040-0043
Account Number
67045

a&lgreatlakes LABORATORIES
Scientists who don't mind getting dirty.™

3505 Conestoga Dr.
Fort Wayne, IN 46808
260.483.4759
algreatlakes.com

To: PDC LABORATORIES, INC.
2231 W ALTORFER DR
PEORIA, IL 61615-1807

For: EB01458

Attn: JANET CLUTTERS

REPORT OF ANALYSIS

Date Received: 02/09/2021
Date Reported: 02/17/2021

Lab Number	Sample ID	Analysis	Result	Unit	Method
20036	01	Cation Exchange Capacity (NH4-Sat.)	19.81	meq/100g	MSA Part 3 (1996) pp 1220-1221
20037	02	Cation Exchange Capacity (NH4-Sat.)	9.36	meq/100g	MSA Part 3 (1996) pp 1220-1221
20038	03	Cation Exchange Capacity (NH4-Sat.)	9.23	meq/100g	MSA Part 3 (1996) pp 1220-1221
20039	04	Cation Exchange Capacity (NH4-Sat.)	9.61	meq/100g	MSA Part 3 (1996) pp 1220-1221
20040	05	Cation Exchange Capacity (NH4-Sat.)	13.05	meq/100g	MSA Part 3 (1996) pp 1220-1221
20041	06	Cation Exchange Capacity (NH4-Sat.)	9.63	meq/100g	MSA Part 3 (1996) pp 1220-1221

Report reviewed and approved by our professional agronomy staff.

SOILMISC

eurofins | Environment Testing America

ANALYTICAL REPORT

Eurofins Lancaster Laboratories Env, LLC
2425 New Holland Pike
Lancaster, PA 17601
Tel: (717)656-2300

Laboratory Job ID: 410-28918-1
Client Project/Site: EB01458

For:
PDC Laboratories, Inc.
3278 N. HWY 67
Florissant, Missouri 63033

Attn: Amy Holmes

Marrissa Williams

Authorized for release by:
2/18/2021 8:12:16 AM

Marrissa Williams, Project Manager
(717)556-7246
Marrissa.Williams@eurofinset.com

LINKS

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The test results in this report meet all 2003 NELAC, 2009 TNI, and 2016 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Analytical test results meet all requirements of the associated regulatory program (e.g., NELAC (TNI), DoD, and ISO 17025) unless otherwise noted under the individual analysis. Data qualifiers are applied to note exceptions. Noncompliant quality control (QC) is further explained in narrative comments.
· QC results that exceed the upper limits and are associated with non-detect samples are qualified but further narration is not required since the bias is high and does not change a non-detect result. Further narration is also not required with QC blank detection when the associated sample concentration is non-detect or more than ten times the level in the blank.
· Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD is performed, unless otherwise specified in the method.
· Surrogate and/or isotope dilution analyte recoveries (if applicable) which are outside of the QC window are confirmed unless attributed to a dilution or otherwise noted in the narrative.
Regulated compliance samples (e.g. SDWA, NPDES) must comply with the associated agency requirements/permits.

Measurement uncertainty values, as applicable, are available upon request.

Test results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. Times are local to the area of activity. Parameters listed in the 40 CFR Part 136 Table II as "analyze immediately" and tested in the laboratory are not performed within 15 minutes of collection.

This report shall not be reproduced except in full, without the written approval of the laboratory.

WARRANTY AND LIMITS OF LIABILITY - In accepting analytical work, we warrant the accuracy of test results for the sample as submitted. The foregoing express warranty is exclusive and is given in lieu of all other warranties, expressed or implied, except as otherwise agreed. We disclaim any other warranties, expressed or implied, including a warranty of fitness for particular purpose and warranty of merchantability. In no event shall Eurofins Lancaster Laboratories Environmental, LLC be liable for indirect, special, consequential, or incidental damages including, but not limited to, damages for loss of profit or goodwill regardless of (A) the negligence (either sole or concurrent) of Eurofins Lancaster Laboratories Environmental and (B) whether Eurofins Lancaster Laboratories Environmental has been informed of the possibility of such damages. We accept no legal responsibility for the purposes for which the client uses the test results. Except as otherwise agreed, no purchase order or other order for work shall be accepted by Eurofins Lancaster Laboratories Environmental which includes any conditions that vary from the Standard Terms and Conditions, and Eurofins Lancaster Laboratories Environmental hereby objects to any conflicting terms contained in any acceptance or order submitted by client.

Marrissa Williams

Marrissa Williams
Project Manager
2/18/2021 8:12:16 AM

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Qualifiers

General Chemistry

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
1C	Result is from the primary column on a dual-column method.
2C	Result is from the confirmation column on a dual-column method.
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Case Narrative

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Job ID: 410-28918-1

Laboratory: Eurofins Lancaster Laboratories Env, LLC

Narrative

Job Narrative
410-28918-1

Receipt
The samples were received on 2/10/2021 8:26 AM. Unless otherwise noted below, the samples arrived in good condition, and, where required, properly preserved and on ice. The temperature of the cooler at receipt time was 0.0°C

General Chemistry
No additional analytical or quality issues were noted, other than those described above or in the Definitions/ Glossary page.

Detection Summary

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Client Sample ID: EB01458-01 — Lab Sample ID: 410-28918-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	1800		594	198	mg/Kg	1.98		Lloyd Kahn	Total/NA

Client Sample ID: EB01458-02 — Lab Sample ID: 410-28918-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	118	J	318	106	mg/Kg	1.06		Lloyd Kahn	Total/NA

Client Sample ID: EB01458-03 — Lab Sample ID: 410-28918-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	11500		1510	502	mg/Kg	5.02		Lloyd Kahn	Total/NA

Client Sample ID: EB01458-04 — Lab Sample ID: 410-28918-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	14800		3010	1000	mg/Kg	10.03		Lloyd Kahn	Total/NA

Client Sample ID: EB01458-05 — Lab Sample ID: 410-28918-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	563		309	103	mg/Kg	1.03		Lloyd Kahn	Total/NA

Client Sample ID: EB01458-06 — Lab Sample ID: 410-28918-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Total Organic Carbon	17100		1370	455	mg/Kg	4.55		Lloyd Kahn	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample Results

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Client Sample ID: EB01458-01

Lab Sample ID: 410-28918-1
Matrix: Solid

Date Collected: 02/01/21 14:00
Date Received: 02/10/21 08:26

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	1800		594	198	mg/Kg			02/12/21 15:42	1.98
Percent Moisture	17.3		1.0	1.0	%			02/10/21 12:04	1
Percent Solids	82.7		1.0	1.0	%			02/10/21 12:04	1

Client Sample ID: EB01458-02

Lab Sample ID: 410-28918-2
Matrix: Solid

Date Collected: 02/05/21 08:30
Date Received: 02/10/21 08:26

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	118	J	318	106	mg/Kg			02/17/21 12:58	1.06
Percent Moisture	15.0		1.0	1.0	%			02/10/21 12:04	1
Percent Solids	85.0		1.0	1.0	%			02/10/21 12:04	1

Client Sample ID: EB01458-03

Lab Sample ID: 410-28918-3
Matrix: Solid

Date Collected: 02/05/21 09:15
Date Received: 02/10/21 08:26

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	11500		1510	502	mg/Kg			02/16/21 18:26	5.02
Percent Moisture	13.5		1.0	1.0	%			02/10/21 12:04	1
Percent Solids	86.5		1.0	1.0	%			02/10/21 12:04	1

Client Sample ID: EB01458-04

Lab Sample ID: 410-28918-4
Matrix: Solid

Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	14800		3010	1000	mg/Kg			02/17/21 13:49	10.03
Percent Moisture	13.9		1.0	1.0	%			02/10/21 12:04	1
Percent Solids	86.1		1.0	1.0	%			02/10/21 12:04	1

Client Sample ID: EB01458-05

Lab Sample ID: 410-28918-5
Matrix: Solid

Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	563		309	103	mg/Kg			02/17/21 14:01	1.03
Percent Moisture	17.0		1.0	1.0	%			02/10/21 12:04	1
Percent Solids	83.0		1.0	1.0	%			02/10/21 12:04	1

Client Sample ID: EB01458-06

Lab Sample ID: 410-28918-6
Matrix: Solid

Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	17100		1370	455	mg/Kg			02/16/21 19:30	4.55
Percent Moisture	14.1		1.0	1.0	%			02/10/21 12:04	1

Client Sample Results

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Client Sample ID: EB01458-06
Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

Lab Sample ID: 410-28918-6
Matrix: Solid

General Chemistry (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	85.9		1.0	1.0	%			02/10/21 12:04	1

Method: Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: MB 410-94001/3
Matrix: Solid
Analysis Batch: 94001

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	ND		300	100	mg/Kg			02/12/21 15:04	1

Lab Sample ID: LCS 410-94001/4
Matrix: Solid
Analysis Batch: 94001

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	4300	3266		mg/Kg		76	47 - 143

Lab Sample ID: LCSD 410-94001/5
Matrix: Solid
Analysis Batch: 94001

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Total Organic Carbon	4300	3297		mg/Kg		77	47 - 143	1	20

Lab Sample ID: MB 410-95006/3
Matrix: Solid
Analysis Batch: 95006

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	ND		300	100	mg/Kg			02/16/21 16:45	1

Lab Sample ID: LCS 410-95006/4
Matrix: Solid
Analysis Batch: 95006

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	4300	2835		mg/Kg		66	47 - 143

Lab Sample ID: MB 410-95204/3
Matrix: Solid
Analysis Batch: 95204

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	ND		300	100	mg/Kg			02/17/21 12:33	1

Lab Sample ID: LCS 410-95204/4
Matrix: Solid
Analysis Batch: 95204

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	4300	3276		mg/Kg		76	47 - 143

QC Association Summary

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

General Chemistry

Analysis Batch: 92878

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-28918-1	EB01458-01	Total/NA	Solid	Moisture	
410-28918-2	EB01458-02	Total/NA	Solid	Moisture	
410-28918-3	EB01458-03	Total/NA	Solid	Moisture	
410-28918-4	EB01458-04	Total/NA	Solid	Moisture	
410-28918-5	EB01458-05	Total/NA	Solid	Moisture	
410-28918-6	EB01458-06	Total/NA	Solid	Moisture	

Analysis Batch: 94001

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-28918-1	EB01458-01	Total/NA	Solid	Lloyd Kahn	
410-28918-1	EB01458-01	Total/NA	Solid	Lloyd Kahn	
410-28918-1	EB01458-01	Total/NA	Solid	Lloyd Kahn	
410-28918-1	EB01458-01	Total/NA	Solid	Lloyd Kahn	
MB 410-94001/3	Method Blank	Total/NA	Solid	Lloyd Kahn	
LCS 410-94001/4	Lab Control Sample	Total/NA	Solid	Lloyd Kahn	
LCSD 410-94001/5	Lab Control Sample Dup	Total/NA	Solid	Lloyd Kahn	

Analysis Batch: 95006

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-28918-3	EB01458-03	Total/NA	Solid	Lloyd Kahn	
410-28918-6	EB01458-06	Total/NA	Solid	Lloyd Kahn	
MB 410-95006/3	Method Blank	Total/NA	Solid	Lloyd Kahn	
LCS 410-95006/4	Lab Control Sample	Total/NA	Solid	Lloyd Kahn	

Analysis Batch: 95204

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
410-28918-2	EB01458-02	Total/NA	Solid	Lloyd Kahn	
410-28918-2	EB01458-02	Total/NA	Solid	Lloyd Kahn	
410-28918-2	EB01458-02	Total/NA	Solid	Lloyd Kahn	
410-28918-2	EB01458-02	Total/NA	Solid	Lloyd Kahn	
410-28918-4	EB01458-04	Total/NA	Solid	Lloyd Kahn	
410-28918-5	EB01458-05	Total/NA	Solid	Lloyd Kahn	
MB 410-95204/3	Method Blank	Total/NA	Solid	Lloyd Kahn	
LCS 410-95204/4	Lab Control Sample	Total/NA	Solid	Lloyd Kahn	

Lab Chronicle

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Client Sample ID: EB01458-01

Lab Sample ID: 410-28918-1
Matrix: Solid

Date Collected: 02/01/21 14:00
Date Received: 02/10/21 08:26

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.98	94001	02/12/21 15:42	NKL9	ELLE
Total/NA	Analysis	Lloyd Kahn		1.97	94001	02/12/21 15:55	NKL9	ELLE
Total/NA	Analysis	Lloyd Kahn		1.96	94001	02/12/21 16:07	NKL9	ELLE
Total/NA	Analysis	Lloyd Kahn		1.97	94001	02/12/21 16:20	NKL9	ELLE
Total/NA	Analysis	Moisture		1	92878	02/10/21 12:04	UVJN	ELLE

Client Sample ID: EB01458-02

Lab Sample ID: 410-28918-2
Matrix: Solid

Date Collected: 02/05/21 08:30
Date Received: 02/10/21 08:26

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.06	95204	02/17/21 12:58	NKL9	ELLE
Total/NA	Analysis	Lloyd Kahn		1.05	95204	02/17/21 13:11	NKL9	ELLE
Total/NA	Analysis	Lloyd Kahn		1.06	95204	02/17/21 13:23	NKL9	ELLE
Total/NA	Analysis	Lloyd Kahn		1.06	95204	02/17/21 13:36	NKL9	ELLE
Total/NA	Analysis	Moisture		1	92878	02/10/21 12:04	UVJN	ELLE

Client Sample ID: EB01458-03

Lab Sample ID: 410-28918-3
Matrix: Solid

Date Collected: 02/05/21 09:15
Date Received: 02/10/21 08:26

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		5.02	95006	02/16/21 18:26	NKL9	ELLE
Total/NA	Analysis	Moisture		1	92878	02/10/21 12:04	UVJN	ELLE

Client Sample ID: EB01458-04

Lab Sample ID: 410-28918-4
Matrix: Solid

Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		10.03	95204	02/17/21 13:49	NKL9	ELLE
Total/NA	Analysis	Moisture		1	92878	02/10/21 12:04	UVJN	ELLE

Client Sample ID: EB01458-05

Lab Sample ID: 410-28918-5
Matrix: Solid

Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		1.03	95204	02/17/21 14:01	NKL9	ELLE
Total/NA	Analysis	Moisture		1	92878	02/10/21 12:04	UVJN	ELLE

Lab Chronicle

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Client Sample ID: EB01458-06

Date Collected: 02/05/21 11:45
Date Received: 02/10/21 08:26

Lab Sample ID: 410-28918-6

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Lloyd Kahn		4.55	95006	02/16/21 19:30	NKL9	ELLE
Total/NA	Analysis	Moisture		1	92878	02/10/21 12:04	UVJN	ELLE

Laboratory References:

ELLE = Eurofins Lancaster Laboratories Env, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Accreditation/Certification Summary

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Laboratory: Eurofins Lancaster Laboratories Env, LLC

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Illinois	NELAP	004559	01-31-22

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
Lloyd Kahn		Solid	Total Organic Carbon
Moisture		Solid	Percent Moisture
Moisture		Solid	Percent Solids

Missouri	State	450	01-31-22

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
Lloyd Kahn		Solid	Total Organic Carbon
Moisture		Solid	Percent Moisture
Moisture		Solid	Percent Solids

Method Summary

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Method	Method Description	Protocol	Laboratory
Lloyd Kahn	Organic Carbon, Total (TOC)	EPA	ELLE
Moisture	Percent Moisture	EPA	ELLE

Protocol References:

EPA = US Environmental Protection Agency

Laboratory References:

ELLE = Eurofins Lancaster Laboratories Env, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

Sample Summary

Client: PDC Laboratories, Inc.
Project/Site: EB01458

Job ID: 410-28918-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
410-28918-1	EB01458-01	Solid	02/01/21 14:00	02/10/21 08:26	
410-28918-2	EB01458-02	Solid	02/05/21 08:30	02/10/21 08:26	
410-28918-3	EB01458-03	Solid	02/05/21 09:15	02/10/21 08:26	
410-28918-4	EB01458-04	Solid	02/05/21 11:45	02/10/21 08:26	
410-28918-5	EB01458-05	Solid	02/05/21 11:45	02/10/21 08:26	
410-28918-6	EB01458-06	Solid	02/05/21 11:45	02/10/21 08:26	

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB01458

410-28918 Chain of Custody

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Eurofins Eaton Analytical, Inc. - Lancaster, PA
2425 New Holland Pike
Lancaster, PA 17601
(717) 656-2300

Sample: EB01458-01
Name: G289-S4 (COFFEEN GMF)
Sampled: 02/01/21 14:00
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/16/21 16:00	03/01/21 14:00	

Sample: EB01458-02
Name: G311D-S1 (COFFEEN AP1)
Sampled: 02/05/21 08:30
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/16/21 16:00	03/05/21 08:30	

Sample: EB01458-03
Name: G311D-S2 (COFFEEN AP1)
Sampled: 02/05/21 09:15
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/16/21 16:00	03/05/21 09:15	

Sample: EB01458-04
Name: G311D-S3 (COFFEEN AP1)
Sampled: 02/05/21 11:45
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/16/21 16:00	03/05/21 11:45	

Sample: EB01458-05
Name: G311D-S4 (COFFEEN AP1)
Sampled: 02/05/21 11:45
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/16/21 16:00	03/05/21 11:45	

JR

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB01458

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Eurofins Eaton Analytical, Inc. - Lancaster, PA
2425 New Holland Pike
Lancaster, PA 17601
(717) 656-2300

Sample: EB01458-06
Name: G311D-S2 (COFFEEN AP1) DUPCLIAT

Sampled: 02/05/21 11:45
Matrix: Soil
Preservative: H2SO4, cool <6

Analysis	Due	Expires	Comments
01-TOC-STL	02/16/21 16:00	03/05/21 11:45	MS/MSD

Please email results to Gail Schindler at gschindler@pdclab.com

Date Shipped: 2/8/21 Total # of Containers: 6 Sample Origin (State): IL PO #: 11506

Turn-Around Time Requested ☒ NORMAL ☐ RUSH Date Results Needed: _____

Relinquished By	Date/Time	Received By	Date/Time
[signature]	2/8/21 1330		
		Julissa R	2/10/21 08:26

Sample Temperature Upon Receipt	____ °C
Sample(s) Received on Ice	Y or N
Proper Bottles Received in Good Condition	Y or N
Bottles Filled with Adequate Volume	Y or N
Samples Received Within Hold Time	Y or N
Date/Time Taken From Sample Bottle	Y or N

Login Sample Receipt Checklist

Client: PDC Laboratories, Inc.

Job Number: 410-28918-1

Login Number: 28918
List Number: 1
Creator: Rivera-Santa, Julissa

List Source: Eurofins Lancaster Laboratories Env

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal is intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable (</=6C, not frozen).	True	
Cooler Temperature is recorded.	True	
WV: Container Temperature is acceptable (</=6C, not frozen).	N/A	
WV: Container Temperature is recorded.	N/A	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses.	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	N/A	
Is the Field Sampler's name present on COC?	False	Received project as a subcontract.
Sample Preservation Verified.	N/A	
Residual Chlorine Checked.	N/A	
Sample custody seals are intact.	N/A	

ANALYTICAL REPORT

February 26, 2021

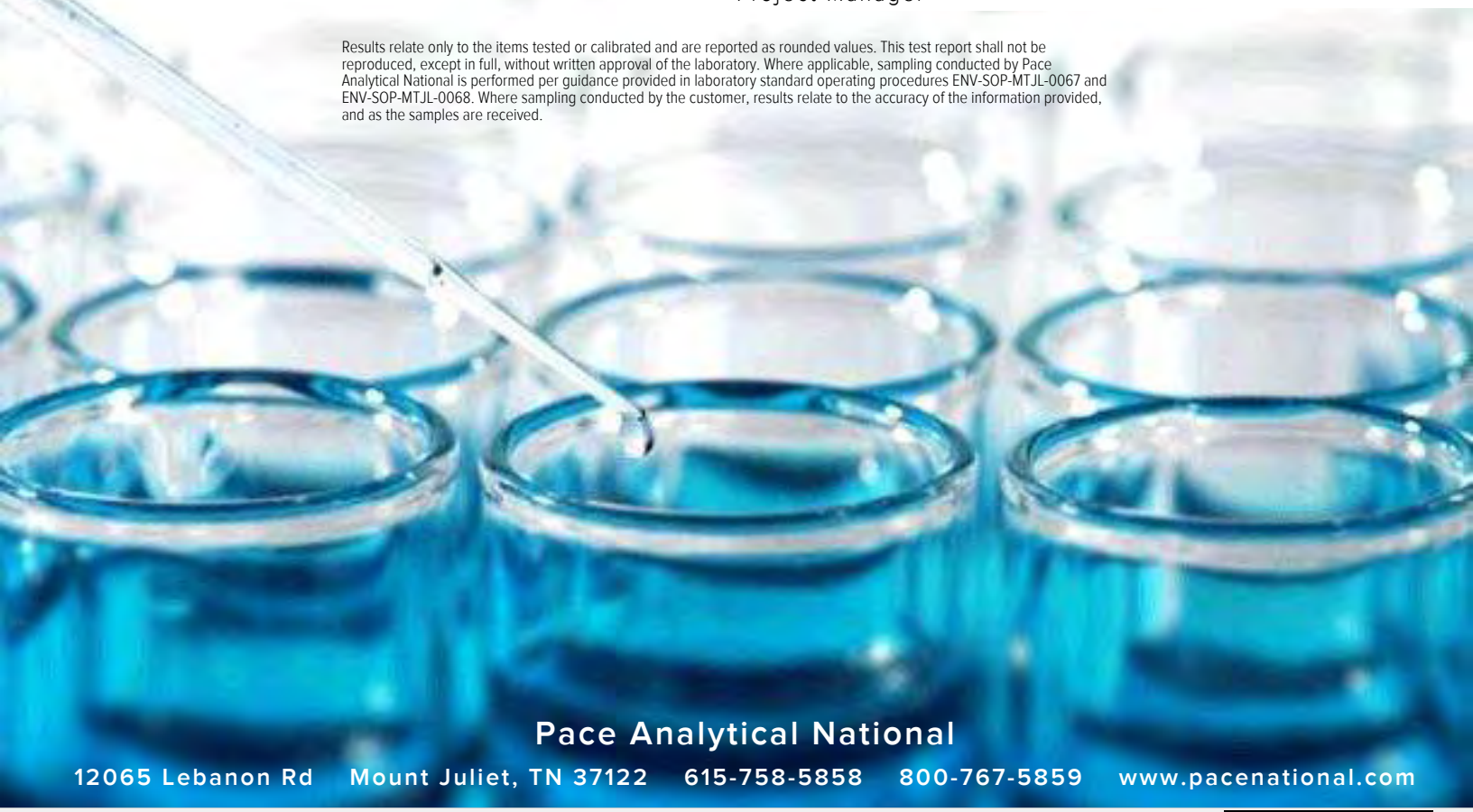
PDC Laboratory, Inc.

Sample Delivery Group:	L1316169
Samples Received:	02/11/2021
Project Number:	EB01458
Description:	
Report To:	Gail Schindler 2231 W. Altorfer Drive Peoria, IL 61615

Entire Report Reviewed By:

Mark W. Beasley
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace Analytical National is performed per guidance provided in laboratory standard operating procedures ENV-SOP-MTJL-0067 and ENV-SOP-MTJL-0068. Where sampling conducted by the customer, results relate to the accuracy of the information provided, and as the samples are received.



Pace Analytical National
12065 Lebanon Rd Mount Juliet, TN 37122 615-758-5858 800-767-5859 www.pacenational.com

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EB01458-01 L1316169-01 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/01/21 14:00	02/11/21 10:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1620727	1	02/19/21 08:35	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1622719	1	02/20/21 08:10	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1622719	1	02/20/21 08:10	02/22/21 14:02	RGT	Mt. Juliet, TN

EB01458-02 L1316169-02 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/05/21 08:30	02/11/21 10:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1620727	1	02/19/21 08:35	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1622719	1	02/20/21 08:10	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1622719	1	02/20/21 08:10	02/22/21 14:02	RGT	Mt. Juliet, TN

EB01458-03 L1316169-03 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/05/21 09:15	02/11/21 10:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1620727	1	02/19/21 08:35	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1622719	1	02/20/21 08:10	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1622719	1	02/20/21 08:10	02/22/21 14:02	RGT	Mt. Juliet, TN

EB01458-04 L1316169-04 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/05/21 11:45	02/11/21 10:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1620727	1	02/19/21 08:35	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1622719	1	02/20/21 08:10	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1622719	1	02/20/21 08:10	02/22/21 14:02	RGT	Mt. Juliet, TN

EB01458-05 L1316169-05 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/05/21 11:45	02/11/21 10:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1620727	1	02/19/21 08:35	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1622719	1	02/20/21 08:10	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1622719	1	02/20/21 08:10	02/22/21 14:02	RGT	Mt. Juliet, TN

EB01458-06 L1316169-06 Solids and Chemical Materials

Collected by	Collected date/time	Received date/time
	02/05/21 11:45	02/11/21 10:15

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 9320	WG1620727	1	02/19/21 08:35	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1622719	1	02/20/21 08:10	02/24/21 09:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1622719	1	02/20/21 08:10	02/22/21 14:02	RGT	Mt. Juliet, TN

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Project Manager

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.195	U	0.251	0.451	02/24/2021 09:05	WG1620727
(T) Barium	*98.2*			*62.0-143*	*02/24/2021 09:05*	WG1620727
(T) Yttrium	*105*			*79.0-136*	*02/24/2021 09:05*	WG1620727

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.725		0.382	0.512	02/24/2021 09:05	WG1622719

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.529		0.131	0.0612	02/22/2021 14:02	WG1622719
(T) Barium-133	*99.4*			*30.0-143*	*02/22/2021 14:02*	WG1622719

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.278	J	0.223	0.399	02/24/2021 09:05	WG1620727
(T) Barium	*106*			*62.0-143*	*02/24/2021 09:05*	WG1620727
(T) Yttrium	*105*			*79.0-136*	*02/24/2021 09:05*	WG1620727

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.06		0.399	0.474	02/24/2021 09:05	WG1622719

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.780		0.176	0.0752	02/22/2021 14:02	WG1622719
(T) Barium-133	*94.3*			*30.0-143*	*02/22/2021 14:02*	WG1622719

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.281	J	0.238	0.425	02/24/2021 09:05	WG1620727
(T) Barium	*107*			*62.0-143*	*02/24/2021 09:05*	WG1620727
(T) Yttrium	*110*			*79.0-136*	*02/24/2021 09:05*	WG1620727

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.02		0.401	0.482	02/24/2021 09:05	WG1622719

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.742		0.163	0.0569	02/22/2021 14:02	WG1622719
(T) Barium-133	*94.3*			*30.0-143*	*02/22/2021 14:02*	WG1622719

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.621		0.240	0.42	02/24/2021 09:05	WG1620727
(T) Barium	*101*			*62.0-143*	*02/24/2021 09:05*	WG1620727
(T) Yttrium	*107*			*79.0-136*	*02/24/2021 09:05*	WG1620727

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.31		0.410	0.489	02/24/2021 09:05	WG1622719

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.693		0.170	0.0694	02/22/2021 14:02	WG1622719
(T) Barium-133	*93.4*			*30.0-143*	*02/22/2021 14:02*	WG1622719

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.946		0.213	0.359	02/24/2021 09:05	WG1620727
(T) Barium	*111*			*62.0-143*	*02/24/2021 09:05*	WG1620727
(T) Yttrium	*100*			*79.0-136*	*02/24/2021 09:05*	WG1620727

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	1.46		0.356	0.441	02/24/2021 09:05	WG1622719

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.518		0.143	0.0824	02/22/2021 14:02	WG1622719
(T) Barium-133	*93.9*			*30.0-143*	*02/22/2021 14:02*	WG1622719

Radiochemistry by Method 9320

Analyte	Result pCi/l	Qualifier	Uncertainty + / -	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	-0.410	U	0.198	0.372	02/24/2021 09:05	WG1620727
(T) Barium	*105*			*62.0-143*	*02/24/2021 09:05*	WG1620727
(T) Yttrium	*111*			*79.0-136*	*02/24/2021 09:05*	WG1620727

Radiochemistry by Method Calculation

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
Combined Radium	0.429		0.328	0.425	02/24/2021 09:05	WG1622719

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/g	Qualifier	Uncertainty + / -	MDA pCi/g	Analysis Date date / time	Batch
RADIUM-226	0.429		0.130	0.0532	02/22/2021 14:02	WG1622719
(T) Barium-133	*91.6*			*30.0-143*	*02/22/2021 14:02*	WG1622719

Method Blank (MB)

(MB) R3625131-1 02/24/21 09:05

Analyte	MB Result pCi/l	MB Qualifier	MB MDA pCi/l
Radium-228	0.356	J	0.400
(T) Barium	*110*		
(T) Yttrium	*107*		

L1316169-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1316169-01 02/24/21 09:05 • (DUP) R3625131-11 02/24/21 09:05

Analyte	Original Result pCi/l	DUP Result pCi/l	Dilution	DUP RPD %	DUP RER	DUP Qualifier	DUP RPD Limits %	DUP RER Limit
Radium-228	0.195	0.301	1	42.8	0.306	J	20	3
(T) Barium	*98.2*	*107*						
(T) Yttrium	*105*	*98.5*						

Laboratory Control Sample (LCS)

(LCS) R3625131-2 02/24/21 09:05

Analyte	Spike Amount pCi/l	LCS Result pCi/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-228	5.00	5.05	101	80.0-120	
(T) Barium			*101*		
(T) Yttrium			*103*		

L1316169-06 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316169-06 02/24/21 09:05 • (MS) R3625131-3 02/24/21 09:05 • (MSD) R3625131-7 02/24/21 09:05

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.87	-0.410	5.39	5.09	111	104	1	70.0-130			5.79		20
(T) Barium		*105*			*110*	*105*							
(T) Yttrium		*111*			*103*	*101*							

L1316174-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316174-04 02/24/21 09:05 • (MS) R3625131-4 02/24/21 09:05 • (MSD) R3625131-8 02/24/21 09:05

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.87	0.901	6.01	6.36	105	112	1	70.0-130			5.59		20
(T) Barium		*90.2*			*103*	*111*							

L1316174-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316174-04 02/24/21 09:05 • (MS) R3625131-4 02/24/21 09:05 • (MSD) R3625131-8 02/24/21 09:05

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
(T) Yttrium		*119*			*106*	*104*							

Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) • (MS) R3625131-5 02/24/21 09:05 • (MSD) R3625131-9 02/24/21 09:05

Analyte	Spike Amount pCi/l	Original Result	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.87		6.00	6.45	110	119	1	70.0-130			7.19		20
(T) Barium					*105*	*108*							
(T) Yttrium					*98.5*	*107*							

L1316185-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316185-01 02/24/21 09:05 • (MS) R3625131-6 02/24/21 09:05 • (MSD) R3625131-10 02/24/21 09:05

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	4.87	0.00928	5.75	6.00	118	123	1	70.0-130			4.24		20
(T) Barium		*97.1*			*106*	*100*							
(T) Yttrium		*114*			*102*	*101*							

Method Blank (MB)

(MB) R3624208-1 02/22/21 14:02

Analyte	MB Result pCi/g	MB Qualifier	MB MDA pCi/g
Radium-226	0.0917		0.0774
(T) Barium-133	*82.3*		

Laboratory Control Sample (LCS)

(LCS) R3624208-2 02/22/21 14:02

Analyte	Spike Amount pCi/g	LCS Result pCi/g	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-226	5.02	4.76	94.9	60.0-144	
(T) Barium-133			*99.1*		

L1316169-06 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316169-06 02/22/21 14:02 • (MS) R3624208-3 02/22/21 14:02 • (MSD) R3624208-4 02/22/21 14:02

Analyte	Spike Amount pCi/g	Original Result pCi/g	MS Result pCi/g	MSD Result pCi/g	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	5.01	0.429	5.46	5.71	100	106	1	65.0-135			4.42		20
(T) Barium-133		*91.6*			*96.0*	*99.0*							

L1316174-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316174-04 02/22/21 14:10 • (MS) R3624208-5 02/22/21 14:10 • (MSD) R3624208-6 02/22/21 14:10

Analyte	Spike Amount pCi/g	Original Result pCi/g	MS Result pCi/g	MSD Result pCi/g	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	4.96	0.347	5.84	5.17	111	97.1	1	65.0-135			12.2		20
(T) Barium-133		*91.4*			*93.8*	*101*							

L1316179-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1316179-02 02/22/21 14:10 • (MS) R3624208-7 02/22/21 14:10 • (MSD) R3624208-8 02/22/21 14:10

Analyte	Spike Amount pCi/g	Original Result pCi/g	MS Result pCi/g	MSD Result pCi/g	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	4.98	0.584	4.89	4.95	86.4	87.9	1	65.0-135			1.32		20
(T) Barium-133		*102*			*100*	*98.2*							

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Results Disclaimer - Information that may be provided by the customer, and contained within this report, include Permit Limits, Project Name, Sample ID, Sample Matrix, Sample Preservation, Field Blanks, Field Spikes, Field Duplicates, On-Site Data, Sampling Collection Dates/Times, and Sampling Location. Results relate to the accuracy of this information provided, and as the samples are received.

Abbreviations and Definitions

MDA	Minimum Detectable Activity.
Rec.	Recovery.
RER	Replicate Error Ratio.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(T)	Tracer - A radioisotope of known concentration added to a solution of chemically equivalent radioisotopes at a known concentration to assist in monitoring the yield of the chemical separation.
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.
U	Below Detectable Limits: Indicates that the analyte was not detected.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

Pace Analytical National 12065 Lebanon Rd Mount Juliet, TN, 37122

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN000032021-1
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	TN00003
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	KY90010	South Carolina	84004002
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana	LA018	Texas	T104704245-20-18
Maine	TN00003	Texas [5]	LAB0152
Maryland	324	Utah	TN000032021-11
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	110033
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	998093910
Montana	CERT0086	Wyoming	A2LA
A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

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Alabama	40160
ANSI National Accreditation Board	L2239

Pace Analytical National 660 Bercut Dr. Ste. C Sacramento, CA, 95811

California	2961	Oregon	CA300002
Minnesota	006-999-465	Washington	C926
North Dakota	R-214		

Pace Analytical National 6000 South Eastern Avenue Ste 9A Las Vegas, NV, 89119

Nevada	NV009412021-1

Pace Analytical National 1606 E. Brazos Street Suite D Victoria, TX, 77901

Texas	T104704328-20-18

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

H212

EB01458

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Pace Analytical - Mt Juliet, Tn
12065 Lebanon Rd
Mt Juliet, TN 37122
(615) 758-5858

Sample: EB01458-01
Name: G289-S4 (COFFEEN GMF)

Sampled: 02/01/21 14:00 136169-01
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/16/21 16:00	07/31/21 14:00	

Sample: EB01458-02
Name: G311D-S1 (COFFEEN AP1)

Sampled: 02/05/21 08:30 02
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/16/21 16:00	08/04/21 08:30	

Sample: EB01458-03
Name: G311D-S2 (COFFEEN AP1)

Sampled: 02/05/21 09:15 03
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/16/21 16:00	08/04/21 09:15	04

Sample: EB01458-04
Name: G311D-S3 (COFFEEN AP1)

Sampled: 02/05/21 11:45 04
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/16/21 16:00	08/04/21 11:45	

Sample: EB01458-05
Name: G311D-S4 (COFFEEN AP1)

Sampled: 02/05/21 11:45 05
Matrix: Soil
Preservative: Cool <6

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/16/21 16:00	08/04/21 11:45	

SUBCONTRACT ORDER
Transfer Chain of Custody

PDC Laboratories, Inc.

EB01458

SENDING LABORATORY

PDC Laboratories, Inc.
2231 W Altorfer Dr
Peoria, IL 61615
(800) 752-6651

RECEIVING LABORATORY

Pace Analytical - Mt Juliet, Tn
12065 Lebanon Rd
Mt Juliet, TN 37122
(615) 758-5858

Sample: EB01458-06
Name: G311D-S2 (COFFEEN AP1) DUPCLIAT

Sampled: 02/05/21 11:45
Matrix: Soil
Preservative: Cool <6

B161169-06

Analysis	Due	Expires	Comments
01-Radium 226/228 combined	02/16/21 16:00	08/04/21 11:45	MS/MSD

6 total

Sample Receipt Checklist

COC Seal Present/Intact:	Y ✗ N	If Applicable	
COC Signed/Accurate:	✓ Y __ N	VOA Zero Headspace:	__ Y __ N
Bottles arrive intact:	✓ Y __ N	Pres.Correct/Check:	__ Y __ N
Correct bottles used:	✓ Y __ N		
Sufficient volume sent:	✓ Y __ N		
RAD Screen <0.5 mR/hr:	✗ Y N		

All Cont <500 CPM

MPH 5.6.3=5.3

Please email results to Gail Schindler at gschindler@pdclab.com

Date Shipped: 2-9-21 Total # of Containers: 6 Sample Origin (State): IL PO #: 11508

Turn-Around Time Requested ☑ NORMAL ☐ RUSH Date Results Needed: _____

Relinquished By	Date/Time	Received By	Date/Time
[signature]	2-9-21 13:00		
		MPapp	2-11-21 1015

Sample Temperature Upon Receipt	____ °C
Sample(s) Received on Ice	Y or N
Proper Bottles Received in Good Condition	Y or N
Bottles Filled with Adequate Volume	Y or N
Samples Received Within Hold Time	Y or N
Date/Time Taken From Sample Bottle	Y or N

PDC LABORATORIES, INC.
WWW.PDCLAB.COM

REGULATORY PROGRAM (CIRCLE):	NPDES
MORBCA	RCRA
CCDD	TACO: RES OR IND/COMM

CHAIN OF CUSTODY RECORD

STATE WHERE SAMPLE COLLECTED IL

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

1 CLIENT: HANSON PROFESSIONAL SERVICES
PROJECT NUMBER: COFFEEN GMF
PROJECT LOCATION:
PURCHASE ORDER #:
ADDRESS: 1525 S 6TH STREET
PHONE NUMBER:
E-MAIL: AND ASH POND #1
DATE SHIPPED:
CITY / STATE / ZIP: SPRINGFIELD IL 62703-6801
SAMPLER (PLEASE PRINT): COLIN WINTER
CONTACT PERSON: MR RHON HASENYAGER
SAMPLER'S SIGNATURE:

MATRIX TYPES:
WW- WASTEWATER
DW- DRINKING WATER
GW- GROUND WATER
WWSL- SLUDGE
NAS- NON AQUEOUS SOLID
LCHT-LEACHATE
OIL-OIL
SO-SOIL
SOL-SOLID

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN # EB01458-06
LOGGED BY: DW
CLIENT: HANSON PROFESSIONAL SERVICES
PROJECT: HANSON VISTRA COFFEEN GMF SOIL — AND ASH POND #1
PRJ. MGR.: GJ SCHINDLER

2 SAMPLE DESCRIPTION (UNIQUE DESCRIPTION AS IT WILL APPEAR ON THE ANALYTICAL REPORT)	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP	MATRIX TYPE	BOTTLE COUNT	PRES CODE (CLIENT PROVIDED)	SB, AS, BA, BE, B, CD, CA, CR,	CO, FE, PB, LI, MG, MN, MO, K	SE, NA, S, TL, CL, F, SO4, TN	FE OXIDE, MN OXIDE	RAD 226/228	TOC	CEC	REMARKS
G289-S4 (COFFEEN GMF)	2/1/21	2-3PM		X	SO	See Jars									
G311D-S1 (" " API)	2/5/21	8:30-9		X		3									
G311D-S2 (" " API)	2/5/21	9-11:15		X		3									
G311D-S3 (" " API)	2/5/21	11:15-11:45		X		3									
G311D-S4 (" ")	2/5/21	11:45-12:15		X		3									
G311D-S2 (MS/MSD + FIELD DUP) (" ")	2/5/21	9-11:15		X		3									
G311D-S21 EQUIP BLANK (" ")	2/5/21	11AM	X		N/A										

CHEMICAL PRESERVATION CODES: 1 – HCL | 2 – H2SO4 | 3 – HNO3 | 4 – NAOH | 5 – NA2S2O3 | 6 – UNPRESERVED | 7 – OTHER

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
RUSH RESULTS VIA (PLEASE CIRCLE) EMAIL PHONE
DATE RESULTS NEEDED:
EMAIL IF DIFFERENT FROM ABOVE:
PHONE # IF DIFFERENT FROM ABOVE:

6 *I understand that by initialing this box I give the lab permission to proceed with analysis, even though it may not meet all sample conformance requirements as defined in the receiving facility's Sample Acceptance Policy and the data will be qualified. Qualified data may NOT be acceptable to report to all regulatory authorities.*
PROCEED WITH ANALYSIS AND QUALIFY RESULTS: (INITIALS) _____

7

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME
	2/5/21 12:40 PM		2-5-21 12:40 ~~12:30~~
RELINQUISHED BY: (SIGNATURE)	2-5-21 16:00	RECEIVED BY: (SIGNATURE)	
RELINQUISHED BY: (SIGNATURE)		RECEIVED BY: (SIGNATURE)	2/5/21 1600

8 COMMENTS: (FOR LAB USE ONLY)
SAMPLE TEMPERATURE UPON RECEIPT 6.9 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
SAMPLE ACCEPTANCE NONCONFORMANT REPORT IS NEEDED Y OR N
DATE AND TIME TAKEN FROM SAMPLE BOTTLE _____

Attachment F
X-Ray Fluorescence Analytical Data

ANALYSIS REPORT BBM23-31378

To F400101 SGS CANADA INC
LISA THOMPSON
185 Concession Street
Lakefield K0L 2H0
ON
CANADA

Order Number	PO#	Date Received	23-Aug-2023
Submission Number	CA19113-JUL23 / 6 Pulp	Date Analysed	30-Aug-2023 - 06-Sep-2023
Number of Samples	6	Date Completed	09-Sep-2023
		SGS Order Number	BBM23-31378

Methods Summary

Number of Sample	Method Code	Description
6	G_PHY01V	Loss on ignition (LOI), Furnace, variable wt, variable temp
6	GO_XRF72	Borate Fusion, XRF, Ore Grade

Comments

Preparation of samples was performed at the SGS Lakefield site.
Analysis of samples was performed at the SGS Burnaby site.

Authorised Signatory

John Chiang
Laboratory Operations Manager

SCC Accredited LAB
LAB Accrédité CCN

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WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativeness of any goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted. The findings report on the samples provided by the client and are not intended for commercial or contractual settlement purposes.

- not analysed | -- element not determined | I.S. insufficient sample | L.N.R. listed not received

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Order Number PO#
Submission Number CA19113-JUL23 / 6 Pulp
Number of Samples 6

ANALYSIS REPORT BBM23-31378

Element	LOI	@Al2O3	@CaO	@Cr2O3	@Fe2O3	@K2O
Method	G_PHY01V	GO_XRF72	GO_XRF72	GO_XRF72	GO_XRF72	GO_XRF72
Lower Limit	-10	0.01	0.01	0.01	0.01	0.01
Upper Limit	100	100	60	5	100	70
Unit	%	%	%	%	%	%
COF1-13-18-20230619	12.4300	8.36	6.73	<0.01	3.19	1.88
COF1-18-23-20230619	12.3300	8.41	6.72	0.02	3.48	1.88
COF1-38-43-20230619	12.3000	8.35	6.69	0.02	3.71	1.89
COF2-10-13-20230619	2.53949	6.73	0.52	0.01	2.08	2.01
COF3-11-12-20230619	3.75000	8.14	1.04	<0.01	2.77	2.42
COF3-12.5-13-20230619	11.9572	4.92	9.10	<0.01	1.69	1.59
*Std OREAS 70b	6.78796	-	-	-	-	-
*Std OREAS 70b	-	7.12	4.28	0.18	7.95	0.71
*Blk BLANK	-	<0.01	<0.01	<0.01	<0.01	<0.01
*Std OREAS 751	-	15.87	1.04	<0.01	2.40	2.89

Element	@MgO	Mn3O4	@Na2O	@P2O5	@SiO2	@TiO2
Method	GO_XRF72	GO_XRF72	GO_XRF72	GO_XRF72	GO_XRF72	GO_XRF72
Lower Limit	0.01	0.01	0.01	0.01	0.01	0.01
Upper Limit	100	100	60	55	100	100
Unit	%	%	%	%	%	%
COF1-13-18-20230619	3.71	0.07	0.79	0.07	62.07	0.49
COF1-18-23-20230619	3.66	0.07	0.80	0.08	61.80	0.50
COF1-38-43-20230619	3.62	0.07	0.77	0.08	61.72	0.50
COF2-10-13-20230619	0.54	0.03	0.82	0.06	84.59	0.36
COF3-11-12-20230619	0.77	0.13	0.85	0.06	80.21	0.40
COF3-12.5-13-20230619	4.44	0.08	0.69	0.05	64.55	0.26
*Std OREAS 70b	22.38	0.16	1.04	0.05	48.48	0.30
*Blk BLANK	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
*Std OREAS 751	0.50	0.10	3.40	0.27	71.34	0.24

- not analysed | -- element not determined | I.S. insufficient sample | L.N.R. listed not received

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Order Number	PO#
Submission Number	CA19113-JUL23 / 6 Pulp
Number of Samples	6

ANALYSIS REPORT BBM23-31378

Element	@V2O5	Sum
Method	GO_XRF72	GO_XRF72
Lower Limit	0.01	0.01
Upper Limit	10	100
Unit	%	%
COF1-13-18-20230619	0.01	87.60
COF1-18-23-20230619	<0.01	87.86
COF1-38-43-20230619	0.01	87.81
COF2-10-13-20230619	<0.01	97.81
COF3-11-12-20230619	0.01	96.90
COF3-12.5-13-20230619	<0.01	87.45
*Std OREAS 70b	0.01	93.40
*Blk BLANK	<0.01	0.03
*Std OREAS 751	<0.01	98.27

SGS Canada Minerals Burnaby conforms to the requirements of ISO/IEC17025 for specific tests as listed on their scope of accreditation found at https://www.scc.ca/en/search/laboratories/sgs
Tests and Elements marked with an "@" symbol in the report denote ISO/IEC17025 accreditation.

- not analysed | -- element not determined | I.S. insufficient sample | L.N.R. listed not received

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Attachment G

X-Ray Diffraction Analytical Data

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Environmental Services*
Project Number/ LIMS No.	*Custom XRD/MI4544-MAY21*
Sample Receipt:	*May 27, 2021*
Sample Analysis:	*May 31, 2021*
Reporting Date:	*June 17, 2021*

Instrument:	BRUKER AXS D8 Advance Diffractometer
Test Conditions:	Co radiation, 35 kV, 40 mA Regular Scanning: Step: 0.02°, Step time: 1s, 2θ range: 3-80°
Interpretations :	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

Kim Gibbs, H.B.Sc., P.Geo.
Senior Mineralogist

Huyun Zhou, Ph.D., P.Geo.
Senior Mineralogist

ACCREDITATION: SGS Minerals Services Lakefield is accredited to the requirements of ISO/IEC 17025 for specific tests as listed on our scope of accreditation, including geochemical, mineralogical and trade mineral tests. To view a list of the accredited methods, please visit the following website and search SGS Canada - Minerals Services - Lakefield: http://palcan.scc.ca/SpecsSearch/GLSearchForm.do.

Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Minerals Services is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativeness of any goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted.

Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	G1001-(6-11) MAY4544-01 (wt %)	401B-(16-20) MAY4544-02 (wt %)	270A-(12-16) MAY4544-03 (wt %)
Quartz	46.3	68.9	60.6
Muscovite	10.3	6.8	9.0
Biotite	2.4	2.1	2.4
Microcline	7.8	7.8	9.8
Albite	10.4	8.6	9.1
Calcite	4.2	-	-
Dolomite	11.3	-	0.6
Ankerite	1.5	0.1	0.5
Chlorite	1.5	-	1.4
Pyrite	0.1	-	0.2
Stilpnomelane	2.6	2.7	2.0
Diopside	0.8	1.4	1.3
Actinolite	0.9	1.4	3.3
TOTAL	100	100	100

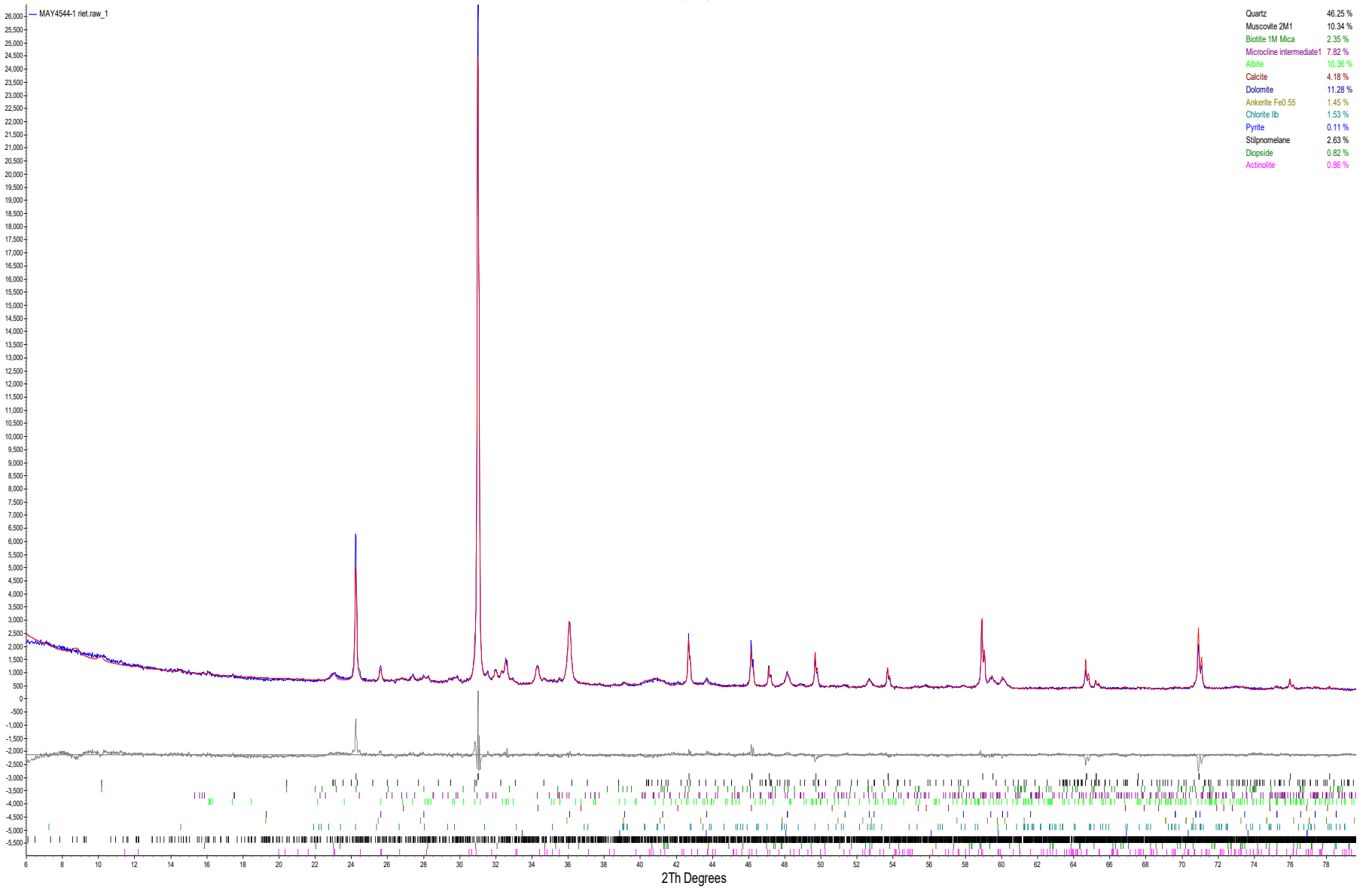
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

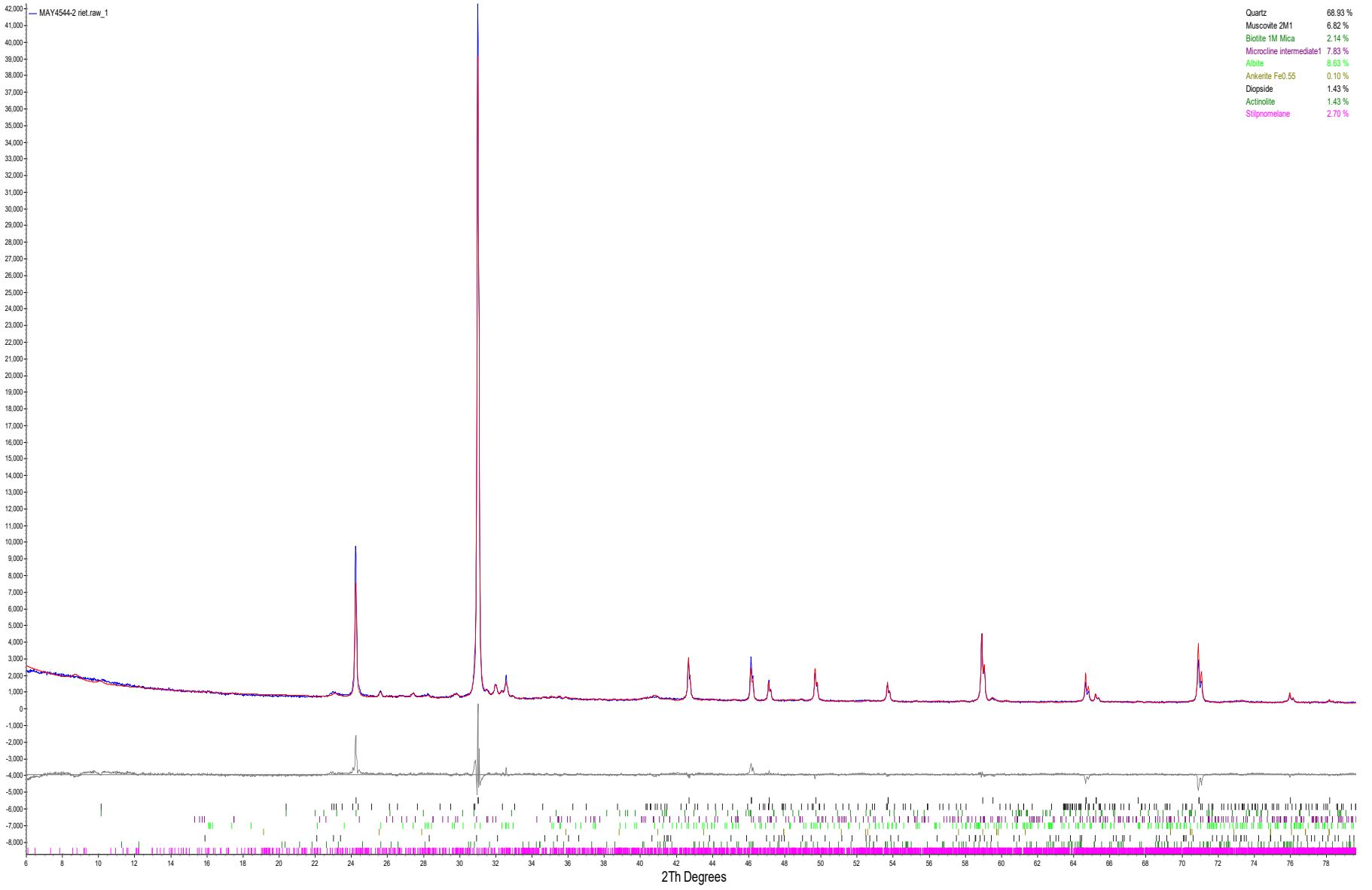
Mineral/Compound	Formula
Quartz	SiO_2
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$
Microcline	$KAlSi_3O_8$
Albite	$NaAlSi_3O_8$
Calcite	$CaCO_3$
Dolomite	$CaMg(CO_3)_2$
Ankerite	$CaFe(CO_3)_2$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Pyrite	FeS_2
Stilpnomelane	$K(Fe^{2+},Mg,Fe^{3+})_8(Si,Al)_{12}(O,OH)_{27}\cdot n(H_2O)$
Diopside	$CaMgSi_2O_6$
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

G1001-(6-11)



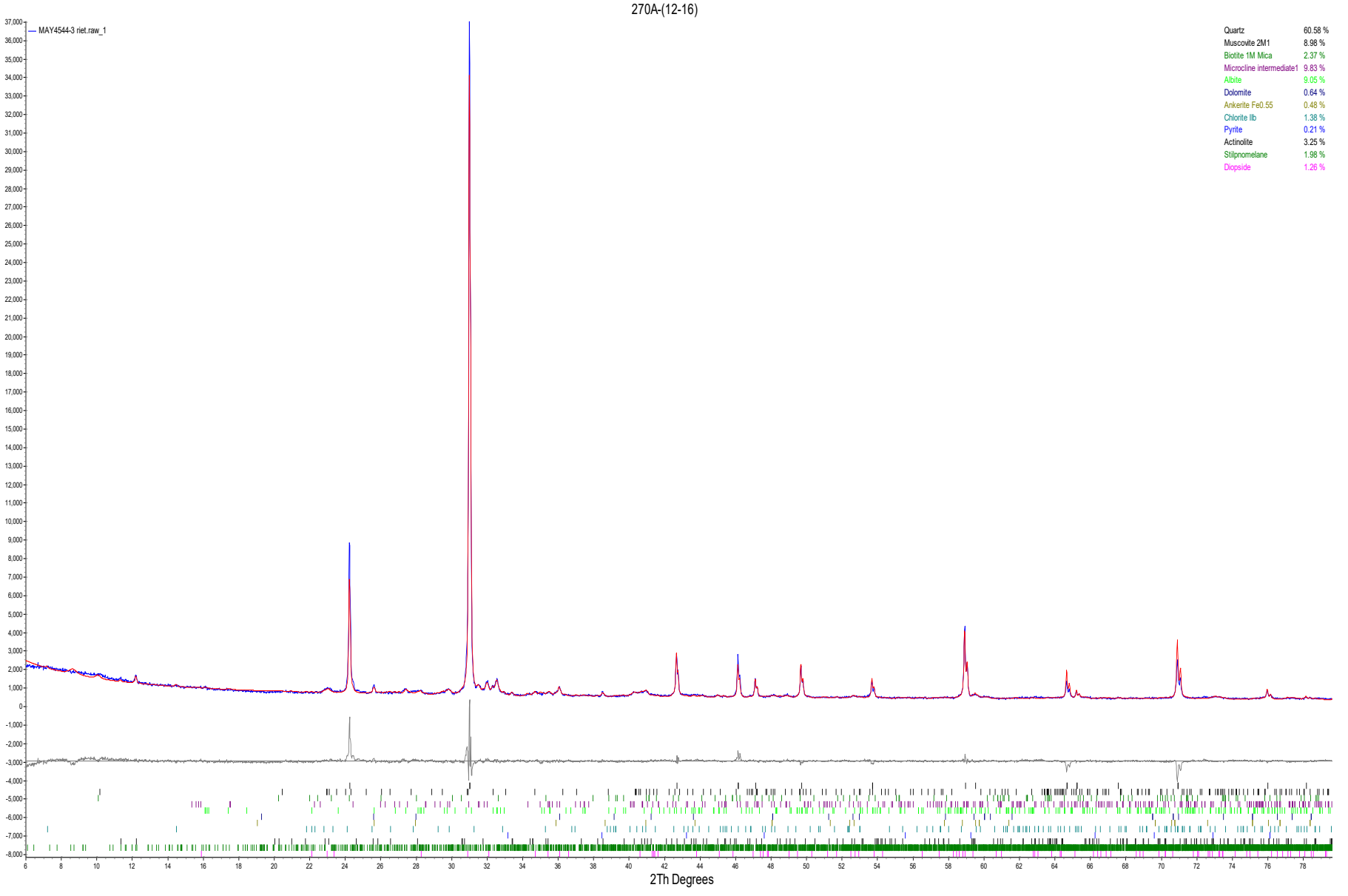
Quartz	46.25 %
Muscovite 2M1	10.34 %
Biotite 1M Mica	2.35 %
Microcline intermediate1	7.82 %
Albite	10.36 %
Calcite	4.18 %
Dolomite	11.28 %
Ankerite Fe0.55	1.45 %
Chlorite IIb	1.53 %
Pyrite	0.11 %
Stilpnomelane	2.63 %
Diopside	0.82 %
Actinolite	0.86 %

401B-(16-20)



Quartz	68.93 %
Muscovite 2M1	6.82 %
Biotite 1M Mica	2.14 %
Microcline intermediate1	7.83 %
Albite	8.63 %
Ankerite Fe0.55	0.10 %
Diopside	1.43 %
Actinolite	1.43 %
Stilpnomelane	2.70 %

270A-(12-16)



Quartz	60.58 %
Muscovite 2M1	8.98 %
Biotite 1M Mica	2.37 %
Microcline intermediate1	9.83 %
Albite	9.05 %
Dolomite	0.64 %
Ankerite Fe0.55	0.48 %
Chlorite IIb	1.38 %
Pyrite	0.21 %
Actinolite	3.25 %
Stilpnomelane	1.98 %
Diopside	1.26 %

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Environmental Services*
Project Number/ LIMS No.	*Custom XRD/MI4509-SEP21*
Sample Receipt:	*September 9, 2021*
Sample Analysis:	*September 24, 2021*
Reporting Date:	*October 22, 2021*

Instrument:	BRUKER AXS D8 Advance Diffractometer
Test Conditions:	Co radiation, 35 kV, 40 mA Regular Scanning: Step: 0.02°, Step time: 1s, 2θ range: 3-80°
Interpretations :	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

Kim Gibbs, H.B.Sc., P.Geo.
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Huyun Zhou, Ph.D., P.Geo.
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Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Minerals Services is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativeness of any goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted.

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Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	SB-306-(14-16) SEP4509-01 (wt %)	SB-311-(14-15) SEP4509-02 (wt %)	SB-313-(8-9) SEP4509-03 (wt %)	SB-316-(13-14,15-16) SEP4509-04 (wt %)
Quartz	70.9	58.9	51.3	67.6
Microcline	8.5	7.4	7.6	9.8
Albite	9.6	8.6	7.9	9.6
Calcite	0.5	2.5	4.1	-
Dolomite	3.5	12.1	15.7	1.9
Ankerite	2.1	5.0	7.7	0.8
Chlorite	1.8	1.7	1.1	1.7
Diopside	3.1	3.8	4.6	1.3
Muscovite	-	-	-	7.3
TOTAL	100	100	100	100

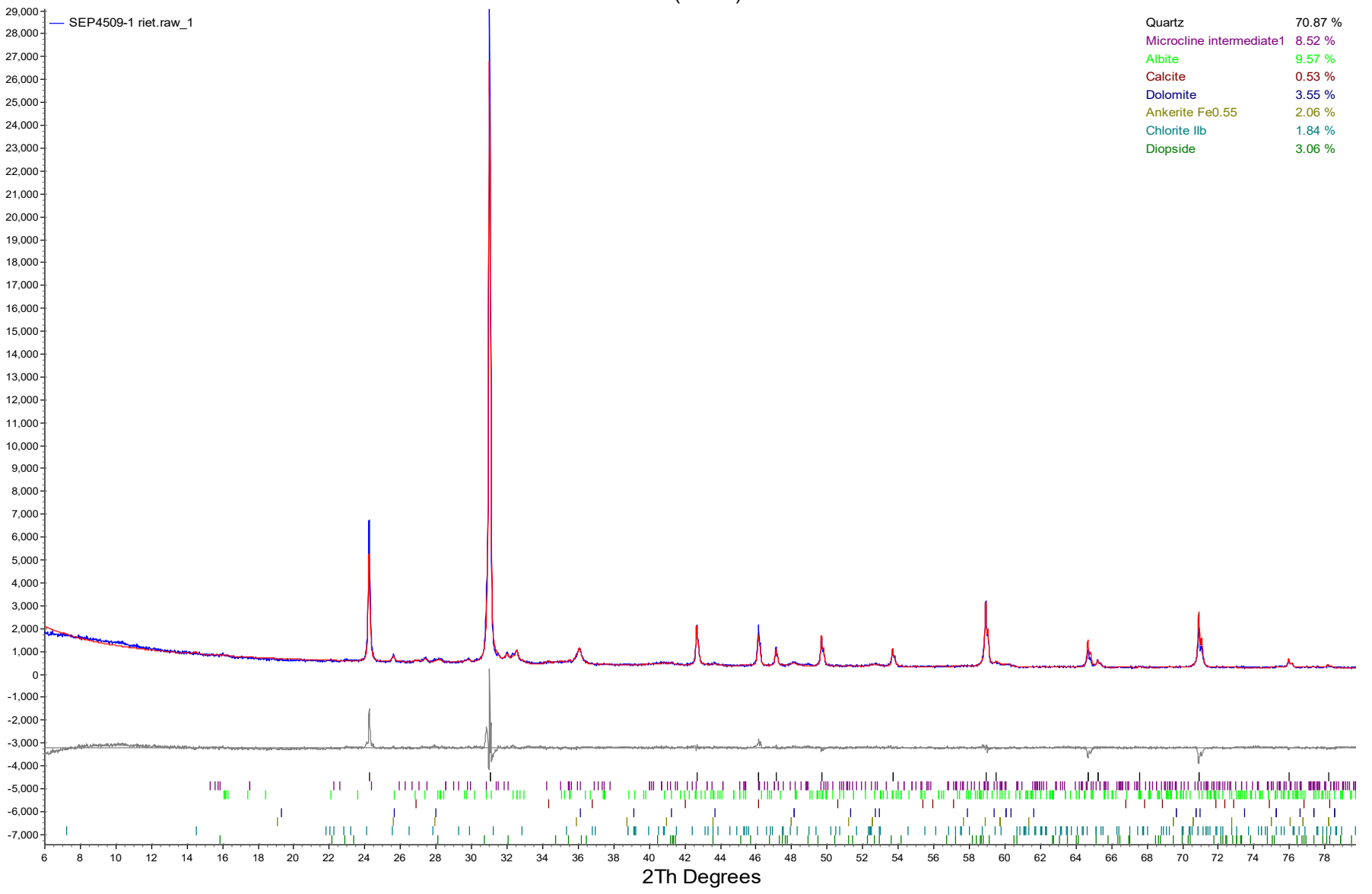
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

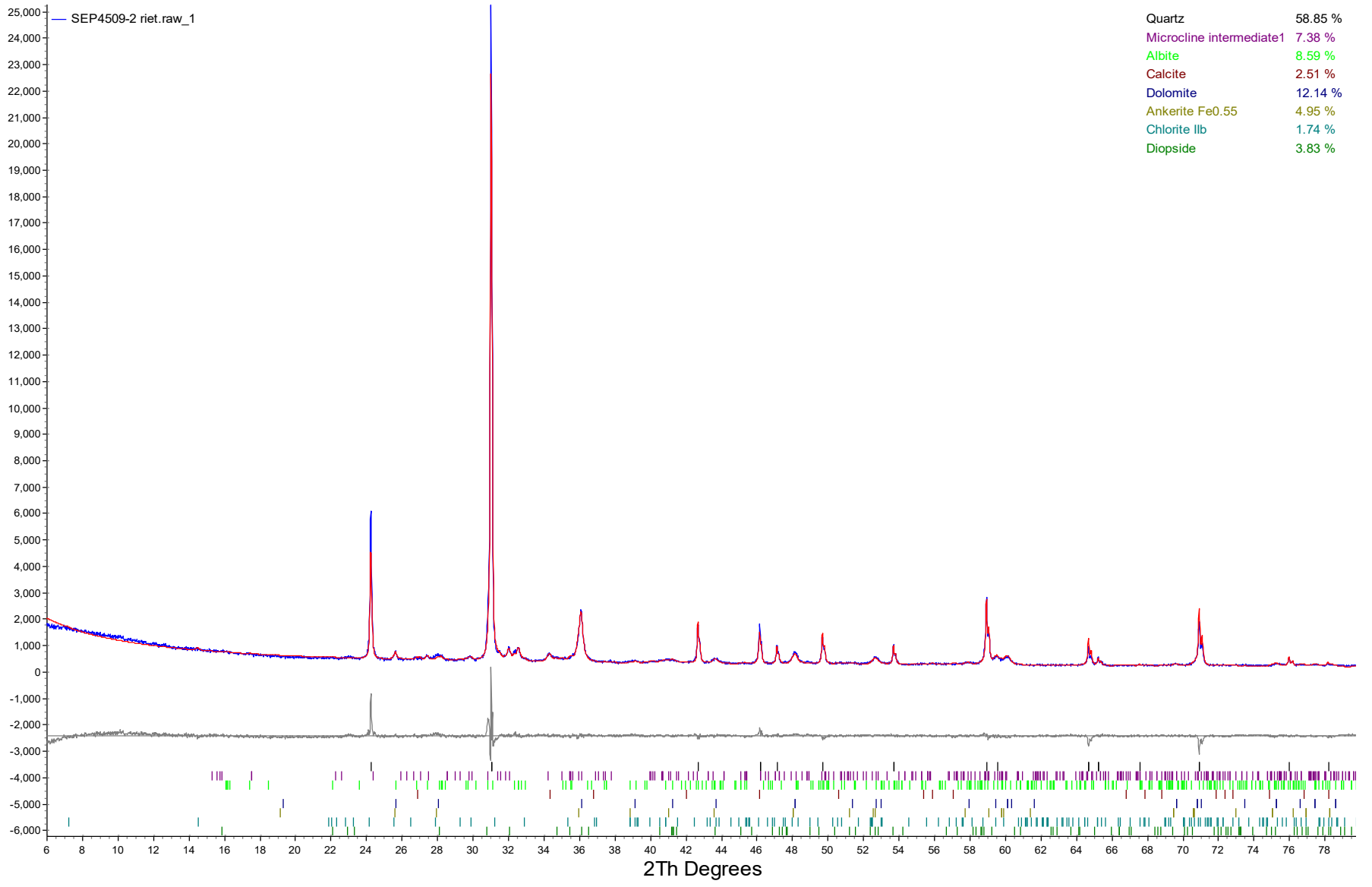
Mineral/Compound	Formula
Quartz	SiO_2
Microcline	$KAlSi_3O_8$
Albite	$NaAlSi_3O_8$
Calcite	$CaCO_3$
Dolomite	$CaMg(CO_3)_2$
Ankerite	$CaFe(CO_3)_2$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Diopside	$CaMgSi_2O_6$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$

SB-306-(14-16)



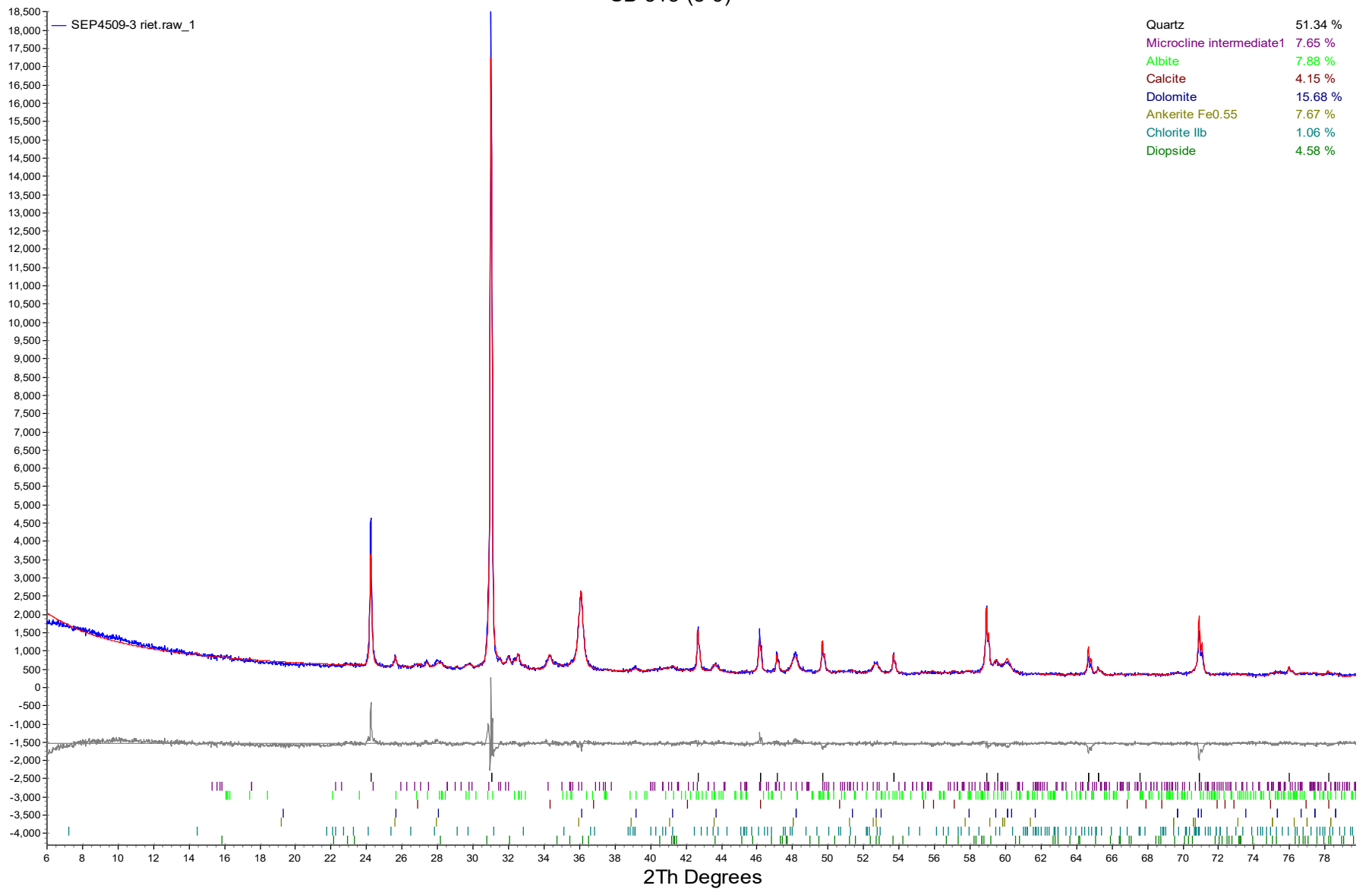
Quartz	70.87 %
Microcline intermediate1	8.52 %
Albite	9.57 %
Calcite	0.53 %
Dolomite	3.55 %
Ankerite Fe0.55	2.06 %
Chlorite IIb	1.84 %
Diopside	3.06 %

SB-311-(14-15)



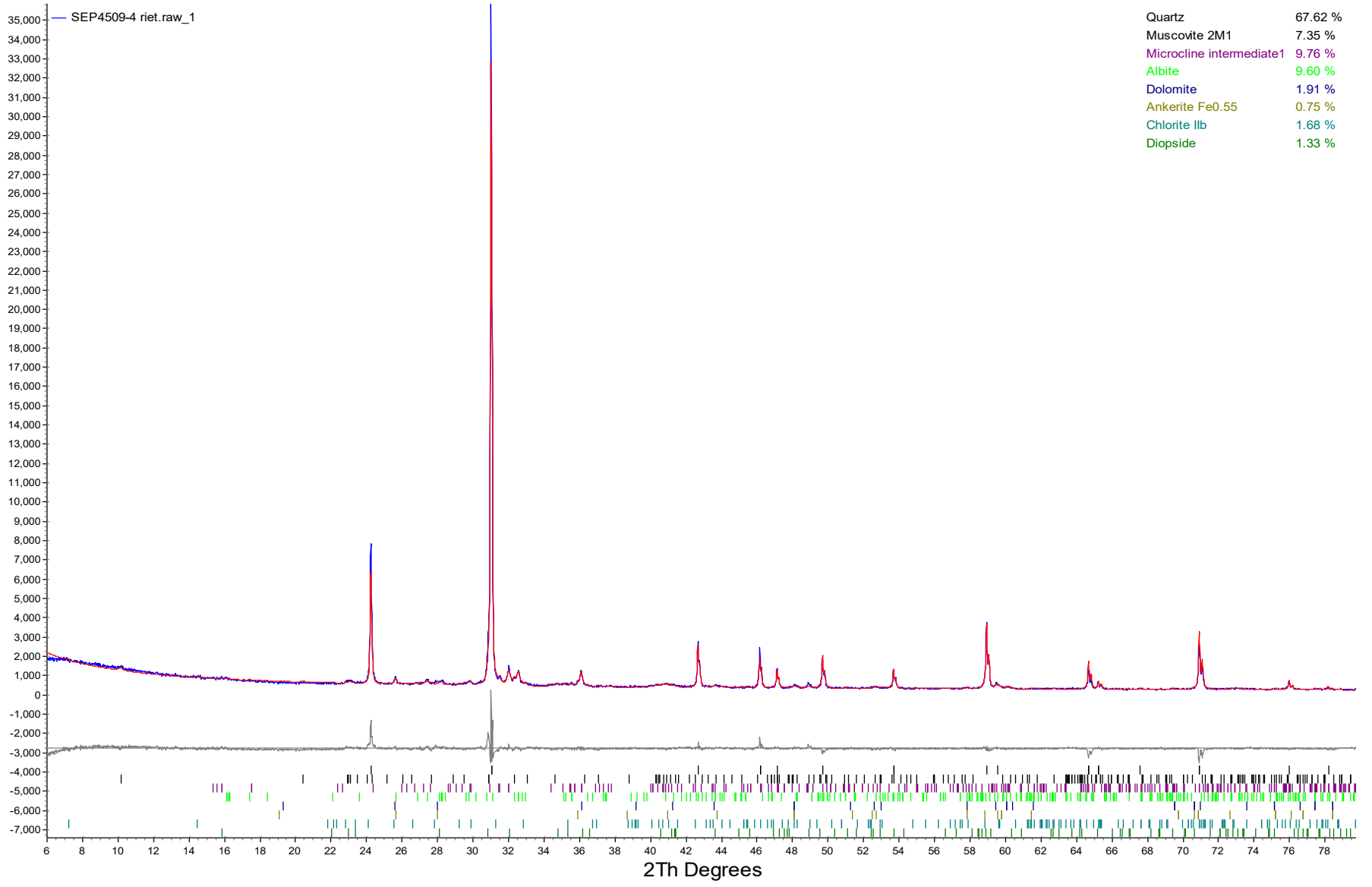
Quartz	58.85 %
Microcline intermediate1	7.38 %
Albite	8.59 %
Calcite	2.51 %
Dolomite	12.14 %
Ankerite Fe0.55	4.95 %
Chlorite IIb	1.74 %
Diopside	3.83 %

SB-313-(8-9)



Quartz	51.34 %
Microcline intermediate1	7.65 %
Albite	7.88 %
Calcite	4.15 %
Dolomite	15.68 %
Ankerite Fe0.55	7.67 %
Chlorite IIb	1.06 %
Diopside	4.58 %

SB-316-(13-14,15-16)



Quartz	67.62 %
Muscovite 2M1	7.35 %
Microcline intermediate1	9.76 %
Albite	9.60 %
Dolomite	1.91 %
Ankerite Fe0.55	0.75 %
Chlorite IIb	1.68 %
Diopside	1.33 %

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Environmental Services*
Project Number/ LIMS No.	*Custom XRD/MI4528-AUG23*
Sample Receipt:	*August 10, 2023*
Sample Analysis:	*August 31, 2023*
Reporting Date:	*September 15, 2023*

Instrument:	BRUKER AXS D8 Advance Diffractometer
Test Conditions:	Co radiation, 35 kV, 40 mA; Detector: LYNXEYE Regular Scanning: Step: 0.02°, Step time: 0.75s, 2θ range: 6-80° Clay Section Scanning: Step: 0.01°, Step time:0.2s, 2θ range: 3-40°
Interpretations :	PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

Kim Gibbs, H.B.Sc., P.Geo.
Senior Mineralogist

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Method Summary

The Rietveld Method of Mineral Identification by XRD (ME-LR-MIN-MET-MN-D05) method used by SGS Natural Resources is accredited to the requirements of ISO/IEC 17025.

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Clay Mineral Separation and Identification:

Clay minerals are typically fine-grained (<2 µm) phyllosilicates in sedimentary rock. Due to the poor crystallinity and fine size of clay minerals, separation of the clay fraction from bulk samples by centrifuge is required. A slide of the oriented clay fraction is prepared and scanned followed by a series of procedures (the addition of ethylene glycol and high temperature heating). Clay minerals are identified by their individual diffraction patterns and changes in their diffraction pattern after different treatments. Clay speciation and mineral identification of the bulk sample are performed using DIFFRACplus EVA (Bruker AXS).

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	COF1-13-18-20230619 AUG4528-01 (wt %)	COF1-18-23-20230619 AUG4528-02 (wt %)	COF1-38-43-20230619 AUG4528-03 (wt %)	COF2-10-13-20230619 AUG4528-04 (wt %)	COF3-11-12-20230619 AUG4528-05 (wt %)	COF3-12.5-13-20230619 AUG4528-06 (wt %)
Quartz	53.9	67.5	73.5	51.2	50.7	50.5
Chlorite	1.6	1.7	1.5	3.0	3.9	3.2
Albite	6.1	8.3	8.2	6.8	7.4	7.5
Microcline	5.1	9.7	7.8	7.2	5.9	5.8
Calcite	4.1	0.4	-	2.4	2.6	2.8
Ankerite	7.2	1.2	0.5	9.4	8.4	8.1
Dolomite	13.3	0.5	0.0	6.0	7.6	8.1
Actinolite	0.3	0.7	0.8	0.5	0.6	0.6
Diopside	1.0	0.7	0.7	0.4	0.5	0.7
Kutnohorite	0.5	0.3	0.2	0.1	-	0.2
Muscovite	1.0	4.8	3.3	5.5	4.4	4.3
Magnetite	-	0.2	0.0	0.1	0.1	0.2
Clay	-	-	-	-	-	-
Illite	4.0	2.0	1.7	3.3	3.0	2.9
Montmorillonite	1.1	1.0	1.1	3.2	3.2	2.9
Kaolinite	0.7	1.1	0.7	0.9	0.6	0.6
Illite-Montmorillonite	-	-	-	-	1.3	1.7
TOTAL	100	100	100	100	100	100

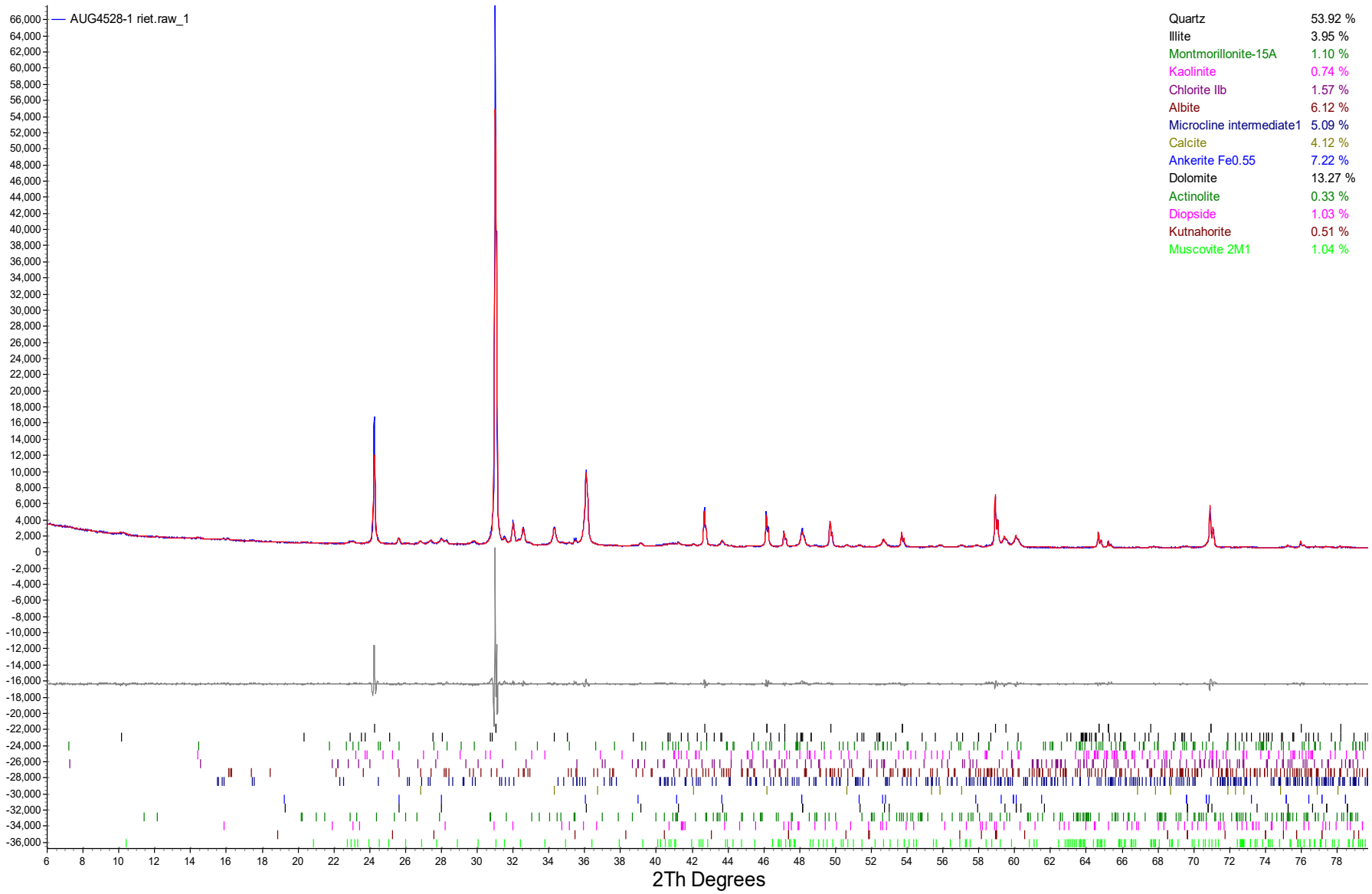
Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

Mineral/Compound	Formula
Quartz	SiO_2
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Albite	$NaAlSi_3O_8$
Microcline	$KAlSi_3O_8$
Calcite	$CaCO_3$
Ankerite	$CaFe(CO_3)_2$
Dolomite	$CaMg(CO_3)_2$
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$
Diopside	$CaMgSi_2O_6$
Kutnohorite	$CaMn(CO_3)_2$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Magnetite	Fe_3O_4
Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot 10H_2O$
Kaolinite	$Al_2Si_2O_5(OH)_4$
Illite-Montmorillonite	$KAl_4(Si,Al)_8O_{20}(OH)_4 \cdot 8H_2O$

COF1-13-18-20230619



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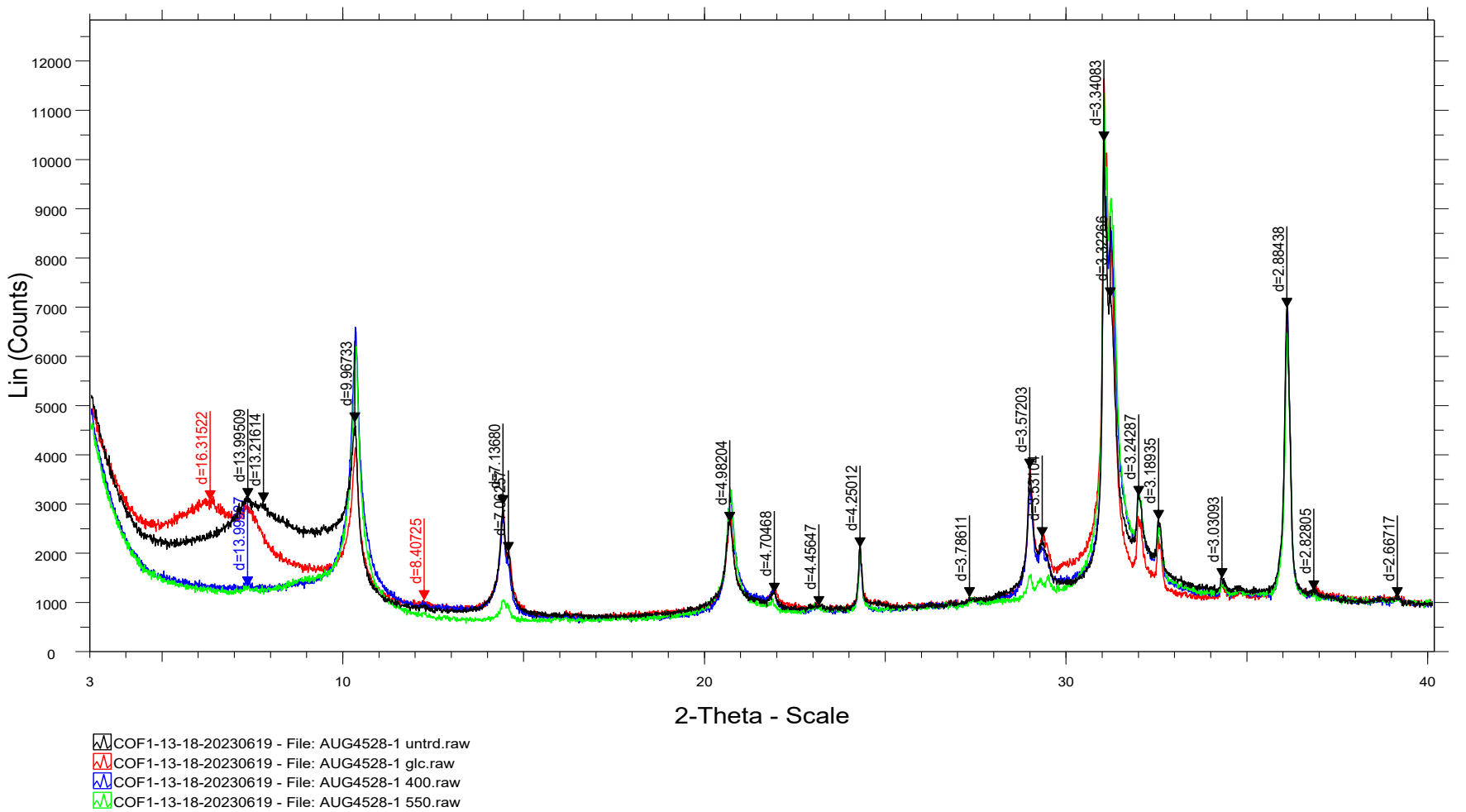

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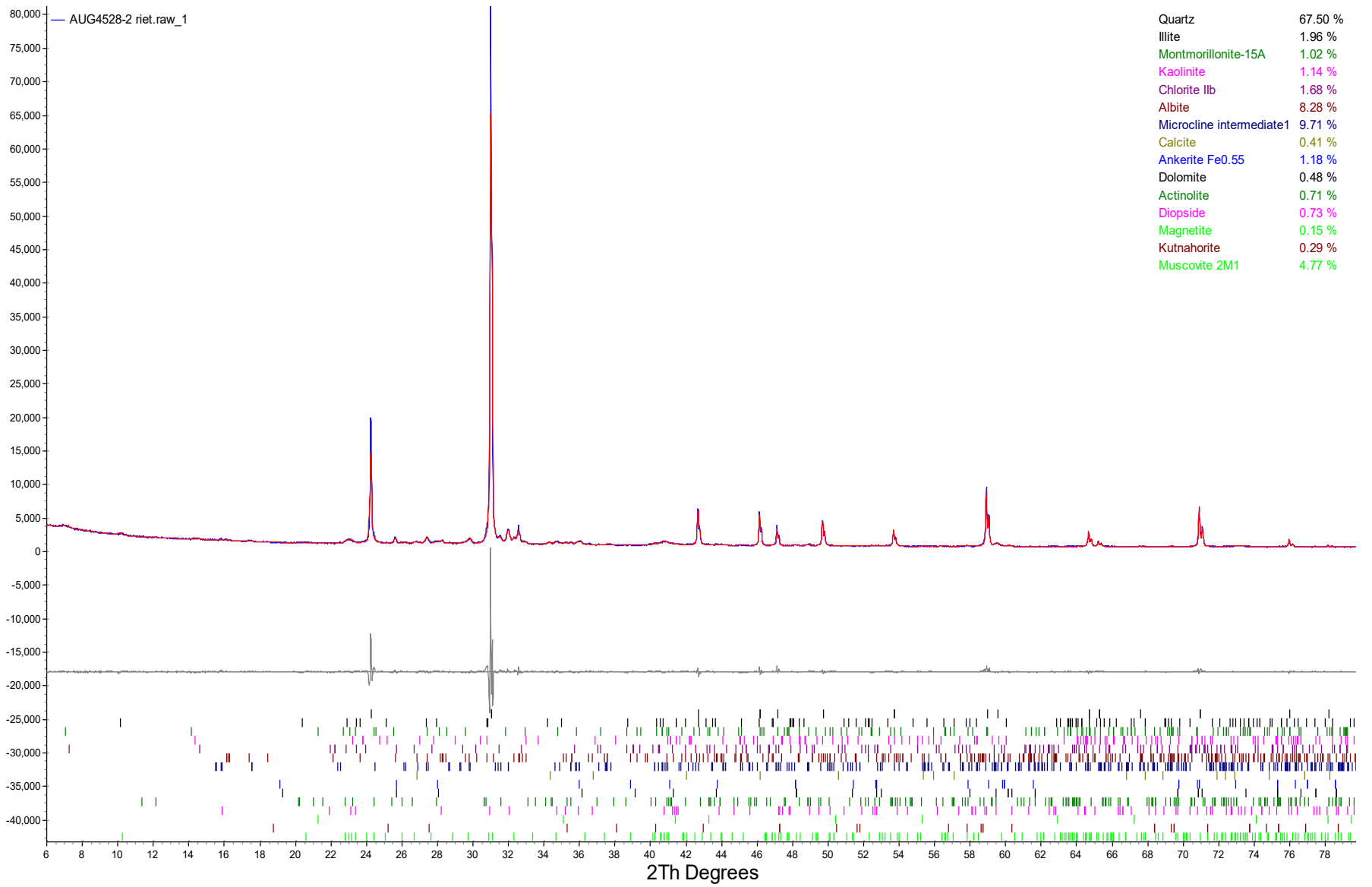

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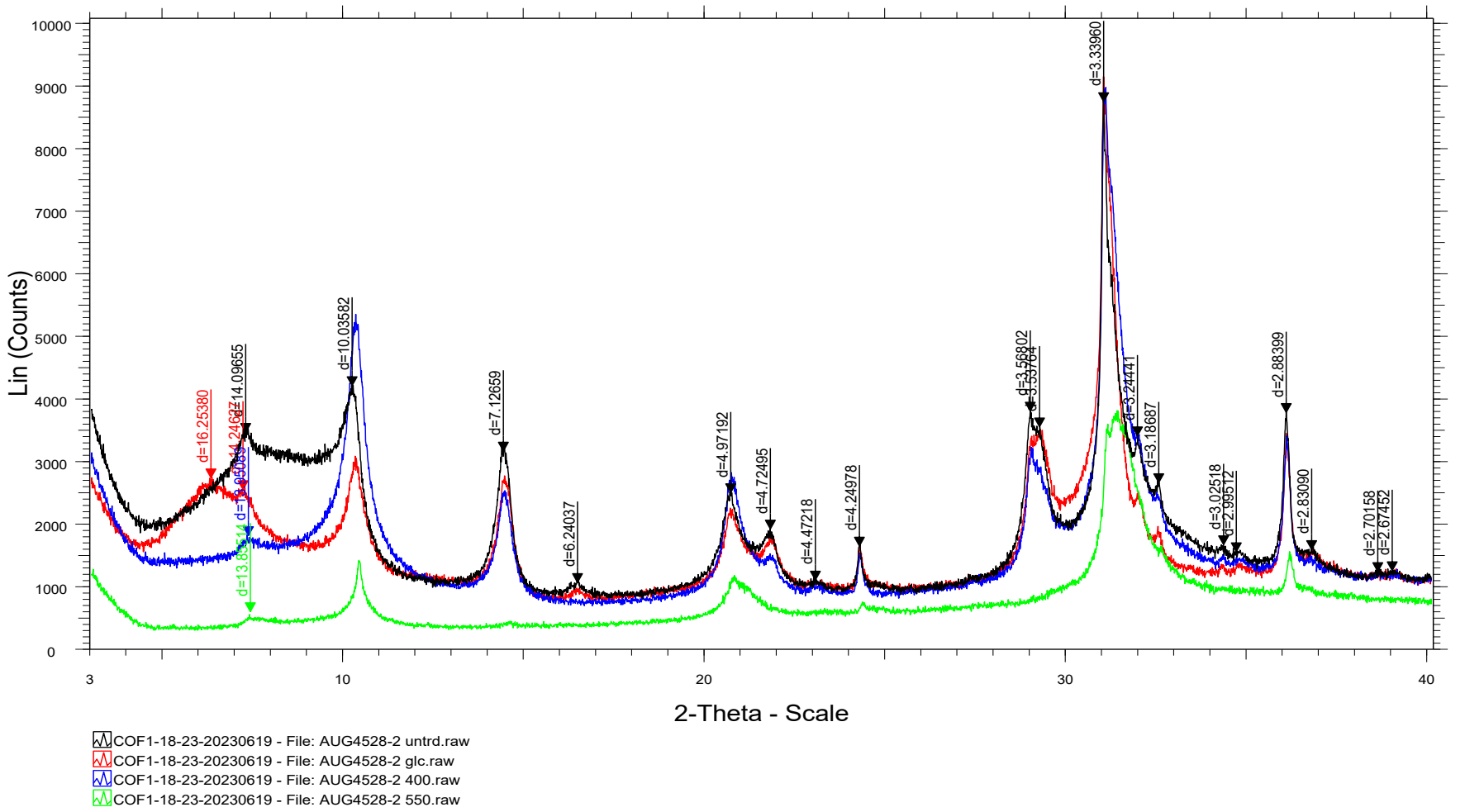

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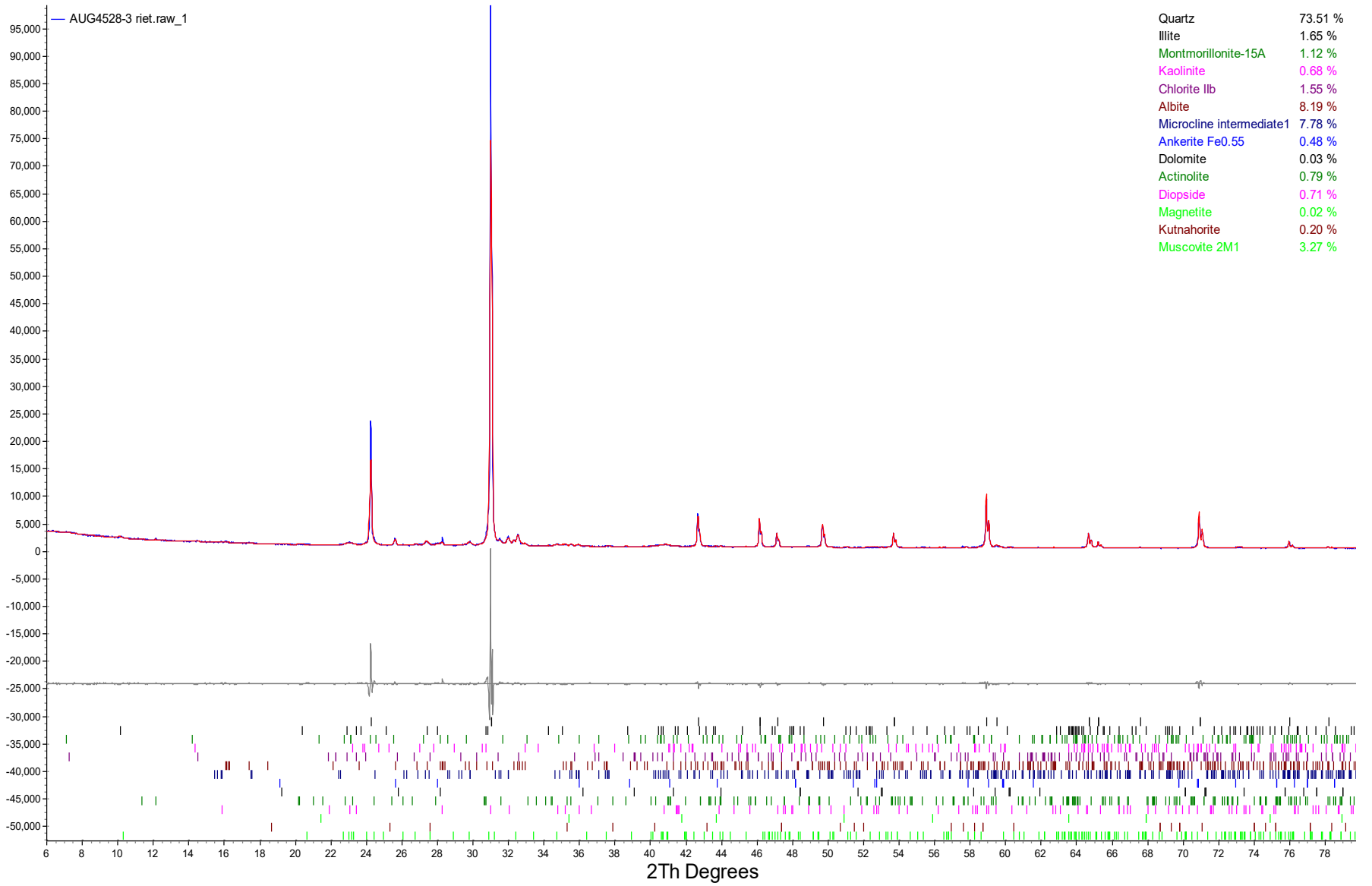

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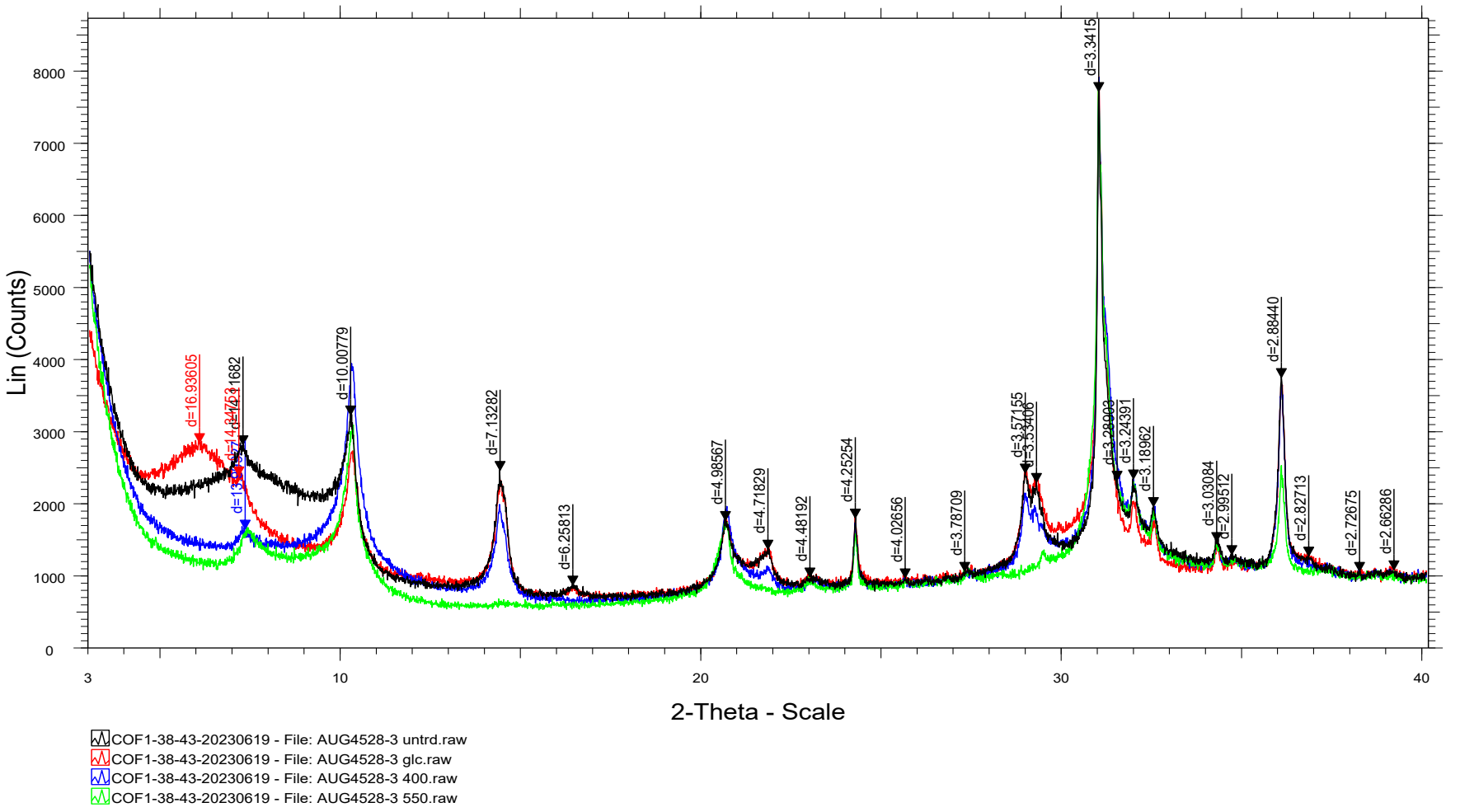

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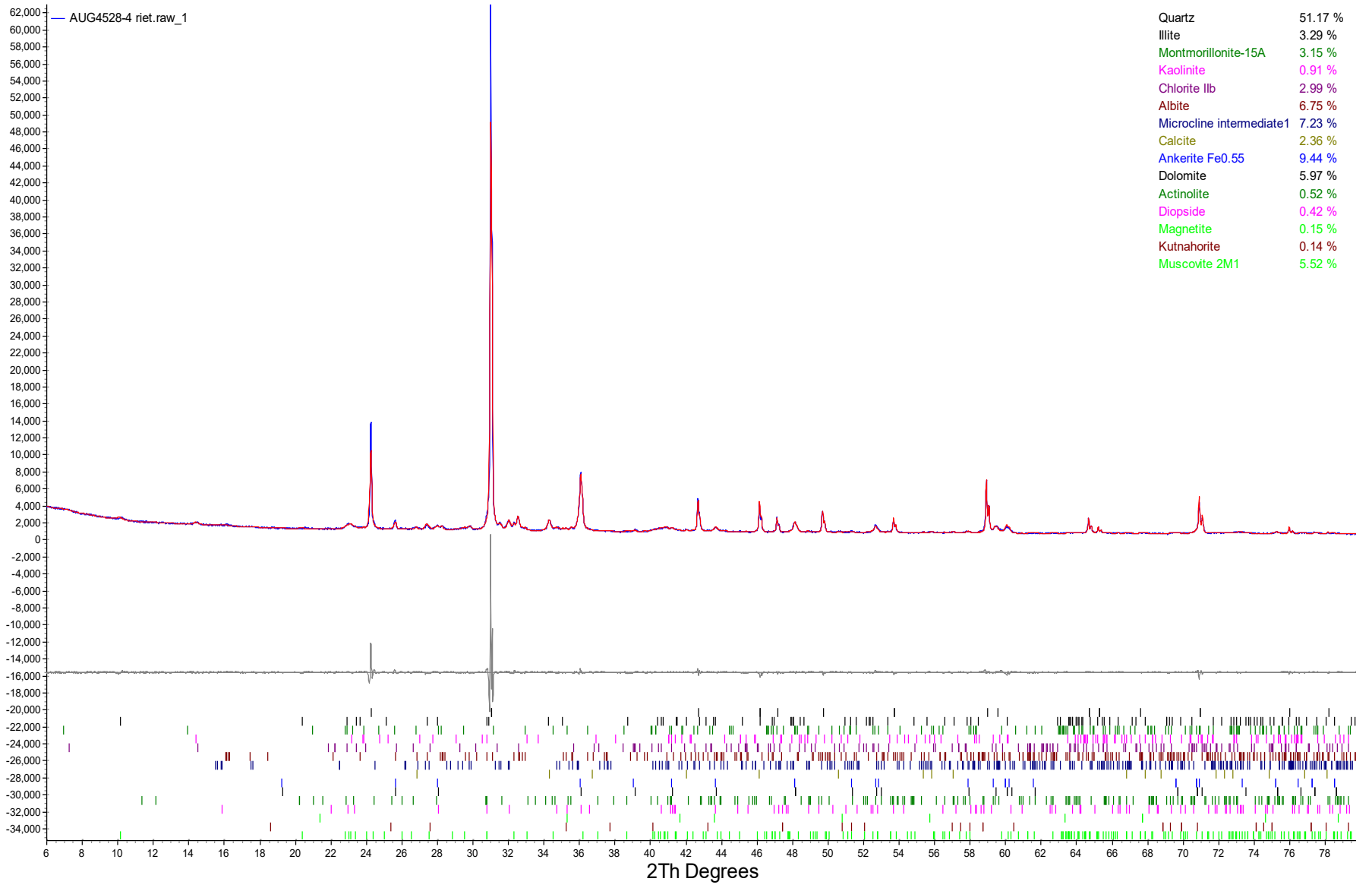

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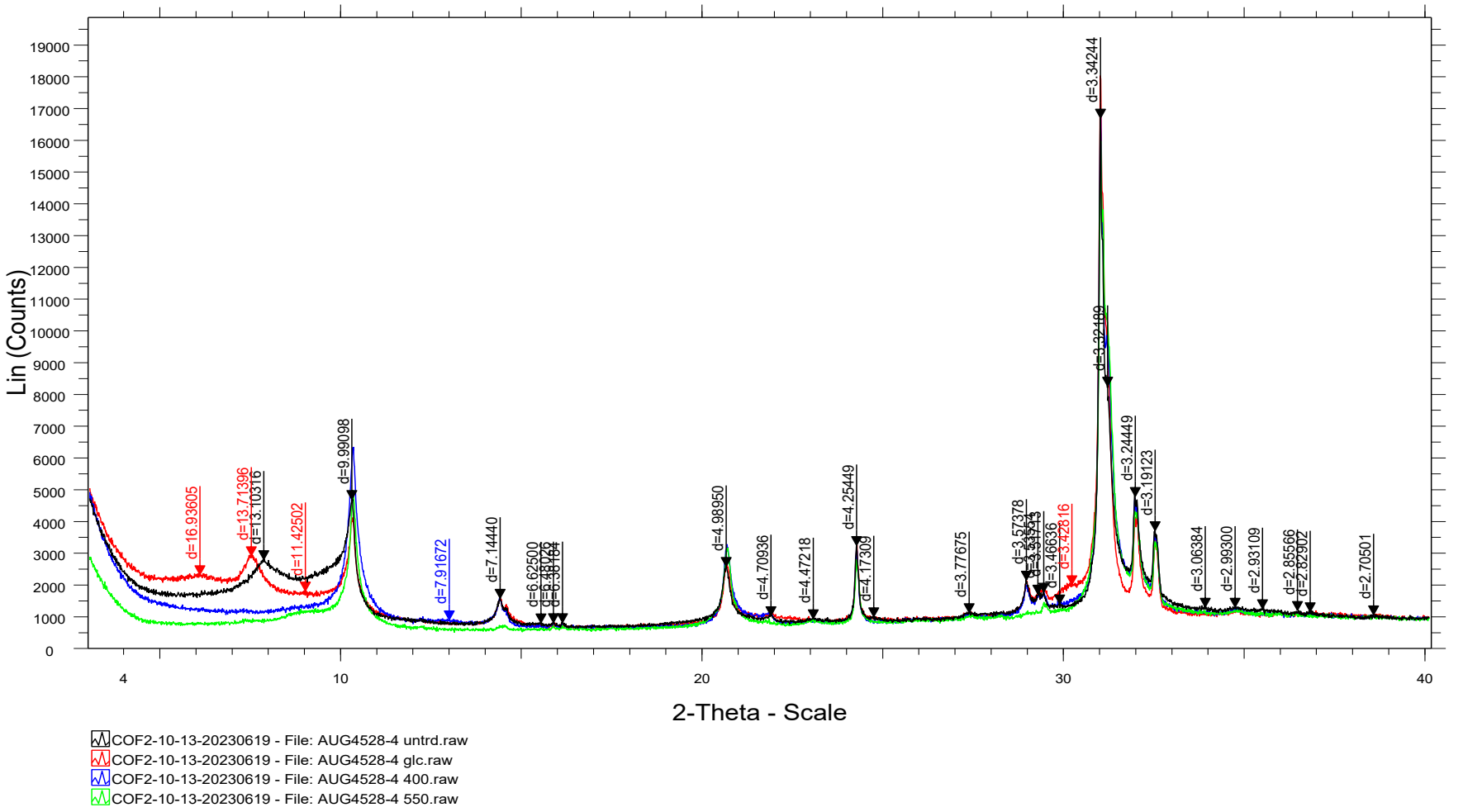

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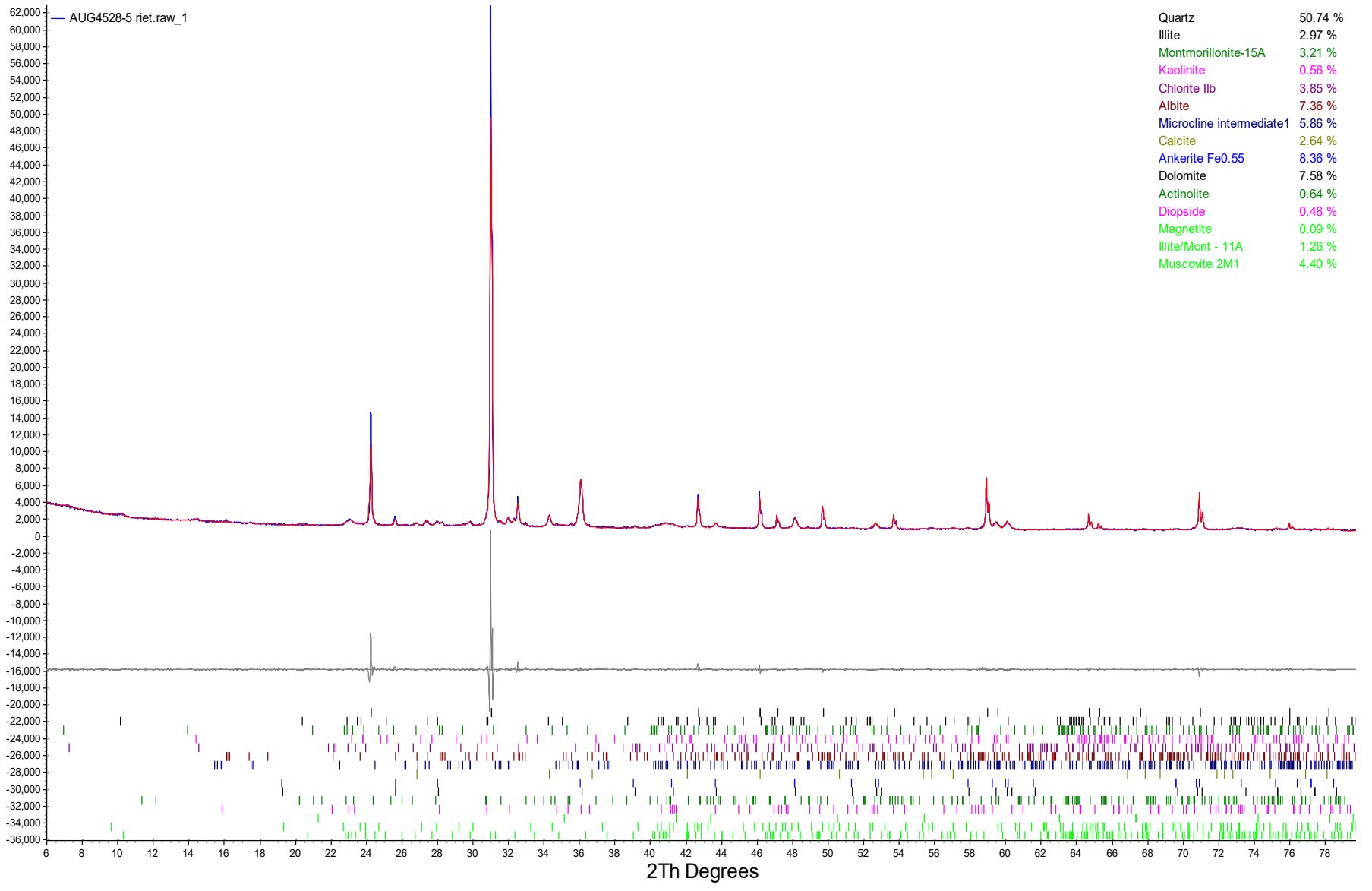

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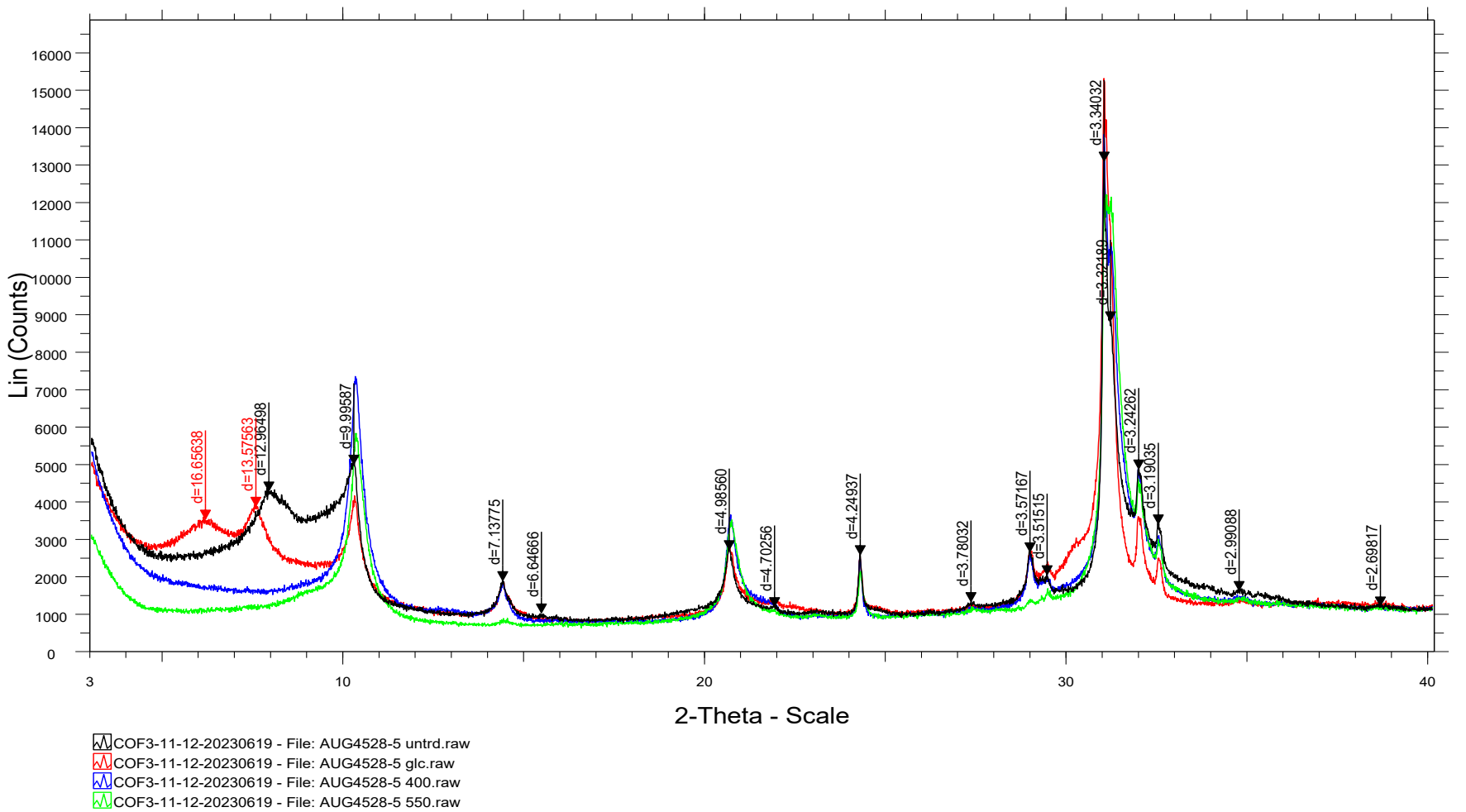

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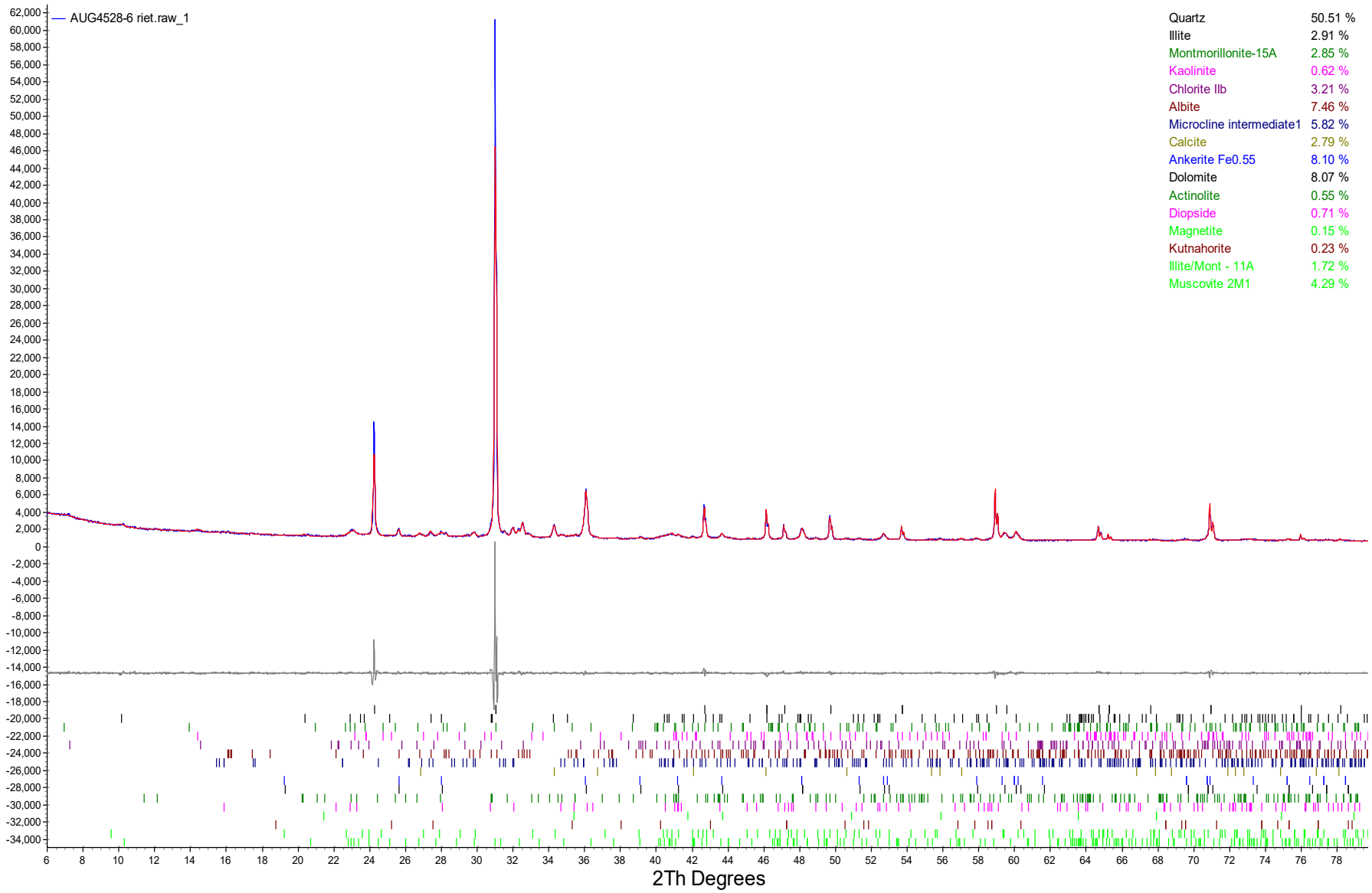

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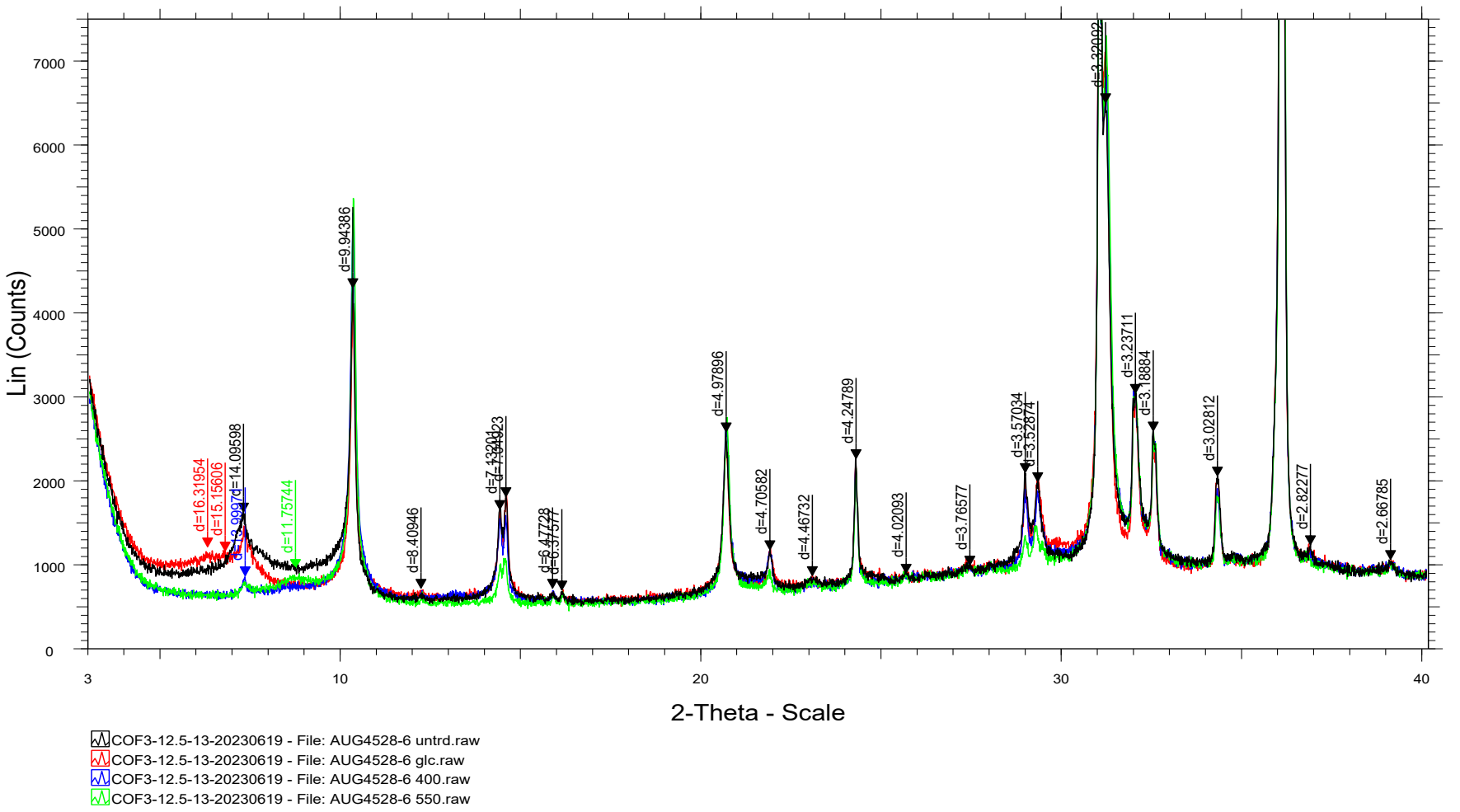

Attachment H

Site Evaluation Aqueous Phase Data

Attachment H. Site Evaluation Groundwater Data
Geochemical Conceptual Site Model
Coffeen Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

HSU	Location	Well Type	Date	Parameter	Unit	Result
CCR	XPW01	Porewater	2021/03/30	pH (field)	SU	8.0
CCR	XPW01	Porewater	2021/04/22	pH (field)	SU	7.8
CCR	XPW01	Porewater	2021/05/05	pH (field)	SU	8.0
CCR	XPW01	Porewater	2021/05/18	pH (field)	SU	8.0
CCR	XPW01	Porewater	2021/07/27	pH (field)	SU	8.1
CCR	XPW01	Porewater	2022/06/15	pH (field)	SU	8.5
CCR	XPW01	Porewater	2022/08/24	pH (field)	SU	7.7
CCR	XPW01	Porewater	2023/02/15	pH (field)	SU	7.8
CCR	XPW01	Porewater	2023/08/10	pH (field)	SU	7.7
CCR	XPW01	Porewater	2023/11/17	pH (field)	SU	7.1
CCR	XPW01	Porewater	2021/03/30	Oxidation Reduction Potential	mV	-7.20
CCR	XPW01	Porewater	2021/04/22	Oxidation Reduction Potential	mV	-7.80
CCR	XPW01	Porewater	2021/05/05	Oxidation Reduction Potential	mV	147
CCR	XPW01	Porewater	2021/05/18	Oxidation Reduction Potential	mV	-146
CCR	XPW01	Porewater	2021/07/27	Oxidation Reduction Potential	mV	-190
CCR	XPW01	Porewater	2022/06/15	Oxidation Reduction Potential	mV	-35.4
CCR	XPW01	Porewater	2022/08/24	Oxidation Reduction Potential	mV	-72.0
CCR	XPW01	Porewater	2023/02/15	Oxidation Reduction Potential	mV	-35.0
CCR	XPW01	Porewater	2023/08/10	Oxidation Reduction Potential	mV	-104
CCR	XPW01	Porewater	2023/11/17	Oxidation Reduction Potential	mV	-83.0
CCR	XPW01	Porewater	2021/03/30	Eh	V	0.19
CCR	XPW01	Porewater	2021/04/22	Eh	V	0.19
CCR	XPW01	Porewater	2021/05/05	Eh	V	0.34
CCR	XPW01	Porewater	2021/05/18	Eh	V	0.049
CCR	XPW01	Porewater	2021/07/27	Eh	V	-0.00024
CCR	XPW01	Porewater	2022/06/15	Eh	V	0.16
CCR	XPW01	Porewater	2022/08/24	Eh	V	0.12
CCR	XPW01	Porewater	2023/02/15	Eh	V	0.16
CCR	XPW01	Porewater	2023/08/10	Eh	V	0.089
CCR	XPW01	Porewater	2023/11/17	Eh	V	0.11
CCR	XPW01	Porewater	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	68.0
CCR	XPW01	Porewater	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	75.0
CCR	XPW01	Porewater	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	75.0
CCR	XPW01	Porewater	2021/05/18	Alkalinity, bicarbonate	mg/L CaCO3	78.0
CCR	XPW01	Porewater	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	100
CCR	XPW01	Porewater	2022/06/15	Alkalinity, bicarbonate	mg/L CaCO3	92.0
CCR	XPW01	Porewater	2022/08/24	Alkalinity, bicarbonate	mg/L CaCO3	100
CCR	XPW01	Porewater	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	100
CCR	XPW01	Porewater	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	220
CCR	XPW01	Porewater	2023/11/17	Alkalinity, bicarbonate	mg/L CaCO3	270
CCR	XPW01	Porewater	2022/08/24	Alkalinity, carbonate	mg/L CaCO3	10.0
CCR	XPW01	Porewater	2021/03/30	Barium, total	mg/L	0.0430
CCR	XPW01	Porewater	2021/04/22	Barium, total	mg/L	0.0350
CCR	XPW01	Porewater	2021/05/05	Barium, total	mg/L	0.0330
CCR	XPW01	Porewater	2021/05/18	Barium, total	mg/L	0.0320
CCR	XPW01	Porewater	2021/07/27	Barium, total	mg/L	0.0310
CCR	XPW01	Porewater	2023/08/10	Barium, total	mg/L	0.0589
CCR	XPW01	Porewater	2021/03/30	Boron, total	mg/L	2.40
CCR	XPW01	Porewater	2021/04/22	Boron, total	mg/L	2.40
CCR	XPW01	Porewater	2021/05/05	Boron, total	mg/L	2.50
CCR	XPW01	Porewater	2021/05/18	Boron, total	mg/L	2.50
CCR	XPW01	Porewater	2021/07/27	Boron, total	mg/L	2.90
CCR	XPW01	Porewater	2023/08/10	Boron, total	mg/L	3.97
CCR	XPW01	Porewater	2021/03/30	Calcium, total	mg/L	280
CCR	XPW01	Porewater	2021/04/22	Calcium, total	mg/L	270

CCR	XPW01	Porewater	2021/05/05	Calcium, total	mg/L	290
CCR	XPW01	Porewater	2021/05/18	Calcium, total	mg/L	270
CCR	XPW01	Porewater	2021/07/27	Calcium, total	mg/L	250
CCR	XPW01	Porewater	2022/06/15	Calcium, total	mg/L	230
CCR	XPW01	Porewater	2022/08/24	Calcium, total	mg/L	250
CCR	XPW01	Porewater	2023/02/15	Calcium, total	mg/L	240
CCR	XPW01	Porewater	2023/08/10	Calcium, total	mg/L	221
CCR	XPW01	Porewater	2023/11/17	Calcium, total	mg/L	209
CCR	XPW01	Porewater	2021/03/30	Chloride, total	mg/L	13.0
CCR	XPW01	Porewater	2021/04/22	Chloride, total	mg/L	17.0
CCR	XPW01	Porewater	2021/05/05	Chloride, total	mg/L	17.0
CCR	XPW01	Porewater	2021/05/18	Chloride, total	mg/L	15.0
CCR	XPW01	Porewater	2021/07/27	Chloride, total	mg/L	13.0
CCR	XPW01	Porewater	2022/06/15	Chloride, total	mg/L	11.0
CCR	XPW01	Porewater	2022/08/24	Chloride, total	mg/L	15.0
CCR	XPW01	Porewater	2023/02/15	Chloride, total	mg/L	8.90
CCR	XPW01	Porewater	2023/08/10	Chloride, total	mg/L	8.00
CCR	XPW01	Porewater	2023/11/17	Chloride, total	mg/L	8.00
CCR	XPW01	Porewater	2023/06/06	Ferrous Iron, dissolved	mg/L	0.690
CCR	XPW01	Porewater	2023/06/06	Iron, dissolved	mg/L	0.870
CCR	XPW01	Porewater	2023/08/10	Iron, dissolved	mg/L	1.06
CCR	XPW01	Porewater	2021/03/30	Magnesium, total	mg/L	28.0
CCR	XPW01	Porewater	2021/04/22	Magnesium, total	mg/L	26.0
CCR	XPW01	Porewater	2021/05/05	Magnesium, total	mg/L	29.0
CCR	XPW01	Porewater	2021/05/18	Magnesium, total	mg/L	28.0
CCR	XPW01	Porewater	2021/07/27	Magnesium, total	mg/L	32.0
CCR	XPW01	Porewater	2022/06/15	Magnesium, total	mg/L	24.0
CCR	XPW01	Porewater	2022/08/24	Magnesium, total	mg/L	29.0
CCR	XPW01	Porewater	2023/02/15	Magnesium, total	mg/L	20.0
CCR	XPW01	Porewater	2023/08/10	Magnesium, total	mg/L	31.6
CCR	XPW01	Porewater	2023/11/17	Magnesium, total	mg/L	29.4
CCR	XPW01	Porewater	2023/06/06	Manganese, dissolved	mg/L	0.0930
CCR	XPW01	Porewater	2023/08/10	Manganese, dissolved	mg/L	0.115
CCR	XPW01	Porewater	2023/08/10	Phosphate, dissolved	mg/L	0.0310
CCR	XPW01	Porewater	2021/03/30	Potassium, total	mg/L	19.0
CCR	XPW01	Porewater	2021/04/22	Potassium, total	mg/L	19.0
CCR	XPW01	Porewater	2021/05/05	Potassium, total	mg/L	20.0
CCR	XPW01	Porewater	2021/05/18	Potassium, total	mg/L	20.0
CCR	XPW01	Porewater	2021/07/27	Potassium, total	mg/L	21.0
CCR	XPW01	Porewater	2022/06/15	Potassium, total	mg/L	20.0
CCR	XPW01	Porewater	2022/08/24	Potassium, total	mg/L	23.0
CCR	XPW01	Porewater	2023/02/15	Potassium, total	mg/L	21.0
CCR	XPW01	Porewater	2023/08/10	Potassium, total	mg/L	22.7
CCR	XPW01	Porewater	2023/11/17	Potassium, total	mg/L	22.5
CCR	XPW01	Porewater	2023/06/06	Silicon, dissolved	mg/L	5.50
CCR	XPW01	Porewater	2023/08/10	Silicon, dissolved	mg/L	5.47
CCR	XPW01	Porewater	2021/03/30	Sodium, total	mg/L	80.0
CCR	XPW01	Porewater	2021/04/22	Sodium, total	mg/L	82.0
CCR	XPW01	Porewater	2021/05/05	Sodium, total	mg/L	89.0
CCR	XPW01	Porewater	2021/05/18	Sodium, total	mg/L	87.0
CCR	XPW01	Porewater	2021/07/27	Sodium, total	mg/L	82.0
CCR	XPW01	Porewater	2022/06/15	Sodium, total	mg/L	75.0
CCR	XPW01	Porewater	2022/08/24	Sodium, total	mg/L	90.0
CCR	XPW01	Porewater	2023/02/15	Sodium, total	mg/L	67.0
CCR	XPW01	Porewater	2023/08/10	Sodium, total	mg/L	76.8
CCR	XPW01	Porewater	2023/11/17	Sodium, total	mg/L	65.2
CCR	XPW01	Porewater	2021/03/30	Sulfate, total	mg/L	820
CCR	XPW01	Porewater	2021/04/22	Sulfate, total	mg/L	860
CCR	XPW01	Porewater	2021/05/05	Sulfate, total	mg/L	850
CCR	XPW01	Porewater	2021/05/18	Sulfate, total	mg/L	820
CCR	XPW01	Porewater	2021/07/27	Sulfate, total	mg/L	740
CCR	XPW01	Porewater	2022/06/15	Sulfate, total	mg/L	730

CCR	XPW01	Porewater	2022/08/24	Sulfate, total	mg/L	760
CCR	XPW01	Porewater	2023/02/15	Sulfate, total	mg/L	700
CCR	XPW01	Porewater	2023/08/10	Sulfate, total	mg/L	666
CCR	XPW01	Porewater	2023/11/17	Sulfate, total	mg/L	480
CCR	XPW01	Porewater	2021/03/30	Temperature (Celsius)	degrees C	14.3
CCR	XPW01	Porewater	2021/04/22	Temperature (Celsius)	degrees C	14.6
CCR	XPW01	Porewater	2021/05/05	Temperature (Celsius)	degrees C	15.5
CCR	XPW01	Porewater	2021/05/18	Temperature (Celsius)	degrees C	16.3
CCR	XPW01	Porewater	2021/07/27	Temperature (Celsius)	degrees C	23.2
CCR	XPW01	Porewater	2022/06/15	Temperature (Celsius)	degrees C	21.8
CCR	XPW01	Porewater	2022/08/24	Temperature (Celsius)	degrees C	20.0
CCR	XPW01	Porewater	2023/02/15	Temperature (Celsius)	degrees C	13.6
CCR	XPW01	Porewater	2023/08/10	Temperature (Celsius)	degrees C	18.3
CCR	XPW01	Porewater	2023/11/17	Temperature (Celsius)	degrees C	18.4
CCR	XPW01	Porewater	2021/03/30	Total Dissolved Solids	mg/L	1,300
CCR	XPW01	Porewater	2021/04/22	Total Dissolved Solids	mg/L	1,200
CCR	XPW01	Porewater	2021/05/05	Total Dissolved Solids	mg/L	1,300
CCR	XPW01	Porewater	2021/05/18	Total Dissolved Solids	mg/L	1,300
CCR	XPW01	Porewater	2021/07/27	Total Dissolved Solids	mg/L	1,200
CCR	XPW01	Porewater	2022/06/15	Total Dissolved Solids	mg/L	1,200
CCR	XPW01	Porewater	2022/08/24	Total Dissolved Solids	mg/L	1,400
CCR	XPW01	Porewater	2023/02/15	Total Dissolved Solids	mg/L	1,100
CCR	XPW01	Porewater	2023/08/10	Total Dissolved Solids	mg/L	1,080
CCR	XPW01	Porewater	2023/11/17	Total Dissolved Solids	mg/L	1,020
CCR	XPW02	Porewater	2021/03/30	pH (field)	SU	7.9
CCR	XPW02	Porewater	2021/04/22	pH (field)	SU	8.0
CCR	XPW02	Porewater	2021/05/05	pH (field)	SU	7.9
CCR	XPW02	Porewater	2021/05/19	pH (field)	SU	8.1
CCR	XPW02	Porewater	2021/07/27	pH (field)	SU	8.2
CCR	XPW02	Porewater	2022/06/15	pH (field)	SU	8.4
CCR	XPW02	Porewater	2022/08/24	pH (field)	SU	7.0
CCR	XPW02	Porewater	2023/02/15	pH (field)	SU	7.8
CCR	XPW02	Porewater	2023/08/10	pH (field)	SU	7.6
CCR	XPW02	Porewater	2023/11/17	pH (field)	SU	7.6
CCR	XPW02	Porewater	2021/03/30	Oxidation Reduction Potential	mV	-112
CCR	XPW02	Porewater	2021/04/22	Oxidation Reduction Potential	mV	-61.8
CCR	XPW02	Porewater	2021/05/05	Oxidation Reduction Potential	mV	21.1
CCR	XPW02	Porewater	2021/05/19	Oxidation Reduction Potential	mV	-187
CCR	XPW02	Porewater	2021/07/27	Oxidation Reduction Potential	mV	-209
CCR	XPW02	Porewater	2022/06/15	Oxidation Reduction Potential	mV	-160
CCR	XPW02	Porewater	2022/08/24	Oxidation Reduction Potential	mV	-61.0
CCR	XPW02	Porewater	2023/02/15	Oxidation Reduction Potential	mV	-108
CCR	XPW02	Porewater	2023/08/10	Oxidation Reduction Potential	mV	-111
CCR	XPW02	Porewater	2023/11/17	Oxidation Reduction Potential	mV	-107
CCR	XPW02	Porewater	2021/03/30	Eh	V	0.081
CCR	XPW02	Porewater	2021/04/22	Eh	V	0.13
CCR	XPW02	Porewater	2021/05/05	Eh	V	0.21
CCR	XPW02	Porewater	2021/05/19	Eh	V	0.0047
CCR	XPW02	Porewater	2021/07/27	Eh	V	-0.020
CCR	XPW02	Porewater	2022/06/15	Eh	V	0.031
CCR	XPW02	Porewater	2022/08/24	Eh	V	0.13
CCR	XPW02	Porewater	2023/02/15	Eh	V	0.087
CCR	XPW02	Porewater	2023/08/10	Eh	V	0.082
CCR	XPW02	Porewater	2023/11/17	Eh	V	0.085
CCR	XPW02	Porewater	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	180
CCR	XPW02	Porewater	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	170
CCR	XPW02	Porewater	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	180
CCR	XPW02	Porewater	2021/05/19	Alkalinity, bicarbonate	mg/L CaCO3	160
CCR	XPW02	Porewater	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	160
CCR	XPW02	Porewater	2022/06/15	Alkalinity, bicarbonate	mg/L CaCO3	140
CCR	XPW02	Porewater	2022/08/24	Alkalinity, bicarbonate	mg/L CaCO3	150
CCR	XPW02	Porewater	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	160

CCR	XPW02	Porewater	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	216
CCR	XPW02	Porewater	2023/11/17	Alkalinity, bicarbonate	mg/L CaCO3	241
CCR	XPW02	Porewater	2022/08/24	Alkalinity, carbonate	mg/L CaCO3	10.0
CCR	XPW02	Porewater	2021/03/30	Barium, total	mg/L	0.110
CCR	XPW02	Porewater	2021/04/22	Barium, total	mg/L	0.0890
CCR	XPW02	Porewater	2021/05/05	Barium, total	mg/L	0.110
CCR	XPW02	Porewater	2021/05/19	Barium, total	mg/L	0.0890
CCR	XPW02	Porewater	2021/07/27	Barium, total	mg/L	0.0830
CCR	XPW02	Porewater	2023/08/10	Barium, total	mg/L	0.118
CCR	XPW02	Porewater	2021/03/30	Boron, total	mg/L	2.40
CCR	XPW02	Porewater	2021/04/22	Boron, total	mg/L	2.20
CCR	XPW02	Porewater	2021/05/05	Boron, total	mg/L	2.40
CCR	XPW02	Porewater	2021/05/19	Boron, total	mg/L	2.40
CCR	XPW02	Porewater	2021/07/27	Boron, total	mg/L	2.40
CCR	XPW02	Porewater	2023/08/10	Boron, total	mg/L	1.92
CCR	XPW02	Porewater	2021/03/30	Calcium, total	mg/L	210
CCR	XPW02	Porewater	2021/04/22	Calcium, total	mg/L	220
CCR	XPW02	Porewater	2021/05/05	Calcium, total	mg/L	230
CCR	XPW02	Porewater	2021/05/19	Calcium, total	mg/L	220
CCR	XPW02	Porewater	2021/07/27	Calcium, total	mg/L	210
CCR	XPW02	Porewater	2022/06/15	Calcium, total	mg/L	180
CCR	XPW02	Porewater	2022/08/24	Calcium, total	mg/L	140
CCR	XPW02	Porewater	2023/02/15	Calcium, total	mg/L	210
CCR	XPW02	Porewater	2023/08/10	Calcium, total	mg/L	103
CCR	XPW02	Porewater	2023/11/17	Calcium, total	mg/L	104
CCR	XPW02	Porewater	2021/03/30	Chloride, total	mg/L	17.0
CCR	XPW02	Porewater	2021/04/22	Chloride, total	mg/L	17.0
CCR	XPW02	Porewater	2021/05/05	Chloride, total	mg/L	17.0
CCR	XPW02	Porewater	2021/05/19	Chloride, total	mg/L	1.50
CCR	XPW02	Porewater	2021/07/27	Chloride, total	mg/L	14.0
CCR	XPW02	Porewater	2022/06/15	Chloride, total	mg/L	11.0
CCR	XPW02	Porewater	2022/08/24	Chloride, total	mg/L	7.20
CCR	XPW02	Porewater	2023/02/15	Chloride, total	mg/L	11.0
CCR	XPW02	Porewater	2023/08/10	Chloride, total	mg/L	8.00
CCR	XPW02	Porewater	2023/11/17	Chloride, total	mg/L	8.00
CCR	XPW02	Porewater	2023/06/06	Ferrous Iron, dissolved	mg/L	0.970
CCR	XPW02	Porewater	2023/06/06	Iron, dissolved	mg/L	1.30
CCR	XPW02	Porewater	2023/08/10	Iron, dissolved	mg/L	0.742
CCR	XPW02	Porewater	2021/03/30	Magnesium, total	mg/L	27.0
CCR	XPW02	Porewater	2021/04/22	Magnesium, total	mg/L	25.0
CCR	XPW02	Porewater	2021/05/05	Magnesium, total	mg/L	29.0
CCR	XPW02	Porewater	2021/05/19	Magnesium, total	mg/L	32.0
CCR	XPW02	Porewater	2021/07/27	Magnesium, total	mg/L	29.0
CCR	XPW02	Porewater	2022/06/15	Magnesium, total	mg/L	25.0
CCR	XPW02	Porewater	2022/08/24	Magnesium, total	mg/L	19.0
CCR	XPW02	Porewater	2023/02/15	Magnesium, total	mg/L	20.0
CCR	XPW02	Porewater	2023/08/10	Magnesium, total	mg/L	15.5
CCR	XPW02	Porewater	2023/11/17	Magnesium, total	mg/L	16.5
CCR	XPW02	Porewater	2023/06/06	Manganese, dissolved	mg/L	0.120
CCR	XPW02	Porewater	2023/08/10	Manganese, dissolved	mg/L	0.0809
CCR	XPW02	Porewater	2023/08/10	Phosphate, dissolved	mg/L	0.0210
CCR	XPW02	Porewater	2021/03/30	Potassium, total	mg/L	19.0
CCR	XPW02	Porewater	2021/04/22	Potassium, total	mg/L	20.0
CCR	XPW02	Porewater	2021/05/05	Potassium, total	mg/L	20.0
CCR	XPW02	Porewater	2021/05/19	Potassium, total	mg/L	20.0
CCR	XPW02	Porewater	2021/07/27	Potassium, total	mg/L	20.0
CCR	XPW02	Porewater	2022/06/15	Potassium, total	mg/L	19.0
CCR	XPW02	Porewater	2022/08/24	Potassium, total	mg/L	16.0
CCR	XPW02	Porewater	2023/02/15	Potassium, total	mg/L	21.0
CCR	XPW02	Porewater	2023/08/10	Potassium, total	mg/L	16.2
CCR	XPW02	Porewater	2023/11/17	Potassium, total	mg/L	20.0
CCR	XPW02	Porewater	2023/06/06	Silicon, dissolved	mg/L	6.40

CCR	XPW02	Porewater	2023/08/10	Silicon, dissolved	mg/L	8.65
CCR	XPW02	Porewater	2021/03/30	Sodium, total	mg/L	76.0
CCR	XPW02	Porewater	2021/04/22	Sodium, total	mg/L	73.0
CCR	XPW02	Porewater	2021/05/05	Sodium, total	mg/L	75.0
CCR	XPW02	Porewater	2021/05/19	Sodium, total	mg/L	67.0
CCR	XPW02	Porewater	2021/07/27	Sodium, total	mg/L	74.0
CCR	XPW02	Porewater	2022/06/15	Sodium, total	mg/L	64.0
CCR	XPW02	Porewater	2022/08/24	Sodium, total	mg/L	51.0
CCR	XPW02	Porewater	2023/02/15	Sodium, total	mg/L	68.0
CCR	XPW02	Porewater	2023/08/10	Sodium, total	mg/L	42.3
CCR	XPW02	Porewater	2023/11/17	Sodium, total	mg/L	43.7
CCR	XPW02	Porewater	2021/03/30	Sulfate, total	mg/L	570
CCR	XPW02	Porewater	2021/04/22	Sulfate, total	mg/L	620
CCR	XPW02	Porewater	2021/05/05	Sulfate, total	mg/L	610
CCR	XPW02	Porewater	2021/05/19	Sulfate, total	mg/L	650
CCR	XPW02	Porewater	2021/07/27	Sulfate, total	mg/L	600
CCR	XPW02	Porewater	2022/06/15	Sulfate, total	mg/L	580
CCR	XPW02	Porewater	2022/08/24	Sulfate, total	mg/L	340
CCR	XPW02	Porewater	2023/02/15	Sulfate, total	mg/L	530
CCR	XPW02	Porewater	2023/08/10	Sulfate, total	mg/L	201
CCR	XPW02	Porewater	2023/11/17	Sulfate, total	mg/L	175
CCR	XPW02	Porewater	2021/03/30	Temperature (Celsius)	degrees C	18.4
CCR	XPW02	Porewater	2021/04/22	Temperature (Celsius)	degrees C	17.8
CCR	XPW02	Porewater	2021/05/05	Temperature (Celsius)	degrees C	18.9
CCR	XPW02	Porewater	2021/05/19	Temperature (Celsius)	degrees C	20.4
CCR	XPW02	Porewater	2021/07/27	Temperature (Celsius)	degrees C	24.6
CCR	XPW02	Porewater	2022/06/15	Temperature (Celsius)	degrees C	21.6
CCR	XPW02	Porewater	2022/08/24	Temperature (Celsius)	degrees C	19.9
CCR	XPW02	Porewater	2023/02/15	Temperature (Celsius)	degrees C	15.3
CCR	XPW02	Porewater	2023/08/10	Temperature (Celsius)	degrees C	18.7
CCR	XPW02	Porewater	2023/11/17	Temperature (Celsius)	degrees C	19.5
CCR	XPW02	Porewater	2021/03/30	Total Dissolved Solids	mg/L	1,000
CCR	XPW02	Porewater	2021/04/22	Total Dissolved Solids	mg/L	1,000
CCR	XPW02	Porewater	2021/05/05	Total Dissolved Solids	mg/L	1,000
CCR	XPW02	Porewater	2021/05/19	Total Dissolved Solids	mg/L	1,100
CCR	XPW02	Porewater	2021/07/27	Total Dissolved Solids	mg/L	1,100
CCR	XPW02	Porewater	2022/06/15	Total Dissolved Solids	mg/L	1,000
CCR	XPW02	Porewater	2022/08/24	Total Dissolved Solids	mg/L	760
CCR	XPW02	Porewater	2023/02/15	Total Dissolved Solids	mg/L	930
CCR	XPW02	Porewater	2023/08/10	Total Dissolved Solids	mg/L	522
CCR	XPW02	Porewater	2023/11/17	Total Dissolved Solids	mg/L	544
DA	G314D	C	2021/03/30	pH (field)	SU	7.3
DA	G314D	C	2021/04/21	pH (field)	SU	7.2
DA	G314D	C	2021/05/04	pH (field)	SU	7.2
DA	G314D	C	2021/05/19	pH (field)	SU	7.2
DA	G314D	C	2021/07/28	pH (field)	SU	7.2
DA	G314D	C	2023/02/16	pH (field)	SU	6.9
DA	G314D	C	2023/06/01	pH (field)	SU	7.1
DA	G314D	C	2023/08/09	pH (field)	SU	6.8
DA	G314D	C	2023/11/20	pH (field)	SU	6.7
DA	G314D	C	2021/03/30	Oxidation Reduction Potential	mV	-21.8
DA	G314D	C	2021/04/21	Oxidation Reduction Potential	mV	62.7
DA	G314D	C	2021/05/04	Oxidation Reduction Potential	mV	77.7
DA	G314D	C	2021/05/19	Oxidation Reduction Potential	mV	130
DA	G314D	C	2021/07/28	Oxidation Reduction Potential	mV	94.8
DA	G314D	C	2023/02/16	Oxidation Reduction Potential	mV	175
DA	G314D	C	2023/06/01	Oxidation Reduction Potential	mV	-8.30
DA	G314D	C	2023/08/09	Oxidation Reduction Potential	mV	-45.0
DA	G314D	C	2023/11/20	Oxidation Reduction Potential	mV	-54.0
DA	G314D	C	2021/03/30	Eh	V	0.17
DA	G314D	C	2021/04/21	Eh	V	0.26
DA	G314D	C	2021/05/04	Eh	V	0.27

DA	G314D	C	2021/05/19	Eh	V	0.33
DA	G314D	C	2021/07/28	Eh	V	0.29
DA	G314D	C	2023/02/16	Eh	V	0.37
DA	G314D	C	2023/06/01	Eh	V	0.19
DA	G314D	C	2023/08/09	Eh	V	0.15
DA	G314D	C	2023/11/20	Eh	V	0.14
DA	G314D	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	520
DA	G314D	C	2021/04/21	Alkalinity, bicarbonate	mg/L CaCO3	560
DA	G314D	C	2021/05/19	Alkalinity, bicarbonate	mg/L CaCO3	550
DA	G314D	C	2021/07/28	Alkalinity, bicarbonate	mg/L CaCO3	550
DA	G314D	C	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	620
DA	G314D	C	2023/06/01	Alkalinity, bicarbonate	mg/L CaCO3	680
DA	G314D	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	719
DA	G314D	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	741
DA	G314D	C	2021/03/30	Barium, total	mg/L	0.0490
DA	G314D	C	2021/04/21	Barium, total	mg/L	0.0480
DA	G314D	C	2021/05/04	Barium, total	mg/L	0.0450
DA	G314D	C	2021/05/19	Barium, total	mg/L	0.0520
DA	G314D	C	2021/07/28	Barium, total	mg/L	0.0460
DA	G314D	C	2023/02/16	Barium, total	mg/L	0.0370
DA	G314D	C	2023/06/01	Barium, total	mg/L	0.0160
DA	G314D	C	2023/08/09	Barium, total	mg/L	0.0351
DA	G314D	C	2023/11/20	Barium, total	mg/L	0.0395
DA	G314D	C	2021/03/30	Boron, total	mg/L	0.180
DA	G314D	C	2021/04/21	Boron, total	mg/L	0.170
DA	G314D	C	2021/05/04	Boron, total	mg/L	0.180
DA	G314D	C	2021/05/19	Boron, total	mg/L	0.160
DA	G314D	C	2021/07/28	Boron, total	mg/L	0.140
DA	G314D	C	2023/02/16	Boron, total	mg/L	0.190
DA	G314D	C	2023/06/01	Boron, total	mg/L	0.130
DA	G314D	C	2023/08/09	Boron, total	mg/L	0.190
DA	G314D	C	2023/11/20	Boron, total	mg/L	0.236
DA	G314D	C	2021/03/30	Calcium, total	mg/L	110
DA	G314D	C	2021/04/21	Calcium, total	mg/L	130
DA	G314D	C	2021/05/04	Calcium, total	mg/L	130
DA	G314D	C	2021/05/19	Calcium, total	mg/L	140
DA	G314D	C	2021/07/28	Calcium, total	mg/L	160
DA	G314D	C	2023/02/16	Calcium, total	mg/L	230
DA	G314D	C	2023/06/01	Calcium, total	mg/L	770
DA	G314D	C	2023/08/09	Calcium, total	mg/L	274
DA	G314D	C	2023/11/20	Calcium, total	mg/L	299
DA	G314D	C	2021/03/30	Chloride, total	mg/L	170
DA	G314D	C	2021/04/21	Chloride, total	mg/L	180
DA	G314D	C	2021/05/19	Chloride, total	mg/L	130
DA	G314D	C	2021/07/28	Chloride, total	mg/L	93.0
DA	G314D	C	2023/02/16	Chloride, total	mg/L	60.0
DA	G314D	C	2023/06/01	Chloride, total	mg/L	59.0
DA	G314D	C	2023/08/09	Chloride, total	mg/L	63.0
DA	G314D	C	2023/11/20	Chloride, total	mg/L	58.0
DA	G314D	C	2023/06/01	Ferrous Iron, dissolved	mg/L	0.420
DA	G314D	C	2023/06/01	Iron, dissolved	mg/L	4.90
DA	G314D	C	2023/08/09	Iron, dissolved	mg/L	0.704
DA	G314D	C	2021/03/30	Magnesium, total	mg/L	32.0
DA	G314D	C	2021/04/21	Magnesium, total	mg/L	37.0
DA	G314D	C	2021/05/04	Magnesium, total	mg/L	36.0
DA	G314D	C	2021/05/19	Magnesium, total	mg/L	43.0
DA	G314D	C	2021/07/28	Magnesium, total	mg/L	50.0
DA	G314D	C	2023/02/16	Magnesium, total	mg/L	79.0
DA	G314D	C	2023/06/01	Magnesium, total	mg/L	260
DA	G314D	C	2023/08/09	Magnesium, total	mg/L	94.3
DA	G314D	C	2023/11/20	Magnesium, total	mg/L	101
DA	G314D	C	2023/06/01	Manganese, dissolved	mg/L	1.40

DA	G314D	C	2023/08/09	Manganese, dissolved	mg/L	1.01
DA	G314D	C	2023/08/09	Phosphate, dissolved	mg/L	<0.005
DA	G314D	C	2021/03/30	Potassium, total	mg/L	4.70
DA	G314D	C	2021/04/21	Potassium, total	mg/L	4.60
DA	G314D	C	2021/05/04	Potassium, total	mg/L	5.00
DA	G314D	C	2021/05/19	Potassium, total	mg/L	3.50
DA	G314D	C	2021/07/28	Potassium, total	mg/L	3.50
DA	G314D	C	2023/02/16	Potassium, total	mg/L	3.10
DA	G314D	C	2023/06/01	Potassium, total	mg/L	3.30
DA	G314D	C	2023/08/09	Potassium, total	mg/L	3.54
DA	G314D	C	2023/11/20	Potassium, total	mg/L	3.76
DA	G314D	C	2023/06/01	Silicon, dissolved	mg/L	6.20
DA	G314D	C	2023/08/09	Silicon, dissolved	mg/L	5.20
DA	G314D	C	2021/03/30	Sodium, total	mg/L	700
DA	G314D	C	2021/04/21	Sodium, total	mg/L	670
DA	G314D	C	2021/05/04	Sodium, total	mg/L	650
DA	G314D	C	2021/05/19	Sodium, total	mg/L	500
DA	G314D	C	2021/07/28	Sodium, total	mg/L	370
DA	G314D	C	2023/02/16	Sodium, total	mg/L	350
DA	G314D	C	2023/06/01	Sodium, total	mg/L	130
DA	G314D	C	2023/08/09	Sodium, total	mg/L	436
DA	G314D	C	2023/11/20	Sodium, total	mg/L	461
DA	G314D	C	2021/03/30	Sulfate, total	mg/L	1,100
DA	G314D	C	2021/04/21	Sulfate, total	mg/L	1,000
DA	G314D	C	2021/05/19	Sulfate, total	mg/L	820
DA	G314D	C	2021/07/28	Sulfate, total	mg/L	670
DA	G314D	C	2023/02/16	Sulfate, total	mg/L	810
DA	G314D	C	2023/06/01	Sulfate, total	mg/L	1,100
DA	G314D	C	2023/08/09	Sulfate, total	mg/L	1,090
DA	G314D	C	2023/11/20	Sulfate, total	mg/L	1,080
DA	G314D	C	2021/03/30	Temperature (Celsius)	degrees C	15.9
DA	G314D	C	2021/04/21	Temperature (Celsius)	degrees C	13.0
DA	G314D	C	2021/05/04	Temperature (Celsius)	degrees C	14.4
DA	G314D	C	2021/05/19	Temperature (Celsius)	degrees C	15.4
DA	G314D	C	2021/07/28	Temperature (Celsius)	degrees C	20.8
DA	G314D	C	2023/02/16	Temperature (Celsius)	degrees C	10.6
DA	G314D	C	2023/06/01	Temperature (Celsius)	degrees C	15.0
DA	G314D	C	2023/08/09	Temperature (Celsius)	degrees C	15.1
DA	G314D	C	2023/11/20	Temperature (Celsius)	degrees C	14.4
DA	G314D	C	2021/03/30	Total Dissolved Solids	mg/L	2,400
DA	G314D	C	2021/04/21	Total Dissolved Solids	mg/L	2,400
DA	G314D	C	2021/05/19	Total Dissolved Solids	mg/L	1,800
DA	G314D	C	2021/07/28	Total Dissolved Solids	mg/L	1,600
DA	G314D	C	2023/02/16	Total Dissolved Solids	mg/L	2,100
DA	G314D	C	2023/06/01	Total Dissolved Solids	mg/L	2,400
DA	G314D	C	2023/08/09	Total Dissolved Solids	mg/L	2,380
DA	G314D	C	2023/11/20	Total Dissolved Solids	mg/L	2,420
LCU	G307D	C	2021/03/29	pH (field)	SU	7.3
LCU	G307D	C	2021/04/21	pH (field)	SU	7.2
LCU	G307D	C	2021/05/04	pH (field)	SU	7.3
LCU	G307D	C	2021/05/18	pH (field)	SU	7.3
LCU	G307D	C	2021/07/27	pH (field)	SU	7.2
LCU	G307D	C	2023/02/15	pH (field)	SU	7.2
LCU	G307D	C	2023/06/05	pH (field)	SU	7.3
LCU	G307D	C	2023/08/10	pH (field)	SU	7.2
LCU	G307D	C	2023/11/17	pH (field)	SU	7.0
LCU	G307D	C	2021/03/29	Oxidation Reduction Potential	mV	186
LCU	G307D	C	2021/04/21	Oxidation Reduction Potential	mV	-15.1
LCU	G307D	C	2021/05/04	Oxidation Reduction Potential	mV	-2.90
LCU	G307D	C	2021/05/18	Oxidation Reduction Potential	mV	-50.3
LCU	G307D	C	2021/07/27	Oxidation Reduction Potential	mV	-62.4
LCU	G307D	C	2023/02/15	Oxidation Reduction Potential	mV	-43.0

LCU	G307D	C	2023/06/05	Oxidation Reduction Potential	mV	-40.5
LCU	G307D	C	2023/08/10	Oxidation Reduction Potential	mV	-70.0
LCU	G307D	C	2023/11/17	Oxidation Reduction Potential	mV	-101
LCU	G307D	C	2021/03/29	Eh	V	0.38
LCU	G307D	C	2021/04/21	Eh	V	0.18
LCU	G307D	C	2021/05/04	Eh	V	0.19
LCU	G307D	C	2021/05/18	Eh	V	0.14
LCU	G307D	C	2021/07/27	Eh	V	0.13
LCU	G307D	C	2023/02/15	Eh	V	0.15
LCU	G307D	C	2023/06/05	Eh	V	0.15
LCU	G307D	C	2023/08/10	Eh	V	0.12
LCU	G307D	C	2023/11/17	Eh	V	0.094
LCU	G307D	C	2021/03/29	Alkalinity, bicarbonate	mg/L CaCO3	200
LCU	G307D	C	2021/05/04	Alkalinity, bicarbonate	mg/L CaCO3	200
LCU	G307D	C	2021/05/18	Alkalinity, bicarbonate	mg/L CaCO3	200
LCU	G307D	C	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	200
LCU	G307D	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	220
LCU	G307D	C	2023/06/05	Alkalinity, bicarbonate	mg/L CaCO3	240
LCU	G307D	C	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	186
LCU	G307D	C	2023/11/17	Alkalinity, bicarbonate	mg/L CaCO3	317
LCU	G307D	C	2021/03/29	Barium, total	mg/L	0.0440
LCU	G307D	C	2021/04/21	Barium, total	mg/L	0.0400
LCU	G307D	C	2021/05/04	Barium, total	mg/L	0.0370
LCU	G307D	C	2021/05/18	Barium, total	mg/L	0.0350
LCU	G307D	C	2021/07/27	Barium, total	mg/L	0.0320
LCU	G307D	C	2023/02/15	Barium, total	mg/L	0.0400
LCU	G307D	C	2023/06/05	Barium, total	mg/L	0.0320
LCU	G307D	C	2023/08/10	Barium, total	mg/L	0.0217
LCU	G307D	C	2023/11/17	Barium, total	mg/L	0.0550
LCU	G307D	C	2021/03/29	Boron, total	mg/L	1.40
LCU	G307D	C	2021/04/21	Boron, total	mg/L	1.40
LCU	G307D	C	2021/05/04	Boron, total	mg/L	1.40
LCU	G307D	C	2021/05/18	Boron, total	mg/L	1.40
LCU	G307D	C	2021/07/27	Boron, total	mg/L	1.70
LCU	G307D	C	2023/02/15	Boron, total	mg/L	1.20
LCU	G307D	C	2023/06/05	Boron, total	mg/L	1.50
LCU	G307D	C	2023/08/10	Boron, total	mg/L	2.54
LCU	G307D	C	2023/11/17	Boron, total	mg/L	1.01
LCU	G307D	C	2021/03/29	Calcium, total	mg/L	170
LCU	G307D	C	2021/04/21	Calcium, total	mg/L	180
LCU	G307D	C	2021/05/04	Calcium, total	mg/L	180
LCU	G307D	C	2021/05/18	Calcium, total	mg/L	180
LCU	G307D	C	2021/07/27	Calcium, total	mg/L	160
LCU	G307D	C	2023/02/15	Calcium, total	mg/L	170
LCU	G307D	C	2023/06/05	Calcium, total	mg/L	150
LCU	G307D	C	2023/08/10	Calcium, total	mg/L	136
LCU	G307D	C	2023/11/17	Calcium, total	mg/L	152
LCU	G307D	C	2021/03/29	Chloride, total	mg/L	34.0
LCU	G307D	C	2021/05/04	Chloride, total	mg/L	29.0
LCU	G307D	C	2021/05/18	Chloride, total	mg/L	28.0
LCU	G307D	C	2021/07/27	Chloride, total	mg/L	22.0
LCU	G307D	C	2023/02/15	Chloride, total	mg/L	17.0
LCU	G307D	C	2023/06/05	Chloride, total	mg/L	16.0
LCU	G307D	C	2023/08/10	Chloride, total	mg/L	14.0
LCU	G307D	C	2023/11/17	Chloride, total	mg/L	19.0
LCU	G307D	C	2023/06/05	Ferrous Iron, dissolved	mg/L	0.220
LCU	G307D	C	2023/06/05	Iron, dissolved	mg/L	0.200
LCU	G307D	C	2023/08/10	Iron, dissolved	mg/L	0.990
LCU	G307D	C	2021/03/29	Magnesium, total	mg/L	74.0
LCU	G307D	C	2021/04/21	Magnesium, total	mg/L	66.0
LCU	G307D	C	2021/05/04	Magnesium, total	mg/L	71.0
LCU	G307D	C	2021/05/18	Magnesium, total	mg/L	72.0

LCU	G307D	C	2021/07/27	Magnesium, total	mg/L	66.0
LCU	G307D	C	2023/02/15	Magnesium, total	mg/L	59.0
LCU	G307D	C	2023/06/05	Magnesium, total	mg/L	65.0
LCU	G307D	C	2023/08/10	Magnesium, total	mg/L	61.4
LCU	G307D	C	2023/11/17	Magnesium, total	mg/L	56.2
LCU	G307D	C	2023/06/05	Manganese, dissolved	mg/L	0.580
LCU	G307D	C	2023/08/10	Manganese, dissolved	mg/L	0.417
LCU	G307D	C	2023/08/10	Phosphate, dissolved	mg/L	<0.005
LCU	G307D	C	2021/03/29	Potassium, total	mg/L	1.60
LCU	G307D	C	2021/04/21	Potassium, total	mg/L	1.40
LCU	G307D	C	2021/05/04	Potassium, total	mg/L	1.30
LCU	G307D	C	2021/05/18	Potassium, total	mg/L	1.50
LCU	G307D	C	2021/07/27	Potassium, total	mg/L	1.00
LCU	G307D	C	2023/02/15	Potassium, total	mg/L	1.00
LCU	G307D	C	2023/06/05	Potassium, total	mg/L	0.460
LCU	G307D	C	2023/08/10	Potassium, total	mg/L	0.695
LCU	G307D	C	2023/11/17	Potassium, total	mg/L	1.35
LCU	G307D	C	2023/06/05	Silicon, dissolved	mg/L	6.10
LCU	G307D	C	2023/08/10	Silicon, dissolved	mg/L	4.96
LCU	G307D	C	2021/03/29	Sodium, total	mg/L	150
LCU	G307D	C	2021/04/21	Sodium, total	mg/L	140
LCU	G307D	C	2021/05/04	Sodium, total	mg/L	160
LCU	G307D	C	2021/05/18	Sodium, total	mg/L	150
LCU	G307D	C	2021/07/27	Sodium, total	mg/L	120
LCU	G307D	C	2023/02/15	Sodium, total	mg/L	110
LCU	G307D	C	2023/06/05	Sodium, total	mg/L	94.0
LCU	G307D	C	2023/08/10	Sodium, total	mg/L	99.8
LCU	G307D	C	2023/11/17	Sodium, total	mg/L	126
LCU	G307D	C	2021/03/29	Sulfate, total	mg/L	820
LCU	G307D	C	2021/05/04	Sulfate, total	mg/L	850
LCU	G307D	C	2021/05/18	Sulfate, total	mg/L	840
LCU	G307D	C	2021/07/27	Sulfate, total	mg/L	790
LCU	G307D	C	2023/02/15	Sulfate, total	mg/L	660
LCU	G307D	C	2023/06/05	Sulfate, total	mg/L	610
LCU	G307D	C	2023/08/10	Sulfate, total	mg/L	589
LCU	G307D	C	2023/11/17	Sulfate, total	mg/L	537
LCU	G307D	C	2021/03/29	Temperature (Celsius)	degrees C	14.4
LCU	G307D	C	2021/04/21	Temperature (Celsius)	degrees C	14.0
LCU	G307D	C	2021/05/04	Temperature (Celsius)	degrees C	14.0
LCU	G307D	C	2021/05/18	Temperature (Celsius)	degrees C	15.3
LCU	G307D	C	2021/07/27	Temperature (Celsius)	degrees C	24.1
LCU	G307D	C	2023/02/15	Temperature (Celsius)	degrees C	14.4
LCU	G307D	C	2023/06/05	Temperature (Celsius)	degrees C	19.2
LCU	G307D	C	2023/08/10	Temperature (Celsius)	degrees C	19.8
LCU	G307D	C	2023/11/17	Temperature (Celsius)	degrees C	15.4
LCU	G307D	C	2021/03/29	Total Dissolved Solids	mg/L	1,400
LCU	G307D	C	2021/05/04	Total Dissolved Solids	mg/L	1,300
LCU	G307D	C	2021/05/18	Total Dissolved Solids	mg/L	1,500
LCU	G307D	C	2021/07/27	Total Dissolved Solids	mg/L	1,400
LCU	G307D	C	2023/02/15	Total Dissolved Solids	mg/L	1,200
LCU	G307D	C	2023/06/05	Total Dissolved Solids	mg/L	1,100
LCU	G307D	C	2023/08/10	Total Dissolved Solids	mg/L	1,080
LCU	G307D	C	2023/11/17	Total Dissolved Solids	mg/L	1,040
LCU	G314	C	2021/03/30	pH (field)	SU	6.8
LCU	G314	C	2021/04/21	pH (field)	SU	6.6
LCU	G314	C	2021/05/04	pH (field)	SU	7.1
LCU	G314	C	2021/05/17	pH (field)	SU	6.6
LCU	G314	C	2021/06/14	pH (field)	SU	6.6
LCU	G314	C	2021/06/28	pH (field)	SU	6.6
LCU	G314	C	2021/07/13	pH (field)	SU	6.7
LCU	G314	C	2021/07/27	pH (field)	SU	6.6
LCU	G314	C	2023/02/16	pH (field)	SU	6.5

LCU	G314	C	2023/06/01	pH (field)	SU	6.8
LCU	G314	C	2023/08/09	pH (field)	SU	6.4
LCU	G314	C	2023/11/20	pH (field)	SU	6.5
LCU	G314	C	2021/03/30	Oxidation Reduction Potential	mV	177
LCU	G314	C	2021/04/21	Oxidation Reduction Potential	mV	96.8
LCU	G314	C	2021/05/04	Oxidation Reduction Potential	mV	82.1
LCU	G314	C	2021/05/17	Oxidation Reduction Potential	mV	64.9
LCU	G314	C	2021/06/14	Oxidation Reduction Potential	mV	41.1
LCU	G314	C	2021/06/28	Oxidation Reduction Potential	mV	-14.0
LCU	G314	C	2021/07/13	Oxidation Reduction Potential	mV	-17.9
LCU	G314	C	2021/07/27	Oxidation Reduction Potential	mV	-39.1
LCU	G314	C	2023/02/16	Oxidation Reduction Potential	mV	138
LCU	G314	C	2023/06/01	Oxidation Reduction Potential	mV	-4.40
LCU	G314	C	2023/08/09	Oxidation Reduction Potential	mV	-41.0
LCU	G314	C	2023/11/20	Oxidation Reduction Potential	mV	-34.0
LCU	G314	C	2021/03/30	Eh	V	0.37
LCU	G314	C	2021/04/21	Eh	V	0.29
LCU	G314	C	2021/05/04	Eh	V	0.28
LCU	G314	C	2021/05/17	Eh	V	0.26
LCU	G314	C	2021/06/14	Eh	V	0.23
LCU	G314	C	2021/06/28	Eh	V	0.18
LCU	G314	C	2021/07/13	Eh	V	0.18
LCU	G314	C	2021/07/27	Eh	V	0.15
LCU	G314	C	2023/02/16	Eh	V	0.34
LCU	G314	C	2023/06/01	Eh	V	0.19
LCU	G314	C	2023/08/09	Eh	V	0.15
LCU	G314	C	2023/11/20	Eh	V	0.16
LCU	G314	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	590
LCU	G314	C	2021/04/21	Alkalinity, bicarbonate	mg/L CaCO3	680
LCU	G314	C	2021/05/04	Alkalinity, bicarbonate	mg/L CaCO3	660
LCU	G314	C	2021/05/17	Alkalinity, bicarbonate	mg/L CaCO3	660
LCU	G314	C	2021/06/14	Alkalinity, bicarbonate	mg/L CaCO3	680
LCU	G314	C	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	640
LCU	G314	C	2021/07/13	Alkalinity, bicarbonate	mg/L CaCO3	240
LCU	G314	C	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	750
LCU	G314	C	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	660
LCU	G314	C	2023/06/01	Alkalinity, bicarbonate	mg/L CaCO3	660
LCU	G314	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	710
LCU	G314	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	707
LCU	G314	C	2021/03/30	Barium, total	mg/L	0.0350
LCU	G314	C	2021/04/21	Barium, total	mg/L	0.0260
LCU	G314	C	2021/05/04	Barium, total	mg/L	0.0260
LCU	G314	C	2021/05/17	Barium, total	mg/L	0.0210
LCU	G314	C	2021/06/14	Barium, total	mg/L	0.0210
LCU	G314	C	2021/06/28	Barium, total	mg/L	0.0210
LCU	G314	C	2021/07/13	Barium, total	mg/L	0.0220
LCU	G314	C	2021/07/27	Barium, total	mg/L	0.0200
LCU	G314	C	2023/02/16	Barium, total	mg/L	0.0160
LCU	G314	C	2023/06/01	Barium, total	mg/L	0.0370
LCU	G314	C	2023/08/09	Barium, total	mg/L	0.0183
LCU	G314	C	2023/11/20	Barium, total	mg/L	0.0225
LCU	G314	C	2021/03/30	Boron, total	mg/L	0.240
LCU	G314	C	2021/04/21	Boron, total	mg/L	0.160
LCU	G314	C	2021/05/04	Boron, total	mg/L	0.220
LCU	G314	C	2021/05/17	Boron, total	mg/L	0.420
LCU	G314	C	2021/06/14	Boron, total	mg/L	0.150
LCU	G314	C	2021/06/28	Boron, total	mg/L	0.120
LCU	G314	C	2021/07/13	Boron, total	mg/L	0.140
LCU	G314	C	2021/07/27	Boron, total	mg/L	0.230
LCU	G314	C	2023/02/16	Boron, total	mg/L	0.140
LCU	G314	C	2023/06/01	Boron, total	mg/L	0.190
LCU	G314	C	2023/08/09	Boron, total	mg/L	0.130

LCU	G314	C	2023/11/20	Boron, total	mg/L	0.206
LCU	G314	C	2021/03/30	Calcium, total	mg/L	570
LCU	G314	C	2021/04/21	Calcium, total	mg/L	640
LCU	G314	C	2021/05/04	Calcium, total	mg/L	660
LCU	G314	C	2021/05/17	Calcium, total	mg/L	630
LCU	G314	C	2021/06/14	Calcium, total	mg/L	660
LCU	G314	C	2021/06/28	Calcium, total	mg/L	620
LCU	G314	C	2021/07/13	Calcium, total	mg/L	620
LCU	G314	C	2021/07/27	Calcium, total	mg/L	630
LCU	G314	C	2023/02/16	Calcium, total	mg/L	690
LCU	G314	C	2023/06/01	Calcium, total	mg/L	250
LCU	G314	C	2023/08/09	Calcium, total	mg/L	631
LCU	G314	C	2023/11/20	Calcium, total	mg/L	662
LCU	G314	C	2021/03/30	Chloride, total	mg/L	36.0
LCU	G314	C	2021/04/21	Chloride, total	mg/L	35.0
LCU	G314	C	2021/05/04	Chloride, total	mg/L	34.0
LCU	G314	C	2021/05/17	Chloride, total	mg/L	37.0
LCU	G314	C	2021/06/14	Chloride, total	mg/L	100
LCU	G314	C	2021/06/28	Chloride, total	mg/L	36.0
LCU	G314	C	2021/07/13	Chloride, total	mg/L	30.0
LCU	G314	C	2021/07/27	Chloride, total	mg/L	33.0
LCU	G314	C	2023/02/16	Chloride, total	mg/L	32.0
LCU	G314	C	2023/06/01	Chloride, total	mg/L	30.0
LCU	G314	C	2023/08/09	Chloride, total	mg/L	31.0
LCU	G314	C	2023/11/20	Chloride, total	mg/L	31.0
LCU	G314	C	2023/06/01	Ferrous Iron, dissolved	mg/L	4.00
LCU	G314	C	2023/06/01	Iron, dissolved	mg/L	0.340
LCU	G314	C	2023/08/09	Iron, dissolved	mg/L	6.30
LCU	G314	C	2021/03/30	Magnesium, total	mg/L	250
LCU	G314	C	2021/04/21	Magnesium, total	mg/L	270
LCU	G314	C	2021/05/04	Magnesium, total	mg/L	260
LCU	G314	C	2021/05/17	Magnesium, total	mg/L	260
LCU	G314	C	2021/06/14	Magnesium, total	mg/L	280
LCU	G314	C	2021/06/28	Magnesium, total	mg/L	270
LCU	G314	C	2021/07/13	Magnesium, total	mg/L	260
LCU	G314	C	2021/07/27	Magnesium, total	mg/L	280
LCU	G314	C	2023/02/16	Magnesium, total	mg/L	260
LCU	G314	C	2023/06/01	Magnesium, total	mg/L	83.0
LCU	G314	C	2023/08/09	Magnesium, total	mg/L	295
LCU	G314	C	2023/11/20	Magnesium, total	mg/L	312
LCU	G314	C	2023/06/01	Manganese, dissolved	mg/L	1.10
LCU	G314	C	2023/08/09	Manganese, dissolved	mg/L	2.54
LCU	G314	C	2023/08/09	Phosphate, dissolved	mg/L	<0.005
LCU	G314	C	2021/03/30	Potassium, total	mg/L	8.50
LCU	G314	C	2021/04/21	Potassium, total	mg/L	6.00
LCU	G314	C	2021/05/04	Potassium, total	mg/L	6.30
LCU	G314	C	2021/05/17	Potassium, total	mg/L	5.50
LCU	G314	C	2021/06/14	Potassium, total	mg/L	5.50
LCU	G314	C	2021/06/28	Potassium, total	mg/L	4.30
LCU	G314	C	2021/07/13	Potassium, total	mg/L	4.00
LCU	G314	C	2021/07/27	Potassium, total	mg/L	4.50
LCU	G314	C	2023/02/16	Potassium, total	mg/L	3.30
LCU	G314	C	2023/06/01	Potassium, total	mg/L	3.10
LCU	G314	C	2023/08/09	Potassium, total	mg/L	4.06
LCU	G314	C	2023/11/20	Potassium, total	mg/L	4.44
LCU	G314	C	2023/06/01	Silicon, dissolved	mg/L	5.20
LCU	G314	C	2023/08/09	Silicon, dissolved	mg/L	6.35
LCU	G314	C	2021/03/30	Sodium, total	mg/L	130
LCU	G314	C	2021/04/21	Sodium, total	mg/L	120
LCU	G314	C	2021/05/04	Sodium, total	mg/L	130
LCU	G314	C	2021/05/17	Sodium, total	mg/L	120
LCU	G314	C	2021/06/14	Sodium, total	mg/L	130

LCU	G314	C	2021/06/28	Sodium, total	mg/L	120
LCU	G314	C	2021/07/13	Sodium, total	mg/L	120
LCU	G314	C	2021/07/27	Sodium, total	mg/L	120
LCU	G314	C	2023/02/16	Sodium, total	mg/L	120
LCU	G314	C	2023/06/01	Sodium, total	mg/L	390
LCU	G314	C	2023/08/09	Sodium, total	mg/L	136
LCU	G314	C	2023/11/20	Sodium, total	mg/L	149
LCU	G314	C	2021/03/30	Sulfate, total	mg/L	2,000
LCU	G314	C	2021/04/21	Sulfate, total	mg/L	2,100
LCU	G314	C	2021/05/04	Sulfate, total	mg/L	2,100
LCU	G314	C	2021/05/17	Sulfate, total	mg/L	2,200
LCU	G314	C	2021/06/14	Sulfate, total	mg/L	830
LCU	G314	C	2021/06/28	Sulfate, total	mg/L	2,000
LCU	G314	C	2021/07/13	Sulfate, total	mg/L	2,000
LCU	G314	C	2021/07/27	Sulfate, total	mg/L	2,400
LCU	G314	C	2023/02/16	Sulfate, total	mg/L	2,000
LCU	G314	C	2023/06/01	Sulfate, total	mg/L	2,000
LCU	G314	C	2023/08/09	Sulfate, total	mg/L	2,070
LCU	G314	C	2023/11/20	Sulfate, total	mg/L	2,190
LCU	G314	C	2021/03/30	Temperature (Celsius)	degrees C	14.0
LCU	G314	C	2021/04/21	Temperature (Celsius)	degrees C	11.7
LCU	G314	C	2021/05/04	Temperature (Celsius)	degrees C	14.9
LCU	G314	C	2021/05/17	Temperature (Celsius)	degrees C	14.7
LCU	G314	C	2021/06/14	Temperature (Celsius)	degrees C	17.6
LCU	G314	C	2021/06/28	Temperature (Celsius)	degrees C	20.1
LCU	G314	C	2021/07/13	Temperature (Celsius)	degrees C	16.9
LCU	G314	C	2021/07/27	Temperature (Celsius)	degrees C	20.0
LCU	G314	C	2023/02/16	Temperature (Celsius)	degrees C	9.60
LCU	G314	C	2023/06/01	Temperature (Celsius)	degrees C	16.1
LCU	G314	C	2023/08/09	Temperature (Celsius)	degrees C	16.7
LCU	G314	C	2023/11/20	Temperature (Celsius)	degrees C	15.1
LCU	G314	C	2021/03/30	Total Dissolved Solids	mg/L	3,400
LCU	G314	C	2021/04/21	Total Dissolved Solids	mg/L	3,700
LCU	G314	C	2021/05/04	Total Dissolved Solids	mg/L	3,600
LCU	G314	C	2021/05/17	Total Dissolved Solids	mg/L	3,600
LCU	G314	C	2021/06/14	Total Dissolved Solids	mg/L	1,900
LCU	G314	C	2021/06/28	Total Dissolved Solids	mg/L	3,700
LCU	G314	C	2021/07/13	Total Dissolved Solids	mg/L	4,000
LCU	G314	C	2021/07/27	Total Dissolved Solids	mg/L	3,800
LCU	G314	C	2023/02/16	Total Dissolved Solids	mg/L	3,800
LCU	G314	C	2023/06/01	Total Dissolved Solids	mg/L	3,700
LCU	G314	C	2023/08/09	Total Dissolved Solids	mg/L	3,780
LCU	G314	C	2023/11/20	Total Dissolved Solids	mg/L	3,850
LCU	G316	C	2021/03/30	pH (field)	SU	7.0
LCU	G316	C	2021/04/22	pH (field)	SU	7.0
LCU	G316	C	2021/05/05	pH (field)	SU	6.9
LCU	G316	C	2021/05/17	pH (field)	SU	7.1
LCU	G316	C	2021/06/14	pH (field)	SU	7.1
LCU	G316	C	2021/06/28	pH (field)	SU	7.1
LCU	G316	C	2021/07/13	pH (field)	SU	7.0
LCU	G316	C	2021/07/27	pH (field)	SU	7.0
LCU	G316	C	2023/02/16	pH (field)	SU	7.0
LCU	G316	C	2023/05/31	pH (field)	SU	7.2
LCU	G316	C	2023/08/09	pH (field)	SU	6.7
LCU	G316	C	2023/11/20	pH (field)	SU	6.8
LCU	G316	C	2021/03/30	Oxidation Reduction Potential	mV	-81.7
LCU	G316	C	2021/04/22	Oxidation Reduction Potential	mV	-80.3
LCU	G316	C	2021/05/05	Oxidation Reduction Potential	mV	-71.1
LCU	G316	C	2021/05/17	Oxidation Reduction Potential	mV	-99.4
LCU	G316	C	2021/06/14	Oxidation Reduction Potential	mV	-107
LCU	G316	C	2021/06/28	Oxidation Reduction Potential	mV	-112
LCU	G316	C	2021/07/13	Oxidation Reduction Potential	mV	-108

LCU	G316	C	2021/07/27	Oxidation Reduction Potential	mV	-114
LCU	G316	C	2023/02/16	Oxidation Reduction Potential	mV	-78.2
LCU	G316	C	2023/05/31	Oxidation Reduction Potential	mV	-94.3
LCU	G316	C	2023/08/09	Oxidation Reduction Potential	mV	-114
LCU	G316	C	2023/11/20	Oxidation Reduction Potential	mV	-117
LCU	G316	C	2021/03/30	Eh	V	0.12
LCU	G316	C	2021/04/22	Eh	V	0.12
LCU	G316	C	2021/05/05	Eh	V	0.13
LCU	G316	C	2021/05/17	Eh	V	0.097
LCU	G316	C	2021/06/14	Eh	V	0.087
LCU	G316	C	2021/06/28	Eh	V	0.081
LCU	G316	C	2021/07/13	Eh	V	0.084
LCU	G316	C	2021/07/27	Eh	V	0.079
LCU	G316	C	2023/02/16	Eh	V	0.12
LCU	G316	C	2023/05/31	Eh	V	0.10
LCU	G316	C	2023/08/09	Eh	V	0.081
LCU	G316	C	2023/11/20	Eh	V	0.078
LCU	G316	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	580
LCU	G316	C	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	590
LCU	G316	C	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	580
LCU	G316	C	2021/05/17	Alkalinity, bicarbonate	mg/L CaCO3	590
LCU	G316	C	2021/06/14	Alkalinity, bicarbonate	mg/L CaCO3	600
LCU	G316	C	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	580
LCU	G316	C	2021/07/13	Alkalinity, bicarbonate	mg/L CaCO3	560
LCU	G316	C	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	590
LCU	G316	C	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	610
LCU	G316	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	590
LCU	G316	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	646
LCU	G316	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	707
LCU	G316	C	2021/03/30	Barium, total	mg/L	0.0630
LCU	G316	C	2021/04/22	Barium, total	mg/L	0.0640
LCU	G316	C	2021/05/05	Barium, total	mg/L	0.0630
LCU	G316	C	2021/05/17	Barium, total	mg/L	0.0590
LCU	G316	C	2021/06/14	Barium, total	mg/L	0.0620
LCU	G316	C	2021/06/28	Barium, total	mg/L	0.0650
LCU	G316	C	2021/07/13	Barium, total	mg/L	0.0690
LCU	G316	C	2021/07/27	Barium, total	mg/L	0.0620
LCU	G316	C	2023/02/16	Barium, total	mg/L	0.0690
LCU	G316	C	2023/05/31	Barium, total	mg/L	0.0660
LCU	G316	C	2023/08/09	Barium, total	mg/L	0.0743
LCU	G316	C	2023/11/20	Barium, total	mg/L	0.0855
LCU	G316	C	2021/03/30	Boron, total	mg/L	0.350
LCU	G316	C	2021/04/22	Boron, total	mg/L	0.370
LCU	G316	C	2021/05/05	Boron, total	mg/L	0.350
LCU	G316	C	2021/05/17	Boron, total	mg/L	0.550
LCU	G316	C	2021/06/14	Boron, total	mg/L	0.420
LCU	G316	C	2021/06/28	Boron, total	mg/L	0.460
LCU	G316	C	2021/07/13	Boron, total	mg/L	0.490
LCU	G316	C	2021/07/27	Boron, total	mg/L	0.520
LCU	G316	C	2023/02/16	Boron, total	mg/L	0.330
LCU	G316	C	2023/05/31	Boron, total	mg/L	0.390
LCU	G316	C	2023/08/09	Boron, total	mg/L	0.441
LCU	G316	C	2023/11/20	Boron, total	mg/L	0.526
LCU	G316	C	2021/03/30	Calcium, total	mg/L	200
LCU	G316	C	2021/04/22	Calcium, total	mg/L	200
LCU	G316	C	2021/05/05	Calcium, total	mg/L	210
LCU	G316	C	2021/05/17	Calcium, total	mg/L	200
LCU	G316	C	2021/06/14	Calcium, total	mg/L	210
LCU	G316	C	2021/06/28	Calcium, total	mg/L	190
LCU	G316	C	2021/07/13	Calcium, total	mg/L	190
LCU	G316	C	2021/07/27	Calcium, total	mg/L	190
LCU	G316	C	2023/02/16	Calcium, total	mg/L	200

LCU	G316	C	2023/05/31	Calcium, total	mg/L	190
LCU	G316	C	2023/08/09	Calcium, total	mg/L	203
LCU	G316	C	2023/11/20	Calcium, total	mg/L	220
LCU	G316	C	2021/03/30	Chloride, total	mg/L	25.0
LCU	G316	C	2021/04/22	Chloride, total	mg/L	52.0
LCU	G316	C	2021/05/05	Chloride, total	mg/L	26.0
LCU	G316	C	2021/05/17	Chloride, total	mg/L	28.0
LCU	G316	C	2021/06/14	Chloride, total	mg/L	23.0
LCU	G316	C	2021/06/28	Chloride, total	mg/L	22.0
LCU	G316	C	2021/07/13	Chloride, total	mg/L	25.0
LCU	G316	C	2021/07/27	Chloride, total	mg/L	30.0
LCU	G316	C	2023/02/16	Chloride, total	mg/L	25.0
LCU	G316	C	2023/05/31	Chloride, total	mg/L	26.0
LCU	G316	C	2023/08/09	Chloride, total	mg/L	26.0
LCU	G316	C	2023/11/20	Chloride, total	mg/L	26.0
LCU	G316	C	2023/05/31	Ferrous Iron, dissolved	mg/L	0.610
LCU	G316	C	2023/05/31	Iron, dissolved	mg/L	17.0
LCU	G316	C	2023/08/09	Iron, dissolved	mg/L	16.3
LCU	G316	C	2021/03/30	Magnesium, total	mg/L	170
LCU	G316	C	2021/04/22	Magnesium, total	mg/L	160
LCU	G316	C	2021/05/05	Magnesium, total	mg/L	160
LCU	G316	C	2021/05/17	Magnesium, total	mg/L	160
LCU	G316	C	2021/06/14	Magnesium, total	mg/L	160
LCU	G316	C	2021/06/28	Magnesium, total	mg/L	160
LCU	G316	C	2021/07/13	Magnesium, total	mg/L	150
LCU	G316	C	2021/07/27	Magnesium, total	mg/L	160
LCU	G316	C	2023/02/16	Magnesium, total	mg/L	170
LCU	G316	C	2023/05/31	Magnesium, total	mg/L	150
LCU	G316	C	2023/08/09	Magnesium, total	mg/L	165
LCU	G316	C	2023/11/20	Magnesium, total	mg/L	175
LCU	G316	C	2023/05/31	Manganese, dissolved	mg/L	8.70
LCU	G316	C	2023/08/09	Manganese, dissolved	mg/L	9.82
LCU	G316	C	2023/08/09	Phosphate, dissolved	mg/L	0.215
LCU	G316	C	2021/03/30	Potassium, total	mg/L	1.70
LCU	G316	C	2021/04/22	Potassium, total	mg/L	1.60
LCU	G316	C	2021/05/05	Potassium, total	mg/L	1.70
LCU	G316	C	2021/05/17	Potassium, total	mg/L	2.30
LCU	G316	C	2021/06/14	Potassium, total	mg/L	1.90
LCU	G316	C	2021/06/28	Potassium, total	mg/L	1.90
LCU	G316	C	2021/07/13	Potassium, total	mg/L	1.90
LCU	G316	C	2021/07/27	Potassium, total	mg/L	1.90
LCU	G316	C	2023/02/16	Potassium, total	mg/L	1.80
LCU	G316	C	2023/05/31	Potassium, total	mg/L	1.80
LCU	G316	C	2023/08/09	Potassium, total	mg/L	2.41
LCU	G316	C	2023/11/20	Potassium, total	mg/L	2.51
LCU	G316	C	2023/05/31	Silicon, dissolved	mg/L	9.70
LCU	G316	C	2023/08/09	Silicon, dissolved	mg/L	8.92
LCU	G316	C	2021/03/30	Sodium, total	mg/L	100
LCU	G316	C	2021/04/22	Sodium, total	mg/L	99.0
LCU	G316	C	2021/05/05	Sodium, total	mg/L	110
LCU	G316	C	2021/05/17	Sodium, total	mg/L	110
LCU	G316	C	2021/06/14	Sodium, total	mg/L	100
LCU	G316	C	2021/06/28	Sodium, total	mg/L	100
LCU	G316	C	2021/07/13	Sodium, total	mg/L	100
LCU	G316	C	2021/07/27	Sodium, total	mg/L	100
LCU	G316	C	2023/02/16	Sodium, total	mg/L	110
LCU	G316	C	2023/05/31	Sodium, total	mg/L	100
LCU	G316	C	2023/08/09	Sodium, total	mg/L	108
LCU	G316	C	2023/11/20	Sodium, total	mg/L	122
LCU	G316	C	2021/03/30	Sulfate, total	mg/L	840
LCU	G316	C	2021/04/22	Sulfate, total	mg/L	770
LCU	G316	C	2021/05/05	Sulfate, total	mg/L	740

LCU	G316	C	2021/05/17	Sulfate, total	mg/L	760
LCU	G316	C	2021/06/14	Sulfate, total	mg/L	750
LCU	G316	C	2021/06/28	Sulfate, total	mg/L	330
LCU	G316	C	2021/07/13	Sulfate, total	mg/L	680
LCU	G316	C	2021/07/27	Sulfate, total	mg/L	660
LCU	G316	C	2023/02/16	Sulfate, total	mg/L	740
LCU	G316	C	2023/05/31	Sulfate, total	mg/L	760
LCU	G316	C	2023/08/09	Sulfate, total	mg/L	662
LCU	G316	C	2023/11/20	Sulfate, total	mg/L	670
LCU	G316	C	2021/03/30	Temperature (Celsius)	degrees C	11.5
LCU	G316	C	2021/04/22	Temperature (Celsius)	degrees C	10.6
LCU	G316	C	2021/05/05	Temperature (Celsius)	degrees C	12.5
LCU	G316	C	2021/05/17	Temperature (Celsius)	degrees C	14.4
LCU	G316	C	2021/06/14	Temperature (Celsius)	degrees C	17.7
LCU	G316	C	2021/06/28	Temperature (Celsius)	degrees C	18.0
LCU	G316	C	2021/07/13	Temperature (Celsius)	degrees C	19.6
LCU	G316	C	2021/07/27	Temperature (Celsius)	degrees C	18.6
LCU	G316	C	2023/02/16	Temperature (Celsius)	degrees C	9.60
LCU	G316	C	2023/05/31	Temperature (Celsius)	degrees C	14.5
LCU	G316	C	2023/08/09	Temperature (Celsius)	degrees C	16.1
LCU	G316	C	2023/11/20	Temperature (Celsius)	degrees C	15.0
LCU	G316	C	2021/03/30	Total Dissolved Solids	mg/L	1,600
LCU	G316	C	2021/04/22	Total Dissolved Solids	mg/L	1,100
LCU	G316	C	2021/05/05	Total Dissolved Solids	mg/L	1,600
LCU	G316	C	2021/05/17	Total Dissolved Solids	mg/L	1,700
LCU	G316	C	2021/06/14	Total Dissolved Solids	mg/L	1,700
LCU	G316	C	2021/06/28	Total Dissolved Solids	mg/L	1,600
LCU	G316	C	2021/07/13	Total Dissolved Solids	mg/L	1,600
LCU	G316	C	2021/07/27	Total Dissolved Solids	mg/L	1,600
LCU	G316	C	2023/02/16	Total Dissolved Solids	mg/L	1,800
LCU	G316	C	2023/05/31	Total Dissolved Solids	mg/L	1,700
LCU	G316	C	2023/08/09	Total Dissolved Solids	mg/L	1,620
LCU	G316	C	2023/11/20	Total Dissolved Solids	mg/L	1,680
UA	G281	B	2015/11/20	pH (field)	SU	7.0
UA	G281	B	2016/02/11	pH (field)	SU	7.1
UA	G281	B	2016/05/10	pH (field)	SU	7.0
UA	G281	B	2016/08/01	pH (field)	SU	7.0
UA	G281	B	2016/11/16	pH (field)	SU	6.9
UA	G281	B	2017/02/10	pH (field)	SU	6.7
UA	G281	B	2017/05/16	pH (field)	SU	6.9
UA	G281	B	2017/07/12	pH (field)	SU	7.0
UA	G281	B	2017/10/25	pH (field)	SU	7.0
UA	G281	B	2018/05/11	pH (field)	SU	7.1
UA	G281	B	2018/08/03	pH (field)	SU	7.0
UA	G281	B	2019/01/23	pH (field)	SU	7.0
UA	G281	B	2019/08/13	pH (field)	SU	6.9
UA	G281	B	2020/01/24	pH (field)	SU	7.3
UA	G281	B	2020/08/12	pH (field)	SU	6.9
UA	G281	B	2020/10/14	pH (field)	SU	7.0
UA	G281	B	2021/01/29	pH (field)	SU	7.1
UA	G281	B	2021/03/31	pH (field)	SU	7.0
UA	G281	B	2021/04/21	pH (field)	SU	6.9
UA	G281	B	2021/05/05	pH (field)	SU	7.1
UA	G281	B	2021/05/17	pH (field)	SU	7.1
UA	G281	B	2021/06/14	pH (field)	SU	7.1
UA	G281	B	2021/06/28	pH (field)	SU	7.2
UA	G281	B	2021/07/12	pH (field)	SU	7.2
UA	G281	B	2021/07/27	pH (field)	SU	7.1
UA	G281	B	2021/08/17	pH (field)	SU	7.1
UA	G281	B	2021/10/26	pH (field)	SU	7.0
UA	G281	B	2022/02/08	pH (field)	SU	7.0
UA	G281	B	2022/05/10	pH (field)	SU	6.9

UA	G281	B	2022/08/25	pH (field)	SU	6.8
UA	G281	B	2022/11/08	pH (field)	SU	6.8
UA	G281	B	2023/02/16	pH (field)	SU	7.2
UA	G281	B	2023/06/08	pH (field)	SU	6.8
UA	G281	B	2023/08/14	pH (field)	SU	6.8
UA	G281	B	2023/11/20	pH (field)	SU	6.9
UA	G281	B	2015/11/20	Oxidation Reduction Potential	mV	-18.0
UA	G281	B	2016/02/11	Oxidation Reduction Potential	mV	171
UA	G281	B	2016/05/10	Oxidation Reduction Potential	mV	40.0
UA	G281	B	2016/08/01	Oxidation Reduction Potential	mV	56.0
UA	G281	B	2016/11/16	Oxidation Reduction Potential	mV	58.0
UA	G281	B	2017/02/10	Oxidation Reduction Potential	mV	65.0
UA	G281	B	2017/05/16	Oxidation Reduction Potential	mV	63.0
UA	G281	B	2017/07/12	Oxidation Reduction Potential	mV	62.0
UA	G281	B	2017/10/25	Oxidation Reduction Potential	mV	75.0
UA	G281	B	2018/05/11	Oxidation Reduction Potential	mV	45.0
UA	G281	B	2018/08/03	Oxidation Reduction Potential	mV	62.0
UA	G281	B	2019/01/23	Oxidation Reduction Potential	mV	65.0
UA	G281	B	2019/08/13	Oxidation Reduction Potential	mV	65.0
UA	G281	B	2020/01/24	Oxidation Reduction Potential	mV	151
UA	G281	B	2020/08/12	Oxidation Reduction Potential	mV	129
UA	G281	B	2020/10/14	Oxidation Reduction Potential	mV	87.1
UA	G281	B	2021/01/29	Oxidation Reduction Potential	mV	110
UA	G281	B	2021/03/31	Oxidation Reduction Potential	mV	257
UA	G281	B	2021/04/21	Oxidation Reduction Potential	mV	41.7
UA	G281	B	2021/05/05	Oxidation Reduction Potential	mV	189
UA	G281	B	2021/05/17	Oxidation Reduction Potential	mV	181
UA	G281	B	2021/06/14	Oxidation Reduction Potential	mV	54.1
UA	G281	B	2021/06/28	Oxidation Reduction Potential	mV	26.1
UA	G281	B	2021/07/12	Oxidation Reduction Potential	mV	210
UA	G281	B	2021/07/27	Oxidation Reduction Potential	mV	72.7
UA	G281	B	2021/08/17	Oxidation Reduction Potential	mV	105
UA	G281	B	2021/10/26	Oxidation Reduction Potential	mV	24.5
UA	G281	B	2022/02/08	Oxidation Reduction Potential	mV	102
UA	G281	B	2022/05/10	Oxidation Reduction Potential	mV	41.0
UA	G281	B	2022/08/25	Oxidation Reduction Potential	mV	4.00
UA	G281	B	2022/11/08	Oxidation Reduction Potential	mV	57.6
UA	G281	B	2023/02/16	Oxidation Reduction Potential	mV	64.4
UA	G281	B	2023/06/08	Oxidation Reduction Potential	mV	11.0
UA	G281	B	2023/08/14	Oxidation Reduction Potential	mV	102
UA	G281	B	2023/11/20	Oxidation Reduction Potential	mV	112
UA	G281	B	2015/11/20	Eh	V	0.18
UA	G281	B	2016/02/11	Eh	V	0.37
UA	G281	B	2016/05/10	Eh	V	0.24
UA	G281	B	2016/08/01	Eh	V	0.25
UA	G281	B	2016/11/16	Eh	V	0.25
UA	G281	B	2017/02/10	Eh	V	0.26
UA	G281	B	2017/05/16	Eh	V	0.26
UA	G281	B	2017/07/12	Eh	V	0.26
UA	G281	B	2017/10/25	Eh	V	0.27
UA	G281	B	2018/05/11	Eh	V	0.24
UA	G281	B	2018/08/03	Eh	V	0.26
UA	G281	B	2019/01/23	Eh	V	0.26
UA	G281	B	2019/08/13	Eh	V	0.26
UA	G281	B	2020/01/24	Eh	V	0.35
UA	G281	B	2020/08/12	Eh	V	0.32
UA	G281	B	2020/10/14	Eh	V	0.28
UA	G281	B	2021/01/29	Eh	V	0.31
UA	G281	B	2021/03/31	Eh	V	0.46
UA	G281	B	2021/04/21	Eh	V	0.24
UA	G281	B	2021/05/05	Eh	V	0.39
UA	G281	B	2021/05/17	Eh	V	0.38

UA	G281	B	2021/06/14	Eh	V	0.25
UA	G281	B	2021/06/28	Eh	V	0.22
UA	G281	B	2021/07/12	Eh	V	0.40
UA	G281	B	2021/07/27	Eh	V	0.26
UA	G281	B	2021/08/17	Eh	V	0.30
UA	G281	B	2021/10/26	Eh	V	0.22
UA	G281	B	2022/02/08	Eh	V	0.30
UA	G281	B	2022/05/10	Eh	V	0.23
UA	G281	B	2022/08/25	Eh	V	0.20
UA	G281	B	2022/11/08	Eh	V	0.25
UA	G281	B	2023/02/16	Eh	V	0.26
UA	G281	B	2023/06/08	Eh	V	0.20
UA	G281	B	2023/08/14	Eh	V	0.29
UA	G281	B	2023/11/20	Eh	V	0.31
UA	G281	B	2016/11/16	Alkalinity, bicarbonate	mg/L CaCO3	370
UA	G281	B	2017/05/16	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2017/07/12	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	G281	B	2020/01/24	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2020/08/12	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2021/01/29	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	G281	B	2021/03/31	Alkalinity, bicarbonate	mg/L CaCO3	350
UA	G281	B	2021/04/21	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	G281	B	2021/05/17	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2021/06/14	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	350
UA	G281	B	2021/07/12	Alkalinity, bicarbonate	mg/L CaCO3	350
UA	G281	B	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	G281	B	2021/08/17	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	G281	B	2022/02/08	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	G281	B	2022/08/25	Alkalinity, bicarbonate	mg/L CaCO3	390
UA	G281	B	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G281	B	2023/06/08	Alkalinity, bicarbonate	mg/L CaCO3	360
UA	G281	B	2023/08/14	Alkalinity, bicarbonate	mg/L CaCO3	357
UA	G281	B	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	358
UA	G281	B	2022/08/25	Alkalinity, carbonate	mg/L CaCO3	10.0
UA	G281	B	2015/11/20	Barium, total	mg/L	0.140
UA	G281	B	2016/02/11	Barium, total	mg/L	0.0670
UA	G281	B	2016/05/10	Barium, total	mg/L	0.0720
UA	G281	B	2016/08/01	Barium, total	mg/L	0.0780
UA	G281	B	2016/11/16	Barium, total	mg/L	0.0810
UA	G281	B	2017/02/10	Barium, total	mg/L	0.0800
UA	G281	B	2017/05/16	Barium, total	mg/L	0.0810
UA	G281	B	2017/07/12	Barium, total	mg/L	0.0870
UA	G281	B	2018/05/11	Barium, total	mg/L	0.0810
UA	G281	B	2018/08/03	Barium, total	mg/L	0.100
UA	G281	B	2019/01/23	Barium, total	mg/L	0.0720
UA	G281	B	2019/08/13	Barium, total	mg/L	0.0910
UA	G281	B	2020/01/24	Barium, total	mg/L	0.0700
UA	G281	B	2020/08/12	Barium, total	mg/L	0.0570
UA	G281	B	2020/10/14	Barium, total	mg/L	0.0630
UA	G281	B	2021/01/29	Barium, total	mg/L	0.0640
UA	G281	B	2021/03/31	Barium, total	mg/L	0.0660
UA	G281	B	2021/04/21	Barium, total	mg/L	0.0610
UA	G281	B	2021/05/05	Barium, total	mg/L	0.0650
UA	G281	B	2021/05/17	Barium, total	mg/L	0.0860
UA	G281	B	2021/06/14	Barium, total	mg/L	0.0600
UA	G281	B	2021/06/28	Barium, total	mg/L	0.0620
UA	G281	B	2021/07/12	Barium, total	mg/L	0.0610
UA	G281	B	2021/07/27	Barium, total	mg/L	0.0610
UA	G281	B	2021/08/17	Barium, total	mg/L	0.0650
UA	G281	B	2021/10/26	Barium, total	mg/L	0.0600

UA	G281	B	2022/02/08	Barium, total	mg/L	0.0650
UA	G281	B	2022/05/10	Barium, total	mg/L	0.0630
UA	G281	B	2022/08/25	Barium, total	mg/L	0.0680
UA	G281	B	2022/11/08	Barium, total	mg/L	0.0520
UA	G281	B	2023/02/16	Barium, total	mg/L	0.0650
UA	G281	B	2023/06/08	Barium, total	mg/L	0.0710
UA	G281	B	2023/08/14	Barium, total	mg/L	0.0707
UA	G281	B	2023/11/20	Barium, total	mg/L	0.0651
UA	G281	B	2015/11/20	Boron, total	mg/L	<0.0023
UA	G281	B	2016/02/11	Boron, total	mg/L	0.0100
UA	G281	B	2016/05/10	Boron, total	mg/L	<0.0023
UA	G281	B	2016/08/01	Boron, total	mg/L	0.0120
UA	G281	B	2016/11/16	Boron, total	mg/L	0.0220
UA	G281	B	2017/02/10	Boron, total	mg/L	<0.0023
UA	G281	B	2017/05/16	Boron, total	mg/L	<0.0023
UA	G281	B	2017/07/12	Boron, total	mg/L	<0.0023
UA	G281	B	2017/10/25	Boron, total	mg/L	0.0120
UA	G281	B	2018/05/11	Boron, total	mg/L	<0.0079
UA	G281	B	2018/08/03	Boron, total	mg/L	0.0130
UA	G281	B	2019/01/23	Boron, total	mg/L	0.0130
UA	G281	B	2019/08/13	Boron, total	mg/L	<0.0034
UA	G281	B	2020/01/24	Boron, total	mg/L	0.0110
UA	G281	B	2020/08/12	Boron, total	mg/L	0.0370
UA	G281	B	2020/10/14	Boron, total	mg/L	0.0160
UA	G281	B	2021/01/29	Boron, total	mg/L	<0.008
UA	G281	B	2021/03/31	Boron, total	mg/L	0.110
UA	G281	B	2021/04/21	Boron, total	mg/L	<0.008
UA	G281	B	2021/05/05	Boron, total	mg/L	0.0150
UA	G281	B	2021/05/17	Boron, total	mg/L	0.0430
UA	G281	B	2021/06/14	Boron, total	mg/L	<0.008
UA	G281	B	2021/06/28	Boron, total	mg/L	0.0360
UA	G281	B	2021/07/12	Boron, total	mg/L	<0.008
UA	G281	B	2021/07/27	Boron, total	mg/L	<0.008
UA	G281	B	2021/08/17	Boron, total	mg/L	0.0320
UA	G281	B	2021/10/26	Boron, total	mg/L	<0.01
UA	G281	B	2022/02/08	Boron, total	mg/L	<0.0046
UA	G281	B	2022/05/10	Boron, total	mg/L	<0.0071
UA	G281	B	2022/08/25	Boron, total	mg/L	0.0140
UA	G281	B	2022/11/08	Boron, total	mg/L	<0.0071
UA	G281	B	2023/02/16	Boron, total	mg/L	0.0210
UA	G281	B	2023/06/08	Boron, total	mg/L	<0.0071
UA	G281	B	2023/08/14	Boron, total	mg/L	<0.0092
UA	G281	B	2023/11/20	Boron, total	mg/L	<0.0092
UA	G281	B	2015/11/20	Calcium, total	mg/L	150
UA	G281	B	2016/02/11	Calcium, total	mg/L	120
UA	G281	B	2016/05/10	Calcium, total	mg/L	130
UA	G281	B	2016/08/01	Calcium, total	mg/L	140
UA	G281	B	2016/11/16	Calcium, total	mg/L	110
UA	G281	B	2017/02/10	Calcium, total	mg/L	120
UA	G281	B	2017/05/16	Calcium, total	mg/L	130
UA	G281	B	2017/07/12	Calcium, total	mg/L	130
UA	G281	B	2017/10/25	Calcium, total	mg/L	110
UA	G281	B	2018/05/11	Calcium, total	mg/L	120
UA	G281	B	2018/08/03	Calcium, total	mg/L	130
UA	G281	B	2019/01/23	Calcium, total	mg/L	130
UA	G281	B	2019/08/13	Calcium, total	mg/L	140
UA	G281	B	2020/01/24	Calcium, total	mg/L	140
UA	G281	B	2020/08/12	Calcium, total	mg/L	130
UA	G281	B	2020/10/14	Calcium, total	mg/L	130
UA	G281	B	2021/01/29	Calcium, total	mg/L	130
UA	G281	B	2021/03/31	Calcium, total	mg/L	130
UA	G281	B	2021/04/21	Calcium, total	mg/L	130

UA	G281	B	2021/05/05	Calcium, total	mg/L	130
UA	G281	B	2021/05/17	Calcium, total	mg/L	130
UA	G281	B	2021/06/14	Calcium, total	mg/L	140
UA	G281	B	2021/06/28	Calcium, total	mg/L	130
UA	G281	B	2021/07/12	Calcium, total	mg/L	130
UA	G281	B	2021/07/27	Calcium, total	mg/L	120
UA	G281	B	2021/08/17	Calcium, total	mg/L	140
UA	G281	B	2021/10/26	Calcium, total	mg/L	130
UA	G281	B	2022/02/08	Calcium, total	mg/L	130
UA	G281	B	2022/05/10	Calcium, total	mg/L	140
UA	G281	B	2022/08/25	Calcium, total	mg/L	150
UA	G281	B	2022/11/08	Calcium, total	mg/L	110
UA	G281	B	2023/02/16	Calcium, total	mg/L	130
UA	G281	B	2023/06/08	Calcium, total	mg/L	130
UA	G281	B	2023/08/14	Calcium, total	mg/L	137
UA	G281	B	2023/11/20	Calcium, total	mg/L	152
UA	G281	B	2015/11/20	Chloride, total	mg/L	74.0
UA	G281	B	2016/02/11	Chloride, total	mg/L	55.0
UA	G281	B	2016/05/10	Chloride, total	mg/L	72.0
UA	G281	B	2016/08/01	Chloride, total	mg/L	70.0
UA	G281	B	2016/11/16	Chloride, total	mg/L	68.0
UA	G281	B	2017/02/10	Chloride, total	mg/L	67.0
UA	G281	B	2017/05/16	Chloride, total	mg/L	68.0
UA	G281	B	2017/07/12	Chloride, total	mg/L	75.0
UA	G281	B	2017/10/25	Chloride, total	mg/L	64.0
UA	G281	B	2018/05/11	Chloride, total	mg/L	69.0
UA	G281	B	2018/08/03	Chloride, total	mg/L	66.0
UA	G281	B	2019/01/23	Chloride, total	mg/L	85.0
UA	G281	B	2019/08/13	Chloride, total	mg/L	72.0
UA	G281	B	2020/01/24	Chloride, total	mg/L	75.0
UA	G281	B	2020/08/12	Chloride, total	mg/L	81.0
UA	G281	B	2020/10/14	Chloride, total	mg/L	79.0
UA	G281	B	2021/01/29	Chloride, total	mg/L	100
UA	G281	B	2021/03/31	Chloride, total	mg/L	90.0
UA	G281	B	2021/04/21	Chloride, total	mg/L	120
UA	G281	B	2021/05/05	Chloride, total	mg/L	86.0
UA	G281	B	2021/05/17	Chloride, total	mg/L	85.0
UA	G281	B	2021/06/14	Chloride, total	mg/L	76.0
UA	G281	B	2021/06/28	Chloride, total	mg/L	86.0
UA	G281	B	2021/07/12	Chloride, total	mg/L	73.0
UA	G281	B	2021/07/27	Chloride, total	mg/L	73.0
UA	G281	B	2021/08/17	Chloride, total	mg/L	89.0
UA	G281	B	2021/10/26	Chloride, total	mg/L	160
UA	G281	B	2022/02/08	Chloride, total	mg/L	78.0
UA	G281	B	2022/05/10	Chloride, total	mg/L	85.0
UA	G281	B	2022/08/25	Chloride, total	mg/L	69.0
UA	G281	B	2022/11/08	Chloride, total	mg/L	63.0
UA	G281	B	2023/02/16	Chloride, total	mg/L	76.0
UA	G281	B	2023/06/08	Chloride, total	mg/L	75.0
UA	G281	B	2023/08/14	Chloride, total	mg/L	88.0
UA	G281	B	2023/11/20	Chloride, total	mg/L	74.0
UA	G281	B	2023/06/08	Ferrous Iron, dissolved	mg/L	0.260
UA	G281	B	2020/08/11	Iron, dissolved	mg/L	<0.01
UA	G281	B	2020/10/14	Iron, dissolved	mg/L	<0.01
UA	G281	B	2021/01/29	Iron, dissolved	mg/L	<0.01
UA	G281	B	2021/04/21	Iron, dissolved	mg/L	0.0620
UA	G281	B	2021/08/17	Iron, dissolved	mg/L	<0.01
UA	G281	B	2021/10/26	Iron, dissolved	mg/L	<0.01
UA	G281	B	2022/02/08	Iron, dissolved	mg/L	<0.01
UA	G281	B	2022/05/10	Iron, dissolved	mg/L	0.00350
UA	G281	B	2022/08/25	Iron, dissolved	mg/L	0.00820
UA	G281	B	2022/11/08	Iron, dissolved	mg/L	0.0250

UA	G281	B	2023/02/16	Iron, dissolved	mg/L	1.20
UA	G281	B	2023/06/08	Iron, dissolved	mg/L	0.0160
UA	G281	B	2023/08/14	Iron, dissolved	mg/L	<0.0175
UA	G281	B	2023/11/20	Iron, dissolved	mg/L	<0.0115
UA	G281	B	2016/11/16	Magnesium, total	mg/L	66.0
UA	G281	B	2017/05/16	Magnesium, total	mg/L	59.0
UA	G281	B	2017/07/12	Magnesium, total	mg/L	63.0
UA	G281	B	2020/01/24	Magnesium, total	mg/L	67.0
UA	G281	B	2020/08/12	Magnesium, total	mg/L	60.0
UA	G281	B	2021/01/29	Magnesium, total	mg/L	61.0
UA	G281	B	2021/03/31	Magnesium, total	mg/L	53.0
UA	G281	B	2021/04/21	Magnesium, total	mg/L	58.0
UA	G281	B	2021/05/05	Magnesium, total	mg/L	62.0
UA	G281	B	2021/05/17	Magnesium, total	mg/L	63.0
UA	G281	B	2021/06/14	Magnesium, total	mg/L	61.0
UA	G281	B	2021/06/28	Magnesium, total	mg/L	61.0
UA	G281	B	2021/07/12	Magnesium, total	mg/L	58.0
UA	G281	B	2021/07/27	Magnesium, total	mg/L	59.0
UA	G281	B	2021/08/17	Magnesium, total	mg/L	64.0
UA	G281	B	2022/02/08	Magnesium, total	mg/L	60.0
UA	G281	B	2022/08/25	Magnesium, total	mg/L	67.0
UA	G281	B	2023/02/16	Magnesium, total	mg/L	62.0
UA	G281	B	2023/06/08	Magnesium, total	mg/L	61.0
UA	G281	B	2023/08/14	Magnesium, total	mg/L	61.0
UA	G281	B	2023/11/20	Magnesium, total	mg/L	68.5
UA	G281	B	2018/03/01	Manganese, dissolved	mg/L	0.160
UA	G281	B	2018/05/11	Manganese, dissolved	mg/L	0.0200
UA	G281	B	2018/08/11	Manganese, dissolved	mg/L	0.340
UA	G281	B	2018/11/06	Manganese, dissolved	mg/L	0.360
UA	G281	B	2019/01/23	Manganese, dissolved	mg/L	0.450
UA	G281	B	2019/05/02	Manganese, dissolved	mg/L	0.0590
UA	G281	B	2019/08/13	Manganese, dissolved	mg/L	0.300
UA	G281	B	2019/10/21	Manganese, dissolved	mg/L	0.350
UA	G281	B	2020/01/24	Manganese, dissolved	mg/L	0.0690
UA	G281	B	2020/05/05	Manganese, dissolved	mg/L	0.100
UA	G281	B	2020/08/11	Manganese, dissolved	mg/L	0.170
UA	G281	B	2020/10/14	Manganese, dissolved	mg/L	0.160
UA	G281	B	2021/01/29	Manganese, dissolved	mg/L	0.0390
UA	G281	B	2021/04/21	Manganese, dissolved	mg/L	0.0610
UA	G281	B	2021/08/17	Manganese, dissolved	mg/L	0.110
UA	G281	B	2021/10/26	Manganese, dissolved	mg/L	0.150
UA	G281	B	2022/02/08	Manganese, dissolved	mg/L	0.0300
UA	G281	B	2022/05/10	Manganese, dissolved	mg/L	0.0710
UA	G281	B	2022/08/25	Manganese, dissolved	mg/L	0.180
UA	G281	B	2022/11/08	Manganese, dissolved	mg/L	0.140
UA	G281	B	2023/02/16	Manganese, dissolved	mg/L	0.250
UA	G281	B	2023/06/08	Manganese, dissolved	mg/L	0.310
UA	G281	B	2023/08/14	Manganese, dissolved	mg/L	0.291
UA	G281	B	2023/11/20	Manganese, dissolved	mg/L	0.306
UA	G281	B	2023/08/14	Phosphate, dissolved	mg/L	0.0340
UA	G281	B	2016/11/16	Potassium, total	mg/L	0.880
UA	G281	B	2017/05/16	Potassium, total	mg/L	0.800
UA	G281	B	2017/07/12	Potassium, total	mg/L	1.10
UA	G281	B	2020/01/24	Potassium, total	mg/L	0.620
UA	G281	B	2020/08/12	Potassium, total	mg/L	0.360
UA	G281	B	2021/01/29	Potassium, total	mg/L	0.610
UA	G281	B	2021/03/31	Potassium, total	mg/L	1.40
UA	G281	B	2021/04/21	Potassium, total	mg/L	0.400
UA	G281	B	2021/05/05	Potassium, total	mg/L	1.50
UA	G281	B	2021/05/17	Potassium, total	mg/L	0.840
UA	G281	B	2021/06/14	Potassium, total	mg/L	0.430
UA	G281	B	2021/06/28	Potassium, total	mg/L	0.450

UA	G281	B	2021/07/12	Potassium, total	mg/L	0.440
UA	G281	B	2021/07/27	Potassium, total	mg/L	0.420
UA	G281	B	2021/08/17	Potassium, total	mg/L	0.590
UA	G281	B	2022/02/08	Potassium, total	mg/L	0.510
UA	G281	B	2022/08/25	Potassium, total	mg/L	0.730
UA	G281	B	2023/02/16	Potassium, total	mg/L	0.550
UA	G281	B	2023/06/08	Potassium, total	mg/L	0.530
UA	G281	B	2023/08/14	Potassium, total	mg/L	0.609
UA	G281	B	2023/11/20	Potassium, total	mg/L	0.663
UA	G281	B	2023/06/08	Silicon, dissolved	mg/L	10.0
UA	G281	B	2023/08/14	Silicon, dissolved	mg/L	8.59
UA	G281	B	2016/11/16	Sodium, total	mg/L	86.0
UA	G281	B	2017/05/16	Sodium, total	mg/L	80.0
UA	G281	B	2017/07/12	Sodium, total	mg/L	86.0
UA	G281	B	2020/01/24	Sodium, total	mg/L	90.0
UA	G281	B	2020/08/12	Sodium, total	mg/L	88.0
UA	G281	B	2021/01/29	Sodium, total	mg/L	90.0
UA	G281	B	2021/03/31	Sodium, total	mg/L	79.0
UA	G281	B	2021/04/21	Sodium, total	mg/L	83.0
UA	G281	B	2021/05/05	Sodium, total	mg/L	93.0
UA	G281	B	2021/05/17	Sodium, total	mg/L	88.0
UA	G281	B	2021/06/14	Sodium, total	mg/L	83.0
UA	G281	B	2021/06/28	Sodium, total	mg/L	86.0
UA	G281	B	2021/07/12	Sodium, total	mg/L	78.0
UA	G281	B	2021/07/27	Sodium, total	mg/L	85.0
UA	G281	B	2021/08/17	Sodium, total	mg/L	100
UA	G281	B	2022/02/08	Sodium, total	mg/L	89.0
UA	G281	B	2022/08/25	Sodium, total	mg/L	100
UA	G281	B	2023/02/16	Sodium, total	mg/L	100
UA	G281	B	2023/06/08	Sodium, total	mg/L	89.0
UA	G281	B	2023/08/14	Sodium, total	mg/L	90.7
UA	G281	B	2023/11/20	Sodium, total	mg/L	93.3
UA	G281	B	2015/11/20	Sulfate, total	mg/L	300
UA	G281	B	2016/02/11	Sulfate, total	mg/L	340
UA	G281	B	2016/05/10	Sulfate, total	mg/L	370
UA	G281	B	2016/08/01	Sulfate, total	mg/L	310
UA	G281	B	2016/11/16	Sulfate, total	mg/L	310
UA	G281	B	2017/02/10	Sulfate, total	mg/L	310
UA	G281	B	2017/05/16	Sulfate, total	mg/L	330
UA	G281	B	2017/07/12	Sulfate, total	mg/L	300
UA	G281	B	2017/10/25	Sulfate, total	mg/L	300
UA	G281	B	2018/05/11	Sulfate, total	mg/L	310
UA	G281	B	2018/08/03	Sulfate, total	mg/L	280
UA	G281	B	2019/01/23	Sulfate, total	mg/L	380
UA	G281	B	2019/08/13	Sulfate, total	mg/L	310
UA	G281	B	2020/01/24	Sulfate, total	mg/L	300
UA	G281	B	2020/08/12	Sulfate, total	mg/L	260
UA	G281	B	2020/10/14	Sulfate, total	mg/L	250
UA	G281	B	2021/01/29	Sulfate, total	mg/L	260
UA	G281	B	2021/03/31	Sulfate, total	mg/L	280
UA	G281	B	2021/04/21	Sulfate, total	mg/L	250
UA	G281	B	2021/05/05	Sulfate, total	mg/L	260
UA	G281	B	2021/05/17	Sulfate, total	mg/L	280
UA	G281	B	2021/06/14	Sulfate, total	mg/L	260
UA	G281	B	2021/06/28	Sulfate, total	mg/L	280
UA	G281	B	2021/07/12	Sulfate, total	mg/L	260
UA	G281	B	2021/07/27	Sulfate, total	mg/L	270
UA	G281	B	2021/08/17	Sulfate, total	mg/L	260
UA	G281	B	2021/10/26	Sulfate, total	mg/L	270
UA	G281	B	2022/02/08	Sulfate, total	mg/L	270
UA	G281	B	2022/05/10	Sulfate, total	mg/L	290
UA	G281	B	2022/08/25	Sulfate, total	mg/L	310

UA	G281	B	2022/11/08	Sulfate, total	mg/L	300
UA	G281	B	2023/02/16	Sulfate, total	mg/L	270
UA	G281	B	2023/06/08	Sulfate, total	mg/L	140
UA	G281	B	2023/08/14	Sulfate, total	mg/L	268
UA	G281	B	2023/11/20	Sulfate, total	mg/L	293
UA	G281	B	2015/11/20	Temperature (Celsius)	degrees C	16.8
UA	G281	B	2016/02/11	Temperature (Celsius)	degrees C	8.00
UA	G281	B	2016/05/10	Temperature (Celsius)	degrees C	15.5
UA	G281	B	2016/08/01	Temperature (Celsius)	degrees C	16.7
UA	G281	B	2016/11/16	Temperature (Celsius)	degrees C	13.6
UA	G281	B	2017/02/10	Temperature (Celsius)	degrees C	14.5
UA	G281	B	2017/05/16	Temperature (Celsius)	degrees C	15.4
UA	G281	B	2017/07/12	Temperature (Celsius)	degrees C	16.5
UA	G281	B	2017/10/25	Temperature (Celsius)	degrees C	13.0
UA	G281	B	2018/05/11	Temperature (Celsius)	degrees C	14.3
UA	G281	B	2018/08/03	Temperature (Celsius)	degrees C	16.1
UA	G281	B	2019/01/23	Temperature (Celsius)	degrees C	11.9
UA	G281	B	2019/08/13	Temperature (Celsius)	degrees C	17.4
UA	G281	B	2020/01/24	Temperature (Celsius)	degrees C	9.70
UA	G281	B	2020/08/12	Temperature (Celsius)	degrees C	21.5
UA	G281	B	2020/10/14	Temperature (Celsius)	degrees C	17.9
UA	G281	B	2021/01/29	Temperature (Celsius)	degrees C	9.40
UA	G281	B	2021/03/31	Temperature (Celsius)	degrees C	11.1
UA	G281	B	2021/04/21	Temperature (Celsius)	degrees C	12.0
UA	G281	B	2021/05/05	Temperature (Celsius)	degrees C	14.0
UA	G281	B	2021/05/17	Temperature (Celsius)	degrees C	15.0
UA	G281	B	2021/06/14	Temperature (Celsius)	degrees C	20.8
UA	G281	B	2021/06/28	Temperature (Celsius)	degrees C	20.7
UA	G281	B	2021/07/12	Temperature (Celsius)	degrees C	19.9
UA	G281	B	2021/07/27	Temperature (Celsius)	degrees C	20.4
UA	G281	B	2021/08/17	Temperature (Celsius)	degrees C	20.7
UA	G281	B	2021/10/26	Temperature (Celsius)	degrees C	17.3
UA	G281	B	2022/02/08	Temperature (Celsius)	degrees C	10.6
UA	G281	B	2022/05/10	Temperature (Celsius)	degrees C	17.8
UA	G281	B	2022/08/25	Temperature (Celsius)	degrees C	21.0
UA	G281	B	2022/11/08	Temperature (Celsius)	degrees C	17.9
UA	G281	B	2023/02/16	Temperature (Celsius)	degrees C	9.20
UA	G281	B	2023/06/08	Temperature (Celsius)	degrees C	18.4
UA	G281	B	2023/08/14	Temperature (Celsius)	degrees C	18.6
UA	G281	B	2023/11/20	Temperature (Celsius)	degrees C	16.1
UA	G281	B	2015/11/20	Total Dissolved Solids	mg/L	820
UA	G281	B	2016/02/11	Total Dissolved Solids	mg/L	740
UA	G281	B	2016/05/10	Total Dissolved Solids	mg/L	740
UA	G281	B	2016/08/01	Total Dissolved Solids	mg/L	780
UA	G281	B	2016/11/16	Total Dissolved Solids	mg/L	840
UA	G281	B	2017/02/10	Total Dissolved Solids	mg/L	840
UA	G281	B	2017/05/16	Total Dissolved Solids	mg/L	840
UA	G281	B	2017/07/12	Total Dissolved Solids	mg/L	760
UA	G281	B	2017/10/25	Total Dissolved Solids	mg/L	800
UA	G281	B	2018/05/11	Total Dissolved Solids	mg/L	840
UA	G281	B	2018/08/03	Total Dissolved Solids	mg/L	840
UA	G281	B	2019/01/23	Total Dissolved Solids	mg/L	880
UA	G281	B	2019/08/13	Total Dissolved Solids	mg/L	900
UA	G281	B	2020/01/24	Total Dissolved Solids	mg/L	880
UA	G281	B	2020/08/12	Total Dissolved Solids	mg/L	700
UA	G281	B	2020/10/14	Total Dissolved Solids	mg/L	870
UA	G281	B	2021/01/29	Total Dissolved Solids	mg/L	870
UA	G281	B	2021/03/31	Total Dissolved Solids	mg/L	830
UA	G281	B	2021/04/21	Total Dissolved Solids	mg/L	1,000
UA	G281	B	2021/05/05	Total Dissolved Solids	mg/L	820
UA	G281	B	2021/05/17	Total Dissolved Solids	mg/L	870
UA	G281	B	2021/06/14	Total Dissolved Solids	mg/L	930

UA	G281	B	2021/06/28	Total Dissolved Solids	mg/L	830
UA	G281	B	2021/07/12	Total Dissolved Solids	mg/L	910
UA	G281	B	2021/07/27	Total Dissolved Solids	mg/L	880
UA	G281	B	2021/08/17	Total Dissolved Solids	mg/L	910
UA	G281	B	2021/10/26	Total Dissolved Solids	mg/L	820
UA	G281	B	2022/02/08	Total Dissolved Solids	mg/L	910
UA	G281	B	2022/05/10	Total Dissolved Solids	mg/L	910
UA	G281	B	2022/08/25	Total Dissolved Solids	mg/L	980
UA	G281	B	2022/11/08	Total Dissolved Solids	mg/L	900
UA	G281	B	2023/02/16	Total Dissolved Solids	mg/L	980
UA	G281	B	2023/06/08	Total Dissolved Solids	mg/L	1,000
UA	G281	B	2023/08/14	Total Dissolved Solids	mg/L	930
UA	G281	B	2023/11/20	Total Dissolved Solids	mg/L	958
UA	G306	B	2016/05/19	pH (field)	SU	6.7
UA	G306	B	2016/07/01	pH (field)	SU	6.5
UA	G306	B	2016/08/16	pH (field)	SU	6.9
UA	G306	B	2016/09/29	pH (field)	SU	6.6
UA	G306	B	2016/11/16	pH (field)	SU	7.0
UA	G306	B	2017/02/19	pH (field)	SU	7.0
UA	G306	B	2017/05/17	pH (field)	SU	7.1
UA	G306	B	2017/07/13	pH (field)	SU	7.0
UA	G306	B	2017/10/27	pH (field)	SU	6.9
UA	G306	B	2018/05/14	pH (field)	SU	6.9
UA	G306	B	2018/08/03	pH (field)	SU	7.0
UA	G306	B	2019/01/23	pH (field)	SU	7.0
UA	G306	B	2019/08/19	pH (field)	SU	7.0
UA	G306	B	2020/01/21	pH (field)	SU	7.0
UA	G306	B	2020/08/11	pH (field)	SU	6.9
UA	G306	B	2021/01/26	pH (field)	SU	6.8
UA	G306	B	2021/03/29	pH (field)	SU	6.7
UA	G306	B	2021/04/21	pH (field)	SU	6.8
UA	G306	B	2021/05/05	pH (field)	SU	6.8
UA	G306	B	2021/05/18	pH (field)	SU	6.9
UA	G306	B	2021/06/15	pH (field)	SU	6.8
UA	G306	B	2021/06/28	pH (field)	SU	7.0
UA	G306	B	2021/07/14	pH (field)	SU	6.8
UA	G306	B	2021/07/27	pH (field)	SU	6.8
UA	G306	B	2021/08/17	pH (field)	SU	6.5
UA	G306	B	2022/02/08	pH (field)	SU	6.8
UA	G306	B	2022/08/24	pH (field)	SU	6.6
UA	G306	B	2023/02/16	pH (field)	SU	7.0
UA	G306	B	2023/06/05	pH (field)	SU	6.9
UA	G306	B	2023/08/10	pH (field)	SU	6.2
UA	G306	B	2023/11/17	pH (field)	SU	6.2
UA	G306	B	2016/05/19	Oxidation Reduction Potential	mV	-21.0
UA	G306	B	2016/07/01	Oxidation Reduction Potential	mV	139
UA	G306	B	2016/08/16	Oxidation Reduction Potential	mV	225
UA	G306	B	2016/09/29	Oxidation Reduction Potential	mV	178
UA	G306	B	2016/11/16	Oxidation Reduction Potential	mV	205
UA	G306	B	2017/02/19	Oxidation Reduction Potential	mV	122
UA	G306	B	2017/05/17	Oxidation Reduction Potential	mV	109
UA	G306	B	2017/07/13	Oxidation Reduction Potential	mV	122
UA	G306	B	2017/10/27	Oxidation Reduction Potential	mV	210
UA	G306	B	2018/05/14	Oxidation Reduction Potential	mV	200
UA	G306	B	2018/08/03	Oxidation Reduction Potential	mV	92.0
UA	G306	B	2019/01/23	Oxidation Reduction Potential	mV	95.0
UA	G306	B	2019/08/19	Oxidation Reduction Potential	mV	99.0
UA	G306	B	2020/01/21	Oxidation Reduction Potential	mV	212
UA	G306	B	2020/08/11	Oxidation Reduction Potential	mV	132
UA	G306	B	2021/01/26	Oxidation Reduction Potential	mV	115
UA	G306	B	2021/03/29	Oxidation Reduction Potential	mV	227
UA	G306	B	2021/04/21	Oxidation Reduction Potential	mV	102

UA	G306	B	2021/05/05	Oxidation Reduction Potential	mV	132
UA	G306	B	2021/05/18	Oxidation Reduction Potential	mV	149
UA	G306	B	2021/06/15	Oxidation Reduction Potential	mV	156
UA	G306	B	2021/06/28	Oxidation Reduction Potential	mV	149
UA	G306	B	2021/07/14	Oxidation Reduction Potential	mV	134
UA	G306	B	2021/07/27	Oxidation Reduction Potential	mV	114
UA	G306	B	2021/08/17	Oxidation Reduction Potential	mV	70.7
UA	G306	B	2022/02/08	Oxidation Reduction Potential	mV	11.6
UA	G306	B	2022/08/24	Oxidation Reduction Potential	mV	69.0
UA	G306	B	2023/02/16	Oxidation Reduction Potential	mV	69.6
UA	G306	B	2023/06/05	Oxidation Reduction Potential	mV	115
UA	G306	B	2023/08/10	Oxidation Reduction Potential	mV	143
UA	G306	B	2023/11/17	Oxidation Reduction Potential	mV	64.0
UA	G306	B	2016/05/19	Eh	V	0.17
UA	G306	B	2016/07/01	Eh	V	0.33
UA	G306	B	2016/08/16	Eh	V	0.42
UA	G306	B	2016/09/29	Eh	V	0.37
UA	G306	B	2016/11/16	Eh	V	0.40
UA	G306	B	2017/02/19	Eh	V	0.32
UA	G306	B	2017/05/17	Eh	V	0.30
UA	G306	B	2017/07/13	Eh	V	0.32
UA	G306	B	2017/10/27	Eh	V	0.41
UA	G306	B	2018/05/14	Eh	V	0.40
UA	G306	B	2018/08/03	Eh	V	0.29
UA	G306	B	2019/01/23	Eh	V	0.29
UA	G306	B	2019/08/19	Eh	V	0.29
UA	G306	B	2020/01/21	Eh	V	0.41
UA	G306	B	2020/08/11	Eh	V	0.32
UA	G306	B	2021/01/26	Eh	V	0.31
UA	G306	B	2021/03/29	Eh	V	0.42
UA	G306	B	2021/04/21	Eh	V	0.30
UA	G306	B	2021/05/05	Eh	V	0.33
UA	G306	B	2021/05/18	Eh	V	0.35
UA	G306	B	2021/06/15	Eh	V	0.35
UA	G306	B	2021/06/28	Eh	V	0.34
UA	G306	B	2021/07/14	Eh	V	0.33
UA	G306	B	2021/07/27	Eh	V	0.31
UA	G306	B	2021/08/17	Eh	V	0.26
UA	G306	B	2022/02/08	Eh	V	0.21
UA	G306	B	2022/08/24	Eh	V	0.26
UA	G306	B	2023/02/16	Eh	V	0.27
UA	G306	B	2023/06/05	Eh	V	0.31
UA	G306	B	2023/08/10	Eh	V	0.34
UA	G306	B	2023/11/17	Eh	V	0.26
UA	G306	B	2016/11/16	Alkalinity, bicarbonate	mg/L CaCO3	400
UA	G306	B	2017/05/17	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G306	B	2017/07/13	Alkalinity, bicarbonate	mg/L CaCO3	420
UA	G306	B	2020/01/21	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G306	B	2020/08/11	Alkalinity, bicarbonate	mg/L CaCO3	320
UA	G306	B	2021/01/26	Alkalinity, bicarbonate	mg/L CaCO3	290
UA	G306	B	2021/03/29	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	G306	B	2021/04/21	Alkalinity, bicarbonate	mg/L CaCO3	380
UA	G306	B	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	G306	B	2021/05/18	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	G306	B	2021/06/15	Alkalinity, bicarbonate	mg/L CaCO3	320
UA	G306	B	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G306	B	2021/07/14	Alkalinity, bicarbonate	mg/L CaCO3	340
UA	G306	B	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	320
UA	G306	B	2021/08/17	Alkalinity, bicarbonate	mg/L CaCO3	290
UA	G306	B	2022/02/08	Alkalinity, bicarbonate	mg/L CaCO3	310
UA	G306	B	2022/08/24	Alkalinity, bicarbonate	mg/L CaCO3	300
UA	G306	B	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	380

UA	G306	B	2023/06/05	Alkalinity, bicarbonate	mg/L CaCO3	410
UA	G306	B	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	276
UA	G306	B	2023/11/17	Alkalinity, bicarbonate	mg/L CaCO3	285
UA	G306	B	2022/08/24	Alkalinity, carbonate	mg/L CaCO3	10.0
UA	G306	B	2016/05/19	Barium, total	mg/L	0.0880
UA	G306	B	2016/07/01	Barium, total	mg/L	0.0610
UA	G306	B	2016/08/16	Barium, total	mg/L	0.0620
UA	G306	B	2016/09/29	Barium, total	mg/L	0.0590
UA	G306	B	2016/11/16	Barium, total	mg/L	0.0760
UA	G306	B	2017/02/19	Barium, total	mg/L	0.0590
UA	G306	B	2017/05/17	Barium, total	mg/L	0.0660
UA	G306	B	2017/07/13	Barium, total	mg/L	0.0850
UA	G306	B	2018/05/14	Barium, total	mg/L	0.0600
UA	G306	B	2018/08/03	Barium, total	mg/L	0.170
UA	G306	B	2019/01/23	Barium, total	mg/L	0.280
UA	G306	B	2019/08/19	Barium, total	mg/L	0.0880
UA	G306	B	2020/01/21	Barium, total	mg/L	0.0890
UA	G306	B	2020/08/11	Barium, total	mg/L	0.0390
UA	G306	B	2021/01/26	Barium, total	mg/L	0.0300
UA	G306	B	2021/03/29	Barium, total	mg/L	0.0390
UA	G306	B	2021/04/21	Barium, total	mg/L	0.0400
UA	G306	B	2021/05/05	Barium, total	mg/L	0.0390
UA	G306	B	2021/05/18	Barium, total	mg/L	0.0400
UA	G306	B	2021/06/15	Barium, total	mg/L	0.0350
UA	G306	B	2021/06/28	Barium, total	mg/L	0.0420
UA	G306	B	2021/07/14	Barium, total	mg/L	0.0300
UA	G306	B	2021/07/27	Barium, total	mg/L	0.0330
UA	G306	B	2021/08/17	Barium, total	mg/L	0.0300
UA	G306	B	2022/02/08	Barium, total	mg/L	0.0290
UA	G306	B	2022/08/24	Barium, total	mg/L	0.0290
UA	G306	B	2023/02/16	Barium, total	mg/L	0.0770
UA	G306	B	2023/06/05	Barium, total	mg/L	0.0410
UA	G306	B	2023/08/10	Barium, total	mg/L	0.0700
UA	G306	B	2023/11/17	Barium, total	mg/L	0.0532
UA	G306	B	2016/05/19	Boron, total	mg/L	2.30
UA	G306	B	2016/07/01	Boron, total	mg/L	2.70
UA	G306	B	2016/08/16	Boron, total	mg/L	2.40
UA	G306	B	2016/09/29	Boron, total	mg/L	2.60
UA	G306	B	2016/11/16	Boron, total	mg/L	2.70
UA	G306	B	2017/02/19	Boron, total	mg/L	2.70
UA	G306	B	2017/05/17	Boron, total	mg/L	2.50
UA	G306	B	2017/07/13	Boron, total	mg/L	2.90
UA	G306	B	2017/10/27	Boron, total	mg/L	3.10
UA	G306	B	2018/05/14	Boron, total	mg/L	2.80
UA	G306	B	2018/08/03	Boron, total	mg/L	2.70
UA	G306	B	2019/01/23	Boron, total	mg/L	2.40
UA	G306	B	2019/08/19	Boron, total	mg/L	2.50
UA	G306	B	2020/01/21	Boron, total	mg/L	3.50
UA	G306	B	2020/08/11	Boron, total	mg/L	2.60
UA	G306	B	2021/01/26	Boron, total	mg/L	2.40
UA	G306	B	2021/03/29	Boron, total	mg/L	2.50
UA	G306	B	2021/04/21	Boron, total	mg/L	2.60
UA	G306	B	2021/05/05	Boron, total	mg/L	2.90
UA	G306	B	2021/05/18	Boron, total	mg/L	2.90
UA	G306	B	2021/06/15	Boron, total	mg/L	3.20
UA	G306	B	2021/06/28	Boron, total	mg/L	2.50
UA	G306	B	2021/07/14	Boron, total	mg/L	2.90
UA	G306	B	2021/07/27	Boron, total	mg/L	3.10
UA	G306	B	2021/08/17	Boron, total	mg/L	3.00
UA	G306	B	2022/02/08	Boron, total	mg/L	3.50
UA	G306	B	2022/08/24	Boron, total	mg/L	3.00
UA	G306	B	2023/02/16	Boron, total	mg/L	2.40

UA	G306	B	2023/06/05	Boron, total	mg/L	2.40
UA	G306	B	2023/08/10	Boron, total	mg/L	2.74
UA	G306	B	2023/11/17	Boron, total	mg/L	2.22
UA	G306	B	2016/05/19	Calcium, total	mg/L	130
UA	G306	B	2016/07/01	Calcium, total	mg/L	130
UA	G306	B	2016/08/16	Calcium, total	mg/L	110
UA	G306	B	2016/09/29	Calcium, total	mg/L	120
UA	G306	B	2016/11/16	Calcium, total	mg/L	120
UA	G306	B	2017/02/19	Calcium, total	mg/L	130
UA	G306	B	2017/05/17	Calcium, total	mg/L	150
UA	G306	B	2017/07/13	Calcium, total	mg/L	130
UA	G306	B	2017/10/27	Calcium, total	mg/L	120
UA	G306	B	2018/05/14	Calcium, total	mg/L	130
UA	G306	B	2018/08/03	Calcium, total	mg/L	160
UA	G306	B	2019/01/23	Calcium, total	mg/L	170
UA	G306	B	2019/08/19	Calcium, total	mg/L	160
UA	G306	B	2020/01/21	Calcium, total	mg/L	150
UA	G306	B	2020/08/11	Calcium, total	mg/L	140
UA	G306	B	2021/01/26	Calcium, total	mg/L	110
UA	G306	B	2021/03/29	Calcium, total	mg/L	120
UA	G306	B	2021/04/21	Calcium, total	mg/L	130
UA	G306	B	2021/05/05	Calcium, total	mg/L	130
UA	G306	B	2021/05/18	Calcium, total	mg/L	140
UA	G306	B	2021/06/15	Calcium, total	mg/L	140
UA	G306	B	2021/06/28	Calcium, total	mg/L	140
UA	G306	B	2021/07/14	Calcium, total	mg/L	110
UA	G306	B	2021/07/27	Calcium, total	mg/L	110
UA	G306	B	2021/08/17	Calcium, total	mg/L	110
UA	G306	B	2022/02/08	Calcium, total	mg/L	120
UA	G306	B	2022/08/24	Calcium, total	mg/L	100
UA	G306	B	2023/02/16	Calcium, total	mg/L	110
UA	G306	B	2023/06/05	Calcium, total	mg/L	110
UA	G306	B	2023/08/10	Calcium, total	mg/L	81.3
UA	G306	B	2023/11/17	Calcium, total	mg/L	85.5
UA	G306	B	2016/05/19	Chloride, total	mg/L	14.0
UA	G306	B	2016/07/01	Chloride, total	mg/L	8.90
UA	G306	B	2016/08/16	Chloride, total	mg/L	7.20
UA	G306	B	2016/09/29	Chloride, total	mg/L	6.80
UA	G306	B	2016/11/16	Chloride, total	mg/L	6.60
UA	G306	B	2017/02/19	Chloride, total	mg/L	6.20
UA	G306	B	2017/05/17	Chloride, total	mg/L	5.50
UA	G306	B	2017/07/13	Chloride, total	mg/L	8.30
UA	G306	B	2017/10/27	Chloride, total	mg/L	4.70
UA	G306	B	2018/05/14	Chloride, total	mg/L	3.90
UA	G306	B	2018/08/03	Chloride, total	mg/L	3.70
UA	G306	B	2019/01/23	Chloride, total	mg/L	4.10
UA	G306	B	2019/08/19	Chloride, total	mg/L	4.40
UA	G306	B	2020/01/21	Chloride, total	mg/L	2.50
UA	G306	B	2020/08/11	Chloride, total	mg/L	1.50
UA	G306	B	2021/01/26	Chloride, total	mg/L	2.10
UA	G306	B	2021/03/29	Chloride, total	mg/L	1.60
UA	G306	B	2021/04/21	Chloride, total	mg/L	2.00
UA	G306	B	2021/05/05	Chloride, total	mg/L	<0.96
UA	G306	B	2021/05/18	Chloride, total	mg/L	1.10
UA	G306	B	2021/06/15	Chloride, total	mg/L	1.50
UA	G306	B	2021/06/28	Chloride, total	mg/L	2.40
UA	G306	B	2021/07/14	Chloride, total	mg/L	<0.96
UA	G306	B	2021/07/27	Chloride, total	mg/L	<0.96
UA	G306	B	2021/08/17	Chloride, total	mg/L	1.50
UA	G306	B	2022/02/08	Chloride, total	mg/L	1.30
UA	G306	B	2022/08/24	Chloride, total	mg/L	<0.96
UA	G306	B	2023/02/16	Chloride, total	mg/L	1.60

UA	G306	B	2023/06/05	Chloride, total	mg/L	<0.96
UA	G306	B	2023/08/10	Chloride, total	mg/L	1.00
UA	G306	B	2023/11/17	Chloride, total	mg/L	2.00
UA	G306	B	2023/06/05	Ferrous Iron, dissolved	mg/L	0.110
UA	G306	B	2023/06/05	Iron, dissolved	mg/L	0.00940
UA	G306	B	2023/08/10	Iron, dissolved	mg/L	<0.0115
UA	G306	B	2016/11/16	Magnesium, total	mg/L	62.0
UA	G306	B	2017/05/17	Magnesium, total	mg/L	66.0
UA	G306	B	2017/07/13	Magnesium, total	mg/L	66.0
UA	G306	B	2020/01/21	Magnesium, total	mg/L	56.0
UA	G306	B	2020/08/11	Magnesium, total	mg/L	54.0
UA	G306	B	2021/01/26	Magnesium, total	mg/L	47.0
UA	G306	B	2021/03/29	Magnesium, total	mg/L	48.0
UA	G306	B	2021/04/21	Magnesium, total	mg/L	49.0
UA	G306	B	2021/05/05	Magnesium, total	mg/L	50.0
UA	G306	B	2021/05/18	Magnesium, total	mg/L	47.0
UA	G306	B	2021/06/15	Magnesium, total	mg/L	51.0
UA	G306	B	2021/06/28	Magnesium, total	mg/L	51.0
UA	G306	B	2021/07/14	Magnesium, total	mg/L	46.0
UA	G306	B	2021/07/27	Magnesium, total	mg/L	43.0
UA	G306	B	2021/08/17	Magnesium, total	mg/L	42.0
UA	G306	B	2022/02/08	Magnesium, total	mg/L	41.0
UA	G306	B	2022/08/24	Magnesium, total	mg/L	38.0
UA	G306	B	2023/02/16	Magnesium, total	mg/L	43.0
UA	G306	B	2023/06/05	Magnesium, total	mg/L	40.0
UA	G306	B	2023/08/10	Magnesium, total	mg/L	31.2
UA	G306	B	2023/11/17	Magnesium, total	mg/L	31.4
UA	G306	B	2023/06/05	Manganese, dissolved	mg/L	0.00600
UA	G306	B	2023/08/10	Manganese, dissolved	mg/L	0.0833
UA	G306	B	2023/08/10	Phosphate, dissolved	mg/L	0.0430
UA	G306	B	2016/11/16	Potassium, total	mg/L	0.990
UA	G306	B	2017/05/17	Potassium, total	mg/L	0.890
UA	G306	B	2017/07/13	Potassium, total	mg/L	1.20
UA	G306	B	2020/01/21	Potassium, total	mg/L	1.60
UA	G306	B	2020/08/11	Potassium, total	mg/L	0.470
UA	G306	B	2021/01/26	Potassium, total	mg/L	0.300
UA	G306	B	2021/03/29	Potassium, total	mg/L	0.510
UA	G306	B	2021/04/21	Potassium, total	mg/L	0.510
UA	G306	B	2021/05/05	Potassium, total	mg/L	0.420
UA	G306	B	2021/05/18	Potassium, total	mg/L	0.540
UA	G306	B	2021/06/15	Potassium, total	mg/L	0.350
UA	G306	B	2021/06/28	Potassium, total	mg/L	0.670
UA	G306	B	2021/07/14	Potassium, total	mg/L	0.320
UA	G306	B	2021/07/27	Potassium, total	mg/L	0.210
UA	G306	B	2021/08/17	Potassium, total	mg/L	0.240
UA	G306	B	2022/02/08	Potassium, total	mg/L	0.270
UA	G306	B	2022/08/24	Potassium, total	mg/L	0.310
UA	G306	B	2023/02/16	Potassium, total	mg/L	1.30
UA	G306	B	2023/06/05	Potassium, total	mg/L	0.300
UA	G306	B	2023/08/10	Potassium, total	mg/L	1.43
UA	G306	B	2023/11/17	Potassium, total	mg/L	0.420
UA	G306	B	2023/06/05	Silicon, dissolved	mg/L	16.0
UA	G306	B	2023/08/10	Silicon, dissolved	mg/L	14.4
UA	G306	B	2016/11/16	Sodium, total	mg/L	58.0
UA	G306	B	2017/05/17	Sodium, total	mg/L	61.0
UA	G306	B	2017/07/13	Sodium, total	mg/L	55.0
UA	G306	B	2020/01/21	Sodium, total	mg/L	55.0
UA	G306	B	2020/08/11	Sodium, total	mg/L	50.0
UA	G306	B	2021/01/26	Sodium, total	mg/L	48.0
UA	G306	B	2021/03/29	Sodium, total	mg/L	46.0
UA	G306	B	2021/04/21	Sodium, total	mg/L	48.0
UA	G306	B	2021/05/05	Sodium, total	mg/L	49.0

UA	G306	B	2021/05/18	Sodium, total	mg/L	48.0
UA	G306	B	2021/06/15	Sodium, total	mg/L	50.0
UA	G306	B	2021/06/28	Sodium, total	mg/L	48.0
UA	G306	B	2021/07/14	Sodium, total	mg/L	46.0
UA	G306	B	2021/07/27	Sodium, total	mg/L	41.0
UA	G306	B	2021/08/17	Sodium, total	mg/L	50.0
UA	G306	B	2022/02/08	Sodium, total	mg/L	47.0
UA	G306	B	2022/08/24	Sodium, total	mg/L	45.0
UA	G306	B	2023/02/16	Sodium, total	mg/L	47.0
UA	G306	B	2023/06/05	Sodium, total	mg/L	44.0
UA	G306	B	2023/08/10	Sodium, total	mg/L	39.5
UA	G306	B	2023/11/17	Sodium, total	mg/L	36.6
UA	G306	B	2016/05/19	Sulfate, total	mg/L	350
UA	G306	B	2016/07/01	Sulfate, total	mg/L	330
UA	G306	B	2016/08/16	Sulfate, total	mg/L	320
UA	G306	B	2016/09/29	Sulfate, total	mg/L	320
UA	G306	B	2016/11/16	Sulfate, total	mg/L	330
UA	G306	B	2017/02/19	Sulfate, total	mg/L	5.90
UA	G306	B	2017/05/17	Sulfate, total	mg/L	700
UA	G306	B	2017/07/13	Sulfate, total	mg/L	340
UA	G306	B	2017/10/27	Sulfate, total	mg/L	350
UA	G306	B	2018/05/14	Sulfate, total	mg/L	320
UA	G306	B	2018/08/03	Sulfate, total	mg/L	290
UA	G306	B	2019/01/23	Sulfate, total	mg/L	250
UA	G306	B	2019/08/19	Sulfate, total	mg/L	260
UA	G306	B	2020/01/21	Sulfate, total	mg/L	260
UA	G306	B	2020/08/11	Sulfate, total	mg/L	250
UA	G306	B	2021/01/26	Sulfate, total	mg/L	240
UA	G306	B	2021/03/29	Sulfate, total	mg/L	260
UA	G306	B	2021/04/21	Sulfate, total	mg/L	240
UA	G306	B	2021/05/05	Sulfate, total	mg/L	240
UA	G306	B	2021/05/18	Sulfate, total	mg/L	250
UA	G306	B	2021/06/15	Sulfate, total	mg/L	250
UA	G306	B	2021/06/28	Sulfate, total	mg/L	210
UA	G306	B	2021/07/14	Sulfate, total	mg/L	230
UA	G306	B	2021/07/27	Sulfate, total	mg/L	220
UA	G306	B	2021/08/17	Sulfate, total	mg/L	210
UA	G306	B	2022/02/08	Sulfate, total	mg/L	200
UA	G306	B	2022/08/24	Sulfate, total	mg/L	210
UA	G306	B	2023/02/16	Sulfate, total	mg/L	140
UA	G306	B	2023/06/05	Sulfate, total	mg/L	130
UA	G306	B	2023/08/10	Sulfate, total	mg/L	141
UA	G306	B	2023/11/17	Sulfate, total	mg/L	141
UA	G306	B	2016/05/19	Temperature (Celsius)	degrees C	16.6
UA	G306	B	2016/07/01	Temperature (Celsius)	degrees C	20.8
UA	G306	B	2016/08/16	Temperature (Celsius)	degrees C	17.6
UA	G306	B	2016/09/29	Temperature (Celsius)	degrees C	18.1
UA	G306	B	2016/11/16	Temperature (Celsius)	degrees C	13.7
UA	G306	B	2017/02/19	Temperature (Celsius)	degrees C	14.8
UA	G306	B	2017/05/17	Temperature (Celsius)	degrees C	15.8
UA	G306	B	2017/07/13	Temperature (Celsius)	degrees C	17.3
UA	G306	B	2017/10/27	Temperature (Celsius)	degrees C	13.9
UA	G306	B	2018/05/14	Temperature (Celsius)	degrees C	15.6
UA	G306	B	2018/08/03	Temperature (Celsius)	degrees C	15.1
UA	G306	B	2019/01/23	Temperature (Celsius)	degrees C	11.2
UA	G306	B	2019/08/19	Temperature (Celsius)	degrees C	16.8
UA	G306	B	2020/01/21	Temperature (Celsius)	degrees C	9.90
UA	G306	B	2020/08/11	Temperature (Celsius)	degrees C	18.7
UA	G306	B	2021/01/26	Temperature (Celsius)	degrees C	10.4
UA	G306	B	2021/03/29	Temperature (Celsius)	degrees C	14.5
UA	G306	B	2021/04/21	Temperature (Celsius)	degrees C	12.5
UA	G306	B	2021/05/05	Temperature (Celsius)	degrees C	14.7

UA	G306	B	2021/05/18	Temperature (Celsius)	degrees C	14.0
UA	G306	B	2021/06/15	Temperature (Celsius)	degrees C	17.0
UA	G306	B	2021/06/28	Temperature (Celsius)	degrees C	23.4
UA	G306	B	2021/07/14	Temperature (Celsius)	degrees C	18.6
UA	G306	B	2021/07/27	Temperature (Celsius)	degrees C	19.6
UA	G306	B	2021/08/17	Temperature (Celsius)	degrees C	18.6
UA	G306	B	2022/02/08	Temperature (Celsius)	degrees C	12.0
UA	G306	B	2022/08/24	Temperature (Celsius)	degrees C	19.9
UA	G306	B	2023/02/16	Temperature (Celsius)	degrees C	10.8
UA	G306	B	2023/06/05	Temperature (Celsius)	degrees C	16.8
UA	G306	B	2023/08/10	Temperature (Celsius)	degrees C	14.5
UA	G306	B	2023/11/17	Temperature (Celsius)	degrees C	15.3
UA	G306	B	2016/05/19	Total Dissolved Solids	mg/L	720
UA	G306	B	2016/07/01	Total Dissolved Solids	mg/L	720
UA	G306	B	2016/08/16	Total Dissolved Solids	mg/L	680
UA	G306	B	2016/09/29	Total Dissolved Solids	mg/L	660
UA	G306	B	2016/11/16	Total Dissolved Solids	mg/L	820
UA	G306	B	2017/02/19	Total Dissolved Solids	mg/L	820
UA	G306	B	2017/05/17	Total Dissolved Solids	mg/L	800
UA	G306	B	2017/07/13	Total Dissolved Solids	mg/L	720
UA	G306	B	2017/10/27	Total Dissolved Solids	mg/L	720
UA	G306	B	2018/05/14	Total Dissolved Solids	mg/L	720
UA	G306	B	2018/08/03	Total Dissolved Solids	mg/L	820
UA	G306	B	2019/01/23	Total Dissolved Solids	mg/L	900
UA	G306	B	2019/08/19	Total Dissolved Solids	mg/L	780
UA	G306	B	2020/01/21	Total Dissolved Solids	mg/L	830
UA	G306	B	2020/08/11	Total Dissolved Solids	mg/L	700
UA	G306	B	2021/01/26	Total Dissolved Solids	mg/L	700
UA	G306	B	2021/03/29	Total Dissolved Solids	mg/L	690
UA	G306	B	2021/04/21	Total Dissolved Solids	mg/L	830
UA	G306	B	2021/05/05	Total Dissolved Solids	mg/L	670
UA	G306	B	2021/05/18	Total Dissolved Solids	mg/L	680
UA	G306	B	2021/06/15	Total Dissolved Solids	mg/L	670
UA	G306	B	2021/06/28	Total Dissolved Solids	mg/L	700
UA	G306	B	2021/07/14	Total Dissolved Solids	mg/L	730
UA	G306	B	2021/07/27	Total Dissolved Solids	mg/L	650
UA	G306	B	2021/08/17	Total Dissolved Solids	mg/L	640
UA	G306	B	2022/02/08	Total Dissolved Solids	mg/L	640
UA	G306	B	2022/08/24	Total Dissolved Solids	mg/L	610
UA	G306	B	2023/02/16	Total Dissolved Solids	mg/L	560
UA	G306	B	2023/06/05	Total Dissolved Solids	mg/L	520
UA	G306	B	2023/08/10	Total Dissolved Solids	mg/L	455
UA	G306	B	2023/11/17	Total Dissolved Solids	mg/L	550
UA	G301	C	2015/11/20	pH (field)	SU	6.9
UA	G301	C	2016/02/23	pH (field)	SU	6.6
UA	G301	C	2016/05/20	pH (field)	SU	6.4
UA	G301	C	2016/08/15	pH (field)	SU	6.8
UA	G301	C	2016/11/17	pH (field)	SU	6.9
UA	G301	C	2017/02/16	pH (field)	SU	7.0
UA	G301	C	2017/05/17	pH (field)	SU	7.1
UA	G301	C	2017/07/12	pH (field)	SU	6.8
UA	G301	C	2017/10/26	pH (field)	SU	6.8
UA	G301	C	2018/05/11	pH (field)	SU	6.9
UA	G301	C	2018/08/03	pH (field)	SU	6.9
UA	G301	C	2019/01/23	pH (field)	SU	7.0
UA	G301	C	2019/08/19	pH (field)	SU	6.9
UA	G301	C	2020/01/23	pH (field)	SU	6.7
UA	G301	C	2020/08/11	pH (field)	SU	6.6
UA	G301	C	2021/01/27	pH (field)	SU	6.6
UA	G301	C	2021/08/17	pH (field)	SU	6.6
UA	G301	C	2022/02/08	pH (field)	SU	6.5
UA	G301	C	2022/08/23	pH (field)	SU	6.6

UA	G301	C	2023/02/15	pH (field)	SU	7.0
UA	G301	C	2023/06/06	pH (field)	SU	6.8
UA	G301	C	2023/08/09	pH (field)	SU	6.4
UA	G301	C	2023/11/20	pH (field)	SU	6.4
UA	G301	C	2015/11/20	Oxidation Reduction Potential	mV	-37.0
UA	G301	C	2016/02/23	Oxidation Reduction Potential	mV	127
UA	G301	C	2016/05/20	Oxidation Reduction Potential	mV	136
UA	G301	C	2016/08/15	Oxidation Reduction Potential	mV	125
UA	G301	C	2016/11/17	Oxidation Reduction Potential	mV	109
UA	G301	C	2017/02/16	Oxidation Reduction Potential	mV	122
UA	G301	C	2017/05/17	Oxidation Reduction Potential	mV	103
UA	G301	C	2017/07/12	Oxidation Reduction Potential	mV	121
UA	G301	C	2017/10/26	Oxidation Reduction Potential	mV	96.0
UA	G301	C	2018/05/11	Oxidation Reduction Potential	mV	98.0
UA	G301	C	2018/08/03	Oxidation Reduction Potential	mV	109
UA	G301	C	2019/01/23	Oxidation Reduction Potential	mV	112
UA	G301	C	2019/08/19	Oxidation Reduction Potential	mV	101
UA	G301	C	2020/01/23	Oxidation Reduction Potential	mV	147
UA	G301	C	2020/08/11	Oxidation Reduction Potential	mV	-102
UA	G301	C	2021/01/27	Oxidation Reduction Potential	mV	50.6
UA	G301	C	2021/08/17	Oxidation Reduction Potential	mV	-178
UA	G301	C	2022/02/08	Oxidation Reduction Potential	mV	-23.3
UA	G301	C	2022/08/23	Oxidation Reduction Potential	mV	1.40
UA	G301	C	2023/02/15	Oxidation Reduction Potential	mV	151
UA	G301	C	2023/06/06	Oxidation Reduction Potential	mV	-259
UA	G301	C	2023/08/09	Oxidation Reduction Potential	mV	-96.0
UA	G301	C	2023/11/20	Oxidation Reduction Potential	mV	-49.0
UA	G301	C	2015/11/20	Eh	V	0.16
UA	G301	C	2016/02/23	Eh	V	0.33
UA	G301	C	2016/05/20	Eh	V	0.33
UA	G301	C	2016/08/15	Eh	V	0.32
UA	G301	C	2016/11/17	Eh	V	0.30
UA	G301	C	2017/02/16	Eh	V	0.32
UA	G301	C	2017/05/17	Eh	V	0.30
UA	G301	C	2017/07/12	Eh	V	0.31
UA	G301	C	2017/10/26	Eh	V	0.29
UA	G301	C	2018/05/11	Eh	V	0.29
UA	G301	C	2018/08/03	Eh	V	0.30
UA	G301	C	2019/01/23	Eh	V	0.31
UA	G301	C	2019/08/19	Eh	V	0.29
UA	G301	C	2020/01/23	Eh	V	0.35
UA	G301	C	2020/08/11	Eh	V	0.089
UA	G301	C	2021/01/27	Eh	V	0.25
UA	G301	C	2021/08/17	Eh	V	0.014
UA	G301	C	2022/02/08	Eh	V	0.17
UA	G301	C	2022/08/23	Eh	V	0.19
UA	G301	C	2023/02/15	Eh	V	0.35
UA	G301	C	2023/06/06	Eh	V	-0.066
UA	G301	C	2023/08/09	Eh	V	0.098
UA	G301	C	2023/11/20	Eh	V	0.15
UA	G301	C	2016/11/17	Alkalinity, bicarbonate	mg/L CaCO3	180
UA	G301	C	2017/05/17	Alkalinity, bicarbonate	mg/L CaCO3	130
UA	G301	C	2017/07/12	Alkalinity, bicarbonate	mg/L CaCO3	160
UA	G301	C	2020/01/23	Alkalinity, bicarbonate	mg/L CaCO3	140
UA	G301	C	2020/08/11	Alkalinity, bicarbonate	mg/L CaCO3	140
UA	G301	C	2021/01/27	Alkalinity, bicarbonate	mg/L CaCO3	120
UA	G301	C	2021/08/17	Alkalinity, bicarbonate	mg/L CaCO3	140
UA	G301	C	2022/02/08	Alkalinity, bicarbonate	mg/L CaCO3	150
UA	G301	C	2022/08/23	Alkalinity, bicarbonate	mg/L CaCO3	140
UA	G301	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	160
UA	G301	C	2023/06/06	Alkalinity, bicarbonate	mg/L CaCO3	160
UA	G301	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	141

UA	G301	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	163
UA	G301	C	2022/08/23	Alkalinity, carbonate	mg/L CaCO3	10.0
UA	G301	C	2015/11/20	Barium, total	mg/L	0.0790
UA	G301	C	2016/02/23	Barium, total	mg/L	0.0410
UA	G301	C	2016/05/20	Barium, total	mg/L	0.0310
UA	G301	C	2016/08/15	Barium, total	mg/L	0.0320
UA	G301	C	2016/11/17	Barium, total	mg/L	0.0360
UA	G301	C	2017/02/16	Barium, total	mg/L	0.0630
UA	G301	C	2017/05/17	Barium, total	mg/L	0.0290
UA	G301	C	2017/07/12	Barium, total	mg/L	0.0580
UA	G301	C	2018/05/11	Barium, total	mg/L	0.0600
UA	G301	C	2018/08/03	Barium, total	mg/L	0.0840
UA	G301	C	2019/01/23	Barium, total	mg/L	0.110
UA	G301	C	2019/08/19	Barium, total	mg/L	0.0200
UA	G301	C	2020/01/23	Barium, total	mg/L	0.0340
UA	G301	C	2020/08/11	Barium, total	mg/L	0.0160
UA	G301	C	2021/01/27	Barium, total	mg/L	0.0170
UA	G301	C	2021/08/17	Barium, total	mg/L	0.0160
UA	G301	C	2022/02/08	Barium, total	mg/L	0.0130
UA	G301	C	2022/08/23	Barium, total	mg/L	0.0250
UA	G301	C	2023/02/15	Barium, total	mg/L	0.0220
UA	G301	C	2023/06/06	Barium, total	mg/L	0.0180
UA	G301	C	2023/08/09	Barium, total	mg/L	0.0152
UA	G301	C	2023/11/20	Barium, total	mg/L	0.0168
UA	G301	C	2015/11/20	Boron, total	mg/L	2.30
UA	G301	C	2016/02/23	Boron, total	mg/L	2.40
UA	G301	C	2016/05/20	Boron, total	mg/L	2.60
UA	G301	C	2016/08/15	Boron, total	mg/L	2.90
UA	G301	C	2016/11/17	Boron, total	mg/L	2.40
UA	G301	C	2017/02/16	Boron, total	mg/L	2.40
UA	G301	C	2017/05/17	Boron, total	mg/L	2.10
UA	G301	C	2017/07/12	Boron, total	mg/L	2.30
UA	G301	C	2017/10/26	Boron, total	mg/L	2.30
UA	G301	C	2018/05/11	Boron, total	mg/L	2.10
UA	G301	C	2018/08/03	Boron, total	mg/L	2.40
UA	G301	C	2019/01/23	Boron, total	mg/L	2.10
UA	G301	C	2019/08/19	Boron, total	mg/L	2.00
UA	G301	C	2020/01/23	Boron, total	mg/L	2.10
UA	G301	C	2020/08/11	Boron, total	mg/L	2.10
UA	G301	C	2021/01/27	Boron, total	mg/L	2.00
UA	G301	C	2021/08/17	Boron, total	mg/L	2.20
UA	G301	C	2022/02/08	Boron, total	mg/L	2.20
UA	G301	C	2022/08/23	Boron, total	mg/L	2.20
UA	G301	C	2023/02/15	Boron, total	mg/L	1.90
UA	G301	C	2023/06/06	Boron, total	mg/L	2.50
UA	G301	C	2023/08/09	Boron, total	mg/L	2.08
UA	G301	C	2023/11/20	Boron, total	mg/L	2.80
UA	G301	C	2015/11/20	Calcium, total	mg/L	140
UA	G301	C	2016/02/23	Calcium, total	mg/L	140
UA	G301	C	2016/05/20	Calcium, total	mg/L	130
UA	G301	C	2016/08/15	Calcium, total	mg/L	140
UA	G301	C	2016/11/17	Calcium, total	mg/L	120
UA	G301	C	2017/02/16	Calcium, total	mg/L	150
UA	G301	C	2017/05/17	Calcium, total	mg/L	120
UA	G301	C	2017/07/12	Calcium, total	mg/L	120
UA	G301	C	2017/10/26	Calcium, total	mg/L	110
UA	G301	C	2018/05/11	Calcium, total	mg/L	130
UA	G301	C	2018/08/03	Calcium, total	mg/L	150
UA	G301	C	2019/01/23	Calcium, total	mg/L	170
UA	G301	C	2019/08/19	Calcium, total	mg/L	110
UA	G301	C	2020/01/23	Calcium, total	mg/L	160
UA	G301	C	2020/08/11	Calcium, total	mg/L	150

UA	G301	C	2021/01/27	Calcium, total	mg/L	160
UA	G301	C	2021/08/17	Calcium, total	mg/L	150
UA	G301	C	2022/02/08	Calcium, total	mg/L	140
UA	G301	C	2022/08/23	Calcium, total	mg/L	130
UA	G301	C	2023/02/15	Calcium, total	mg/L	120
UA	G301	C	2023/06/06	Calcium, total	mg/L	110
UA	G301	C	2023/08/09	Calcium, total	mg/L	113
UA	G301	C	2023/11/20	Calcium, total	mg/L	123
UA	G301	C	2015/11/20	Chloride, total	mg/L	33.0
UA	G301	C	2016/02/23	Chloride, total	mg/L	25.0
UA	G301	C	2016/05/20	Chloride, total	mg/L	24.0
UA	G301	C	2016/08/15	Chloride, total	mg/L	24.0
UA	G301	C	2016/11/17	Chloride, total	mg/L	25.0
UA	G301	C	2017/02/16	Chloride, total	mg/L	23.0
UA	G301	C	2017/05/17	Chloride, total	mg/L	21.0
UA	G301	C	2017/07/12	Chloride, total	mg/L	23.0
UA	G301	C	2017/10/26	Chloride, total	mg/L	22.0
UA	G301	C	2018/05/11	Chloride, total	mg/L	22.0
UA	G301	C	2018/08/03	Chloride, total	mg/L	20.0
UA	G301	C	2019/01/23	Chloride, total	mg/L	21.0
UA	G301	C	2019/08/19	Chloride, total	mg/L	12.0
UA	G301	C	2020/01/23	Chloride, total	mg/L	16.0
UA	G301	C	2020/08/11	Chloride, total	mg/L	14.0
UA	G301	C	2021/01/27	Chloride, total	mg/L	17.0
UA	G301	C	2021/08/17	Chloride, total	mg/L	18.0
UA	G301	C	2022/02/08	Chloride, total	mg/L	15.0
UA	G301	C	2022/08/23	Chloride, total	mg/L	15.0
UA	G301	C	2023/02/15	Chloride, total	mg/L	13.0
UA	G301	C	2023/06/06	Chloride, total	mg/L	13.0
UA	G301	C	2023/08/09	Chloride, total	mg/L	12.0
UA	G301	C	2023/11/20	Chloride, total	mg/L	12.0
UA	G301	C	2023/06/06	Ferrous Iron, dissolved	mg/L	0.200
UA	G301	C	2023/06/06	Iron, dissolved	mg/L	0.170
UA	G301	C	2023/08/09	Iron, dissolved	mg/L	0.0697
UA	G301	C	2016/11/17	Magnesium, total	mg/L	56.0
UA	G301	C	2017/05/17	Magnesium, total	mg/L	52.0
UA	G301	C	2017/07/12	Magnesium, total	mg/L	55.0
UA	G301	C	2020/01/23	Magnesium, total	mg/L	61.0
UA	G301	C	2020/08/11	Magnesium, total	mg/L	59.0
UA	G301	C	2021/01/27	Magnesium, total	mg/L	61.0
UA	G301	C	2021/08/17	Magnesium, total	mg/L	57.0
UA	G301	C	2022/02/08	Magnesium, total	mg/L	49.0
UA	G301	C	2022/08/23	Magnesium, total	mg/L	51.0
UA	G301	C	2023/02/15	Magnesium, total	mg/L	43.0
UA	G301	C	2023/06/06	Magnesium, total	mg/L	42.0
UA	G301	C	2023/08/09	Magnesium, total	mg/L	42.6
UA	G301	C	2023/11/20	Magnesium, total	mg/L	46.6
UA	G301	C	2023/06/06	Manganese, dissolved	mg/L	2.30
UA	G301	C	2023/08/09	Manganese, dissolved	mg/L	2.04
UA	G301	C	2023/08/09	Phosphate, dissolved	mg/L	0.0250
UA	G301	C	2016/11/17	Potassium, total	mg/L	1.40
UA	G301	C	2017/05/17	Potassium, total	mg/L	1.50
UA	G301	C	2017/07/12	Potassium, total	mg/L	2.30
UA	G301	C	2020/01/23	Potassium, total	mg/L	1.90
UA	G301	C	2020/08/11	Potassium, total	mg/L	1.30
UA	G301	C	2021/01/27	Potassium, total	mg/L	1.60
UA	G301	C	2021/08/17	Potassium, total	mg/L	1.70
UA	G301	C	2022/02/08	Potassium, total	mg/L	1.40
UA	G301	C	2022/08/23	Potassium, total	mg/L	1.90
UA	G301	C	2023/02/15	Potassium, total	mg/L	1.70
UA	G301	C	2023/06/06	Potassium, total	mg/L	1.60
UA	G301	C	2023/08/09	Potassium, total	mg/L	1.77

UA	G301	C	2023/11/20	Potassium, total	mg/L	1.97
UA	G301	C	2023/06/06	Silicon, dissolved	mg/L	10.0
UA	G301	C	2023/08/09	Silicon, dissolved	mg/L	9.55
UA	G301	C	2016/11/17	Sodium, total	mg/L	180
UA	G301	C	2017/05/17	Sodium, total	mg/L	160
UA	G301	C	2017/07/12	Sodium, total	mg/L	170
UA	G301	C	2020/01/23	Sodium, total	mg/L	150
UA	G301	C	2020/08/11	Sodium, total	mg/L	150
UA	G301	C	2021/01/27	Sodium, total	mg/L	160
UA	G301	C	2021/08/17	Sodium, total	mg/L	160
UA	G301	C	2022/02/08	Sodium, total	mg/L	140
UA	G301	C	2022/08/23	Sodium, total	mg/L	140
UA	G301	C	2023/02/15	Sodium, total	mg/L	110
UA	G301	C	2023/06/06	Sodium, total	mg/L	120
UA	G301	C	2023/08/09	Sodium, total	mg/L	113
UA	G301	C	2023/11/20	Sodium, total	mg/L	122
UA	G301	C	2015/11/20	Sulfate, total	mg/L	700
UA	G301	C	2016/02/23	Sulfate, total	mg/L	740
UA	G301	C	2016/05/20	Sulfate, total	mg/L	710
UA	G301	C	2016/08/15	Sulfate, total	mg/L	740
UA	G301	C	2016/11/17	Sulfate, total	mg/L	800
UA	G301	C	2017/02/16	Sulfate, total	mg/L	790
UA	G301	C	2017/05/17	Sulfate, total	mg/L	650
UA	G301	C	2017/07/12	Sulfate, total	mg/L	760
UA	G301	C	2017/10/26	Sulfate, total	mg/L	680
UA	G301	C	2018/05/11	Sulfate, total	mg/L	810
UA	G301	C	2018/08/03	Sulfate, total	mg/L	860
UA	G301	C	2019/01/23	Sulfate, total	mg/L	850
UA	G301	C	2019/08/19	Sulfate, total	mg/L	570
UA	G301	C	2020/01/23	Sulfate, total	mg/L	820
UA	G301	C	2020/08/11	Sulfate, total	mg/L	750
UA	G301	C	2021/01/27	Sulfate, total	mg/L	650
UA	G301	C	2021/08/17	Sulfate, total	mg/L	810
UA	G301	C	2022/02/08	Sulfate, total	mg/L	620
UA	G301	C	2022/08/23	Sulfate, total	mg/L	650
UA	G301	C	2023/02/15	Sulfate, total	mg/L	560
UA	G301	C	2023/06/06	Sulfate, total	mg/L	540
UA	G301	C	2023/08/09	Sulfate, total	mg/L	513
UA	G301	C	2023/11/20	Sulfate, total	mg/L	535
UA	G301	C	2015/11/20	Temperature (Celsius)	degrees C	16.5
UA	G301	C	2016/02/23	Temperature (Celsius)	degrees C	11.3
UA	G301	C	2016/05/20	Temperature (Celsius)	degrees C	15.7
UA	G301	C	2016/08/15	Temperature (Celsius)	degrees C	18.3
UA	G301	C	2016/11/17	Temperature (Celsius)	degrees C	14.4
UA	G301	C	2017/02/16	Temperature (Celsius)	degrees C	15.8
UA	G301	C	2017/05/17	Temperature (Celsius)	degrees C	15.4
UA	G301	C	2017/07/12	Temperature (Celsius)	degrees C	17.2
UA	G301	C	2017/10/26	Temperature (Celsius)	degrees C	13.0
UA	G301	C	2018/05/11	Temperature (Celsius)	degrees C	13.7
UA	G301	C	2018/08/03	Temperature (Celsius)	degrees C	15.6
UA	G301	C	2019/01/23	Temperature (Celsius)	degrees C	12.0
UA	G301	C	2019/08/19	Temperature (Celsius)	degrees C	17.4
UA	G301	C	2020/01/23	Temperature (Celsius)	degrees C	8.60
UA	G301	C	2020/08/11	Temperature (Celsius)	degrees C	21.1
UA	G301	C	2021/01/27	Temperature (Celsius)	degrees C	9.10
UA	G301	C	2021/08/17	Temperature (Celsius)	degrees C	20.6
UA	G301	C	2022/02/08	Temperature (Celsius)	degrees C	12.6
UA	G301	C	2022/08/23	Temperature (Celsius)	degrees C	18.9
UA	G301	C	2023/02/15	Temperature (Celsius)	degrees C	12.6
UA	G301	C	2023/06/06	Temperature (Celsius)	degrees C	18.1
UA	G301	C	2023/08/09	Temperature (Celsius)	degrees C	16.5
UA	G301	C	2023/11/20	Temperature (Celsius)	degrees C	15.5

UA	G301	C	2015/11/20	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2016/02/23	Total Dissolved Solids	mg/L	1,000
UA	G301	C	2016/05/20	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2016/08/15	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2016/11/17	Total Dissolved Solids	mg/L	1,400
UA	G301	C	2017/02/16	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2017/05/17	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2017/07/12	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2017/10/26	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2018/05/11	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2018/08/03	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2019/01/23	Total Dissolved Solids	mg/L	1,500
UA	G301	C	2019/08/19	Total Dissolved Solids	mg/L	950
UA	G301	C	2020/01/23	Total Dissolved Solids	mg/L	1,400
UA	G301	C	2020/08/11	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2021/01/27	Total Dissolved Solids	mg/L	1,300
UA	G301	C	2021/08/17	Total Dissolved Solids	mg/L	1,200
UA	G301	C	2022/02/08	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2022/08/23	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2023/02/15	Total Dissolved Solids	mg/L	1,100
UA	G301	C	2023/06/06	Total Dissolved Solids	mg/L	900
UA	G301	C	2023/08/09	Total Dissolved Solids	mg/L	1,000
UA	G301	C	2023/11/20	Total Dissolved Solids	mg/L	1,020
UA	G302	C	2015/11/20	pH (field)	SU	6.9
UA	G302	C	2016/02/23	pH (field)	SU	6.8
UA	G302	C	2016/05/20	pH (field)	SU	6.8
UA	G302	C	2016/08/15	pH (field)	SU	7.0
UA	G302	C	2016/11/17	pH (field)	SU	7.1
UA	G302	C	2017/02/16	pH (field)	SU	7.1
UA	G302	C	2017/05/17	pH (field)	SU	7.0
UA	G302	C	2017/07/12	pH (field)	SU	7.0
UA	G302	C	2017/10/26	pH (field)	SU	7.1
UA	G302	C	2018/05/11	pH (field)	SU	7.1
UA	G302	C	2018/08/03	pH (field)	SU	7.0
UA	G302	C	2019/01/23	pH (field)	SU	7.0
UA	G302	C	2019/08/19	pH (field)	SU	7.0
UA	G302	C	2020/01/23	pH (field)	SU	7.1
UA	G302	C	2020/08/11	pH (field)	SU	6.9
UA	G302	C	2021/01/27	pH (field)	SU	6.6
UA	G302	C	2021/08/17	pH (field)	SU	6.6
UA	G302	C	2022/02/08	pH (field)	SU	6.7
UA	G302	C	2022/08/23	pH (field)	SU	6.9
UA	G302	C	2023/02/15	pH (field)	SU	6.8
UA	G302	C	2023/05/31	pH (field)	SU	7.0
UA	G302	C	2023/08/09	pH (field)	SU	6.5
UA	G302	C	2023/11/20	pH (field)	SU	6.5
UA	G302	C	2015/11/20	Oxidation Reduction Potential	mV	-120
UA	G302	C	2016/02/23	Oxidation Reduction Potential	mV	27.0
UA	G302	C	2016/05/20	Oxidation Reduction Potential	mV	-118
UA	G302	C	2016/08/15	Oxidation Reduction Potential	mV	95.0
UA	G302	C	2016/11/17	Oxidation Reduction Potential	mV	71.0
UA	G302	C	2017/02/16	Oxidation Reduction Potential	mV	71.0
UA	G302	C	2017/05/17	Oxidation Reduction Potential	mV	70.0
UA	G302	C	2017/07/12	Oxidation Reduction Potential	mV	112
UA	G302	C	2017/10/26	Oxidation Reduction Potential	mV	78.0
UA	G302	C	2018/05/11	Oxidation Reduction Potential	mV	87.0
UA	G302	C	2018/08/03	Oxidation Reduction Potential	mV	93.0
UA	G302	C	2019/01/23	Oxidation Reduction Potential	mV	94.0
UA	G302	C	2019/08/19	Oxidation Reduction Potential	mV	87.0
UA	G302	C	2020/01/23	Oxidation Reduction Potential	mV	44.7
UA	G302	C	2020/08/11	Oxidation Reduction Potential	mV	5.60
UA	G302	C	2021/01/27	Oxidation Reduction Potential	mV	63.0

UA	G302	C	2021/08/17	Oxidation Reduction Potential	mV	-1.10
UA	G302	C	2022/02/08	Oxidation Reduction Potential	mV	-13.9
UA	G302	C	2022/08/23	Oxidation Reduction Potential	mV	-133
UA	G302	C	2023/02/15	Oxidation Reduction Potential	mV	64.4
UA	G302	C	2023/05/31	Oxidation Reduction Potential	mV	-79.9
UA	G302	C	2023/08/09	Oxidation Reduction Potential	mV	-80.0
UA	G302	C	2023/11/20	Oxidation Reduction Potential	mV	-81.0
UA	G302	C	2015/11/20	Eh	V	0.075
UA	G302	C	2016/02/23	Eh	V	0.22
UA	G302	C	2016/05/20	Eh	V	0.077
UA	G302	C	2016/08/15	Eh	V	0.29
UA	G302	C	2016/11/17	Eh	V	0.27
UA	G302	C	2017/02/16	Eh	V	0.27
UA	G302	C	2017/05/17	Eh	V	0.27
UA	G302	C	2017/07/12	Eh	V	0.31
UA	G302	C	2017/10/26	Eh	V	0.27
UA	G302	C	2018/05/11	Eh	V	0.28
UA	G302	C	2018/08/03	Eh	V	0.29
UA	G302	C	2019/01/23	Eh	V	0.29
UA	G302	C	2019/08/19	Eh	V	0.28
UA	G302	C	2020/01/23	Eh	V	0.24
UA	G302	C	2020/08/11	Eh	V	0.20
UA	G302	C	2021/01/27	Eh	V	0.26
UA	G302	C	2021/08/17	Eh	V	0.19
UA	G302	C	2022/02/08	Eh	V	0.18
UA	G302	C	2022/08/23	Eh	V	0.060
UA	G302	C	2023/02/15	Eh	V	0.26
UA	G302	C	2023/05/31	Eh	V	0.11
UA	G302	C	2023/08/09	Eh	V	0.11
UA	G302	C	2023/11/20	Eh	V	0.11
UA	G302	C	2016/11/17	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G302	C	2017/05/17	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G302	C	2017/07/12	Alkalinity, bicarbonate	mg/L CaCO3	540
UA	G302	C	2020/01/23	Alkalinity, bicarbonate	mg/L CaCO3	500
UA	G302	C	2020/08/11	Alkalinity, bicarbonate	mg/L CaCO3	440
UA	G302	C	2021/01/27	Alkalinity, bicarbonate	mg/L CaCO3	440
UA	G302	C	2021/08/17	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G302	C	2022/02/08	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G302	C	2022/08/23	Alkalinity, bicarbonate	mg/L CaCO3	400
UA	G302	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G302	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G302	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	474
UA	G302	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	472
UA	G302	C	2022/08/23	Alkalinity, carbonate	mg/L CaCO3	10.0
UA	G302	C	2015/11/20	Barium, total	mg/L	0.0670
UA	G302	C	2016/02/23	Barium, total	mg/L	0.0290
UA	G302	C	2016/05/20	Barium, total	mg/L	0.0240
UA	G302	C	2016/08/15	Barium, total	mg/L	0.0280
UA	G302	C	2016/11/17	Barium, total	mg/L	0.0370
UA	G302	C	2017/02/16	Barium, total	mg/L	0.0300
UA	G302	C	2017/05/17	Barium, total	mg/L	0.0200
UA	G302	C	2017/07/12	Barium, total	mg/L	0.0600
UA	G302	C	2018/05/11	Barium, total	mg/L	0.0390
UA	G302	C	2018/08/03	Barium, total	mg/L	0.0540
UA	G302	C	2019/01/23	Barium, total	mg/L	0.0950
UA	G302	C	2019/08/19	Barium, total	mg/L	0.0280
UA	G302	C	2020/01/23	Barium, total	mg/L	0.0450
UA	G302	C	2020/08/11	Barium, total	mg/L	0.0220
UA	G302	C	2021/01/27	Barium, total	mg/L	0.0270
UA	G302	C	2021/08/17	Barium, total	mg/L	0.0290
UA	G302	C	2022/02/08	Barium, total	mg/L	0.0250
UA	G302	C	2022/08/23	Barium, total	mg/L	0.0240

UA	G302	C	2023/02/15	Barium, total	mg/L	0.0490
UA	G302	C	2023/05/31	Barium, total	mg/L	0.0420
UA	G302	C	2023/08/09	Barium, total	mg/L	0.0259
UA	G302	C	2023/11/20	Barium, total	mg/L	0.0435
UA	G302	C	2015/11/20	Boron, total	mg/L	2.00
UA	G302	C	2016/02/23	Boron, total	mg/L	2.10
UA	G302	C	2016/05/20	Boron, total	mg/L	2.50
UA	G302	C	2016/08/15	Boron, total	mg/L	1.90
UA	G302	C	2016/11/17	Boron, total	mg/L	1.90
UA	G302	C	2017/02/16	Boron, total	mg/L	1.40
UA	G302	C	2017/05/17	Boron, total	mg/L	1.10
UA	G302	C	2017/07/12	Boron, total	mg/L	2.00
UA	G302	C	2017/10/26	Boron, total	mg/L	1.10
UA	G302	C	2018/05/11	Boron, total	mg/L	2.10
UA	G302	C	2018/08/03	Boron, total	mg/L	2.30
UA	G302	C	2019/01/23	Boron, total	mg/L	1.90
UA	G302	C	2019/08/19	Boron, total	mg/L	1.80
UA	G302	C	2020/01/23	Boron, total	mg/L	1.70
UA	G302	C	2020/08/11	Boron, total	mg/L	1.20
UA	G302	C	2021/01/27	Boron, total	mg/L	1.20
UA	G302	C	2021/08/17	Boron, total	mg/L	1.80
UA	G302	C	2022/02/08	Boron, total	mg/L	2.20
UA	G302	C	2022/08/23	Boron, total	mg/L	1.70
UA	G302	C	2023/02/15	Boron, total	mg/L	1.90
UA	G302	C	2023/05/31	Boron, total	mg/L	2.10
UA	G302	C	2023/08/09	Boron, total	mg/L	1.93
UA	G302	C	2023/11/20	Boron, total	mg/L	2.96
UA	G302	C	2015/11/20	Calcium, total	mg/L	180
UA	G302	C	2016/02/23	Calcium, total	mg/L	170
UA	G302	C	2016/05/20	Calcium, total	mg/L	140
UA	G302	C	2016/08/15	Calcium, total	mg/L	130
UA	G302	C	2016/11/17	Calcium, total	mg/L	140
UA	G302	C	2017/02/16	Calcium, total	mg/L	160
UA	G302	C	2017/05/17	Calcium, total	mg/L	130
UA	G302	C	2017/07/12	Calcium, total	mg/L	160
UA	G302	C	2017/10/26	Calcium, total	mg/L	180
UA	G302	C	2018/05/11	Calcium, total	mg/L	170
UA	G302	C	2018/08/03	Calcium, total	mg/L	180
UA	G302	C	2019/01/23	Calcium, total	mg/L	210
UA	G302	C	2019/08/19	Calcium, total	mg/L	120
UA	G302	C	2020/01/23	Calcium, total	mg/L	150
UA	G302	C	2020/08/11	Calcium, total	mg/L	140
UA	G302	C	2021/01/27	Calcium, total	mg/L	180
UA	G302	C	2021/08/17	Calcium, total	mg/L	200
UA	G302	C	2022/02/08	Calcium, total	mg/L	170
UA	G302	C	2022/08/23	Calcium, total	mg/L	140
UA	G302	C	2023/02/15	Calcium, total	mg/L	180
UA	G302	C	2023/05/31	Calcium, total	mg/L	160
UA	G302	C	2023/08/09	Calcium, total	mg/L	157
UA	G302	C	2023/11/20	Calcium, total	mg/L	182
UA	G302	C	2015/11/20	Chloride, total	mg/L	22.0
UA	G302	C	2016/02/23	Chloride, total	mg/L	21.0
UA	G302	C	2016/05/20	Chloride, total	mg/L	12.0
UA	G302	C	2016/08/15	Chloride, total	mg/L	9.70
UA	G302	C	2016/11/17	Chloride, total	mg/L	14.0
UA	G302	C	2017/02/16	Chloride, total	mg/L	14.0
UA	G302	C	2017/05/17	Chloride, total	mg/L	6.50
UA	G302	C	2017/07/12	Chloride, total	mg/L	14.0
UA	G302	C	2017/10/26	Chloride, total	mg/L	8.30
UA	G302	C	2018/05/11	Chloride, total	mg/L	17.0
UA	G302	C	2018/08/03	Chloride, total	mg/L	17.0
UA	G302	C	2019/01/23	Chloride, total	mg/L	20.0

UA	G302	C	2019/08/19	Chloride, total	mg/L	5.90
UA	G302	C	2020/01/23	Chloride, total	mg/L	14.0
UA	G302	C	2020/08/11	Chloride, total	mg/L	5.90
UA	G302	C	2021/01/27	Chloride, total	mg/L	22.0
UA	G302	C	2021/08/17	Chloride, total	mg/L	21.0
UA	G302	C	2022/02/08	Chloride, total	mg/L	15.0
UA	G302	C	2022/08/23	Chloride, total	mg/L	<9.6
UA	G302	C	2023/02/15	Chloride, total	mg/L	23.0
UA	G302	C	2023/05/31	Chloride, total	mg/L	18.0
UA	G302	C	2023/08/09	Chloride, total	mg/L	9.00
UA	G302	C	2023/11/20	Chloride, total	mg/L	18.0
UA	G302	C	2023/05/31	Ferrous Iron, dissolved	mg/L	0.600
UA	G302	C	2023/05/31	Iron, dissolved	mg/L	0.660
UA	G302	C	2023/08/09	Iron, dissolved	mg/L	0.284
UA	G302	C	2016/11/17	Magnesium, total	mg/L	82.0
UA	G302	C	2017/05/17	Magnesium, total	mg/L	68.0
UA	G302	C	2017/07/12	Magnesium, total	mg/L	93.0
UA	G302	C	2020/01/23	Magnesium, total	mg/L	70.0
UA	G302	C	2020/08/11	Magnesium, total	mg/L	61.0
UA	G302	C	2021/01/27	Magnesium, total	mg/L	76.0
UA	G302	C	2021/08/17	Magnesium, total	mg/L	82.0
UA	G302	C	2022/02/08	Magnesium, total	mg/L	68.0
UA	G302	C	2022/08/23	Magnesium, total	mg/L	62.0
UA	G302	C	2023/02/15	Magnesium, total	mg/L	71.0
UA	G302	C	2023/05/31	Magnesium, total	mg/L	67.0
UA	G302	C	2023/08/09	Magnesium, total	mg/L	65.8
UA	G302	C	2023/11/20	Magnesium, total	mg/L	75.4
UA	G302	C	2023/05/31	Manganese, dissolved	mg/L	1.00
UA	G302	C	2023/08/09	Manganese, dissolved	mg/L	0.424
UA	G302	C	2023/08/09	Phosphate, dissolved	mg/L	0.123
UA	G302	C	2016/11/17	Potassium, total	mg/L	1.70
UA	G302	C	2017/05/17	Potassium, total	mg/L	0.400
UA	G302	C	2017/07/12	Potassium, total	mg/L	3.40
UA	G302	C	2020/01/23	Potassium, total	mg/L	1.50
UA	G302	C	2020/08/11	Potassium, total	mg/L	0.670
UA	G302	C	2021/01/27	Potassium, total	mg/L	0.500
UA	G302	C	2021/08/17	Potassium, total	mg/L	0.560
UA	G302	C	2022/02/08	Potassium, total	mg/L	0.680
UA	G302	C	2022/08/23	Potassium, total	mg/L	1.10
UA	G302	C	2023/02/15	Potassium, total	mg/L	1.50
UA	G302	C	2023/05/31	Potassium, total	mg/L	0.870
UA	G302	C	2023/08/09	Potassium, total	mg/L	1.58
UA	G302	C	2023/11/20	Potassium, total	mg/L	0.644
UA	G302	C	2023/05/31	Silicon, dissolved	mg/L	14.0
UA	G302	C	2023/08/09	Silicon, dissolved	mg/L	11.6
UA	G302	C	2016/11/17	Sodium, total	mg/L	110
UA	G302	C	2017/05/17	Sodium, total	mg/L	76.0
UA	G302	C	2017/07/12	Sodium, total	mg/L	110
UA	G302	C	2020/01/23	Sodium, total	mg/L	120
UA	G302	C	2020/08/11	Sodium, total	mg/L	74.0
UA	G302	C	2021/01/27	Sodium, total	mg/L	81.0
UA	G302	C	2021/08/17	Sodium, total	mg/L	100
UA	G302	C	2022/02/08	Sodium, total	mg/L	120
UA	G302	C	2022/08/23	Sodium, total	mg/L	110
UA	G302	C	2023/02/15	Sodium, total	mg/L	110
UA	G302	C	2023/05/31	Sodium, total	mg/L	120
UA	G302	C	2023/08/09	Sodium, total	mg/L	110
UA	G302	C	2023/11/20	Sodium, total	mg/L	119
UA	G302	C	2015/11/20	Sulfate, total	mg/L	480
UA	G302	C	2016/02/23	Sulfate, total	mg/L	530
UA	G302	C	2016/05/20	Sulfate, total	mg/L	440
UA	G302	C	2016/08/15	Sulfate, total	mg/L	360

UA	G302	C	2016/11/17	Sulfate, total	mg/L	450
UA	G302	C	2017/02/16	Sulfate, total	mg/L	430
UA	G302	C	2017/05/17	Sulfate, total	mg/L	330
UA	G302	C	2017/07/12	Sulfate, total	mg/L	460
UA	G302	C	2017/10/26	Sulfate, total	mg/L	320
UA	G302	C	2018/05/11	Sulfate, total	mg/L	510
UA	G302	C	2018/08/03	Sulfate, total	mg/L	500
UA	G302	C	2019/01/23	Sulfate, total	mg/L	500
UA	G302	C	2019/08/19	Sulfate, total	mg/L	280
UA	G302	C	2020/01/23	Sulfate, total	mg/L	350
UA	G302	C	2020/08/11	Sulfate, total	mg/L	260
UA	G302	C	2021/01/27	Sulfate, total	mg/L	430
UA	G302	C	2021/08/17	Sulfate, total	mg/L	480
UA	G302	C	2022/02/08	Sulfate, total	mg/L	410
UA	G302	C	2022/08/23	Sulfate, total	mg/L	290
UA	G302	C	2023/02/15	Sulfate, total	mg/L	440
UA	G302	C	2023/05/31	Sulfate, total	mg/L	450
UA	G302	C	2023/08/09	Sulfate, total	mg/L	356
UA	G302	C	2023/11/20	Sulfate, total	mg/L	423
UA	G302	C	2015/11/20	Temperature (Celsius)	degrees C	16.4
UA	G302	C	2016/02/23	Temperature (Celsius)	degrees C	11.6
UA	G302	C	2016/05/20	Temperature (Celsius)	degrees C	15.9
UA	G302	C	2016/08/15	Temperature (Celsius)	degrees C	17.7
UA	G302	C	2016/11/17	Temperature (Celsius)	degrees C	15.1
UA	G302	C	2017/02/16	Temperature (Celsius)	degrees C	15.3
UA	G302	C	2017/05/17	Temperature (Celsius)	degrees C	15.5
UA	G302	C	2017/07/12	Temperature (Celsius)	degrees C	17.1
UA	G302	C	2017/10/26	Temperature (Celsius)	degrees C	13.3
UA	G302	C	2018/05/11	Temperature (Celsius)	degrees C	15.0
UA	G302	C	2018/08/03	Temperature (Celsius)	degrees C	15.2
UA	G302	C	2019/01/23	Temperature (Celsius)	degrees C	12.2
UA	G302	C	2019/08/19	Temperature (Celsius)	degrees C	17.0
UA	G302	C	2020/01/23	Temperature (Celsius)	degrees C	9.20
UA	G302	C	2020/08/11	Temperature (Celsius)	degrees C	20.1
UA	G302	C	2021/01/27	Temperature (Celsius)	degrees C	9.80
UA	G302	C	2021/08/17	Temperature (Celsius)	degrees C	18.9
UA	G302	C	2022/02/08	Temperature (Celsius)	degrees C	11.8
UA	G302	C	2022/08/23	Temperature (Celsius)	degrees C	18.9
UA	G302	C	2023/02/15	Temperature (Celsius)	degrees C	12.7
UA	G302	C	2023/05/31	Temperature (Celsius)	degrees C	17.6
UA	G302	C	2023/08/09	Temperature (Celsius)	degrees C	16.0
UA	G302	C	2023/11/20	Temperature (Celsius)	degrees C	15.4
UA	G302	C	2015/11/20	Total Dissolved Solids	mg/L	1,200
UA	G302	C	2016/02/23	Total Dissolved Solids	mg/L	1,000
UA	G302	C	2016/05/20	Total Dissolved Solids	mg/L	1,000
UA	G302	C	2016/08/15	Total Dissolved Solids	mg/L	910
UA	G302	C	2016/11/17	Total Dissolved Solids	mg/L	1,100
UA	G302	C	2017/02/16	Total Dissolved Solids	mg/L	1,100
UA	G302	C	2017/05/17	Total Dissolved Solids	mg/L	820
UA	G302	C	2017/07/12	Total Dissolved Solids	mg/L	1,000
UA	G302	C	2017/10/26	Total Dissolved Solids	mg/L	840
UA	G302	C	2018/05/11	Total Dissolved Solids	mg/L	1,100
UA	G302	C	2018/08/03	Total Dissolved Solids	mg/L	1,200
UA	G302	C	2019/01/23	Total Dissolved Solids	mg/L	1,400
UA	G302	C	2019/08/19	Total Dissolved Solids	mg/L	800
UA	G302	C	2020/01/23	Total Dissolved Solids	mg/L	960
UA	G302	C	2020/08/11	Total Dissolved Solids	mg/L	780
UA	G302	C	2021/01/27	Total Dissolved Solids	mg/L	1,100
UA	G302	C	2021/08/17	Total Dissolved Solids	mg/L	1,200
UA	G302	C	2022/02/08	Total Dissolved Solids	mg/L	1,100
UA	G302	C	2022/08/23	Total Dissolved Solids	mg/L	860
UA	G302	C	2023/02/15	Total Dissolved Solids	mg/L	1,200

UA	G302	C	2023/05/31	Total Dissolved Solids	mg/L	1,200
UA	G302	C	2023/08/09	Total Dissolved Solids	mg/L	998
UA	G302	C	2023/11/20	Total Dissolved Solids	mg/L	1,190
UA	G303	C	2015/11/20	pH (field)	SU	6.9
UA	G303	C	2016/02/23	pH (field)	SU	7.0
UA	G303	C	2016/05/20	pH (field)	SU	6.9
UA	G303	C	2016/08/15	pH (field)	SU	6.9
UA	G303	C	2016/11/17	pH (field)	SU	6.9
UA	G303	C	2017/02/19	pH (field)	SU	6.9
UA	G303	C	2017/05/17	pH (field)	SU	7.1
UA	G303	C	2017/07/13	pH (field)	SU	7.0
UA	G303	C	2017/10/26	pH (field)	SU	7.0
UA	G303	C	2018/05/14	pH (field)	SU	7.0
UA	G303	C	2018/08/03	pH (field)	SU	7.0
UA	G303	C	2019/01/23	pH (field)	SU	7.0
UA	G303	C	2019/08/19	pH (field)	SU	7.0
UA	G303	C	2020/01/23	pH (field)	SU	7.0
UA	G303	C	2020/08/11	pH (field)	SU	6.9
UA	G303	C	2021/01/26	pH (field)	SU	6.8
UA	G303	C	2021/08/17	pH (field)	SU	6.8
UA	G303	C	2022/02/08	pH (field)	SU	6.8
UA	G303	C	2022/08/24	pH (field)	SU	6.7
UA	G303	C	2023/02/15	pH (field)	SU	6.5
UA	G303	C	2023/05/31	pH (field)	SU	7.1
UA	G303	C	2023/08/09	pH (field)	SU	6.8
UA	G303	C	2023/11/21	pH (field)	SU	6.6
UA	G303	C	2015/11/20	Oxidation Reduction Potential	mV	-29.0
UA	G303	C	2016/02/23	Oxidation Reduction Potential	mV	121
UA	G303	C	2016/05/20	Oxidation Reduction Potential	mV	-77.0
UA	G303	C	2016/08/15	Oxidation Reduction Potential	mV	-2.00
UA	G303	C	2016/11/17	Oxidation Reduction Potential	mV	-2.00
UA	G303	C	2017/02/19	Oxidation Reduction Potential	mV	-31.0
UA	G303	C	2017/05/17	Oxidation Reduction Potential	mV	-26.0
UA	G303	C	2017/07/13	Oxidation Reduction Potential	mV	59.0
UA	G303	C	2017/10/26	Oxidation Reduction Potential	mV	-3.00
UA	G303	C	2018/05/14	Oxidation Reduction Potential	mV	-1.00
UA	G303	C	2018/08/03	Oxidation Reduction Potential	mV	-60.0
UA	G303	C	2019/01/23	Oxidation Reduction Potential	mV	-69.0
UA	G303	C	2019/08/19	Oxidation Reduction Potential	mV	-59.0
UA	G303	C	2020/01/23	Oxidation Reduction Potential	mV	33.8
UA	G303	C	2020/08/11	Oxidation Reduction Potential	mV	-69.9
UA	G303	C	2021/01/26	Oxidation Reduction Potential	mV	55.5
UA	G303	C	2021/08/17	Oxidation Reduction Potential	mV	-107
UA	G303	C	2022/02/08	Oxidation Reduction Potential	mV	5.70
UA	G303	C	2022/08/24	Oxidation Reduction Potential	mV	-43.0
UA	G303	C	2023/02/15	Oxidation Reduction Potential	mV	89.7
UA	G303	C	2023/05/31	Oxidation Reduction Potential	mV	-70.2
UA	G303	C	2023/08/09	Oxidation Reduction Potential	mV	-91.0
UA	G303	C	2023/11/21	Oxidation Reduction Potential	mV	-28.0
UA	G303	C	2015/11/20	Eh	V	0.17
UA	G303	C	2016/02/23	Eh	V	0.32
UA	G303	C	2016/05/20	Eh	V	0.11
UA	G303	C	2016/08/15	Eh	V	0.19
UA	G303	C	2016/11/17	Eh	V	0.19
UA	G303	C	2017/02/19	Eh	V	0.16
UA	G303	C	2017/05/17	Eh	V	0.17
UA	G303	C	2017/07/13	Eh	V	0.25
UA	G303	C	2017/10/26	Eh	V	0.19
UA	G303	C	2018/05/14	Eh	V	0.20
UA	G303	C	2018/08/03	Eh	V	0.14
UA	G303	C	2019/01/23	Eh	V	0.13
UA	G303	C	2019/08/19	Eh	V	0.13

UA	G303	C	2020/01/23	Eh	V	0.23
UA	G303	C	2020/08/11	Eh	V	0.12
UA	G303	C	2021/01/26	Eh	V	0.26
UA	G303	C	2021/08/17	Eh	V	0.085
UA	G303	C	2022/02/08	Eh	V	0.20
UA	G303	C	2022/08/24	Eh	V	0.15
UA	G303	C	2023/02/15	Eh	V	0.29
UA	G303	C	2023/05/31	Eh	V	0.12
UA	G303	C	2023/08/09	Eh	V	0.10
UA	G303	C	2023/11/21	Eh	V	0.17
UA	G303	C	2016/11/17	Alkalinity, bicarbonate	mg/L CaCO3	620
UA	G303	C	2017/05/17	Alkalinity, bicarbonate	mg/L CaCO3	680
UA	G303	C	2017/07/13	Alkalinity, bicarbonate	mg/L CaCO3	680
UA	G303	C	2020/01/23	Alkalinity, bicarbonate	mg/L CaCO3	640
UA	G303	C	2020/08/11	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G303	C	2021/01/26	Alkalinity, bicarbonate	mg/L CaCO3	620
UA	G303	C	2021/08/17	Alkalinity, bicarbonate	mg/L CaCO3	640
UA	G303	C	2022/02/08	Alkalinity, bicarbonate	mg/L CaCO3	590
UA	G303	C	2022/08/24	Alkalinity, bicarbonate	mg/L CaCO3	610
UA	G303	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	620
UA	G303	C	2023/05/31	Alkalinity, bicarbonate	mg/L CaCO3	620
UA	G303	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	634
UA	G303	C	2023/11/21	Alkalinity, bicarbonate	mg/L CaCO3	646
UA	G303	C	2022/08/24	Alkalinity, carbonate	mg/L CaCO3	10.0
UA	G303	C	2015/11/20	Barium, total	mg/L	0.0460
UA	G303	C	2016/02/23	Barium, total	mg/L	0.0140
UA	G303	C	2016/05/20	Barium, total	mg/L	0.0160
UA	G303	C	2016/08/15	Barium, total	mg/L	0.0160
UA	G303	C	2016/11/17	Barium, total	mg/L	0.0160
UA	G303	C	2017/02/19	Barium, total	mg/L	0.0160
UA	G303	C	2017/05/17	Barium, total	mg/L	0.0170
UA	G303	C	2017/07/13	Barium, total	mg/L	0.0160
UA	G303	C	2018/05/14	Barium, total	mg/L	0.0180
UA	G303	C	2018/08/03	Barium, total	mg/L	0.0190
UA	G303	C	2019/01/23	Barium, total	mg/L	0.0150
UA	G303	C	2019/08/19	Barium, total	mg/L	0.0160
UA	G303	C	2020/01/23	Barium, total	mg/L	0.0150
UA	G303	C	2020/08/11	Barium, total	mg/L	0.0330
UA	G303	C	2021/01/26	Barium, total	mg/L	0.0130
UA	G303	C	2021/08/17	Barium, total	mg/L	0.0170
UA	G303	C	2022/02/08	Barium, total	mg/L	0.0130
UA	G303	C	2022/08/24	Barium, total	mg/L	0.0200
UA	G303	C	2023/02/15	Barium, total	mg/L	0.0210
UA	G303	C	2023/05/31	Barium, total	mg/L	0.0150
UA	G303	C	2023/08/09	Barium, total	mg/L	0.0183
UA	G303	C	2023/11/21	Barium, total	mg/L	0.0300
UA	G303	C	2015/11/20	Boron, total	mg/L	1.50
UA	G303	C	2016/02/23	Boron, total	mg/L	2.50
UA	G303	C	2016/05/20	Boron, total	mg/L	2.40
UA	G303	C	2016/08/15	Boron, total	mg/L	1.80
UA	G303	C	2016/11/17	Boron, total	mg/L	1.60
UA	G303	C	2017/02/19	Boron, total	mg/L	1.70
UA	G303	C	2017/05/17	Boron, total	mg/L	1.40
UA	G303	C	2017/07/13	Boron, total	mg/L	1.70
UA	G303	C	2017/10/26	Boron, total	mg/L	2.50
UA	G303	C	2018/05/14	Boron, total	mg/L	1.50
UA	G303	C	2018/08/03	Boron, total	mg/L	1.60
UA	G303	C	2019/01/23	Boron, total	mg/L	1.80
UA	G303	C	2019/08/19	Boron, total	mg/L	1.80
UA	G303	C	2020/01/23	Boron, total	mg/L	2.30
UA	G303	C	2020/08/11	Boron, total	mg/L	1.70
UA	G303	C	2021/01/26	Boron, total	mg/L	2.00

UA	G303	C	2021/08/17	Boron, total	mg/L	2.10
UA	G303	C	2022/02/08	Boron, total	mg/L	2.50
UA	G303	C	2022/08/24	Boron, total	mg/L	1.90
UA	G303	C	2023/02/15	Boron, total	mg/L	2.10
UA	G303	C	2023/05/31	Boron, total	mg/L	1.80
UA	G303	C	2023/08/09	Boron, total	mg/L	1.95
UA	G303	C	2023/11/21	Boron, total	mg/L	2.98
UA	G303	C	2015/11/20	Calcium, total	mg/L	170
UA	G303	C	2016/02/23	Calcium, total	mg/L	170
UA	G303	C	2016/05/20	Calcium, total	mg/L	160
UA	G303	C	2016/08/15	Calcium, total	mg/L	170
UA	G303	C	2016/11/17	Calcium, total	mg/L	180
UA	G303	C	2017/02/19	Calcium, total	mg/L	170
UA	G303	C	2017/05/17	Calcium, total	mg/L	210
UA	G303	C	2017/07/13	Calcium, total	mg/L	170
UA	G303	C	2017/10/26	Calcium, total	mg/L	130
UA	G303	C	2018/05/14	Calcium, total	mg/L	170
UA	G303	C	2018/08/03	Calcium, total	mg/L	200
UA	G303	C	2019/01/23	Calcium, total	mg/L	190
UA	G303	C	2019/08/19	Calcium, total	mg/L	190
UA	G303	C	2020/01/23	Calcium, total	mg/L	160
UA	G303	C	2020/08/11	Calcium, total	mg/L	210
UA	G303	C	2021/01/26	Calcium, total	mg/L	170
UA	G303	C	2021/08/17	Calcium, total	mg/L	190
UA	G303	C	2022/02/08	Calcium, total	mg/L	170
UA	G303	C	2022/08/24	Calcium, total	mg/L	200
UA	G303	C	2023/02/15	Calcium, total	mg/L	170
UA	G303	C	2023/05/31	Calcium, total	mg/L	180
UA	G303	C	2023/08/09	Calcium, total	mg/L	190
UA	G303	C	2023/11/21	Calcium, total	mg/L	207
UA	G303	C	2015/11/20	Chloride, total	mg/L	32.0
UA	G303	C	2016/02/23	Chloride, total	mg/L	32.0
UA	G303	C	2016/05/20	Chloride, total	mg/L	29.0
UA	G303	C	2016/08/15	Chloride, total	mg/L	30.0
UA	G303	C	2016/11/17	Chloride, total	mg/L	30.0
UA	G303	C	2017/02/19	Chloride, total	mg/L	28.0
UA	G303	C	2017/05/17	Chloride, total	mg/L	28.0
UA	G303	C	2017/07/13	Chloride, total	mg/L	31.0
UA	G303	C	2017/10/26	Chloride, total	mg/L	28.0
UA	G303	C	2018/05/14	Chloride, total	mg/L	30.0
UA	G303	C	2018/08/03	Chloride, total	mg/L	28.0
UA	G303	C	2019/01/23	Chloride, total	mg/L	30.0
UA	G303	C	2019/08/19	Chloride, total	mg/L	32.0
UA	G303	C	2020/01/23	Chloride, total	mg/L	29.0
UA	G303	C	2020/08/11	Chloride, total	mg/L	24.0
UA	G303	C	2021/01/26	Chloride, total	mg/L	32.0
UA	G303	C	2021/08/17	Chloride, total	mg/L	30.0
UA	G303	C	2022/02/08	Chloride, total	mg/L	29.0
UA	G303	C	2022/08/24	Chloride, total	mg/L	28.0
UA	G303	C	2023/02/15	Chloride, total	mg/L	28.0
UA	G303	C	2023/05/31	Chloride, total	mg/L	25.0
UA	G303	C	2023/08/09	Chloride, total	mg/L	27.0
UA	G303	C	2023/11/21	Chloride, total	mg/L	27.0
UA	G303	C	2023/05/31	Ferrous Iron, dissolved	mg/L	1.10
UA	G303	C	2023/05/31	Iron, dissolved	mg/L	1.10
UA	G303	C	2023/08/09	Iron, dissolved	mg/L	0.612
UA	G303	C	2016/11/17	Magnesium, total	mg/L	180
UA	G303	C	2017/05/17	Magnesium, total	mg/L	170
UA	G303	C	2017/07/13	Magnesium, total	mg/L	160
UA	G303	C	2020/01/23	Magnesium, total	mg/L	140
UA	G303	C	2020/08/11	Magnesium, total	mg/L	170
UA	G303	C	2021/01/26	Magnesium, total	mg/L	150

UA	G303	C	2021/08/17	Magnesium, total	mg/L	160
UA	G303	C	2022/02/08	Magnesium, total	mg/L	130
UA	G303	C	2022/08/24	Magnesium, total	mg/L	150
UA	G303	C	2023/02/15	Magnesium, total	mg/L	120
UA	G303	C	2023/05/31	Magnesium, total	mg/L	140
UA	G303	C	2023/08/09	Magnesium, total	mg/L	159
UA	G303	C	2023/11/21	Magnesium, total	mg/L	168
UA	G303	C	2023/05/31	Manganese, dissolved	mg/L	0.400
UA	G303	C	2023/08/09	Manganese, dissolved	mg/L	0.323
UA	G303	C	2023/08/09	Phosphate, dissolved	mg/L	0.111
UA	G303	C	2016/11/17	Potassium, total	mg/L	3.00
UA	G303	C	2017/05/17	Potassium, total	mg/L	2.70
UA	G303	C	2017/07/13	Potassium, total	mg/L	2.70
UA	G303	C	2020/01/23	Potassium, total	mg/L	0.960
UA	G303	C	2020/08/11	Potassium, total	mg/L	3.00
UA	G303	C	2021/01/26	Potassium, total	mg/L	1.80
UA	G303	C	2021/08/17	Potassium, total	mg/L	1.90
UA	G303	C	2022/02/08	Potassium, total	mg/L	1.10
UA	G303	C	2022/08/24	Potassium, total	mg/L	2.30
UA	G303	C	2023/02/15	Potassium, total	mg/L	1.70
UA	G303	C	2023/05/31	Potassium, total	mg/L	2.20
UA	G303	C	2023/08/09	Potassium, total	mg/L	3.11
UA	G303	C	2023/11/21	Potassium, total	mg/L	3.26
UA	G303	C	2023/05/31	Silicon, dissolved	mg/L	12.0
UA	G303	C	2023/08/09	Silicon, dissolved	mg/L	9.85
UA	G303	C	2016/11/17	Sodium, total	mg/L	180
UA	G303	C	2017/05/17	Sodium, total	mg/L	170
UA	G303	C	2017/07/13	Sodium, total	mg/L	180
UA	G303	C	2020/01/23	Sodium, total	mg/L	180
UA	G303	C	2020/08/11	Sodium, total	mg/L	170
UA	G303	C	2021/01/26	Sodium, total	mg/L	170
UA	G303	C	2021/08/17	Sodium, total	mg/L	190
UA	G303	C	2022/02/08	Sodium, total	mg/L	180
UA	G303	C	2022/08/24	Sodium, total	mg/L	170
UA	G303	C	2023/02/15	Sodium, total	mg/L	160
UA	G303	C	2023/05/31	Sodium, total	mg/L	160
UA	G303	C	2023/08/09	Sodium, total	mg/L	168
UA	G303	C	2023/11/21	Sodium, total	mg/L	180
UA	G303	C	2015/11/20	Sulfate, total	mg/L	860
UA	G303	C	2016/02/23	Sulfate, total	mg/L	700
UA	G303	C	2016/05/20	Sulfate, total	mg/L	700
UA	G303	C	2016/08/15	Sulfate, total	mg/L	830
UA	G303	C	2016/11/17	Sulfate, total	mg/L	870
UA	G303	C	2017/02/19	Sulfate, total	mg/L	860
UA	G303	C	2017/05/17	Sulfate, total	mg/L	780
UA	G303	C	2017/07/13	Sulfate, total	mg/L	860
UA	G303	C	2017/10/26	Sulfate, total	mg/L	600
UA	G303	C	2018/05/14	Sulfate, total	mg/L	780
UA	G303	C	2018/08/03	Sulfate, total	mg/L	780
UA	G303	C	2019/01/23	Sulfate, total	mg/L	760
UA	G303	C	2019/08/19	Sulfate, total	mg/L	730
UA	G303	C	2020/01/23	Sulfate, total	mg/L	690
UA	G303	C	2020/08/11	Sulfate, total	mg/L	790
UA	G303	C	2021/01/26	Sulfate, total	mg/L	730
UA	G303	C	2021/08/17	Sulfate, total	mg/L	730
UA	G303	C	2022/02/08	Sulfate, total	mg/L	650
UA	G303	C	2022/08/24	Sulfate, total	mg/L	760
UA	G303	C	2023/02/15	Sulfate, total	mg/L	590
UA	G303	C	2023/05/31	Sulfate, total	mg/L	740
UA	G303	C	2023/08/09	Sulfate, total	mg/L	723
UA	G303	C	2023/11/21	Sulfate, total	mg/L	721
UA	G303	C	2015/11/20	Temperature (Celsius)	degrees C	16.4

UA	G303	C	2016/02/23	Temperature (Celsius)	degrees C	11.0
UA	G303	C	2016/05/20	Temperature (Celsius)	degrees C	20.2
UA	G303	C	2016/08/15	Temperature (Celsius)	degrees C	17.9
UA	G303	C	2016/11/17	Temperature (Celsius)	degrees C	15.0
UA	G303	C	2017/02/19	Temperature (Celsius)	degrees C	16.0
UA	G303	C	2017/05/17	Temperature (Celsius)	degrees C	15.7
UA	G303	C	2017/07/13	Temperature (Celsius)	degrees C	17.4
UA	G303	C	2017/10/26	Temperature (Celsius)	degrees C	13.3
UA	G303	C	2018/05/14	Temperature (Celsius)	degrees C	13.4
UA	G303	C	2018/08/03	Temperature (Celsius)	degrees C	15.3
UA	G303	C	2019/01/23	Temperature (Celsius)	degrees C	11.5
UA	G303	C	2019/08/19	Temperature (Celsius)	degrees C	17.3
UA	G303	C	2020/01/23	Temperature (Celsius)	degrees C	9.40
UA	G303	C	2020/08/11	Temperature (Celsius)	degrees C	19.9
UA	G303	C	2021/01/26	Temperature (Celsius)	degrees C	8.90
UA	G303	C	2021/08/17	Temperature (Celsius)	degrees C	19.7
UA	G303	C	2022/02/08	Temperature (Celsius)	degrees C	11.7
UA	G303	C	2022/08/24	Temperature (Celsius)	degrees C	19.2
UA	G303	C	2023/02/15	Temperature (Celsius)	degrees C	13.0
UA	G303	C	2023/05/31	Temperature (Celsius)	degrees C	17.8
UA	G303	C	2023/08/09	Temperature (Celsius)	degrees C	15.4
UA	G303	C	2023/11/21	Temperature (Celsius)	degrees C	14.0
UA	G303	C	2015/11/20	Total Dissolved Solids	mg/L	1,700
UA	G303	C	2016/02/23	Total Dissolved Solids	mg/L	1,400
UA	G303	C	2016/05/20	Total Dissolved Solids	mg/L	1,400
UA	G303	C	2016/08/15	Total Dissolved Solids	mg/L	1,600
UA	G303	C	2016/11/17	Total Dissolved Solids	mg/L	1,900
UA	G303	C	2017/02/19	Total Dissolved Solids	mg/L	1,700
UA	G303	C	2017/05/17	Total Dissolved Solids	mg/L	1,900
UA	G303	C	2017/07/13	Total Dissolved Solids	mg/L	1,500
UA	G303	C	2017/10/26	Total Dissolved Solids	mg/L	1,300
UA	G303	C	2018/05/14	Total Dissolved Solids	mg/L	1,500
UA	G303	C	2018/08/03	Total Dissolved Solids	mg/L	1,600
UA	G303	C	2019/01/23	Total Dissolved Solids	mg/L	1,800
UA	G303	C	2019/08/19	Total Dissolved Solids	mg/L	1,700
UA	G303	C	2020/01/23	Total Dissolved Solids	mg/L	1,200
UA	G303	C	2020/08/11	Total Dissolved Solids	mg/L	1,700
UA	G303	C	2021/01/26	Total Dissolved Solids	mg/L	1,600
UA	G303	C	2021/08/17	Total Dissolved Solids	mg/L	1,700
UA	G303	C	2022/02/08	Total Dissolved Solids	mg/L	1,500
UA	G303	C	2022/08/24	Total Dissolved Solids	mg/L	1,900
UA	G303	C	2023/02/15	Total Dissolved Solids	mg/L	1,500
UA	G303	C	2023/05/31	Total Dissolved Solids	mg/L	1,800
UA	G303	C	2023/08/09	Total Dissolved Solids	mg/L	1,620
UA	G303	C	2023/11/21	Total Dissolved Solids	mg/L	1,520
UA	G305	C	2016/05/19	pH (field)	SU	7.1
UA	G305	C	2016/07/01	pH (field)	SU	7.2
UA	G305	C	2016/08/16	pH (field)	SU	7.3
UA	G305	C	2016/09/29	pH (field)	SU	6.9
UA	G305	C	2016/11/17	pH (field)	SU	7.1
UA	G305	C	2023/02/15	pH (field)	SU	7.3
UA	G305	C	2023/06/06	pH (field)	SU	7.3
UA	G305	C	2023/08/10	pH (field)	SU	7.3
UA	G305	C	2023/11/17	pH (field)	SU	6.9
UA	G305	C	2016/05/19	Oxidation Reduction Potential	mV	-29.0
UA	G305	C	2016/07/01	Oxidation Reduction Potential	mV	108
UA	G305	C	2016/08/16	Oxidation Reduction Potential	mV	161
UA	G305	C	2016/09/29	Oxidation Reduction Potential	mV	27.0
UA	G305	C	2016/11/17	Oxidation Reduction Potential	mV	169
UA	G305	C	2023/02/15	Oxidation Reduction Potential	mV	57.9
UA	G305	C	2023/06/06	Oxidation Reduction Potential	mV	-26.5
UA	G305	C	2023/08/10	Oxidation Reduction Potential	mV	-41.0

UA	G305	C	2023/11/17	Oxidation Reduction Potential	mV	12.0
UA	G305	C	2016/05/19	Eh	V	0.16
UA	G305	C	2016/07/01	Eh	V	0.30
UA	G305	C	2016/08/16	Eh	V	0.35
UA	G305	C	2016/09/29	Eh	V	0.22
UA	G305	C	2016/11/17	Eh	V	0.36
UA	G305	C	2023/02/15	Eh	V	0.25
UA	G305	C	2023/06/06	Eh	V	0.17
UA	G305	C	2023/08/10	Eh	V	0.15
UA	G305	C	2023/11/17	Eh	V	0.21
UA	G305	C	2016/11/17	Alkalinity, bicarbonate	mg/L CaCO3	300
UA	G305	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G305	C	2023/06/06	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G305	C	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	216
UA	G305	C	2023/11/17	Alkalinity, bicarbonate	mg/L CaCO3	237
UA	G305	C	2016/05/19	Barium, total	mg/L	0.0930
UA	G305	C	2016/07/01	Barium, total	mg/L	0.0430
UA	G305	C	2016/08/16	Barium, total	mg/L	0.0350
UA	G305	C	2016/09/29	Barium, total	mg/L	0.0360
UA	G305	C	2016/11/17	Barium, total	mg/L	0.0390
UA	G305	C	2023/02/15	Barium, total	mg/L	0.0690
UA	G305	C	2023/06/06	Barium, total	mg/L	0.0380
UA	G305	C	2023/08/10	Barium, total	mg/L	0.0254
UA	G305	C	2023/11/17	Barium, total	mg/L	0.0289
UA	G305	C	2016/05/19	Boron, total	mg/L	2.60
UA	G305	C	2016/07/01	Boron, total	mg/L	2.50
UA	G305	C	2016/08/16	Boron, total	mg/L	2.40
UA	G305	C	2016/09/29	Boron, total	mg/L	2.70
UA	G305	C	2016/11/17	Boron, total	mg/L	1.80
UA	G305	C	2023/02/15	Boron, total	mg/L	2.00
UA	G305	C	2023/06/06	Boron, total	mg/L	1.90
UA	G305	C	2023/08/10	Boron, total	mg/L	2.66
UA	G305	C	2023/11/17	Boron, total	mg/L	2.44
UA	G305	C	2016/05/19	Calcium, total	mg/L	180
UA	G305	C	2016/07/01	Calcium, total	mg/L	190
UA	G305	C	2016/08/16	Calcium, total	mg/L	150
UA	G305	C	2016/09/29	Calcium, total	mg/L	190
UA	G305	C	2016/11/17	Calcium, total	mg/L	100
UA	G305	C	2023/02/15	Calcium, total	mg/L	200
UA	G305	C	2023/06/06	Calcium, total	mg/L	180
UA	G305	C	2023/08/10	Calcium, total	mg/L	188
UA	G305	C	2023/11/17	Calcium, total	mg/L	177
UA	G305	C	2016/05/19	Chloride, total	mg/L	27.0
UA	G305	C	2016/07/01	Chloride, total	mg/L	28.0
UA	G305	C	2016/08/16	Chloride, total	mg/L	27.0
UA	G305	C	2016/09/29	Chloride, total	mg/L	30.0
UA	G305	C	2016/11/17	Chloride, total	mg/L	60.0
UA	G305	C	2023/02/15	Chloride, total	mg/L	22.0
UA	G305	C	2023/06/06	Chloride, total	mg/L	23.0
UA	G305	C	2023/08/10	Chloride, total	mg/L	21.0
UA	G305	C	2023/11/17	Chloride, total	mg/L	17.0
UA	G305	C	2023/06/06	Ferrous Iron, dissolved	mg/L	<0.02
UA	G305	C	2023/06/06	Iron, dissolved	mg/L	0.0110
UA	G305	C	2023/08/10	Iron, dissolved	mg/L	0.0220
UA	G305	C	2016/11/17	Magnesium, total	mg/L	130
UA	G305	C	2023/02/15	Magnesium, total	mg/L	100
UA	G305	C	2023/06/06	Magnesium, total	mg/L	100
UA	G305	C	2023/08/10	Magnesium, total	mg/L	96.5
UA	G305	C	2023/11/17	Magnesium, total	mg/L	93.6
UA	G305	C	2023/06/06	Manganese, dissolved	mg/L	0.240
UA	G305	C	2023/08/10	Manganese, dissolved	mg/L	0.0984
UA	G305	C	2023/08/10	Phosphate, dissolved	mg/L	0.0550

UA	G305	C	2016/11/17	Potassium, total	mg/L	1.10
UA	G305	C	2023/02/15	Potassium, total	mg/L	2.70
UA	G305	C	2023/06/06	Potassium, total	mg/L	1.10
UA	G305	C	2023/08/10	Potassium, total	mg/L	0.549
UA	G305	C	2023/11/17	Potassium, total	mg/L	0.560
UA	G305	C	2023/06/06	Silicon, dissolved	mg/L	11.0
UA	G305	C	2023/08/10	Silicon, dissolved	mg/L	11.0
UA	G305	C	2016/11/17	Sodium, total	mg/L	140
UA	G305	C	2023/02/15	Sodium, total	mg/L	120
UA	G305	C	2023/06/06	Sodium, total	mg/L	130
UA	G305	C	2023/08/10	Sodium, total	mg/L	135
UA	G305	C	2023/11/17	Sodium, total	mg/L	125
UA	G305	C	2016/05/19	Sulfate, total	mg/L	890
UA	G305	C	2016/07/01	Sulfate, total	mg/L	900
UA	G305	C	2016/08/16	Sulfate, total	mg/L	930
UA	G305	C	2016/09/29	Sulfate, total	mg/L	890
UA	G305	C	2016/11/17	Sulfate, total	mg/L	710
UA	G305	C	2023/02/15	Sulfate, total	mg/L	980
UA	G305	C	2023/06/06	Sulfate, total	mg/L	910
UA	G305	C	2023/08/10	Sulfate, total	mg/L	863
UA	G305	C	2023/11/17	Sulfate, total	mg/L	843
UA	G305	C	2016/05/19	Temperature (Celsius)	degrees C	18.1
UA	G305	C	2016/07/01	Temperature (Celsius)	degrees C	24.4
UA	G305	C	2016/08/16	Temperature (Celsius)	degrees C	19.6
UA	G305	C	2016/09/29	Temperature (Celsius)	degrees C	18.5
UA	G305	C	2016/11/17	Temperature (Celsius)	degrees C	14.4
UA	G305	C	2023/02/15	Temperature (Celsius)	degrees C	14.6
UA	G305	C	2023/06/06	Temperature (Celsius)	degrees C	15.8
UA	G305	C	2023/08/10	Temperature (Celsius)	degrees C	15.4
UA	G305	C	2023/11/17	Temperature (Celsius)	degrees C	15.1
UA	G305	C	2016/05/19	Total Dissolved Solids	mg/L	1,300
UA	G305	C	2016/07/01	Total Dissolved Solids	mg/L	1,500
UA	G305	C	2016/08/16	Total Dissolved Solids	mg/L	1,400
UA	G305	C	2016/09/29	Total Dissolved Solids	mg/L	1,400
UA	G305	C	2016/11/17	Total Dissolved Solids	mg/L	1,400
UA	G305	C	2023/02/15	Total Dissolved Solids	mg/L	1,800
UA	G305	C	2023/06/06	Total Dissolved Solids	mg/L	1,500
UA	G305	C	2023/08/10	Total Dissolved Solids	mg/L	1,580
UA	G305	C	2023/11/17	Total Dissolved Solids	mg/L	1,530
UA	G307	C	2016/08/16	pH (field)	SU	7.0
UA	G307	C	2016/09/29	pH (field)	SU	6.9
UA	G307	C	2016/11/16	pH (field)	SU	6.9
UA	G307	C	2017/02/19	pH (field)	SU	7.0
UA	G307	C	2017/05/17	pH (field)	SU	7.2
UA	G307	C	2017/07/13	pH (field)	SU	7.0
UA	G307	C	2017/10/27	pH (field)	SU	7.0
UA	G307	C	2018/05/14	pH (field)	SU	7.0
UA	G307	C	2018/08/03	pH (field)	SU	7.0
UA	G307	C	2019/08/19	pH (field)	SU	7.0
UA	G307	C	2020/02/26	pH (field)	SU	7.0
UA	G307	C	2020/05/06	pH (field)	SU	7.3
UA	G307	C	2020/08/11	pH (field)	SU	7.3
UA	G307	C	2021/01/27	pH (field)	SU	7.4
UA	G307	C	2021/08/17	pH (field)	SU	7.3
UA	G307	C	2022/02/11	pH (field)	SU	7.3
UA	G307	C	2022/08/24	pH (field)	SU	7.0
UA	G307	C	2023/02/15	pH (field)	SU	7.2
UA	G307	C	2023/06/05	pH (field)	SU	7.3
UA	G307	C	2023/11/21	pH (field)	SU	6.8
UA	G307	C	2016/08/16	Oxidation Reduction Potential	mV	167
UA	G307	C	2016/09/29	Oxidation Reduction Potential	mV	-7.00
UA	G307	C	2016/11/16	Oxidation Reduction Potential	mV	174

UA	G307	C	2017/02/19	Oxidation Reduction Potential	mV	162
UA	G307	C	2017/05/17	Oxidation Reduction Potential	mV	140
UA	G307	C	2017/07/13	Oxidation Reduction Potential	mV	170
UA	G307	C	2017/10/27	Oxidation Reduction Potential	mV	175
UA	G307	C	2018/05/14	Oxidation Reduction Potential	mV	105
UA	G307	C	2018/08/03	Oxidation Reduction Potential	mV	161
UA	G307	C	2019/08/19	Oxidation Reduction Potential	mV	155
UA	G307	C	2020/02/26	Oxidation Reduction Potential	mV	128
UA	G307	C	2020/05/06	Oxidation Reduction Potential	mV	87.6
UA	G307	C	2020/08/11	Oxidation Reduction Potential	mV	50.1
UA	G307	C	2021/01/27	Oxidation Reduction Potential	mV	65.7
UA	G307	C	2021/08/17	Oxidation Reduction Potential	mV	10.6
UA	G307	C	2022/02/11	Oxidation Reduction Potential	mV	144
UA	G307	C	2022/08/24	Oxidation Reduction Potential	mV	-79.0
UA	G307	C	2023/02/15	Oxidation Reduction Potential	mV	350
UA	G307	C	2023/06/05	Oxidation Reduction Potential	mV	40.1
UA	G307	C	2023/11/21	Oxidation Reduction Potential	mV	101
UA	G307	C	2016/08/16	Eh	V	0.36
UA	G307	C	2016/09/29	Eh	V	0.19
UA	G307	C	2016/11/16	Eh	V	0.37
UA	G307	C	2017/02/19	Eh	V	0.36
UA	G307	C	2017/05/17	Eh	V	0.34
UA	G307	C	2017/07/13	Eh	V	0.36
UA	G307	C	2017/10/27	Eh	V	0.37
UA	G307	C	2018/05/14	Eh	V	0.30
UA	G307	C	2018/08/03	Eh	V	0.36
UA	G307	C	2019/08/19	Eh	V	0.35
UA	G307	C	2020/02/26	Eh	V	0.33
UA	G307	C	2020/05/06	Eh	V	0.28
UA	G307	C	2020/08/11	Eh	V	0.24
UA	G307	C	2021/01/27	Eh	V	0.27
UA	G307	C	2021/08/17	Eh	V	0.20
UA	G307	C	2022/02/11	Eh	V	0.34
UA	G307	C	2022/08/24	Eh	V	0.11
UA	G307	C	2023/02/15	Eh	V	0.55
UA	G307	C	2023/06/05	Eh	V	0.23
UA	G307	C	2023/11/21	Eh	V	0.30
UA	G307	C	2016/11/16	Alkalinity, bicarbonate	mg/L CaCO3	120
UA	G307	C	2017/05/17	Alkalinity, bicarbonate	mg/L CaCO3	97.0
UA	G307	C	2017/07/13	Alkalinity, bicarbonate	mg/L CaCO3	120
UA	G307	C	2020/02/26	Alkalinity, bicarbonate	mg/L CaCO3	100
UA	G307	C	2020/08/11	Alkalinity, bicarbonate	mg/L CaCO3	140
UA	G307	C	2021/01/27	Alkalinity, bicarbonate	mg/L CaCO3	120
UA	G307	C	2021/08/17	Alkalinity, bicarbonate	mg/L CaCO3	140
UA	G307	C	2022/02/11	Alkalinity, bicarbonate	mg/L CaCO3	120
UA	G307	C	2022/08/24	Alkalinity, bicarbonate	mg/L CaCO3	120
UA	G307	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	160
UA	G307	C	2023/06/05	Alkalinity, bicarbonate	mg/L CaCO3	160
UA	G307	C	2023/11/21	Alkalinity, bicarbonate	mg/L CaCO3	183
UA	G307	C	2022/08/24	Alkalinity, carbonate	mg/L CaCO3	10.0
UA	G307	C	2016/08/16	Barium, total	mg/L	0.0310
UA	G307	C	2016/09/29	Barium, total	mg/L	0.0290
UA	G307	C	2016/11/16	Barium, total	mg/L	0.0340
UA	G307	C	2017/02/19	Barium, total	mg/L	0.0330
UA	G307	C	2017/05/17	Barium, total	mg/L	0.380
UA	G307	C	2017/07/13	Barium, total	mg/L	0.130
UA	G307	C	2018/05/14	Barium, total	mg/L	0.0710
UA	G307	C	2018/08/03	Barium, total	mg/L	0.100
UA	G307	C	2019/08/19	Barium, total	mg/L	0.110
UA	G307	C	2020/02/26	Barium, total	mg/L	0.0330
UA	G307	C	2020/08/11	Barium, total	mg/L	0.0210
UA	G307	C	2021/01/27	Barium, total	mg/L	0.0200

UA	G307	C	2021/08/17	Barium, total	mg/L	0.0300
UA	G307	C	2022/02/11	Barium, total	mg/L	0.0210
UA	G307	C	2022/08/24	Barium, total	mg/L	0.0550
UA	G307	C	2023/02/15	Barium, total	mg/L	0.0650
UA	G307	C	2023/06/05	Barium, total	mg/L	0.0250
UA	G307	C	2023/11/21	Barium, total	mg/L	0.0234
UA	G307	C	2016/08/16	Boron, total	mg/L	2.10
UA	G307	C	2016/09/29	Boron, total	mg/L	2.20
UA	G307	C	2016/11/16	Boron, total	mg/L	2.10
UA	G307	C	2017/02/19	Boron, total	mg/L	2.00
UA	G307	C	2017/05/17	Boron, total	mg/L	1.80
UA	G307	C	2017/07/13	Boron, total	mg/L	2.20
UA	G307	C	2017/10/27	Boron, total	mg/L	2.10
UA	G307	C	2018/05/14	Boron, total	mg/L	2.20
UA	G307	C	2018/08/03	Boron, total	mg/L	2.00
UA	G307	C	2019/08/19	Boron, total	mg/L	2.10
UA	G307	C	2020/02/26	Boron, total	mg/L	2.10
UA	G307	C	2020/08/11	Boron, total	mg/L	2.10
UA	G307	C	2021/01/27	Boron, total	mg/L	1.90
UA	G307	C	2021/08/17	Boron, total	mg/L	2.10
UA	G307	C	2022/02/11	Boron, total	mg/L	2.00
UA	G307	C	2022/08/24	Boron, total	mg/L	2.00
UA	G307	C	2023/02/15	Boron, total	mg/L	2.00
UA	G307	C	2023/06/05	Boron, total	mg/L	2.00
UA	G307	C	2023/11/21	Boron, total	mg/L	2.35
UA	G307	C	2016/08/16	Calcium, total	mg/L	210
UA	G307	C	2016/09/29	Calcium, total	mg/L	250
UA	G307	C	2016/11/16	Calcium, total	mg/L	190
UA	G307	C	2017/02/19	Calcium, total	mg/L	200
UA	G307	C	2017/05/17	Calcium, total	mg/L	400
UA	G307	C	2017/07/13	Calcium, total	mg/L	220
UA	G307	C	2017/10/27	Calcium, total	mg/L	230
UA	G307	C	2018/05/14	Calcium, total	mg/L	220
UA	G307	C	2018/08/03	Calcium, total	mg/L	270
UA	G307	C	2019/08/19	Calcium, total	mg/L	280
UA	G307	C	2020/02/26	Calcium, total	mg/L	250
UA	G307	C	2020/08/11	Calcium, total	mg/L	230
UA	G307	C	2021/01/27	Calcium, total	mg/L	200
UA	G307	C	2021/08/17	Calcium, total	mg/L	210
UA	G307	C	2022/02/11	Calcium, total	mg/L	190
UA	G307	C	2022/08/24	Calcium, total	mg/L	210
UA	G307	C	2023/02/15	Calcium, total	mg/L	170
UA	G307	C	2023/06/05	Calcium, total	mg/L	150
UA	G307	C	2023/11/21	Calcium, total	mg/L	168
UA	G307	C	2016/08/16	Chloride, total	mg/L	26.0
UA	G307	C	2016/09/29	Chloride, total	mg/L	26.0
UA	G307	C	2016/11/16	Chloride, total	mg/L	24.0
UA	G307	C	2017/02/19	Chloride, total	mg/L	22.0
UA	G307	C	2017/05/17	Chloride, total	mg/L	19.0
UA	G307	C	2017/07/13	Chloride, total	mg/L	21.0
UA	G307	C	2017/10/27	Chloride, total	mg/L	18.0
UA	G307	C	2018/05/14	Chloride, total	mg/L	17.0
UA	G307	C	2018/08/03	Chloride, total	mg/L	17.0
UA	G307	C	2019/08/19	Chloride, total	mg/L	18.0
UA	G307	C	2020/02/26	Chloride, total	mg/L	18.0
UA	G307	C	2020/08/11	Chloride, total	mg/L	15.0
UA	G307	C	2021/01/27	Chloride, total	mg/L	14.0
UA	G307	C	2021/08/17	Chloride, total	mg/L	16.0
UA	G307	C	2022/02/11	Chloride, total	mg/L	16.0
UA	G307	C	2022/08/24	Chloride, total	mg/L	14.0
UA	G307	C	2023/02/15	Chloride, total	mg/L	12.0
UA	G307	C	2023/06/05	Chloride, total	mg/L	9.20

UA	G307	C	2023/11/21	Chloride, total	mg/L	11.0
UA	G307	C	2023/06/05	Ferrous Iron, dissolved	mg/L	<0.02
UA	G307	C	2023/06/05	Iron, dissolved	mg/L	0.0150
UA	G307	C	2016/11/16	Magnesium, total	mg/L	89.0
UA	G307	C	2017/05/17	Magnesium, total	mg/L	140
UA	G307	C	2017/07/13	Magnesium, total	mg/L	97.0
UA	G307	C	2020/02/26	Magnesium, total	mg/L	76.0
UA	G307	C	2020/08/11	Magnesium, total	mg/L	77.0
UA	G307	C	2021/01/27	Magnesium, total	mg/L	69.0
UA	G307	C	2021/08/17	Magnesium, total	mg/L	69.0
UA	G307	C	2022/02/11	Magnesium, total	mg/L	65.0
UA	G307	C	2022/08/24	Magnesium, total	mg/L	72.0
UA	G307	C	2023/02/15	Magnesium, total	mg/L	54.0
UA	G307	C	2023/06/05	Magnesium, total	mg/L	49.0
UA	G307	C	2023/11/21	Magnesium, total	mg/L	53.7
UA	G307	C	2023/06/05	Manganese, dissolved	mg/L	1.80
UA	G307	C	2016/11/16	Potassium, total	mg/L	2.40
UA	G307	C	2017/05/17	Potassium, total	mg/L	10.0
UA	G307	C	2017/07/13	Potassium, total	mg/L	4.60
UA	G307	C	2020/02/26	Potassium, total	mg/L	3.90
UA	G307	C	2020/08/11	Potassium, total	mg/L	3.60
UA	G307	C	2021/01/27	Potassium, total	mg/L	4.00
UA	G307	C	2021/08/17	Potassium, total	mg/L	4.70
UA	G307	C	2022/02/11	Potassium, total	mg/L	4.20
UA	G307	C	2022/08/24	Potassium, total	mg/L	5.10
UA	G307	C	2023/02/15	Potassium, total	mg/L	5.30
UA	G307	C	2023/06/05	Potassium, total	mg/L	4.00
UA	G307	C	2023/11/21	Potassium, total	mg/L	4.89
UA	G307	C	2023/06/05	Silicon, dissolved	mg/L	11.0
UA	G307	C	2016/11/16	Sodium, total	mg/L	120
UA	G307	C	2017/05/17	Sodium, total	mg/L	110
UA	G307	C	2017/07/13	Sodium, total	mg/L	100
UA	G307	C	2020/02/26	Sodium, total	mg/L	110
UA	G307	C	2020/08/11	Sodium, total	mg/L	99.0
UA	G307	C	2021/01/27	Sodium, total	mg/L	99.0
UA	G307	C	2021/08/17	Sodium, total	mg/L	100
UA	G307	C	2022/02/11	Sodium, total	mg/L	97.0
UA	G307	C	2022/08/24	Sodium, total	mg/L	94.0
UA	G307	C	2023/02/15	Sodium, total	mg/L	77.0
UA	G307	C	2023/06/05	Sodium, total	mg/L	77.0
UA	G307	C	2023/11/21	Sodium, total	mg/L	87.1
UA	G307	C	2016/08/16	Sulfate, total	mg/L	1,000
UA	G307	C	2016/09/29	Sulfate, total	mg/L	1,000
UA	G307	C	2016/11/16	Sulfate, total	mg/L	1,000
UA	G307	C	2017/02/19	Sulfate, total	mg/L	1,100
UA	G307	C	2017/05/17	Sulfate, total	mg/L	940
UA	G307	C	2017/07/13	Sulfate, total	mg/L	1,300
UA	G307	C	2017/10/27	Sulfate, total	mg/L	980
UA	G307	C	2018/05/14	Sulfate, total	mg/L	1,100
UA	G307	C	2018/08/03	Sulfate, total	mg/L	1,100
UA	G307	C	2019/08/19	Sulfate, total	mg/L	1,100
UA	G307	C	2020/02/26	Sulfate, total	mg/L	1,000
UA	G307	C	2020/08/11	Sulfate, total	mg/L	910
UA	G307	C	2021/01/27	Sulfate, total	mg/L	850
UA	G307	C	2021/08/17	Sulfate, total	mg/L	750
UA	G307	C	2022/02/11	Sulfate, total	mg/L	780
UA	G307	C	2022/08/24	Sulfate, total	mg/L	730
UA	G307	C	2023/02/15	Sulfate, total	mg/L	600
UA	G307	C	2023/06/05	Sulfate, total	mg/L	530
UA	G307	C	2023/11/21	Sulfate, total	mg/L	490
UA	G307	C	2016/08/16	Temperature (Celsius)	degrees C	19.0
UA	G307	C	2016/09/29	Temperature (Celsius)	degrees C	18.8

UA	G307	C	2016/11/16	Temperature (Celsius)	degrees C	15.8
UA	G307	C	2017/02/19	Temperature (Celsius)	degrees C	16.5
UA	G307	C	2017/05/17	Temperature (Celsius)	degrees C	15.7
UA	G307	C	2017/07/13	Temperature (Celsius)	degrees C	17.9
UA	G307	C	2017/10/27	Temperature (Celsius)	degrees C	13.4
UA	G307	C	2018/05/14	Temperature (Celsius)	degrees C	16.0
UA	G307	C	2018/08/03	Temperature (Celsius)	degrees C	16.1
UA	G307	C	2019/08/19	Temperature (Celsius)	degrees C	17.1
UA	G307	C	2020/02/26	Temperature (Celsius)	degrees C	10.4
UA	G307	C	2020/05/06	Temperature (Celsius)	degrees C	14.4
UA	G307	C	2020/08/11	Temperature (Celsius)	degrees C	19.0
UA	G307	C	2021/01/27	Temperature (Celsius)	degrees C	5.70
UA	G307	C	2021/08/17	Temperature (Celsius)	degrees C	20.9
UA	G307	C	2022/02/11	Temperature (Celsius)	degrees C	9.10
UA	G307	C	2022/08/24	Temperature (Celsius)	degrees C	19.5
UA	G307	C	2023/02/15	Temperature (Celsius)	degrees C	14.0
UA	G307	C	2023/06/05	Temperature (Celsius)	degrees C	17.0
UA	G307	C	2023/11/21	Temperature (Celsius)	degrees C	13.2
UA	G307	C	2016/08/16	Total Dissolved Solids	mg/L	1,500
UA	G307	C	2016/09/29	Total Dissolved Solids	mg/L	1,300
UA	G307	C	2016/11/16	Total Dissolved Solids	mg/L	1,600
UA	G307	C	2017/02/19	Total Dissolved Solids	mg/L	1,500
UA	G307	C	2017/05/17	Total Dissolved Solids	mg/L	1,500
UA	G307	C	2017/07/13	Total Dissolved Solids	mg/L	1,300
UA	G307	C	2017/10/27	Total Dissolved Solids	mg/L	1,400
UA	G307	C	2018/05/14	Total Dissolved Solids	mg/L	1,400
UA	G307	C	2018/08/03	Total Dissolved Solids	mg/L	1,500
UA	G307	C	2019/08/19	Total Dissolved Solids	mg/L	1,600
UA	G307	C	2020/02/26	Total Dissolved Solids	mg/L	1,500
UA	G307	C	2020/08/11	Total Dissolved Solids	mg/L	1,200
UA	G307	C	2021/01/27	Total Dissolved Solids	mg/L	1,400
UA	G307	C	2021/08/17	Total Dissolved Solids	mg/L	1,300
UA	G307	C	2022/02/11	Total Dissolved Solids	mg/L	1,200
UA	G307	C	2022/08/24	Total Dissolved Solids	mg/L	1,400
UA	G307	C	2023/02/15	Total Dissolved Solids	mg/L	1,200
UA	G307	C	2023/06/05	Total Dissolved Solids	mg/L	980
UA	G307	C	2023/11/21	Total Dissolved Solids	mg/L	915
UA	G308	C	2021/03/29	pH (field)	SU	7.3
UA	G308	C	2021/04/21	pH (field)	SU	7.2
UA	G308	C	2021/05/05	pH (field)	SU	7.2
UA	G308	C	2021/05/17	pH (field)	SU	7.2
UA	G308	C	2021/06/14	pH (field)	SU	7.2
UA	G308	C	2021/06/28	pH (field)	SU	7.2
UA	G308	C	2021/07/14	pH (field)	SU	7.3
UA	G308	C	2021/07/27	pH (field)	SU	7.3
UA	G308	C	2023/02/16	pH (field)	SU	7.2
UA	G308	C	2023/06/01	pH (field)	SU	7.3
UA	G308	C	2023/08/10	pH (field)	SU	7.3
UA	G308	C	2023/11/17	pH (field)	SU	6.9
UA	G308	C	2021/03/29	Oxidation Reduction Potential	mV	213
UA	G308	C	2021/04/21	Oxidation Reduction Potential	mV	32.1
UA	G308	C	2021/05/05	Oxidation Reduction Potential	mV	103
UA	G308	C	2021/05/17	Oxidation Reduction Potential	mV	42.7
UA	G308	C	2021/06/14	Oxidation Reduction Potential	mV	-8.30
UA	G308	C	2021/06/28	Oxidation Reduction Potential	mV	26.1
UA	G308	C	2021/07/14	Oxidation Reduction Potential	mV	118
UA	G308	C	2021/07/27	Oxidation Reduction Potential	mV	37.2
UA	G308	C	2023/02/16	Oxidation Reduction Potential	mV	278
UA	G308	C	2023/06/01	Oxidation Reduction Potential	mV	98.2
UA	G308	C	2023/08/10	Oxidation Reduction Potential	mV	-3.00
UA	G308	C	2023/11/17	Oxidation Reduction Potential	mV	5.00
UA	G308	C	2021/03/29	Eh	V	0.41

UA	G308	C	2021/04/21	Eh	V	0.23
UA	G308	C	2021/05/05	Eh	V	0.30
UA	G308	C	2021/05/17	Eh	V	0.24
UA	G308	C	2021/06/14	Eh	V	0.18
UA	G308	C	2021/06/28	Eh	V	0.22
UA	G308	C	2021/07/14	Eh	V	0.31
UA	G308	C	2021/07/27	Eh	V	0.23
UA	G308	C	2023/02/16	Eh	V	0.48
UA	G308	C	2023/06/01	Eh	V	0.29
UA	G308	C	2023/08/10	Eh	V	0.19
UA	G308	C	2023/11/17	Eh	V	0.20
UA	G308	C	2021/03/29	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G308	C	2021/04/21	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G308	C	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G308	C	2021/05/17	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G308	C	2021/06/14	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G308	C	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G308	C	2021/07/14	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G308	C	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	G308	C	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G308	C	2023/06/01	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	G308	C	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	252
UA	G308	C	2023/11/17	Alkalinity, bicarbonate	mg/L CaCO3	246
UA	G308	C	2021/03/29	Barium, total	mg/L	0.0240
UA	G308	C	2021/04/21	Barium, total	mg/L	0.0220
UA	G308	C	2021/05/05	Barium, total	mg/L	0.0230
UA	G308	C	2021/05/17	Barium, total	mg/L	0.0210
UA	G308	C	2021/06/14	Barium, total	mg/L	0.0220
UA	G308	C	2021/06/28	Barium, total	mg/L	0.0250
UA	G308	C	2021/07/14	Barium, total	mg/L	0.0210
UA	G308	C	2021/07/27	Barium, total	mg/L	0.0220
UA	G308	C	2023/02/16	Barium, total	mg/L	0.0180
UA	G308	C	2023/06/01	Barium, total	mg/L	0.0210
UA	G308	C	2023/08/10	Barium, total	mg/L	0.0222
UA	G308	C	2023/11/17	Barium, total	mg/L	0.0270
UA	G308	C	2021/03/29	Boron, total	mg/L	2.40
UA	G308	C	2021/04/21	Boron, total	mg/L	2.50
UA	G308	C	2021/05/05	Boron, total	mg/L	2.80
UA	G308	C	2021/05/17	Boron, total	mg/L	2.50
UA	G308	C	2021/06/14	Boron, total	mg/L	2.40
UA	G308	C	2021/06/28	Boron, total	mg/L	2.50
UA	G308	C	2021/07/14	Boron, total	mg/L	2.60
UA	G308	C	2021/07/27	Boron, total	mg/L	2.70
UA	G308	C	2023/02/16	Boron, total	mg/L	2.40
UA	G308	C	2023/06/01	Boron, total	mg/L	2.70
UA	G308	C	2023/08/10	Boron, total	mg/L	2.64
UA	G308	C	2023/11/17	Boron, total	mg/L	2.88
UA	G308	C	2021/03/29	Calcium, total	mg/L	210
UA	G308	C	2021/04/21	Calcium, total	mg/L	210
UA	G308	C	2021/05/05	Calcium, total	mg/L	220
UA	G308	C	2021/05/17	Calcium, total	mg/L	220
UA	G308	C	2021/06/14	Calcium, total	mg/L	230
UA	G308	C	2021/06/28	Calcium, total	mg/L	220
UA	G308	C	2021/07/14	Calcium, total	mg/L	210
UA	G308	C	2021/07/27	Calcium, total	mg/L	190
UA	G308	C	2023/02/16	Calcium, total	mg/L	190
UA	G308	C	2023/06/01	Calcium, total	mg/L	200
UA	G308	C	2023/08/10	Calcium, total	mg/L	196
UA	G308	C	2023/11/17	Calcium, total	mg/L	189
UA	G308	C	2021/03/29	Chloride, total	mg/L	17.0
UA	G308	C	2021/04/21	Chloride, total	mg/L	19.0
UA	G308	C	2021/05/05	Chloride, total	mg/L	19.0

UA	G308	C	2021/05/17	Chloride, total	mg/L	20.0
UA	G308	C	2021/06/14	Chloride, total	mg/L	18.0
UA	G308	C	2021/06/28	Chloride, total	mg/L	18.0
UA	G308	C	2021/07/14	Chloride, total	mg/L	17.0
UA	G308	C	2021/07/27	Chloride, total	mg/L	17.0
UA	G308	C	2023/02/16	Chloride, total	mg/L	<240
UA	G308	C	2023/06/01	Chloride, total	mg/L	14.0
UA	G308	C	2023/08/10	Chloride, total	mg/L	10.0
UA	G308	C	2023/11/17	Chloride, total	mg/L	10.0
UA	G308	C	2023/06/01	Ferrous Iron, dissolved	mg/L	0.0850
UA	G308	C	2023/06/01	Iron, dissolved	mg/L	0.00570
UA	G308	C	2023/08/10	Iron, dissolved	mg/L	0.0120
UA	G308	C	2021/03/29	Magnesium, total	mg/L	130
UA	G308	C	2021/04/21	Magnesium, total	mg/L	130
UA	G308	C	2021/05/05	Magnesium, total	mg/L	140
UA	G308	C	2021/05/17	Magnesium, total	mg/L	130
UA	G308	C	2021/06/14	Magnesium, total	mg/L	140
UA	G308	C	2021/06/28	Magnesium, total	mg/L	130
UA	G308	C	2021/07/14	Magnesium, total	mg/L	130
UA	G308	C	2021/07/27	Magnesium, total	mg/L	120
UA	G308	C	2023/02/16	Magnesium, total	mg/L	120
UA	G308	C	2023/06/01	Magnesium, total	mg/L	120
UA	G308	C	2023/08/10	Magnesium, total	mg/L	115
UA	G308	C	2023/11/17	Magnesium, total	mg/L	109
UA	G308	C	2023/06/01	Manganese, dissolved	mg/L	0.320
UA	G308	C	2023/08/10	Manganese, dissolved	mg/L	0.353
UA	G308	C	2023/08/10	Phosphate, dissolved	mg/L	0.0210
UA	G308	C	2021/03/29	Potassium, total	mg/L	0.400
UA	G308	C	2021/04/21	Potassium, total	mg/L	0.310
UA	G308	C	2021/05/05	Potassium, total	mg/L	0.950
UA	G308	C	2021/05/17	Potassium, total	mg/L	0.320
UA	G308	C	2021/06/14	Potassium, total	mg/L	0.370
UA	G308	C	2021/06/28	Potassium, total	mg/L	3.40
UA	G308	C	2021/07/14	Potassium, total	mg/L	0.320
UA	G308	C	2021/07/27	Potassium, total	mg/L	0.250
UA	G308	C	2023/02/16	Potassium, total	mg/L	0.350
UA	G308	C	2023/06/01	Potassium, total	mg/L	0.360
UA	G308	C	2023/08/10	Potassium, total	mg/L	0.460
UA	G308	C	2023/11/17	Potassium, total	mg/L	0.495
UA	G308	C	2023/06/01	Silicon, dissolved	mg/L	11.0
UA	G308	C	2023/08/10	Silicon, dissolved	mg/L	11.2
UA	G308	C	2021/03/29	Sodium, total	mg/L	160
UA	G308	C	2021/04/21	Sodium, total	mg/L	160
UA	G308	C	2021/05/05	Sodium, total	mg/L	180
UA	G308	C	2021/05/17	Sodium, total	mg/L	160
UA	G308	C	2021/06/14	Sodium, total	mg/L	180
UA	G308	C	2021/06/28	Sodium, total	mg/L	160
UA	G308	C	2021/07/14	Sodium, total	mg/L	170
UA	G308	C	2021/07/27	Sodium, total	mg/L	150
UA	G308	C	2023/02/16	Sodium, total	mg/L	150
UA	G308	C	2023/06/01	Sodium, total	mg/L	150
UA	G308	C	2023/08/10	Sodium, total	mg/L	152
UA	G308	C	2023/11/17	Sodium, total	mg/L	134
UA	G308	C	2021/03/29	Sulfate, total	mg/L	1,100
UA	G308	C	2021/04/21	Sulfate, total	mg/L	1,100
UA	G308	C	2021/05/05	Sulfate, total	mg/L	1,200
UA	G308	C	2021/05/17	Sulfate, total	mg/L	1,200
UA	G308	C	2021/06/14	Sulfate, total	mg/L	1,100
UA	G308	C	2021/06/28	Sulfate, total	mg/L	1,100
UA	G308	C	2021/07/14	Sulfate, total	mg/L	1,100
UA	G308	C	2021/07/27	Sulfate, total	mg/L	1,100
UA	G308	C	2023/02/16	Sulfate, total	mg/L	960

UA	G308	C	2023/06/01	Sulfate, total	mg/L	1,000
UA	G308	C	2023/08/10	Sulfate, total	mg/L	996
UA	G308	C	2023/11/17	Sulfate, total	mg/L	936
UA	G308	C	2021/03/29	Temperature (Celsius)	degrees C	13.5
UA	G308	C	2021/04/21	Temperature (Celsius)	degrees C	11.6
UA	G308	C	2021/05/05	Temperature (Celsius)	degrees C	13.6
UA	G308	C	2021/05/17	Temperature (Celsius)	degrees C	13.9
UA	G308	C	2021/06/14	Temperature (Celsius)	degrees C	19.0
UA	G308	C	2021/06/28	Temperature (Celsius)	degrees C	20.3
UA	G308	C	2021/07/14	Temperature (Celsius)	degrees C	17.3
UA	G308	C	2021/07/27	Temperature (Celsius)	degrees C	22.6
UA	G308	C	2023/02/16	Temperature (Celsius)	degrees C	9.50
UA	G308	C	2023/06/01	Temperature (Celsius)	degrees C	16.8
UA	G308	C	2023/08/10	Temperature (Celsius)	degrees C	16.2
UA	G308	C	2023/11/17	Temperature (Celsius)	degrees C	16.0
UA	G308	C	2021/03/29	Total Dissolved Solids	mg/L	1,900
UA	G308	C	2021/04/21	Total Dissolved Solids	mg/L	2,000
UA	G308	C	2021/05/05	Total Dissolved Solids	mg/L	1,800
UA	G308	C	2021/05/17	Total Dissolved Solids	mg/L	1,900
UA	G308	C	2021/06/14	Total Dissolved Solids	mg/L	1,900
UA	G308	C	2021/06/28	Total Dissolved Solids	mg/L	1,800
UA	G308	C	2021/07/14	Total Dissolved Solids	mg/L	1,900
UA	G308	C	2021/07/27	Total Dissolved Solids	mg/L	1,900
UA	G308	C	2023/02/16	Total Dissolved Solids	mg/L	1,800
UA	G308	C	2023/06/01	Total Dissolved Solids	mg/L	1,800
UA	G308	C	2023/08/10	Total Dissolved Solids	mg/L	1,760
UA	G308	C	2023/11/17	Total Dissolved Solids	mg/L	1,640
UA	G310	C	2021/03/29	pH (field)	SU	7.1
UA	G310	C	2021/04/22	pH (field)	SU	7.0
UA	G310	C	2021/05/04	pH (field)	SU	7.2
UA	G310	C	2021/05/19	pH (field)	SU	7.2
UA	G310	C	2021/06/15	pH (field)	SU	7.2
UA	G310	C	2021/06/28	pH (field)	SU	7.1
UA	G310	C	2021/07/13	pH (field)	SU	7.2
UA	G310	C	2021/07/28	pH (field)	SU	7.2
UA	G310	C	2023/02/16	pH (field)	SU	7.2
UA	G310	C	2023/06/01	pH (field)	SU	7.2
UA	G310	C	2023/08/09	pH (field)	SU	6.8
UA	G310	C	2023/11/20	pH (field)	SU	6.8
UA	G310	C	2021/03/29	Oxidation Reduction Potential	mV	214
UA	G310	C	2021/04/22	Oxidation Reduction Potential	mV	102
UA	G310	C	2021/05/04	Oxidation Reduction Potential	mV	153
UA	G310	C	2021/05/19	Oxidation Reduction Potential	mV	100
UA	G310	C	2021/06/15	Oxidation Reduction Potential	mV	181
UA	G310	C	2021/06/28	Oxidation Reduction Potential	mV	44.5
UA	G310	C	2021/07/13	Oxidation Reduction Potential	mV	65.5
UA	G310	C	2021/07/28	Oxidation Reduction Potential	mV	51.3
UA	G310	C	2023/02/16	Oxidation Reduction Potential	mV	305
UA	G310	C	2023/06/01	Oxidation Reduction Potential	mV	114
UA	G310	C	2023/08/09	Oxidation Reduction Potential	mV	99.0
UA	G310	C	2023/11/20	Oxidation Reduction Potential	mV	86.0
UA	G310	C	2021/03/29	Eh	V	0.41
UA	G310	C	2021/04/22	Eh	V	0.30
UA	G310	C	2021/05/04	Eh	V	0.35
UA	G310	C	2021/05/19	Eh	V	0.30
UA	G310	C	2021/06/15	Eh	V	0.38
UA	G310	C	2021/06/28	Eh	V	0.24
UA	G310	C	2021/07/13	Eh	V	0.26
UA	G310	C	2021/07/28	Eh	V	0.24
UA	G310	C	2023/02/16	Eh	V	0.50
UA	G310	C	2023/06/01	Eh	V	0.31
UA	G310	C	2023/08/09	Eh	V	0.29

UA	G310	C	2023/11/20	Eh	V	0.28
UA	G310	C	2021/03/29	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	G310	C	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G310	C	2021/05/04	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	G310	C	2021/05/19	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G310	C	2021/06/15	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G310	C	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G310	C	2021/07/13	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G310	C	2021/07/28	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	G310	C	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	250
UA	G310	C	2023/06/01	Alkalinity, bicarbonate	mg/L CaCO3	240
UA	G310	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	244
UA	G310	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	253
UA	G310	C	2021/03/29	Barium, total	mg/L	0.0160
UA	G310	C	2021/04/22	Barium, total	mg/L	0.0220
UA	G310	C	2021/05/04	Barium, total	mg/L	0.0190
UA	G310	C	2021/05/19	Barium, total	mg/L	0.0160
UA	G310	C	2021/06/15	Barium, total	mg/L	0.0180
UA	G310	C	2021/06/28	Barium, total	mg/L	0.0180
UA	G310	C	2021/07/13	Barium, total	mg/L	0.0180
UA	G310	C	2021/07/28	Barium, total	mg/L	0.0170
UA	G310	C	2023/02/16	Barium, total	mg/L	0.0130
UA	G310	C	2023/06/01	Barium, total	mg/L	0.0140
UA	G310	C	2023/08/09	Barium, total	mg/L	0.0147
UA	G310	C	2023/11/20	Barium, total	mg/L	0.0148
UA	G310	C	2021/03/29	Boron, total	mg/L	1.60
UA	G310	C	2021/04/22	Boron, total	mg/L	1.70
UA	G310	C	2021/05/04	Boron, total	mg/L	1.80
UA	G310	C	2021/05/19	Boron, total	mg/L	1.70
UA	G310	C	2021/06/15	Boron, total	mg/L	2.00
UA	G310	C	2021/06/28	Boron, total	mg/L	1.80
UA	G310	C	2021/07/13	Boron, total	mg/L	2.00
UA	G310	C	2021/07/28	Boron, total	mg/L	1.80
UA	G310	C	2023/02/16	Boron, total	mg/L	1.70
UA	G310	C	2023/06/01	Boron, total	mg/L	1.70
UA	G310	C	2023/08/09	Boron, total	mg/L	1.95
UA	G310	C	2023/11/20	Boron, total	mg/L	2.08
UA	G310	C	2021/03/29	Calcium, total	mg/L	170
UA	G310	C	2021/04/22	Calcium, total	mg/L	190
UA	G310	C	2021/05/04	Calcium, total	mg/L	190
UA	G310	C	2021/05/19	Calcium, total	mg/L	180
UA	G310	C	2021/06/15	Calcium, total	mg/L	200
UA	G310	C	2021/06/28	Calcium, total	mg/L	190
UA	G310	C	2021/07/13	Calcium, total	mg/L	180
UA	G310	C	2021/07/28	Calcium, total	mg/L	190
UA	G310	C	2023/02/16	Calcium, total	mg/L	130
UA	G310	C	2023/06/01	Calcium, total	mg/L	150
UA	G310	C	2023/08/09	Calcium, total	mg/L	158
UA	G310	C	2023/11/20	Calcium, total	mg/L	159
UA	G310	C	2021/03/29	Chloride, total	mg/L	20.0
UA	G310	C	2021/04/22	Chloride, total	mg/L	22.0
UA	G310	C	2021/05/04	Chloride, total	mg/L	20.0
UA	G310	C	2021/05/19	Chloride, total	mg/L	22.0
UA	G310	C	2021/06/15	Chloride, total	mg/L	21.0
UA	G310	C	2021/06/28	Chloride, total	mg/L	21.0
UA	G310	C	2021/07/13	Chloride, total	mg/L	24.0
UA	G310	C	2021/07/28	Chloride, total	mg/L	21.0
UA	G310	C	2023/02/16	Chloride, total	mg/L	13.0
UA	G310	C	2023/06/01	Chloride, total	mg/L	14.0
UA	G310	C	2023/08/09	Chloride, total	mg/L	14.0
UA	G310	C	2023/11/20	Chloride, total	mg/L	13.0
UA	G310	C	2023/06/01	Ferrous Iron, dissolved	mg/L	<0.02

UA	G310	C	2023/06/01	Iron, dissolved	mg/L	0.00210
UA	G310	C	2023/08/09	Iron, dissolved	mg/L	<0.0115
UA	G310	C	2021/03/29	Magnesium, total	mg/L	59.0
UA	G310	C	2021/04/22	Magnesium, total	mg/L	68.0
UA	G310	C	2021/05/04	Magnesium, total	mg/L	64.0
UA	G310	C	2021/05/19	Magnesium, total	mg/L	63.0
UA	G310	C	2021/06/15	Magnesium, total	mg/L	68.0
UA	G310	C	2021/06/28	Magnesium, total	mg/L	66.0
UA	G310	C	2021/07/13	Magnesium, total	mg/L	64.0
UA	G310	C	2021/07/28	Magnesium, total	mg/L	69.0
UA	G310	C	2023/02/16	Magnesium, total	mg/L	47.0
UA	G310	C	2023/06/01	Magnesium, total	mg/L	49.0
UA	G310	C	2023/08/09	Magnesium, total	mg/L	52.6
UA	G310	C	2023/11/20	Magnesium, total	mg/L	51.9
UA	G310	C	2023/06/01	Manganese, dissolved	mg/L	0.310
UA	G310	C	2023/08/09	Manganese, dissolved	mg/L	0.336
UA	G310	C	2023/08/09	Phosphate, dissolved	mg/L	0.0180
UA	G310	C	2021/03/29	Potassium, total	mg/L	0.310
UA	G310	C	2021/04/22	Potassium, total	mg/L	0.350
UA	G310	C	2021/05/04	Potassium, total	mg/L	0.360
UA	G310	C	2021/05/19	Potassium, total	mg/L	0.190
UA	G310	C	2021/06/15	Potassium, total	mg/L	0.330
UA	G310	C	2021/06/28	Potassium, total	mg/L	0.300
UA	G310	C	2021/07/13	Potassium, total	mg/L	0.300
UA	G310	C	2021/07/28	Potassium, total	mg/L	0.340
UA	G310	C	2023/02/16	Potassium, total	mg/L	0.280
UA	G310	C	2023/06/01	Potassium, total	mg/L	0.260
UA	G310	C	2023/08/09	Potassium, total	mg/L	0.342
UA	G310	C	2023/11/20	Potassium, total	mg/L	0.356
UA	G310	C	2023/06/01	Silicon, dissolved	mg/L	9.60
UA	G310	C	2023/08/09	Silicon, dissolved	mg/L	9.76
UA	G310	C	2021/03/29	Sodium, total	mg/L	170
UA	G310	C	2021/04/22	Sodium, total	mg/L	180
UA	G310	C	2021/05/04	Sodium, total	mg/L	170
UA	G310	C	2021/05/19	Sodium, total	mg/L	180
UA	G310	C	2021/06/15	Sodium, total	mg/L	190
UA	G310	C	2021/06/28	Sodium, total	mg/L	170
UA	G310	C	2021/07/13	Sodium, total	mg/L	170
UA	G310	C	2021/07/28	Sodium, total	mg/L	170
UA	G310	C	2023/02/16	Sodium, total	mg/L	150
UA	G310	C	2023/06/01	Sodium, total	mg/L	150
UA	G310	C	2023/08/09	Sodium, total	mg/L	144
UA	G310	C	2023/11/20	Sodium, total	mg/L	149
UA	G310	C	2021/03/29	Sulfate, total	mg/L	910
UA	G310	C	2021/04/22	Sulfate, total	mg/L	2,300
UA	G310	C	2021/05/04	Sulfate, total	mg/L	870
UA	G310	C	2021/05/19	Sulfate, total	mg/L	860
UA	G310	C	2021/06/15	Sulfate, total	mg/L	860
UA	G310	C	2021/06/28	Sulfate, total	mg/L	820
UA	G310	C	2021/07/13	Sulfate, total	mg/L	420
UA	G310	C	2021/07/28	Sulfate, total	mg/L	880
UA	G310	C	2023/02/16	Sulfate, total	mg/L	550
UA	G310	C	2023/06/01	Sulfate, total	mg/L	620
UA	G310	C	2023/08/09	Sulfate, total	mg/L	611
UA	G310	C	2023/11/20	Sulfate, total	mg/L	636
UA	G310	C	2021/03/29	Temperature (Celsius)	degrees C	14.0
UA	G310	C	2021/04/22	Temperature (Celsius)	degrees C	13.2
UA	G310	C	2021/05/04	Temperature (Celsius)	degrees C	12.9
UA	G310	C	2021/05/19	Temperature (Celsius)	degrees C	14.9
UA	G310	C	2021/06/15	Temperature (Celsius)	degrees C	15.8
UA	G310	C	2021/06/28	Temperature (Celsius)	degrees C	17.3
UA	G310	C	2021/07/13	Temperature (Celsius)	degrees C	18.8

UA	G310	C	2021/07/28	Temperature (Celsius)	degrees C	18.9
UA	G310	C	2023/02/16	Temperature (Celsius)	degrees C	9.90
UA	G310	C	2023/06/01	Temperature (Celsius)	degrees C	17.1
UA	G310	C	2023/08/09	Temperature (Celsius)	degrees C	15.5
UA	G310	C	2023/11/20	Temperature (Celsius)	degrees C	15.7
UA	G310	C	2021/03/29	Total Dissolved Solids	mg/L	1,400
UA	G310	C	2021/04/22	Total Dissolved Solids	mg/L	1,500
UA	G310	C	2021/05/04	Total Dissolved Solids	mg/L	1,600
UA	G310	C	2021/05/19	Total Dissolved Solids	mg/L	1,500
UA	G310	C	2021/06/15	Total Dissolved Solids	mg/L	1,500
UA	G310	C	2021/06/28	Total Dissolved Solids	mg/L	1,500
UA	G310	C	2021/07/13	Total Dissolved Solids	mg/L	1,600
UA	G310	C	2021/07/28	Total Dissolved Solids	mg/L	1,600
UA	G310	C	2023/02/16	Total Dissolved Solids	mg/L	1,100
UA	G310	C	2023/06/01	Total Dissolved Solids	mg/L	1,100
UA	G310	C	2023/08/09	Total Dissolved Solids	mg/L	1,160
UA	G310	C	2023/11/20	Total Dissolved Solids	mg/L	1,210
UA	G312	C	2021/03/30	pH (field)	SU	6.5
UA	G312	C	2021/04/22	pH (field)	SU	6.4
UA	G312	C	2021/05/04	pH (field)	SU	6.5
UA	G312	C	2021/05/19	pH (field)	SU	6.4
UA	G312	C	2021/06/15	pH (field)	SU	6.5
UA	G312	C	2021/06/29	pH (field)	SU	6.5
UA	G312	C	2021/07/13	pH (field)	SU	6.3
UA	G312	C	2021/07/27	pH (field)	SU	6.5
UA	G312	C	2023/06/01	pH (field)	SU	6.5
UA	G312	C	2023/08/09	pH (field)	SU	6.1
UA	G312	C	2021/03/30	Oxidation Reduction Potential	mV	421
UA	G312	C	2021/04/22	Oxidation Reduction Potential	mV	114
UA	G312	C	2021/05/04	Oxidation Reduction Potential	mV	136
UA	G312	C	2021/05/19	Oxidation Reduction Potential	mV	142
UA	G312	C	2021/06/15	Oxidation Reduction Potential	mV	130
UA	G312	C	2021/06/29	Oxidation Reduction Potential	mV	138
UA	G312	C	2021/07/13	Oxidation Reduction Potential	mV	112
UA	G312	C	2021/07/27	Oxidation Reduction Potential	mV	85.5
UA	G312	C	2023/06/01	Oxidation Reduction Potential	mV	150
UA	G312	C	2023/08/09	Oxidation Reduction Potential	mV	3.00
UA	G312	C	2021/03/30	Eh	V	0.62
UA	G312	C	2021/04/22	Eh	V	0.31
UA	G312	C	2021/05/04	Eh	V	0.33
UA	G312	C	2021/05/19	Eh	V	0.34
UA	G312	C	2021/06/15	Eh	V	0.32
UA	G312	C	2021/06/29	Eh	V	0.33
UA	G312	C	2021/07/13	Eh	V	0.30
UA	G312	C	2021/07/27	Eh	V	0.28
UA	G312	C	2023/06/01	Eh	V	0.34
UA	G312	C	2023/08/09	Eh	V	0.20
UA	G312	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	410
UA	G312	C	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	420
UA	G312	C	2021/05/04	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G312	C	2021/05/19	Alkalinity, bicarbonate	mg/L CaCO3	460
UA	G312	C	2021/06/15	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G312	C	2021/06/29	Alkalinity, bicarbonate	mg/L CaCO3	460
UA	G312	C	2021/07/13	Alkalinity, bicarbonate	mg/L CaCO3	480
UA	G312	C	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	350
UA	G312	C	2023/06/01	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G312	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	566
UA	G312	C	2021/03/30	Barium, total	mg/L	0.0230
UA	G312	C	2021/04/22	Barium, total	mg/L	0.0250
UA	G312	C	2021/05/04	Barium, total	mg/L	0.0300
UA	G312	C	2021/05/19	Barium, total	mg/L	0.0250
UA	G312	C	2021/06/15	Barium, total	mg/L	0.0260

UA	G312	C	2021/06/29	Barium, total	mg/L	0.0290
UA	G312	C	2021/07/13	Barium, total	mg/L	0.0280
UA	G312	C	2021/07/27	Barium, total	mg/L	0.0230
UA	G312	C	2023/06/01	Barium, total	mg/L	0.0290
UA	G312	C	2023/08/09	Barium, total	mg/L	0.0306
UA	G312	C	2021/03/30	Boron, total	mg/L	1.50
UA	G312	C	2021/04/22	Boron, total	mg/L	1.60
UA	G312	C	2021/05/04	Boron, total	mg/L	1.70
UA	G312	C	2021/05/19	Boron, total	mg/L	1.40
UA	G312	C	2021/06/15	Boron, total	mg/L	1.60
UA	G312	C	2021/06/29	Boron, total	mg/L	1.80
UA	G312	C	2021/07/13	Boron, total	mg/L	2.20
UA	G312	C	2021/07/27	Boron, total	mg/L	3.50
UA	G312	C	2023/06/01	Boron, total	mg/L	1.30
UA	G312	C	2023/08/09	Boron, total	mg/L	3.51
UA	G312	C	2021/03/30	Calcium, total	mg/L	190
UA	G312	C	2021/04/22	Calcium, total	mg/L	200
UA	G312	C	2021/05/04	Calcium, total	mg/L	210
UA	G312	C	2021/05/19	Calcium, total	mg/L	190
UA	G312	C	2021/06/15	Calcium, total	mg/L	220
UA	G312	C	2021/06/29	Calcium, total	mg/L	210
UA	G312	C	2021/07/13	Calcium, total	mg/L	200
UA	G312	C	2021/07/27	Calcium, total	mg/L	240
UA	G312	C	2023/06/01	Calcium, total	mg/L	160
UA	G312	C	2023/08/09	Calcium, total	mg/L	242
UA	G312	C	2021/03/30	Chloride, total	mg/L	20.0
UA	G312	C	2021/04/22	Chloride, total	mg/L	20.0
UA	G312	C	2021/05/04	Chloride, total	mg/L	25.0
UA	G312	C	2021/05/19	Chloride, total	mg/L	26.0
UA	G312	C	2021/06/15	Chloride, total	mg/L	26.0
UA	G312	C	2021/06/29	Chloride, total	mg/L	27.0
UA	G312	C	2021/07/13	Chloride, total	mg/L	26.0
UA	G312	C	2021/07/27	Chloride, total	mg/L	22.0
UA	G312	C	2023/06/01	Chloride, total	mg/L	23.0
UA	G312	C	2023/08/09	Chloride, total	mg/L	31.0
UA	G312	C	2023/06/01	Ferrous Iron, dissolved	mg/L	<0.02
UA	G312	C	2023/06/01	Iron, dissolved	mg/L	0.00620
UA	G312	C	2023/08/09	Iron, dissolved	mg/L	0.0240
UA	G312	C	2021/03/30	Magnesium, total	mg/L	120
UA	G312	C	2021/04/22	Magnesium, total	mg/L	130
UA	G312	C	2021/05/04	Magnesium, total	mg/L	130
UA	G312	C	2021/05/19	Magnesium, total	mg/L	120
UA	G312	C	2021/06/15	Magnesium, total	mg/L	120
UA	G312	C	2021/06/29	Magnesium, total	mg/L	130
UA	G312	C	2021/07/13	Magnesium, total	mg/L	120
UA	G312	C	2021/07/27	Magnesium, total	mg/L	170
UA	G312	C	2023/06/01	Magnesium, total	mg/L	100
UA	G312	C	2023/08/09	Magnesium, total	mg/L	176
UA	G312	C	2023/06/01	Manganese, dissolved	mg/L	3.00
UA	G312	C	2023/08/09	Manganese, dissolved	mg/L	4.68
UA	G312	C	2023/08/09	Phosphate, dissolved	mg/L	0.0250
UA	G312	C	2021/03/30	Potassium, total	mg/L	0.490
UA	G312	C	2021/04/22	Potassium, total	mg/L	0.670
UA	G312	C	2021/05/04	Potassium, total	mg/L	0.630
UA	G312	C	2021/05/19	Potassium, total	mg/L	0.400
UA	G312	C	2021/06/15	Potassium, total	mg/L	0.550
UA	G312	C	2021/06/29	Potassium, total	mg/L	0.560
UA	G312	C	2021/07/13	Potassium, total	mg/L	0.550
UA	G312	C	2021/07/27	Potassium, total	mg/L	0.650
UA	G312	C	2023/06/01	Potassium, total	mg/L	0.430
UA	G312	C	2023/08/09	Potassium, total	mg/L	0.850
UA	G312	C	2023/06/01	Silicon, dissolved	mg/L	11.0

UA	G312	C	2023/08/09	Silicon, dissolved	mg/L	12.0
UA	G312	C	2021/03/30	Sodium, total	mg/L	82.0
UA	G312	C	2021/04/22	Sodium, total	mg/L	85.0
UA	G312	C	2021/05/04	Sodium, total	mg/L	91.0
UA	G312	C	2021/05/19	Sodium, total	mg/L	81.0
UA	G312	C	2021/06/15	Sodium, total	mg/L	91.0
UA	G312	C	2021/06/29	Sodium, total	mg/L	95.0
UA	G312	C	2021/07/13	Sodium, total	mg/L	93.0
UA	G312	C	2021/07/27	Sodium, total	mg/L	140
UA	G312	C	2023/06/01	Sodium, total	mg/L	71.0
UA	G312	C	2023/08/09	Sodium, total	mg/L	139
UA	G312	C	2021/03/30	Sulfate, total	mg/L	600
UA	G312	C	2021/04/22	Sulfate, total	mg/L	650
UA	G312	C	2021/05/04	Sulfate, total	mg/L	920
UA	G312	C	2021/05/19	Sulfate, total	mg/L	1,000
UA	G312	C	2021/06/15	Sulfate, total	mg/L	920
UA	G312	C	2021/06/29	Sulfate, total	mg/L	890
UA	G312	C	2021/07/13	Sulfate, total	mg/L	930
UA	G312	C	2021/07/27	Sulfate, total	mg/L	800
UA	G312	C	2023/06/01	Sulfate, total	mg/L	750
UA	G312	C	2023/08/09	Sulfate, total	mg/L	965
UA	G312	C	2021/03/30	Temperature (Celsius)	degrees C	12.4
UA	G312	C	2021/04/22	Temperature (Celsius)	degrees C	13.0
UA	G312	C	2021/05/04	Temperature (Celsius)	degrees C	13.0
UA	G312	C	2021/05/19	Temperature (Celsius)	degrees C	15.8
UA	G312	C	2021/06/15	Temperature (Celsius)	degrees C	17.2
UA	G312	C	2021/06/29	Temperature (Celsius)	degrees C	21.2
UA	G312	C	2021/07/13	Temperature (Celsius)	degrees C	19.5
UA	G312	C	2021/07/27	Temperature (Celsius)	degrees C	18.2
UA	G312	C	2023/06/01	Temperature (Celsius)	degrees C	17.6
UA	G312	C	2023/08/09	Temperature (Celsius)	degrees C	16.6
UA	G312	C	2021/03/30	Total Dissolved Solids	mg/L	1,300
UA	G312	C	2021/04/22	Total Dissolved Solids	mg/L	1,400
UA	G312	C	2021/05/04	Total Dissolved Solids	mg/L	1,600
UA	G312	C	2021/05/19	Total Dissolved Solids	mg/L	1,700
UA	G312	C	2021/06/15	Total Dissolved Solids	mg/L	1,800
UA	G312	C	2021/06/29	Total Dissolved Solids	mg/L	1,600
UA	G312	C	2021/07/13	Total Dissolved Solids	mg/L	1,900
UA	G312	C	2021/07/27	Total Dissolved Solids	mg/L	1,800
UA	G312	C	2023/06/01	Total Dissolved Solids	mg/L	1,700
UA	G312	C	2023/08/09	Total Dissolved Solids	mg/L	2,010
UA	G313	C	2021/03/30	pH (field)	SU	6.9
UA	G313	C	2021/04/22	pH (field)	SU	6.8
UA	G313	C	2021/05/04	pH (field)	SU	7.0
UA	G313	C	2021/05/18	pH (field)	SU	7.0
UA	G313	C	2021/06/14	pH (field)	SU	7.1
UA	G313	C	2021/06/28	pH (field)	SU	7.0
UA	G313	C	2021/07/13	pH (field)	SU	6.9
UA	G313	C	2021/07/27	pH (field)	SU	6.9
UA	G313	C	2023/02/16	pH (field)	SU	6.9
UA	G313	C	2023/06/06	pH (field)	SU	6.9
UA	G313	C	2023/08/09	pH (field)	SU	6.7
UA	G313	C	2023/11/20	pH (field)	SU	6.7
UA	G313	C	2021/03/30	Oxidation Reduction Potential	mV	243
UA	G313	C	2021/04/22	Oxidation Reduction Potential	mV	97.7
UA	G313	C	2021/05/04	Oxidation Reduction Potential	mV	81.4
UA	G313	C	2021/05/18	Oxidation Reduction Potential	mV	38.5
UA	G313	C	2021/06/14	Oxidation Reduction Potential	mV	17.7
UA	G313	C	2021/06/28	Oxidation Reduction Potential	mV	46.3
UA	G313	C	2021/07/13	Oxidation Reduction Potential	mV	17.8
UA	G313	C	2021/07/27	Oxidation Reduction Potential	mV	13.8
UA	G313	C	2023/02/16	Oxidation Reduction Potential	mV	236

UA	G313	C	2023/06/06	Oxidation Reduction Potential	mV	38.2
UA	G313	C	2023/08/09	Oxidation Reduction Potential	mV	-36.0
UA	G313	C	2023/11/20	Oxidation Reduction Potential	mV	6.00
UA	G313	C	2021/03/30	Eh	V	0.44
UA	G313	C	2021/04/22	Eh	V	0.30
UA	G313	C	2021/05/04	Eh	V	0.28
UA	G313	C	2021/05/18	Eh	V	0.23
UA	G313	C	2021/06/14	Eh	V	0.21
UA	G313	C	2021/06/28	Eh	V	0.24
UA	G313	C	2021/07/13	Eh	V	0.21
UA	G313	C	2021/07/27	Eh	V	0.20
UA	G313	C	2023/02/16	Eh	V	0.44
UA	G313	C	2023/06/06	Eh	V	0.23
UA	G313	C	2023/08/09	Eh	V	0.16
UA	G313	C	2023/11/20	Eh	V	0.20
UA	G313	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	500
UA	G313	C	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G313	C	2021/05/04	Alkalinity, bicarbonate	mg/L CaCO3	480
UA	G313	C	2021/05/18	Alkalinity, bicarbonate	mg/L CaCO3	480
UA	G313	C	2021/06/14	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G313	C	2021/06/28	Alkalinity, bicarbonate	mg/L CaCO3	450
UA	G313	C	2021/07/13	Alkalinity, bicarbonate	mg/L CaCO3	480
UA	G313	C	2021/07/27	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G313	C	2023/02/16	Alkalinity, bicarbonate	mg/L CaCO3	500
UA	G313	C	2023/06/06	Alkalinity, bicarbonate	mg/L CaCO3	490
UA	G313	C	2023/08/09	Alkalinity, bicarbonate	mg/L CaCO3	501
UA	G313	C	2023/11/20	Alkalinity, bicarbonate	mg/L CaCO3	507
UA	G313	C	2021/03/30	Barium, total	mg/L	0.0250
UA	G313	C	2021/04/22	Barium, total	mg/L	0.0210
UA	G313	C	2021/05/04	Barium, total	mg/L	0.0230
UA	G313	C	2021/05/18	Barium, total	mg/L	0.0230
UA	G313	C	2021/06/14	Barium, total	mg/L	0.0220
UA	G313	C	2021/06/28	Barium, total	mg/L	0.0200
UA	G313	C	2021/07/13	Barium, total	mg/L	0.0200
UA	G313	C	2021/07/27	Barium, total	mg/L	0.0190
UA	G313	C	2023/02/16	Barium, total	mg/L	0.0170
UA	G313	C	2023/06/06	Barium, total	mg/L	0.0180
UA	G313	C	2023/08/09	Barium, total	mg/L	0.0193
UA	G313	C	2023/11/20	Barium, total	mg/L	0.0270
UA	G313	C	2021/03/30	Boron, total	mg/L	3.30
UA	G313	C	2021/04/22	Boron, total	mg/L	3.40
UA	G313	C	2021/05/04	Boron, total	mg/L	3.50
UA	G313	C	2021/05/18	Boron, total	mg/L	3.30
UA	G313	C	2021/06/14	Boron, total	mg/L	3.30
UA	G313	C	2021/06/28	Boron, total	mg/L	3.50
UA	G313	C	2021/07/13	Boron, total	mg/L	3.40
UA	G313	C	2021/07/27	Boron, total	mg/L	3.50
UA	G313	C	2023/02/16	Boron, total	mg/L	3.20
UA	G313	C	2023/06/06	Boron, total	mg/L	3.30
UA	G313	C	2023/08/09	Boron, total	mg/L	3.63
UA	G313	C	2023/11/20	Boron, total	mg/L	5.23
UA	G313	C	2021/03/30	Calcium, total	mg/L	200
UA	G313	C	2021/04/22	Calcium, total	mg/L	210
UA	G313	C	2021/05/04	Calcium, total	mg/L	200
UA	G313	C	2021/05/18	Calcium, total	mg/L	210
UA	G313	C	2021/06/14	Calcium, total	mg/L	220
UA	G313	C	2021/06/28	Calcium, total	mg/L	200
UA	G313	C	2021/07/13	Calcium, total	mg/L	200
UA	G313	C	2021/07/27	Calcium, total	mg/L	200
UA	G313	C	2023/02/16	Calcium, total	mg/L	190
UA	G313	C	2023/06/06	Calcium, total	mg/L	200
UA	G313	C	2023/08/09	Calcium, total	mg/L	200

UA	G313	C	2023/11/20	Calcium, total	mg/L	211
UA	G313	C	2021/03/30	Chloride, total	mg/L	23.0
UA	G313	C	2021/04/22	Chloride, total	mg/L	25.0
UA	G313	C	2021/05/04	Chloride, total	mg/L	26.0
UA	G313	C	2021/05/18	Chloride, total	mg/L	25.0
UA	G313	C	2021/06/14	Chloride, total	mg/L	26.0
UA	G313	C	2021/06/28	Chloride, total	mg/L	24.0
UA	G313	C	2021/07/13	Chloride, total	mg/L	24.0
UA	G313	C	2021/07/27	Chloride, total	mg/L	<240
UA	G313	C	2023/02/16	Chloride, total	mg/L	20.0
UA	G313	C	2023/06/06	Chloride, total	mg/L	23.0
UA	G313	C	2023/08/09	Chloride, total	mg/L	22.0
UA	G313	C	2023/11/20	Chloride, total	mg/L	20.0
UA	G313	C	2023/06/06	Ferrous Iron, dissolved	mg/L	0.0990
UA	G313	C	2023/06/06	Iron, dissolved	mg/L	0.0680
UA	G313	C	2023/08/09	Iron, dissolved	mg/L	0.0745
UA	G313	C	2021/03/30	Magnesium, total	mg/L	110
UA	G313	C	2021/04/22	Magnesium, total	mg/L	110
UA	G313	C	2021/05/04	Magnesium, total	mg/L	110
UA	G313	C	2021/05/18	Magnesium, total	mg/L	110
UA	G313	C	2021/06/14	Magnesium, total	mg/L	110
UA	G313	C	2021/06/28	Magnesium, total	mg/L	110
UA	G313	C	2021/07/13	Magnesium, total	mg/L	110
UA	G313	C	2021/07/27	Magnesium, total	mg/L	110
UA	G313	C	2023/02/16	Magnesium, total	mg/L	100
UA	G313	C	2023/06/06	Magnesium, total	mg/L	100
UA	G313	C	2023/08/09	Magnesium, total	mg/L	106
UA	G313	C	2023/11/20	Magnesium, total	mg/L	108
UA	G313	C	2023/06/06	Manganese, dissolved	mg/L	0.370
UA	G313	C	2023/08/09	Manganese, dissolved	mg/L	0.386
UA	G313	C	2023/08/09	Phosphate, dissolved	mg/L	<0.005
UA	G313	C	2021/03/30	Potassium, total	mg/L	1.20
UA	G313	C	2021/04/22	Potassium, total	mg/L	0.970
UA	G313	C	2021/05/04	Potassium, total	mg/L	1.00
UA	G313	C	2021/05/18	Potassium, total	mg/L	1.20
UA	G313	C	2021/06/14	Potassium, total	mg/L	1.20
UA	G313	C	2021/06/28	Potassium, total	mg/L	0.980
UA	G313	C	2021/07/13	Potassium, total	mg/L	0.970
UA	G313	C	2021/07/27	Potassium, total	mg/L	0.970
UA	G313	C	2023/02/16	Potassium, total	mg/L	0.950
UA	G313	C	2023/06/06	Potassium, total	mg/L	0.930
UA	G313	C	2023/08/09	Potassium, total	mg/L	1.20
UA	G313	C	2023/11/20	Potassium, total	mg/L	1.24
UA	G313	C	2023/06/06	Silicon, dissolved	mg/L	12.0
UA	G313	C	2023/08/09	Silicon, dissolved	mg/L	11.7
UA	G313	C	2021/03/30	Sodium, total	mg/L	160
UA	G313	C	2021/04/22	Sodium, total	mg/L	150
UA	G313	C	2021/05/04	Sodium, total	mg/L	160
UA	G313	C	2021/05/18	Sodium, total	mg/L	170
UA	G313	C	2021/06/14	Sodium, total	mg/L	170
UA	G313	C	2021/06/28	Sodium, total	mg/L	160
UA	G313	C	2021/07/13	Sodium, total	mg/L	160
UA	G313	C	2021/07/27	Sodium, total	mg/L	160
UA	G313	C	2023/02/16	Sodium, total	mg/L	150
UA	G313	C	2023/06/06	Sodium, total	mg/L	150
UA	G313	C	2023/08/09	Sodium, total	mg/L	153
UA	G313	C	2023/11/20	Sodium, total	mg/L	164
UA	G313	C	2021/03/30	Sulfate, total	mg/L	970
UA	G313	C	2021/04/22	Sulfate, total	mg/L	750
UA	G313	C	2021/05/04	Sulfate, total	mg/L	790
UA	G313	C	2021/05/18	Sulfate, total	mg/L	780
UA	G313	C	2021/06/14	Sulfate, total	mg/L	770

UA	G313	C	2021/06/28	Sulfate, total	mg/L	750
UA	G313	C	2021/07/13	Sulfate, total	mg/L	690
UA	G313	C	2021/07/27	Sulfate, total	mg/L	710
UA	G313	C	2023/02/16	Sulfate, total	mg/L	690
UA	G313	C	2023/06/06	Sulfate, total	mg/L	720
UA	G313	C	2023/08/09	Sulfate, total	mg/L	667
UA	G313	C	2023/11/20	Sulfate, total	mg/L	672
UA	G313	C	2021/03/30	Temperature (Celsius)	degrees C	12.8
UA	G313	C	2021/04/22	Temperature (Celsius)	degrees C	12.1
UA	G313	C	2021/05/04	Temperature (Celsius)	degrees C	13.3
UA	G313	C	2021/05/18	Temperature (Celsius)	degrees C	15.2
UA	G313	C	2021/06/14	Temperature (Celsius)	degrees C	20.7
UA	G313	C	2021/06/28	Temperature (Celsius)	degrees C	23.9
UA	G313	C	2021/07/13	Temperature (Celsius)	degrees C	21.7
UA	G313	C	2021/07/27	Temperature (Celsius)	degrees C	22.4
UA	G313	C	2023/02/16	Temperature (Celsius)	degrees C	9.80
UA	G313	C	2023/06/06	Temperature (Celsius)	degrees C	18.3
UA	G313	C	2023/08/09	Temperature (Celsius)	degrees C	18.1
UA	G313	C	2023/11/20	Temperature (Celsius)	degrees C	15.9
UA	G313	C	2021/03/30	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2021/04/22	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2021/05/04	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2021/05/18	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2021/06/14	Total Dissolved Solids	mg/L	1,700
UA	G313	C	2021/06/28	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2021/07/13	Total Dissolved Solids	mg/L	1,800
UA	G313	C	2021/07/27	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2023/02/16	Total Dissolved Solids	mg/L	1,600
UA	G313	C	2023/06/06	Total Dissolved Solids	mg/L	1,400
UA	G313	C	2023/08/09	Total Dissolved Solids	mg/L	1,500
UA	G313	C	2023/11/20	Total Dissolved Solids	mg/L	1,450
UA	G315	C	2021/03/30	pH (field)	SU	6.9
UA	G315	C	2021/04/22	pH (field)	SU	6.8
UA	G315	C	2021/05/05	pH (field)	SU	6.8
UA	G315	C	2021/05/18	pH (field)	SU	6.9
UA	G315	C	2021/06/15	pH (field)	SU	6.9
UA	G315	C	2021/06/29	pH (field)	SU	7.0
UA	G315	C	2021/07/14	pH (field)	SU	6.8
UA	G315	C	2021/07/28	pH (field)	SU	6.7
UA	G315	C	2023/02/15	pH (field)	SU	7.0
UA	G315	C	2023/06/07	pH (field)	SU	6.9
UA	G315	C	2023/08/10	pH (field)	SU	6.7
UA	G315	C	2023/11/21	pH (field)	SU	6.5
UA	G315	C	2021/03/30	Oxidation Reduction Potential	mV	192
UA	G315	C	2021/04/22	Oxidation Reduction Potential	mV	108
UA	G315	C	2021/05/05	Oxidation Reduction Potential	mV	157
UA	G315	C	2021/05/18	Oxidation Reduction Potential	mV	156
UA	G315	C	2021/06/15	Oxidation Reduction Potential	mV	135
UA	G315	C	2021/06/29	Oxidation Reduction Potential	mV	162
UA	G315	C	2021/07/14	Oxidation Reduction Potential	mV	18.8
UA	G315	C	2021/07/28	Oxidation Reduction Potential	mV	45.1
UA	G315	C	2023/02/15	Oxidation Reduction Potential	mV	182
UA	G315	C	2023/06/07	Oxidation Reduction Potential	mV	140
UA	G315	C	2023/08/10	Oxidation Reduction Potential	mV	98.0
UA	G315	C	2023/11/21	Oxidation Reduction Potential	mV	100
UA	G315	C	2021/03/30	Eh	V	0.39
UA	G315	C	2021/04/22	Eh	V	0.31
UA	G315	C	2021/05/05	Eh	V	0.35
UA	G315	C	2021/05/18	Eh	V	0.35
UA	G315	C	2021/06/15	Eh	V	0.33
UA	G315	C	2021/06/29	Eh	V	0.35
UA	G315	C	2021/07/14	Eh	V	0.21

UA	G315	C	2021/07/28	Eh	V	0.24
UA	G315	C	2023/02/15	Eh	V	0.38
UA	G315	C	2023/06/07	Eh	V	0.34
UA	G315	C	2023/08/10	Eh	V	0.29
UA	G315	C	2023/11/21	Eh	V	0.30
UA	G315	C	2021/03/30	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G315	C	2021/04/22	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G315	C	2021/05/05	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G315	C	2021/05/18	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G315	C	2021/06/15	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G315	C	2021/06/29	Alkalinity, bicarbonate	mg/L CaCO3	190
UA	G315	C	2021/07/14	Alkalinity, bicarbonate	mg/L CaCO3	200
UA	G315	C	2021/07/28	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G315	C	2023/02/15	Alkalinity, bicarbonate	mg/L CaCO3	210
UA	G315	C	2023/06/07	Alkalinity, bicarbonate	mg/L CaCO3	220
UA	G315	C	2023/08/10	Alkalinity, bicarbonate	mg/L CaCO3	240
UA	G315	C	2023/11/21	Alkalinity, bicarbonate	mg/L CaCO3	273
UA	G315	C	2021/03/30	Barium, total	mg/L	0.0280
UA	G315	C	2021/04/22	Barium, total	mg/L	0.0260
UA	G315	C	2021/05/05	Barium, total	mg/L	0.0240
UA	G315	C	2021/05/18	Barium, total	mg/L	0.0240
UA	G315	C	2021/06/15	Barium, total	mg/L	0.0250
UA	G315	C	2021/06/29	Barium, total	mg/L	0.0230
UA	G315	C	2021/07/14	Barium, total	mg/L	0.0280
UA	G315	C	2021/07/28	Barium, total	mg/L	0.0230
UA	G315	C	2023/02/15	Barium, total	mg/L	0.0170
UA	G315	C	2023/06/07	Barium, total	mg/L	0.0360
UA	G315	C	2023/08/10	Barium, total	mg/L	0.0175
UA	G315	C	2023/11/21	Barium, total	mg/L	0.0217
UA	G315	C	2021/03/30	Boron, total	mg/L	1.20
UA	G315	C	2021/04/22	Boron, total	mg/L	1.20
UA	G315	C	2021/05/05	Boron, total	mg/L	1.30
UA	G315	C	2021/05/18	Boron, total	mg/L	1.20
UA	G315	C	2021/06/15	Boron, total	mg/L	1.30
UA	G315	C	2021/06/29	Boron, total	mg/L	1.30
UA	G315	C	2021/07/14	Boron, total	mg/L	1.30
UA	G315	C	2021/07/28	Boron, total	mg/L	1.30
UA	G315	C	2023/02/15	Boron, total	mg/L	1.20
UA	G315	C	2023/06/07	Boron, total	mg/L	1.20
UA	G315	C	2023/08/10	Boron, total	mg/L	1.68
UA	G315	C	2023/11/21	Boron, total	mg/L	1.90
UA	G315	C	2021/03/30	Calcium, total	mg/L	190
UA	G315	C	2021/04/22	Calcium, total	mg/L	200
UA	G315	C	2021/05/05	Calcium, total	mg/L	190
UA	G315	C	2021/05/18	Calcium, total	mg/L	190
UA	G315	C	2021/06/15	Calcium, total	mg/L	210
UA	G315	C	2021/06/29	Calcium, total	mg/L	190
UA	G315	C	2021/07/14	Calcium, total	mg/L	190
UA	G315	C	2021/07/28	Calcium, total	mg/L	190
UA	G315	C	2023/02/15	Calcium, total	mg/L	150
UA	G315	C	2023/06/07	Calcium, total	mg/L	140
UA	G315	C	2023/08/10	Calcium, total	mg/L	147
UA	G315	C	2023/11/21	Calcium, total	mg/L	165
UA	G315	C	2021/03/30	Chloride, total	mg/L	1.90
UA	G315	C	2021/04/22	Chloride, total	mg/L	64.0
UA	G315	C	2021/05/05	Chloride, total	mg/L	19.0
UA	G315	C	2021/05/18	Chloride, total	mg/L	20.0
UA	G315	C	2021/06/15	Chloride, total	mg/L	19.0
UA	G315	C	2021/06/29	Chloride, total	mg/L	19.0
UA	G315	C	2021/07/14	Chloride, total	mg/L	17.0
UA	G315	C	2021/07/28	Chloride, total	mg/L	18.0
UA	G315	C	2023/02/15	Chloride, total	mg/L	12.0

UA	G315	C	2023/06/07	Chloride, total	mg/L	15.0
UA	G315	C	2023/08/10	Chloride, total	mg/L	14.0
UA	G315	C	2023/11/21	Chloride, total	mg/L	14.0
UA	G315	C	2023/06/07	Ferrous Iron, dissolved	mg/L	<0.02
UA	G315	C	2023/06/07	Iron, dissolved	mg/L	<0.00072
UA	G315	C	2023/08/10	Iron, dissolved	mg/L	0.0120
UA	G315	C	2021/03/30	Magnesium, total	mg/L	90.0
UA	G315	C	2021/04/22	Magnesium, total	mg/L	87.0
UA	G315	C	2021/05/05	Magnesium, total	mg/L	93.0
UA	G315	C	2021/05/18	Magnesium, total	mg/L	89.0
UA	G315	C	2021/06/15	Magnesium, total	mg/L	96.0
UA	G315	C	2021/06/29	Magnesium, total	mg/L	93.0
UA	G315	C	2021/07/14	Magnesium, total	mg/L	92.0
UA	G315	C	2021/07/28	Magnesium, total	mg/L	90.0
UA	G315	C	2023/02/15	Magnesium, total	mg/L	64.0
UA	G315	C	2023/06/07	Magnesium, total	mg/L	65.0
UA	G315	C	2023/08/10	Magnesium, total	mg/L	66.6
UA	G315	C	2023/11/21	Magnesium, total	mg/L	73.8
UA	G315	C	2023/06/07	Manganese, dissolved	mg/L	0.240
UA	G315	C	2023/08/10	Manganese, dissolved	mg/L	0.306
UA	G315	C	2023/08/10	Phosphate, dissolved	mg/L	0.0460
UA	G315	C	2021/03/30	Potassium, total	mg/L	0.370
UA	G315	C	2021/04/22	Potassium, total	mg/L	0.230
UA	G315	C	2021/05/05	Potassium, total	mg/L	0.390
UA	G315	C	2021/05/18	Potassium, total	mg/L	0.170
UA	G315	C	2021/06/15	Potassium, total	mg/L	0.390
UA	G315	C	2021/06/29	Potassium, total	mg/L	0.560
UA	G315	C	2021/07/14	Potassium, total	mg/L	0.370
UA	G315	C	2021/07/28	Potassium, total	mg/L	0.250
UA	G315	C	2023/02/15	Potassium, total	mg/L	0.160
UA	G315	C	2023/06/07	Potassium, total	mg/L	0.540
UA	G315	C	2023/08/10	Potassium, total	mg/L	0.299
UA	G315	C	2023/11/21	Potassium, total	mg/L	0.321
UA	G315	C	2023/06/07	Silicon, dissolved	mg/L	13.0
UA	G315	C	2023/08/10	Silicon, dissolved	mg/L	11.9
UA	G315	C	2021/03/30	Sodium, total	mg/L	140
UA	G315	C	2021/04/22	Sodium, total	mg/L	140
UA	G315	C	2021/05/05	Sodium, total	mg/L	150
UA	G315	C	2021/05/18	Sodium, total	mg/L	140
UA	G315	C	2021/06/15	Sodium, total	mg/L	150
UA	G315	C	2021/06/29	Sodium, total	mg/L	150
UA	G315	C	2021/07/14	Sodium, total	mg/L	140
UA	G315	C	2021/07/28	Sodium, total	mg/L	140
UA	G315	C	2023/02/15	Sodium, total	mg/L	110
UA	G315	C	2023/06/07	Sodium, total	mg/L	110
UA	G315	C	2023/08/10	Sodium, total	mg/L	117
UA	G315	C	2023/11/21	Sodium, total	mg/L	126
UA	G315	C	2021/03/30	Sulfate, total	mg/L	1,100
UA	G315	C	2021/04/22	Sulfate, total	mg/L	880
UA	G315	C	2021/05/05	Sulfate, total	mg/L	900
UA	G315	C	2021/05/18	Sulfate, total	mg/L	880
UA	G315	C	2021/06/15	Sulfate, total	mg/L	870
UA	G315	C	2021/06/29	Sulfate, total	mg/L	930
UA	G315	C	2021/07/14	Sulfate, total	mg/L	860
UA	G315	C	2021/07/28	Sulfate, total	mg/L	850
UA	G315	C	2023/02/15	Sulfate, total	mg/L	670
UA	G315	C	2023/06/07	Sulfate, total	mg/L	600
UA	G315	C	2023/08/10	Sulfate, total	mg/L	603
UA	G315	C	2023/11/21	Sulfate, total	mg/L	588
UA	G315	C	2021/03/30	Temperature (Celsius)	degrees C	13.9
UA	G315	C	2021/04/22	Temperature (Celsius)	degrees C	12.7
UA	G315	C	2021/05/05	Temperature (Celsius)	degrees C	14.7

UA	G315	C	2021/05/18	Temperature (Celsius)	degrees C	14.1
UA	G315	C	2021/06/15	Temperature (Celsius)	degrees C	17.6
UA	G315	C	2021/06/29	Temperature (Celsius)	degrees C	19.8
UA	G315	C	2021/07/14	Temperature (Celsius)	degrees C	17.6
UA	G315	C	2021/07/28	Temperature (Celsius)	degrees C	17.8
UA	G315	C	2023/02/15	Temperature (Celsius)	degrees C	11.4
UA	G315	C	2023/06/07	Temperature (Celsius)	degrees C	14.4
UA	G315	C	2023/08/10	Temperature (Celsius)	degrees C	16.1
UA	G315	C	2023/11/21	Temperature (Celsius)	degrees C	14.0
UA	G315	C	2021/03/30	Total Dissolved Solids	mg/L	1,500
UA	G315	C	2021/04/22	Total Dissolved Solids	mg/L	1,600
UA	G315	C	2021/05/05	Total Dissolved Solids	mg/L	1,500
UA	G315	C	2021/05/18	Total Dissolved Solids	mg/L	1,500
UA	G315	C	2021/06/15	Total Dissolved Solids	mg/L	1,500
UA	G315	C	2021/06/29	Total Dissolved Solids	mg/L	1,400
UA	G315	C	2021/07/14	Total Dissolved Solids	mg/L	1,700
UA	G315	C	2021/07/28	Total Dissolved Solids	mg/L	1,600
UA	G315	C	2023/02/15	Total Dissolved Solids	mg/L	1,300
UA	G315	C	2023/06/07	Total Dissolved Solids	mg/L	1,100
UA	G315	C	2023/08/10	Total Dissolved Solids	mg/L	1,190
UA	G315	C	2023/11/21	Total Dissolved Solids	mg/L	362

Notes:

< = results is less than detection limit
B = Background
C = Compliance
HSU = Hydrostratigraphic Unit
CCR = Coal Combustion Residuals
DA = Deep Aquifer
LCU = Lower Confining Unit
UA = Uppermost Aquifer
mg/L = milligrams per liter
SU = standard units
V = volts

Attachment I

Antidegradation Assessment Report
(Hansen 2017)

ATTACHMENT V

Antidegradation Assessment for Management of Coal Combustion Residuals Impoundment Waters

Coffeen Power Station
Illinois Power Generating Company
NPDES Permit No. IL0000108

November 21, 2017

Prepared for:

Illinois Power Generating Company
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Prepared by:

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HANSON
Engineering | Planning | Allied Services

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Appendix A EcoCAT Report

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1. Introduction

Illinois Power Generating Company (IPGC) will be applying for a modification to NPDES Permit No. IL0000108 to reflect the planned physical alterations at the Coffeen Power Station (Coffeen, or "plant") required to meet the U.S. Environmental Protection Agency (USEPA) coal combustion residuals (CCR) rules. These physical alterations will require short-term discharge of waters from coal combustion residuals (CCR) surface impoundments, also known as "ash ponds". The ash ponds assessed in this report include Ash Ponds 1 and 2. Ash Pond 1 is currently an existing operating CCR impoundment, while Ash Pond 2 is an inactive CCR impoundment previously covered with a soil cover system that will require replacement in accordance with the federal CCR rules. This report assesses the potential effects of proposed pollutant load increases on the water quality of Coffeen Lake in accordance with the requirements of 35 Ill. Adm. Code §302.105. Alternatives considered to avoid discharging the waters are discussed.

2. Purpose and Anticipated Benefits

USEPA issued a final rule (the "CCR Rule") that regulates the disposal of CCR under Subtitle D of the Resource Conservation and Recovery Act (RCRA). The CCR Rule, effective October 19, 2015, establishes minimum national criteria for continued operation of CCR surface impoundments.[1] To comply with the CCR Rule, IPGC may need to close Coffeen Ash Ponds 1 and 2 by the end of the timeframe allowed by the Rule. Figure 1 illustrates the layout of the Coffeen ash ponds.

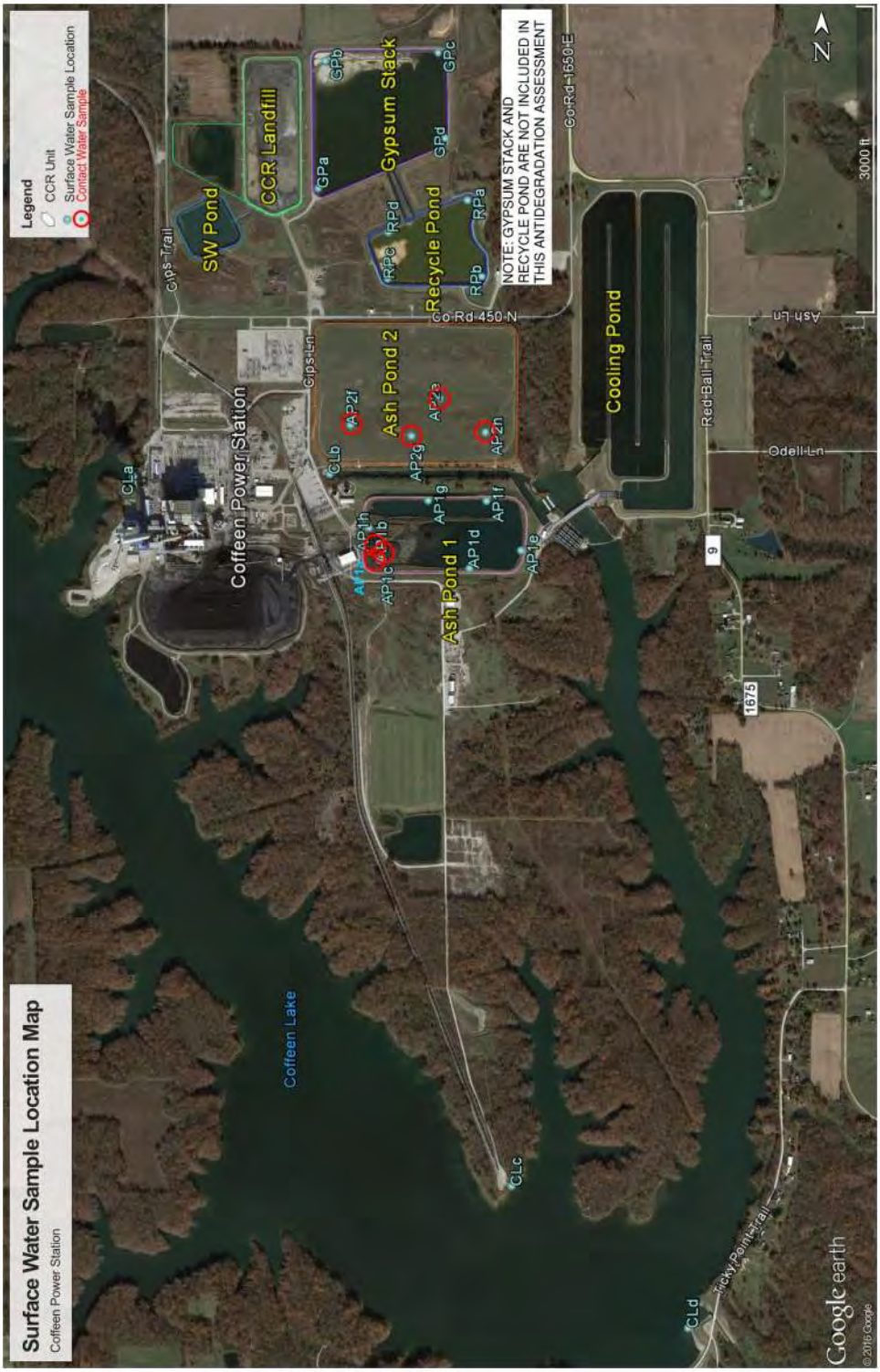
The closure plan for the Coffeen ash ponds includes removal of open water from the ash ponds, referred to as "unwatering;" partial removal of pore water contained in CCR-filled portions of the ash ponds, referred to as "dewatering;" grading and shaping the dewatered CCR surface to facilitate storm water runoff; and installation of a compacted vegetated earthen or composite cover system. Both unwatering and dewatering Ash Pond 1 is necessary to grade the CCR and construct the cover system. No unwaters are present in Ash Pond 2. Dewatering Ash Pond 2 will be necessary. The existing dewatering system in Ash Pond 2, which currently directs the dewaters to the Coffeen plant's Gypsum Management Facility (GMF) ponds, may be adequate to maintain the phreatic surface in the pond far enough below the existing cap to facilitate pond closure. However, this report evaluates the Ash Pond 2 dewaters in case the GMF ponds are overwhelmed and discharge of Ash Pond 2 dewaters is needed.

Due to the large volume of water contained in the ash ponds and the schedule constraints, the preferred alternative to remove the water is to discharge it through the existing NPDES-permitted outfall to Coffeen Lake.

The following sections of this report describe the water sampling, analytical laboratory results, hydraulic and concentration modeling, and alternatives considered to demonstrate the proposed short-term discharge of waters from the ash ponds will result in the continued attainment of water quality standards in Coffeen Lake.

[1] In September 2017, USEPA granted petitions to reconsider the CCR rule. USEPA's reconsideration process may result in revisions to the CCR rule that would change IPGC's current closure plans and future planning regarding the CCR surface impoundments at Coffeen.

Figure 1 Site Map



3. Identification and Characterization of the Affected Water Body

Coffeen Lake (segment ROG) is an artificial cooling lake. The lake is listed on the 2016 *Illinois Integrated Water Quality Report and Section 303(d) List*. Fish consumption use is impaired, with a cause of mercury. A Total Maximum Daily Load (TMDL) has been completed for Coffeen Lake that sets allocations for phosphorus.

The IDNR EcoCAT system does not list any state threatened or endangered aquatic species as residing in the receiving water body near the Coffeen plant. A copy of the EcoCAT report is included in Appendix A.

4. Identification of Proposed Pollutant Load Increases or Potential Impacts on Uses

4.1 Water Sampling and Analyses

PDC Laboratories, Inc. (PDC), under subcontract and field oversight by Hanson Professional Services Inc. (Hanson), collected water samples from the ash ponds and receiving waters on October 24, 2016. Grab samples were collected from open water accumulated in Ash Pond 1 to characterize waters that would be discharged during “unwatering” of the ash pond; these waters are referred to in this report as “unwaters.” Ash Pond 2 is inactive and was previously covered. Unwaters are not associated with Ash Pond 2.

Grab samples were collected from test pits excavated in the CCR-filled portion of Ash Pond 1 and from wells installed in Ash Pond 2 to characterize waters that would be discharged during “dewatering” of the cells; these waters are referred to in this report as “dewaters.” The test pits in Ash Pond 1 were excavated the day before sampling, allowing CCR materials to settle overnight to reduce suspended solids in the samples. Each of the four operable wells in Ash Pond 2 was activated separately and allowed to run until the water appeared clear, then grab samples were collected from the pump discharge. Grab water samples were also collected from Coffeen Lake to evaluate the receiving water that may be affected by the proposed discharges.

In order to further characterize the dewaters as requested by Illinois EPA, an additional round of selected grab samples was collected on January 26, 2017. Table 1 summarizes the water samples collected. Figure 1 shows the sampling locations.

Table 1. Water Samples Collected and Analyzed

Impoundment/Waterbody Sampled	Unwater Samples	Dewater Samples
Ash Pond 1	AP1d, AP1e, AP1f, AP1g, AP1h	AP1a, AP1b, AP1c
Ash Pond 2	None	AP2e, AP2f, AP2g, AP2h

	Receiving Water	
Coffeen Lake	CLa, CLb, CLc, CLd	

The water samples were analyzed by PDC for constituents reviewed and approved by Illinois EPA in an email to Ms. Jacquelyn Bush of IPGC on October 11, 2016. PDC is accredited by Illinois EPA to conduct the laboratory analyses for this assessment. The laboratory analytical reports are included in Appendix B.

Table 2 summarizes the constituents analyzed and the analytical results of samples of the ash pond unwaters and the receiving water. The individual analytical results at each sample location were averaged for evaluation in this antidegradation assessment. None of the representative average unwaters concentrations exceeded the General Effluent Standards listed in 35 Ill. Adm. Code §304.

Table 3 summarizes the constituents analyzed and the analytical results of samples collected from CCR-filled portions of the ash ponds to characterize waters that would be discharged during dewatering the ponds. The individual analytical results at each sample location were averaged for evaluation in this antidegradation assessment. The representative average dewater concentrations of total suspended solids (TSS) in Ash Pond 1, Ash Pond 2, and the combined ash pond dewaters exceeded the General Effluent Standard of 15 mg/L listed in 35 Ill. Adm. Code §304. The representative average dewater concentrations of iron and manganese in Ash Pond 2 dewaters exceeded their respective General Effluent Standards of 2.0 mg/L and 1.0 mg/L. The representative average combined ash pond dewaters concentration of iron exceeded the General Effluent Standard. The representative average concentrations of manganese in Ash Pond 1 dewaters and the combined ash pond dewaters were less than the General Effluent Standard. All other analytes were less than the General Effluent Standards.

4.2 Pollutant Load Increases from Ash Pond Unwatering Discharge

Discharge of unwaters would occur from removal of the free surface water in Ash Pond 1. These waters result from the normal operation of the Coffeen plant and, except for storm water precipitation into the ash pond cells, are generally drawn from Coffeen Lake. These waters are currently discharged under the authorization of the plant's NPDES permit. No unwaters are present in Ash Pond 2.

The means and methods of collecting and conveying the unwaters are undetermined at this time. For purposes of this antidegradation assessment, substances in unwaters at concentrations less than the General Effluent Standards at 35 Ill. Adm. Code §304 are considered to be protective of the receiving water quality, i.e., would not cause degradation of the receiving water quality. As shown in Table 2, the representative average unwater concentrations of all the analytes were less than the General Effluent Standards.

Table 4 shows the estimated mass of each substance proposed to be discharged through the existing NPDES outfall to the Coffeen Lake receiving water (the "Added Load"). The Added Load calculations compensate for the existing receiving water quality by subtracting the "Source Load" of each substance based on the analytical results of the lake samples. Table 4 also estimates the predicted effects of discharging the unwaters to the lake and demonstrates the proposed discharge will not cause exceedances of the Public and Food Processing Water Supply Use Standards at 35 Ill. Adm. Code §302 Subpart C. For substances with no Public and Food Processing Water Supply Use Standard, the chronic General Use Water Quality Standards at 35 Ill. Adm. Code §302 Subpart B were used for comparison. Lake concentrations were calculated at normal pool volume. For substances where concentrations in the lake already exceed the applicable water quality standards (oil and grease, phenols, and phosphorus), the concentrations of these substances in the proposed unwaters discharge are equivalent to the existing lake concentrations. Table 4 illustrates the proposed unwaters discharge will not increase the existing concentrations of oil and grease, phenols, and phosphorus in the lake.

The estimated volume of unwaters to be discharged as part of the CCR closure plan is 40 million gallons. The unwatering rate for Ash Pond 1 will vary depending on schedule and pump rates. The calculations shown in Table 4 assume pumping rates of about 347 gpm (0.5 million gallons per day (MGD)) could remove the free water in approximately 80 days.

Table 2. Ash Pond Unwaters and Receiving Waters Sample Analytical Results

		General Effluent Standards	Ash pond surface water samples (Collected October 24, 2016) All concentration units converted to mg/L for comparison to limits.						Receiving Water				
			Ash Pond 1 Unwaters					Representative Unwaters Concentrations	Coffeen Lake				Representative Lake Concentrations
Sample Date			10/24/2016	10/24/2016	10/24/2016	10/24/2016	10/24/2016		10/24/2016	10/24/2016	10/24/2016	10/24/2016	
Sample ID	Units	35 IAC 304	AP1d	AP1e	AP1f	AP1g	AP1h		CLa	CLb	CLc	CLd	
Ammonia	mg/L	3	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	<0.1	<0.1	<0.1	<0.1	0.05
Arsenic	mg/L	0.25	0.002	0.0014	0.0015	0.0013	0.0015	0.0015	0.0018	0.0018	0.0018	0.0018	0.0018
Barium	mg/L	2.0	0.2	0.16	0.15	0.14	0.18	0.17	0.054	0.052	0.056	0.054	0.054
Boron	mg/L		2	2.1	2.1	2.1	2.2	2.1	0.27	0.28	0.28	0.27	0.28
Cadmium	mg/L	0.15	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005	<0.001	<0.001	<0.001	<0.001	0.0005
Chloride	mg/L		18	18	17	17	17	17	0.023	0.022	0.022	0.023	0.023
Chromium	mg/L	1.0	<0.004	<0.004	<0.004	<0.004	<0.004	0.002	<0.004	<0.004	<0.004	<0.004	0.002
Chromium (hexavalent)	mg/L	0.1	<0.005	<0.005	0.0074	<0.005	<0.005	0.0035	<0.005	<0.005	<0.005	<0.005	0.0025
Copper	mg/L	0.5	0.033	0.016	0.017	0.015	0.014	0.019	0.0091	0.013	0.011	0.012	0.011
Cyanide	mg/L	0.1	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	<0.005	<0.005	<0.005	0.0025
Fluoride	mg/L	15.0	1.08	1.00	1.00	1.00	0.98	1.01	0.443	0.425	0.426	0.421	0.429
Iron	mg/L	2.0	0.54	0.15	0.11	0.089	0.46	0.27	0.22	0.2	0.27	0.14	0.2
Lead	mg/L	0.2	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005	<0.001	<0.001	<0.001	<0.001	0.0005
Manganese	mg/L	1.0	0.015	0.0095	0.0089	0.0081	0.0097	0.0102	0.015	0.022	0.026	0.024	0.022
Mercury	mg/L	0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0001	<0.0002	<0.0002	<0.0002	<0.0002	0.0001
Nickel	mg/L	1.0	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	<0.005	<0.005	<0.005	0.0025
Nitrate	mg/L		<0.02	<0.02	<0.02	<0.02	<0.02	0.01	0.07	0.07	0.06	0.07	0.07
Nitrite	mg/L												
Total K Nitrogen	mg/L		<1.0	<1.0	<1.0	<1.0	<1.0	0.5	1.3	1.1	<1.0	<1.0	1.2
Oil and Grease	mg/L	15.0	<6.0	<6.5	<5.7	<5.9	<6.0	6.0	<5.9	<5.7	<5.9	<6.0	2.9
pH		6 to 9	7.21	7.12	7.20	7.21	7.41	7.23	7.22	7.52	7.62	7.30	7.42
Phenols	mg/L	0.3	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	<0.005	<0.005	<0.005	0.0025
Phosphorus	mg/L	1.0	0.18	0.12	0.12	0.12	0.15	0.14	0.16	0.14	0.15	0.17	0.16
Selenium	mg/L		0.0015	0.0012	0.0012	0.0014	0.0012	0.0013	<0.001	<0.001	<0.001	<0.001	0.0005
Silver	mg/L	0.1	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	<0.005	<0.005	<0.005	0.0025
Sulfate	mg/L		1000	960	1000	970	1000	986	55	56	54	54	55
Total Dissolved Solids (TDS)	mg/L		980	1200	1200	1200	1200	1156	190	180	160	170	175
Total Suspended Solids (TSS)	mg/L	15.0	9.2	5.6	8	4	6	6.6	7.6	4.8	4.8	<4.0	4.8
Zinc	mg/L	1.0	<0.006	<0.006	<0.006	<0.006	<0.006	0.003	0.006	0.006	<0.006	0.015	0.0075

Notes:
1. Metals are total concentrations
2. Non-detect results are assumed to be half the laboratory reporting limit for calculations.
3. Ash Pond 2 contains no unwaters.

Table 3. Ash Pond Dewaters Sample Analytical Results

		General Effluent Standards	Ash pond CCR contact water samples (Collected October 24, 2016 and January 26, 2017) All concentration units converted to mg/L for comparison to limits.																
			Ash Pond 1						Ash Pond 1	Ash Pond 2								Ash Pond 2	Combined Ash Ponds
Sample Date			10/24/2016	1/26/2017	10/24/2016	1/26/2017	10/24/2016	1/26/2017	Representative Average	10/24/2016	1/26/2017	10/24/2016	1/26/2017	10/24/2016	1/26/2017	10/24/2016	1/26/2017	Representative Average	Representative Average
Sample ID	Units	35 IAC 304	AP1a	AP1a	AP1b	AP1b	AP1c	AP1c	Dewater Concentrations	AP2e	AP2e	AP2f	AP2f	AP2g	AP2g	AP2h	AP2h	Dewater Concentrations	Dewater Concentrations
Ammonia	mg/L	3	<0.1	<0.1	0.7	0.67	0.42	0.22	0.35	0.65	0.84	1.1	0.92	0.86	0.8	0.82	0.64	0.83	0.59
Arsenic	mg/L	0.25	0.0072	0.0093	0.017	0.0073	0.018	0.01	0.011	0.023	0.014	0.0012	<0.001	0.0055	0.0044	0.075	0.034	0.022	0.017
Barium	mg/L	2.0	0.13	0.13	0.1	0.099	0.13	0.25	0.14	0.026	0.019	0.022	0.014	0.02	0.015	0.023	0.013	0.02	0.08
Boron	mg/L		3.8	1.6	3.1	2.3	2.9	1.6	2.6	5.3	4.2	2	1.6	4.3	3.1	14	6.8	5.2	3.86
Cadmium	mg/L	0.15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005	<0.001	<0.001	<0.001	<0.001	0.0046	0.012	<0.001	<0.001	0.0025	0.00
Chloride	mg/L		3.2	9	13	10	13	14	10.4	<5	<5	<5	<5	<5	<5	1.7	1.6	2.3	6.3
Chromium	mg/L	1.0	<0.004	0.0045	<0.004	0.0052	<0.004	0.0057	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.002	0.003
Chromium (hexavalent)	mg/L	0.1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	<0.005	0.0055	<0.005	<0.005	<0.005	<0.005	<0.005	0.0030	0.0028
Copper	mg/L	0.5	<0.003	<0.003	<0.003	<0.003	0.0043	0.0041	0.0024	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.0015	0.0020
Cyanide	mg/L	0.1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	0.0025
Fluoride	mg/L	15.0	<0.25	0.142	0.977	0.507	0.614	0.512	0.480	0.438	0.485	0.398	0.32	0.506	0.377	0.406	0.181	0.389	0.434
Iron	mg/L	2.0	0.57	0.9	0.83	1.2	0.77	2.2	1.08	350	320	460	380	360	290	24	22	276	138
Lead	mg/L	0.2	<0.001	<0.001	<0.001	0.0012	<0.001	0.0015	0.0008	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005	0.0006
Manganese	mg/L	1.0	0.012	0.0086	0.074	0.041	0.053	0.022	0.035	2.0	1.9	2.3	2.0	2.9	2.2	1.0	0.9	1.90	0.97
Mercury	mg/L	0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0001	0.0001
Nickel	mg/L	1.0	<0.005	<0.005	0.0061	0.0087	<0.005	<0.005	0.0041	<0.005	<0.005	<0.005	<0.005	0.0064	<0.005	<0.005	<0.005	0.0030	0.0036
Nitrate	mg/L		<0.02	<0.1	<0.02	<0.1	<0.02	<0.1	0.06	<0.02	<0.1	<0.02	<0.1	<0.02	<0.1	<0.02	<0.1	0.06	0.06
Nitrite	mg/L			<0.1		<0.1		<0.1	0.05		<0.1		<0.15		<0.15		<0.1	0.11	0.08
Total K Nitrogen	mg/L		<1.0	0.35	1.5	0.0014	1.4	0.6	0.65	1.2	0.78	1.5	0.77	1.1	0.81	1.4	0.9	1.06	0.85
Oil and Grease	mg/L	15.0	<5.7	<3.2	7.8	<3.1	8.3	<3.1	3.9	<6.0	<3.1	<5.9	<3.2	<5.7	<3.3	<5.7	<3	4.5	4.21
pH		6 to 9	6.99	6.52	7.01	6.92	7.05	6.85	6.890	6.49	5.96	6.42	5.99	6.46	6.34	7.17	6.27	6.39	6.64
Phenols	mg/L	0.3	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0025	<0.005	0.019	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.004
Phosphorus	mg/L	1.0	0.21	0.16	0.16	0.065	0.17	0.22	0.16	0.84	0.16	0.83	0.4	0.17	0.1	0.26	0.038	0.35	0.26
Selenium	mg/L		0.003	0.018	0.0069	0.0021	0.0031	0.003	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005	0.0033
Silver	mg/L	0.1	<0.005	<0.003	<0.005	<0.003	<0.005	<0.003	0.002	<0.005	<0.003	<0.005	<0.003	<0.005	<0.003	<0.005	<0.003	0.004	0.003
Sulfate	mg/L		1500	1300	1300	1500	1600	1200	1400	1500	1400	1500	1200	2300	1800	1300	880	1485	1443
Total Dissolved Solids (TDS)	mg/L		1800	1900	1600	2200	1900	1700	1850	1700	1800	1700	1600	2400	2600	1500	1400	1838	1844
Total Suspended Solids (TSS)	mg/L	15.0	17	8.8	27	20	9.6	58	23	120	110	120	160	120	150	22	39	105	64
Zinc	mg/L	1.0	<0.006	<0.006	0.0092	0.0064	0.0082	0.0064	0.006	0.017	0.02	<0.006	<0.006	0.016	0.028	<0.006	<0.006	0.012	0.009

Notes:
1. Metals are total concentrations
2. Non-detect results are assumed to be half the laboratory reporting limit for calculations.

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Table 4. Antidegradation Assessment - Ash Pond Unwaters

This table shows the "Added Load" of pollutants from unwaters that would be discharged to Coffeen Lake.
The table shows the proposed discharge will not cause exceedances of the 35 IAC Section 302 Public and Food Processing Water Supply Standards in the lake.

Contaminant	35 IAC 304 (mg/L)	35 IAC 302 Chronic (mg/L)	Ash Pond 1 - Unwaters					Flow Mixing with Process Water			Coffeen Lake					
			Treatment Flowrate (gpm) = 347					Average Flowrate (gpm) = 305,500			Normal Pool Volume (gallons) = 7,039,440,000					
			Total Volume (gallons) = 40,000,000													
			Concentration (mg/L)	Meet 304?	Total Load (lbs)	Source Load (lbs)	Added Load (lbs)	Process Water Concentration - CLb (mg/L)	Concentration at Outfall (mg/L)	Meet 304?	Coffeen Lake (mg/L)	Lake Meet 302?	Lake Conc. w/ Effluent (mg/L)	Meet 302?	Meet Lake?	Additional Treatment to meet 302 or Lake (lbs)
Ammonia	3	2.08	**0.05**	yes	16.69	16.69	0.00	0.05	0.05	yes	0.05	yes	0.05	yes	-	-
Arsenic	0.25	0.05	**0.0015**	yes	0.51	0.60	-0.09	0.0018	0.002	yes	0.002	yes	0.002	yes	-	-
Barium	2	1.0	**0.17**	yes	55.42	18.03	37.39	0.052	0.052	yes	0.054	yes	0.054	yes	-	-
Boron	-	1.0	**2.1**	-	701.06	91.81	609.25	0.28	0.282	-	0.275	yes	0.275	yes	-	-
Cadmium	0.15	0.010	**0.0005**	yes	0.17	0.17	0.00	0.0005	0.0005	yes	0.0005	yes	0.0005	yes	-	-
Chloride	-	250	**17**	-	5,808.8	7.5	5,801.25	0.022	0.042	-	0.023	yes	0.023	yes	-	-
Chromium	1	0.050	**0.002**	yes	0.67	0.67	0.00	0.002	0.0020	yes	0.0020	yes	0.0020	yes	-	-
Chromium (hex)	0.1	0.011	**0.003**	yes	1.16	0.83	0.33	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Copper	0.5	0.015	**0.019**	yes	6.34	3.76	2.58	0.013	0.0130	yes	0.0113	yes	0.0113	yes	-	-
Cyanide	0.1	5.2	**0.0025**	yes	0.83	0.83	0.00	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Fluoride	15	1.4	**1.01**	yes	337.8	143.1	194.71	0.425	0.426	yes	0.429	yes	0.429	yes	-	-
Iron	2	0.3	**0.27**	yes	90	69.27	20.80	0.20	0.20	yes	0.208	yes	0.207	yes	-	-
Lead	0.2	0.050	**0.0005**	yes	0.17	0.17	0.00	0.0005	0.0005	yes	0.0005	yes	0.0005	yes	-	-
Manganese	1	1.0	**0.0102**	yes	3.42	7.26	-3.84	0.0220	0.0220	yes	0.0218	yes	0.0218	yes	-	-
Mercury	0.0005	0.0011	**0.0001**	yes	0.0334	0.03	0.00	0.0005	0.0005	yes	0.0001	yes	0.0001	yes	-	-
Nickel	1	0.007	**0.0025**	yes	0.83	0.83	0.00	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Nitrate (302.304)	-	10	**0.01**	-	3.34	23.37	-20.03	0.07	0.070	-	0.070	yes	0.070	yes	-	-
Nitrite	-	-	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-
O&G	15	0.1	**6.0**	yes	2,009.7	980.6	1,029.05	2.85	2.9	yes	2.9	no	2.9	no	yes	-
pH	6 to 9	6 to 9	**7.23**	yes	-	-	-	7.52	7.52	yes	7.42	yes	7.42	yes	-	-
Phenols	0.3	0.001	**0.0025**	yes	0.83	0.83	0.00	0.0025	0.0025	yes	0.0025	no	0.0025	no	yes	-
Phosphorus	1	0.05	**0.14**	yes	46.07	51.74	-5.68	0.14	0.14	yes	0.16	no	0.15	no	yes	-
Selenium	-	0.01	**0.0013**	-	0.43	0.17	0.27	0.0005	0.0005	-	0.0005	yes	0.0005	yes	-	-
Silver	0.1	0.005	**0.0025**	yes	0.83	0.83	0.00	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Sulfate	-	250	**986**	-	329,163	18,278	310,885.71	56.0	57.1	-	54.8	yes	54.8	yes	-	-
TDS	-	500	**1156**	-	385,916	58,421	327,494.10	180	181	-	175	yes	175	yes	-	-
TSS	15	-	**7**	yes	2,190	1,602	587.55	4.8	4.8	yes	4.8	yes	4.8	-	-	-
TKN	-	-	**0.5**	-	166.9	400.6	-233.69	1.1	1.1	-	1.2	yes	1.2	-	-	-
Zinc	1	0.041	**0.003**	yes	1.00	2.50	-1.50	0.0060	0.0060	yes	0.0075	yes	0.0075	yes	-	-

Notes

* Hardness-based numeric water quality standards are calculated using analytical result of 110 mg/L from January 13, 2017 sampling.
* Concentration is represented as a mean of all samples collected. Non-detect results were assumed to be half of the detection limit.
* Concentration at outfall is weighted based on flow rate and concentration of process water flow.
* Additional treatment is the amount of additional treament needed to reduce the concentration of the effluent water to meet either the 302 water quality standard or the concentration of the source water (Coffeen

4.3 Pollutant Load Increases from Ash Pond Dewatering Discharge

Discharge of dewaters would occur from removal of the water from pore spaces in deposited ash in Ash Ponds 1 and 2. The means and methods of collecting and conveying the dewaters are undetermined at this time. This antidegradation assessment assumes the dewaters from Ash Ponds 1 and 2 will be combined for discharge.

For purposes of this antidegradation assessment, substances in dewaters at concentrations less than the General Effluent Standards at 35 Ill. Adm. Code §304 are considered to be protective of the receiving water quality, i.e., would not cause degradation of the receiving water quality. As shown in Table 3 and Table 5, the representative average dewater concentrations of TSS in Ash Pond 1, Ash Pond 2, and the combined ash pond dewaters exceeded the General Effluent Standard. The representative average dewater concentrations of iron and manganese in Ash Pond 2 dewaters exceeded their respective General Effluent Standards. The representative average combined ash pond dewaters concentration of iron exceeded the General Effluent Standard. The representative average concentrations of manganese in Ash Pond 1 dewaters and the combined ash pond dewaters were less than the General Effluent Standard. All other analytes were less than the General Effluent Standards.

Table 5 shows the estimated mass of each substance proposed to be discharged through the existing NPDES outfall to Coffeen Lake receiving water (the “Added Load”). Table 5 estimates the predicted effects of discharging the dewaters to the lake and demonstrates the proposed discharge will not cause exceedances of the Public and Food Processing Water Supply Use Standards at 35 Ill. Adm. Code §302 Subpart C. For substances with no Public and Food Processing Water Supply Use Standard, the chronic General Use Water Quality Standards at 35 Ill. Adm. Code §302 Subpart B were used for comparison. Lake concentrations were calculated at normal pool volume. For substances where concentrations in the lake already exceed the applicable water quality standards (oil and grease, phenols, and phosphorus), the concentrations of these substances in the proposed dewaters discharge are equivalent to the existing lake concentrations. Table 5 illustrates the proposed dewaters discharge will not increase the existing concentrations of oil and grease, phenols, and phosphorus in the lake.

The estimated combined volume of dewaters to be discharged from Ash Ponds 1 and 2 as part of the CCR closure plan is 25 million gallons. The dewaters are expected to be discharged over approximately 120 to 180 days, at a rate of approximately 0.1 to 0.2 MGD. Ash Pond 2 may be dewatered using the pumps in the existing wells. The dewatering volume may be reduced if less dewatering is required to construct the cover system. The proposed short-term CCR dewatering discharge will contribute a negligible effect on receiving water concentrations.

5. Fate and Effect of Parameters Proposed for Increased Loading

Tables 4 and 5 show the estimated mass of each substance proposed to be discharged through the existing NPDES outfall to Coffeen Lake from the ash pond unwatering and dewatering activities (the “Added Load” on each table). The tables also estimate the predicted effects of discharging the unwaters and dewaters and demonstrate the proposed discharges will not cause exceedances of the Public and Food Processing Water Supply Use Standards at 35 Ill. Adm. Code §302 Subpart C or increase the existing lake concentrations. For substances with no Public and Food Processing Water Supply Use Standard, the chronic General Use Water Quality Standards at 35 Ill. Adm. Code §302 Subpart B were used for comparison.

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Table 5. Antidegradation Assessment - Ash Pond Dewaters

This table shows the "Added Load" of pollutants from dewaters that would be discharged to Coffeen Lake.
The table shows the proposed discharge will not cause exceedances of the 35 IAC Section 302 Public and Food Processing Water Supply Standards in the lake.

Contaminant	35 IAC 304 (mg/L)	35 IAC 302 Chronic (mg/L)	Ash Ponds 1 and 2 - Dewaters					Flow Mixing with Process Water			Coffeen Lake					
			Treatment Flowrate (gpm) = 100					Average Flowrate (gpm) = 305,500			Normal Pool Volume (gallons) = 7,039,440,000					
			Total Volume (gallons) = 25,000,000													
			Concentration (mg/L)	Meet 304?	Total Load (lbs)	Source Load (lbs)	Added Load (lbs)	Process Water Concentration - CLb (mg/L)	Concentration at Outfall (mg/L)	Meet 304?	Coffeen Lake (mg/L)	Lake Meet 302?	Lake Conc. w/ Effluent (mg/L)	Meet 302?	Meet Lake?	Additional Treatment to meet 302 or Lake (lbs)
Ammonia	3	2.08	**0.59**	yes	123.15	10.43	112.71	0.05	0.05	yes	0.05	yes	0.05	yes	-	-
Arsenic	0.25	0.05	**0.0170**	yes	3.54	0.38	3.16	0.0018	0.002	yes	0.002	yes	0.002	yes	-	-
Barium	2	1.0	**0.08**	yes	16.57	11.27	5.30	0.052	0.052	yes	0.054	yes	0.054	yes	-	-
Boron	-	1.0	**3.9**	-	804.60	57.38	747.22	0.280	0.281	-	0.275	yes	0.275	yes	-	-
Cadmium	0.15	0.010	**0.0015**	yes	0.31	0.10	0.20	0.0005	0.0005	yes	0.0005	yes	0.0005	yes	-	-
Chloride	-	250	**6**	-	1,320.1	4.7	1,315.44	0.022	0.024	-	0.023	yes	0.023	yes	-	-
Chromium	1	0.050	**0.003**	yes	0.58	0.42	0.16	0.002	0.0020	yes	0.0020	yes	0.0020	yes	-	-
Chromium (hex)	0.1	0.011	**0.003**	yes	0.57	0.52	0.05	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Copper	0.5	0.015	**0.002**	yes	0.41	2.35	-1.95	0.013	0.0130	yes	0.0113	yes	0.0113	yes	-	-
Cyanide	0.1	5.2	**0.0025**	yes	0.52	0.52	0.00	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Fluoride	15	1.4	**0.43**	yes	90.6	89.5	1.13	0.425	0.425	yes	0.429	yes	0.429	yes	-	-
Iron	2	0.3	**138.41**	no	28,880	43.29	28,836.56	0.20	0.25	yes	0.21	yes	0.21	yes	-	-
Lead	0.2	0.050	**0.0006**	yes	0.13	0.10	0.03	0.0005	0.0005	yes	0.0005	yes	0.0005	yes	-	-
Manganese	1	1.0	**0.9657**	yes	201.49	4.54	196.95	0.022	0.0223	yes	0.0218	yes	0.0218	yes	-	-
Mercury	0.0005	0.0011	**0.0001**	yes	0.0209	0.02	0.00	0.0005	0.0005	yes	0.0001	yes	0.0001	yes	-	-
Nickel	1	0.007	**0.0036**	yes	0.74	0.52	0.22	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Nitrate (302.304)	-	10	**0.06**	-	12.52	14.61	-2.09	0.07	0.070	-	0.070	yes	0.070	yes	-	-
Nitrite	-	-	**-**	-	-	-	-	-	-	-	-	-	-	-	-	-
O&G	15	0.1	**4.2**	yes	879.4	612.9	266.46	2.85	2.9	yes	2.9	no	2.9	no	yes	-
pH	6 to 9	6 to 9	**6.64**	yes	-	-	-	7.52	7.52	yes	7.42	yes	7.42	yes	-	-
Phenols	0.3	0.001	**0.0035**	yes	0.74	0.52	0.22	0.0025	0.0025	yes	0.0025	no	0.0025	no	yes	-
Phosphorus	1	0.05	**0.26**	yes	53.61	32.34	21.27	0.14	0.14	yes	0.16	no	0.15	no	yes	-
Selenium	-	0.01	**0.0033**	-	0.68	0.10	0.58	0.0005	0.0005	-	0.0005	yes	0.0005	yes	-	-
Silver	0.1	0.005	**0.0030**	yes	0.63	0.52	0.10	0.0025	0.0025	yes	0.0025	yes	0.0025	yes	-	-
Sulfate	-	250	**1443**	-	300,975	11,423	289,551	56	56.5	-	54.8	yes	54.8	yes	-	-
TDS	-	500	**1844**	-	384,695	36,513	348,182	180	181	-	175	yes	175	yes	-	-
TSS	15	-	**64**	no	13,408	1,002	12,406.74	4.8	4.8	yes	4.8	yes	4.8	-	-	-
TKN	-	-	**0.9**	-	178.2	250.4	-72.22	1.1	1.1	-	1.2	yes	1.2	-	-	-
Zinc	1	0.041	**0.009**	yes	1.84	1.56	0.28	0.006	0.0060	yes	0.0075	yes	0.0075	yes	-	-

Notes

* Hardness-based numeric water quality standards are calculated using analytical result of 110 mg/L from January 13, 2017 sampling.
* Concentration is represented as a mean of all samples collected. Non-detect results were assumed to be half of the detection limit.
* Concentration at outfall is weighted based on flow rate and concentration of process water flow.
* Additional treatment is the amount of additional treament needed to reduce the concentration of the effluent water to meet either the 302 water quality standard or the concentration of the source water (Coffeen

Fish consumption use of Coffeen Lake is listed as impaired, with a cause of mercury. A TMDL has been completed for Coffeen Lake that sets allocations for phosphorus. The concentrations of mercury in the proposed discharges will not cause exceedances of the Public and Food Processing Water Supply Use Standards. The proposed unwaters and dewaters discharges will not increase the existing lake concentrations of the causes of impairment. Since the proposed short-term discharges would not cause exceedances of the Public and Food Processing Water Supply Use standards or contribute to the cause of impairment in the lake, adverse impacts to the existing uses of the water body are not anticipated.

6. Assessments of Alternatives for Less Increase in Loading or Minimal Environmental Degradation

6.1 Water Management Alternatives Considered

Discharge of unwaters would occur from removal of the free surface water in Ash Pond 1. These waters result from the normal operation of the Coffeen plant and, except for storm water precipitation into the ash pond cells, are generally drawn from Coffeen Lake. These waters comply with the General Effluent Standards at 35 Ill. Adm. Code §304 and are currently discharged under the authorization of the plant's NPDES permit. No unwaters are present in Ash Pond 2.

IPGC has considered management alternatives for the dewaters that could avoid or minimize increase in pollutant loading to the receiving water. In addition to assessment of potential degradation of receiving waters that could result from the dewatering discharges, an important criterion used in the alternatives analysis is the reliability of the time required to remove the dewaters from the ash ponds. The unwatering and dewatering must be completed in a limited time frame to enable the regulatory-driven CCR closure construction activities. The alternatives are summarized in Table 6 and discussed in the following sections.

Table 6. Water Management Alternatives Considered

<u>Alternatives that Avoid Discharge to Receiving Water</u>

- No action. (No unwatering or dewatering of ash ponds.)
- Mechanical evaporation.
- Agricultural irrigation.
- Land application.
- Use ash pond water in power generation plant processes.

<u>Alternatives that Discharge to Receiving Water</u>

- ✓ Discharge through existing NPDES Outfall 001. This is the preferred alternative.
- Discharge with additional treatment.
  - Coagulation/flocculation.
  - Precipitation/filtration.
  - Reverse osmosis.

6.2 Alternatives that Avoid Discharge to Receiving Water

6.2.1 No Action Alternative

The closure plan for the Coffeen Ash Ponds 1 and 2 includes installation of a compacted earthen material and vegetated or composite cover system. Site preparation for installation of the cover system requires removal of open water from the ash ponds and partial removal of pore water contained in CCR-filled portions of the ash ponds. Impoundment closure to comply with the federal CCR Rule could not be achieved without removing the unwaters and dewaters. Therefore, the no action alternative is not feasible and is excluded from further consideration.

6.2.2 Mechanical Evaporation

IPGC and Hanson evaluated dewatering the ash ponds by mechanical evaporation. Hanson consulted with one mechanical evaporation equipment provider to discuss the feasibility of removing the ash pond dewaters by evaporation. Based on the information reviewed and the typical climate in this project area, mechanical evaporators could each be expected to evaporate approximately 60,000 gallons per day. Multiple evaporators would be needed to remove the estimated 25 million gallons of dewaters from the ash ponds.

Evaporation rates would be dependent upon many factors such as performance of the evaporation equipment, water make-up and chemistry, ambient temperature and humidity, solar radiation, wind, free flow of air over the ash ponds, and other factors. Evaporation could occur only in the warmer months, between approximately April and October, with the most efficient evaporation occurring in mid-summer.

It is unlikely that ideal evaporation conditions would occur for enough duration to eliminate the total 25 million gallons of dewaters. The unpredictability of weather and unreliability of evaporation rates make this alternative infeasible to comply with the CCR closure timeframes.

6.2.3 Agricultural Irrigation

IPGC and Hanson evaluated using the CCR dewaters for agricultural irrigation. The Coffeen plant is located in a rural agricultural area, although the plant is situated between Coffeen Lake and other waterbodies including East Fork Shoal Creek and Rocky Ford Lakes. Review of aerial photography does not indicate that irrigation is currently used in the vicinity of the plant. Dewaters could be pumped from the ash ponds and piped to fields east of the plant. However, the nearest agricultural fields do not appear to be feasible for the installation of large irrigation rigs due to the presence of large high-voltage electric transmission lines. The nearest fields that could potentially be irrigated would require running about 1.2 miles of temporary piping across and along County Road 1650E. It is unknown if permission could be obtained from the landowners and/or tenant farmers to utilize the irrigation rigs in their fields, and what conditions or payments may be required to obtain permission. It is likely IPGC would have to compensate the farmers for at least one season of crops. Since the purpose of the irrigation would be to remove the dewaters from the ash ponds, it is likely that water would be applied at higher rates than desired for crop growth, resulting in damaged crop or diminished yields.

IPGC has not estimated the cost to negotiate permissions and install the temporary piping to the agricultural irrigation rig(s). As with the mechanical evaporation discussed above, it is unlikely that ideal conditions would occur for enough duration to eliminate the total 25 million gallons of dewaters. The unpredictability of weather and unreliability of evaporation and infiltration rates make this alternative

infeasible to comply with the CCR closure timeframes. The technical obstacles and potential detrimental effects to local farms make this alternative infeasible for the proposed short-term discharge.

6.2.4 Land Application

IPGC and Hanson evaluated land application of the CCR dewaters. Dewaters could be utilized on site for dust control. Land-applied water would be dissipated by evaporation and infiltration. In order to avoid discharge to the receiving water, land application would need to be controlled so that surface runoff did not occur. Due to the large volume of dewaters to be removed, the relatively compact size of the Coffeen plant, and the small area of pervious surfaces for infiltration, it is unlikely the dewaters could be eliminated in a timely manner by land application on stored coal or ground surfaces without causing plant inefficiency (wet coal) or safety or housekeeping issues. Land application is infeasible to eliminate the total 25 million gallons of dewaters within the CCR closure timeframes.

6.2.5 Use CCR Dewaters in Power Generation Plant Processes

IPGC and Hanson evaluated using the CCR dewaters in power plant processes. The plant uses makeup water for various processes. However, the quality of the dewaters, including concentrations of iron, sulfate, TSS, and total dissolved solids (TDS) would not be usable in the processes without substantial pretreatment. The likely pretreatment processes would generate waste streams that would result in wastewater discharges or disposal. Due to the undesirable water quality and the large volume of dewaters, it is infeasible to eliminate the anticipated total 25 million gallons of dewaters by using it in plant processes.

Currently the existing Ash Pond 2 dewatering system is directed to the GMF system, which recirculates to the “closed-loop” scrubber system. This dewatering system could be adequate to lower the Ash Pond 2 phreatic surface, facilitate Ash Pond 2 closure, and reduce the volume of Ash Pond 2 dewaters that would need to be discharged to Coffeen Lake during Ash Pond 2 closure. However, the GMF ystem could be overwhelmed with the large volume of Ash Pond 2 dewaters. Therefore, the option to discharge Ash Pond 2 dewaters to Coffeen Lake must be available.

6.3 Alternatives that Discharge to Receiving Water

6.3.1 Discharge through Existing NPDES Outfall

IPGC and Hanson evaluated discharging the dewaters through the existing NPDES Outfall 001. This is the normal operation and discharge of the ash pond waters. The dewaters would be conveyed through the outfall using existing infrastructure, including pumps, piping, and outfall structures.

Table 5 estimates the predicted effects of discharging the dewaters to the lake and demonstrates the proposed discharge will not cause exceedances of the Public and Food Processing Water Supply Use Standards or the chronic General Use Water Quality Standards at 35 Ill. Adm. Code §302. For substances where concentrations in the lake already exceed the applicable water quality standards (oil and grease, phenols, and phosphorus), the concentrations of these substances in the proposed dewaters discharge are equivalent to the existing lake concentrations. Table 5 illustrates the proposed dewaters discharge will not increase the existing concentrations of oil and grease, phenols, and phosphorus in the lake.

Pollutant loading from the proposed dewatering would increase during the short-term discharges (approximately 120 to 180 days). Considering the demonstration presented in Table 5, no adverse

impacts to the existing uses of the receiving water are anticipated. Pollutant loading would decrease when the short-term dewaters discharges are completed. This alternative eliminates the dewaters in the shortest time and will enable the dewatering to be completed within the CCR closure timeframes.

6.3.2 Direct Discharge with Additional Treatment

IPGC and Hanson conducted cursory evaluations of treatment processes to reduce pollutant concentrations in the dewaters discharges. Wastewater pretreatment processes could conceivably be installed prior to Outfall 001. Pretreatment processes including oxidation, precipitation, coagulation, and flocculation would reduce the TSS in the dewaters and could reduce the dissolved concentrations of certain pollutants such as iron and manganese. However, industry experience has shown that biological treatment, chemical precipitation, or ion exchange processes are not effective in reducing concentrations of boron.

Specialized adsorption processes or reverse osmosis (RO) could be utilized to reduce the concentration of boron in the ash pond dewaters. These technologies are complex, expensive, and generate waste streams that need to be disposed or treated. Considering the large volume of dewaters (25 million gallons total), it is predicted the volumes of wastewaters from the pretreatment processes would be substantially large and concentrated to make these processes infeasible for the proposed short-term discharges of ash pond dewaters.

7. Identification of Preferred Alternative

Discharging the unwaters and dewaters through the existing NPDES outfall is consistent with the plant's normal operation. This alternative would use existing infrastructure at minimal or no additional cost and has been demonstrated to not cause exceedances of the Public and Food Processing Water Supply Standard or the chronic General Use Water Quality Standards. This alternative will remove the dewaters in the shortest practicable time to comply with the CCR closure timeframes. Discharging the dewaters through the existing NPDES outfall is IPGC's preferred alternative.

8. References

Integrated Water Quality Report and 303d Lists. (2016). Retrieved from Illinois Environmental Protection Agency: http://www.epa.illinois.gov/topics/water-quality/watershed-management/tmdls/303d-list/index

National Water Quality Monitoring Council. (2016, October 26). Retrieved from http://www.waterqualitydata.us/portal/

Illinois Environmental Protection Agency. *Public Notice/Fact Sheet* (2009, July 30). Notice No. SMT:05012101.daa. NPDES Permit IL0000108.

Illinois Environmental Protection Agency. *Public Notice/Fact Sheet* (2011, April 25). Notice No. SMT:05012102.daa. NPDES Permit IL0000108.

Illinois Environmental Protection Agency. *Public Notice/Fact Sheet* (2015, August 31). Notice No. SMT:15070201.smt. NPDES Permit IL0000108.

Appendix

EcoCAT Report

ATTACHMENT V

EcoCAT
Ecological Compliance Assessment Tool

Applicant:	Hanson Professional Services Inc.	*IDNR Project Number:*	1704719
Contact:	Doug Dorsey	*Date:*	11/25/2016
Address:	1525 S. 6th St. Springfield, IL 62703		
Project:	Coffeen Lake		
Address:	134 CIPS Lane, Coffeen		

Description: Antidegradation study for CCR Discharge

Natural Resource Review Results

This project was submitted for information only. It is not a consultation under Part 1075.

The Illinois Natural Heritage Database shows the following protected resources may be in the vicinity of the project location:

Eastern Blue-Eyed Grass *(Sisyrinchium atlanticum)*

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Montgomery

Township, Range, Section:
7N, 3W, 3
7N, 3W, 4
7N, 3W, 9
7N, 3W, 10
7N, 3W, 11
7N, 3W, 14
7N, 3W, 15
7N, 3W, 22
7N, 3W, 23

IL Department of Natural Resources Contact
Impact Assessment Section
217-785-5500
Division of Ecosystems & Environment

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

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3. IDNR reserves the right to enhance, modify, alter, or suspend the website at any time without notice, or to terminate or restrict access.

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Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

Privacy

EcoCAT generates a public record subject to disclosure under the Freedom of Information Act. Otherwise, IDNR uses the information submitted to EcoCAT solely for internal tracking purposes.

Attachment J

Memorandum – Evaluation of Partition Coefficient Results – Coffeen AP1

Geosyntec consultants

1 McBride and Son Center Drive, Suite 202
Chesterfield, MO 63005
www.geosyntec.com

Memorandum

Date:	July 5, 2022
To:	David Mitchell, Stu Cravens, Vic Modeer Illinois Power Generating Company
Copies to:	Brian Hennings - Ramboll
From:	Allison Kreinberg, Ryan Fimmen – Geosyntec Consultants, Inc.
Subject:	Evaluation of Partition Coefficient Results – Coffeen Ash Pond No. 1 CCR Unit 101, Coffeen Power Plant, Coffeen, Illinois

INTRODUCTION

The Illinois Power Generation Company (IPGC) currently operates the Coffeen Power Plant (CPP) and its associated ash ponds located in Coffeen, Illinois. Ash Pond Number (No.) 1 (AP1) (Vistra identification (ID) No. 101; Illinois Environmental Protection Agency [IEPA] ID No. W1350150004-01; National Inventory of Dams [NID] No. IL50722) is a 23-acre, unlined SI used to manage CCR (bottom ash) and non-CCR waste streams at the CPP in accordance with the plant's Water Pollution Control Permit 1978-EA-389 issued by the Agency on May 26, 1978. Geosyntec Consultants (Geosyntec) is assisting IPGC with Part 845 compliance at the Site.

IPGC is currently preparing a Construction Permit application for AP1 as required under Section 845.220. As part of the Construction Permit application, groundwater modeling is being completed for known potential exceedances of groundwater protection standards (GWPS) identified in the Operating Permit (Burns & McDonnell, 2021). In the Operating Permit (October 2021), Burns & McDonnell identified potential GWPS exceedances for several compounds potentially associated with AP1, including boron, cobalt, pH (field), sulfate, and total dissolved solids (TDS). An evaluation of potential exceedances of applicable GWPS found that both cobalt and pH potential exceedances are not related to AP1 (Geosyntec, 2022). Batch adsorption testing was conducted for boron and sulfate to generate site-specific partition coefficients. This technical memorandum summarizes the results of the batch adsorption testing and calculation of partition coefficients.

BATCH ATTENUATION TESTING

In 2021, Geosyntec conducted a field investigation at AP1 which included completion of four (4) soil/rock borings ranging in depth from 13 to 18 feet below ground surface. As part of that investigation, soil and groundwater samples were submitted to SiREM Laboratories (Guelph, ON) for batch solid/liquid partitioning testing. A summary of the soil samples used for the batch testing is provided in **Table 1**.

Two groundwater samples (G311 and G313) and three soil samples (SB-306, SB-311, and SB-313) were used for batch attenuation testing at five (5) soil:solution ratios (**Table 1**), each ran in duplicate. For each treatment, 0.1 L of groundwater was brought into contact with varying amounts of soil (0.004 to 0.2 kg, depending on the ratio) and equilibrated over a seven-day period. Each microcosm was amended (i.e., spiked) with sodium sulfate (Na_2SO_4), and the microcosms with G313 groundwater were also amended with boric acid (H_3BO_3), to achieve a target concentration of sulfate and boron, respectively (**Table 2**). The G311 microcosm was not amended with boric acid because potential boron exceedances were not identified in the vicinity of G311. G313 groundwater was combined with aquifer solids both adjacent to downgradient location G311 and background location G306 to understand how partitioning behavior may be affected by position relative to AP1.

An initial sample of the stock solution for each experimental design was collected on Day 0, and a control sample (i.e., only amended G311 or G313 groundwater with no aquifer solids) was collected on Day 7 after tumbling in polypropylene bottleware to evaluate any loss to interactions with the bottleware or ambient conditions. Duplicates were constructed for each microcosm, including the control samples. After seven days of contact time, an aliquot of the free liquid was collected and filtered through a 0.45 micron (µm) filter prior to analysis for dissolved concentrations of sulfate and/or boron. The oxidation/reduction potential (redox) and pH were measured for each batch test at the beginning and end of the contact period and in the control samples.

Data obtained from the tests (**Tables 3** and **4**) were used to construct isotherms for boron and sulfate; 5-point isotherms were constructed by averaging duplicate results for each soil:solution ratio. Mathematical fitting was used to calculate the attenuation distribution coefficients (K_d), assuming linear adsorption. The linear adsorption equation was used:

$$q_e = K_d \times C_e \qquad \text{Eq. 1}$$

where q_e is the mass of constituent adsorbed to the solid phase at equilibrium, C_e is the remaining aqueous constituent concentration at equilibrium, and K_d is the linear sorption coefficient (reported in liters per kilogram [L/kg]). Some of the data showed a deviation from a linear trend, and so were also fitted using non-linear isotherms. The non-linear Langmuir isotherm was used:

$$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \qquad \text{Eq. 2}$$

where q_m is the inverse of the slope and K_L is the Langmuir distribution coefficient. The adsorption data were linearized according to:

$$\frac{C_e}{q_e} = \frac{1}{(K_L \times q_m)} + \frac{C_e}{q_m} \qquad \text{Eq. 3}$$

A common non-linear Freundlich equation was also used:

$$q_e = K_F (C_e)^{1/n} \qquad \text{Eq. 4}$$

where q_e is the mass of constituent adsorbed to the solid phase at equilibrium, C_e is the remaining aqueous constituent concentration at equilibrium, K_F is the Freundlich distribution coefficient, and *1/n* is a non-linearity constant. The adsorption data were plotted as log-transformed values to perform the non-linear isotherm fitting using the linearized Freundlich equation:

$$log(q_e) = \log(K_F) + (1/n)\log(C_e) \qquad \text{Eq. 5}$$

The calculated linear, Langmuir, and Freundlich distribution coefficients (K_d, K_L, and K_F, respectively) and 1/*n* values are shown in **Tables 5** and **6**.

SUMMARY OF RESULTS

The partition coefficient values for G311 and G313 (denoted below as G313/SB-306 when combined with SB-306 geologic material and G313/SB-313 when combined with the SB-313 geologic material) are presented in **Tables 5** and **6**, respectively. Figures which show the linear, Langmuir, and Freundlich isotherms for boron and sulfate are provided in **Appendix A**.

A boron partition coefficient was not calculated for G311, since the microcosm was not amended with boric acid because potential boron exceedances were not identified in the vicinity. The Freundlich isotherm fit the data best for G313/SB-306 and G313/SB-313, yielding K_F values of 0.65 L/kg and 2.03 L/kg, respectively. Though slightly higher at G313/SB-313, these values are comparable to boron partition coefficients reported in the literature, which range from 0.19 to 1.3 L/kg depending on pH conditions and the amount of sorbent present (EPRI, 2005; Strenge & Peterson, 1989).

The G311 partition coefficient for sulfate ranged from -624 L/kg for the Langmuir isotherm to 10.11 L/kg for the linear isotherm, but the best-fitting Freundlich isotherm yielded a low K_F value of 9.2×10^{-12} L/kg. None of the isotherms showed a high goodness-of-fit (i.e., R^2) for either G313/SB-306 or G313/SB-313, with the highest correlation being 0.51, and were associated with erroneously high (1700 L/kg) and low (-690 L/kg) partition coefficients. An accurate sulfate

partition coefficient could therefore not be calculated from any of the data. These results are consistent with the findings of Strenge and Peterson (1989), who found that partition coefficients for sulfate are 0.0 L/kg, regardless of pH conditions and the amount of sorbent present.

REFERENCES

EPRI, 2005. *Chemical constituents in coal combustion product leachate: boron. Final Report 1005258.*

Burns & McDonnell. 2021. Initial Operating Permit Coffeen GMF Recycle Pond. October

Strenge, D. and Peterson, S. 1989. Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS) (No. PNL-7145). Pacific Northwest National Laboratory, Richland, WA (USA).

Geosyntec. 2022. Evaluation of Potential Groundwater Protection Standard Exceedances. Coffeen Ash Pond No. 1. Coffeen, Illinois. May

TABLES

Table 1 - Batch Attenuation Testing Data Summary
Coffeen AP1

Geosyntec Consultants

Groundwater Sample ID	Soil Sample ID	Soil: Water Ratio
G311	SB-311 (14-15 ft bgs)	2:1.4
		1:1.3
		1:5.7
		1:11.3
		1:27.8
G313	SB-306 (14-16 ft bgs)	2:1.5
		1:1.3
		1:6.0
		1:11.7
		1:28.8
G313	SB-313 (8-9 ft bgs)	2:1.5
		1:1.3
		1:6.0
		1:11.7
		1:28.8

Notes:

ft bgs = feet below ground surface

Table 2 - Microcosm Amendment and Target Concentrations
Coffeen AP1

Groundwater Sample ID	Soil Sample ID	Compound	Amendment	Target Concentration (mg/L)
G311	SB-311 (14-15 ft bgs)	Boron	--	--
		Sulfate	2.76 g of Na_2SO_4	1500
G313	SB-306 (14-16 ft bgs)	Boron	19.73 mL of a 2 g/L H_3BO_3	5
		Sulfate	1.98 g of Na_2SO_4	1500
G313	SB-313 (8-9 ft bgs)	Boron	19.73 mL of a 2 g/L H_3BO_3	5
		Sulfate	1.98 g of Na_2SO_4	1500

Notes:

ft bgs - feet below ground surface

mg/L - milligrams per liter

Na_2SO_4 - sodium sulfate

H_3BO_3 - boric acid

Table 3 - Batch Attenuation Testing Results, G311
Coffeen AP1

Groundwater Sample ID	Geologic Material Sample ID	Treatment	Date	Day	Replicate	Dissolved Sulfate	pH	ORP
						mg/L	SU	mV
G311	--	Groundwater Only Control	25-Jan-22	0	G311-1a	1,589	6.83	-62
					G311-2a	1,826	6.88	-66
					Average Concentration (mg/L)	**1,708**	**6.86**	**-64**
			1-Feb-22	7	G311-1	1,617	6.85	42
					G311-2	1,478	6.85	38
					Average Concentration (mg/L)	**1,548**	**6.85**	**40**
	G311 SB-311 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 2:1-1	1,321	6.92	50
					SB-311:G311 2:1-2	1,302	6.86	100
					Average Concentration (mg/L)	**1,311**	**6.89**	**75**
		1:1 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:1-1	1,727	6.92	51
					SB-311:G311 1:1-2	860	6.88	24
					Average Concentration (mg/L)	**1,294**	**6.90**	**38**
		1:5 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:5-1	1,326	6.87	93
					SB-311:G311 1:5-2	1,516	6.88	56
					Average Concentration (mg/L)	**1,421**	**6.88**	**75**
		1:10 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:10-1	1,570	6.89	27
					SB-311:G311 1:10-2	1,551	6.86	133
					Average Concentration (mg/L)	**1,560**	**6.88**	**80**
		1:20 Soil:Water Ratio	25-Jan-22	0				
			1-Feb-22	7	SB-311:G311 1:20-1	1,511	6.88	88
					SB-311:G311 1:20-2	1,588	6.86	39
					Average Concentration (mg/L)	**1,550**	**6.87**	**64**

Notes:

mg/L - milligrams per liter
mV - millivolts
SU - Standard Units
ORP - oxidation/reduction potential

Table 4 - Batch Attenuation Testing Results, G313
Coffeen AP1

Groundwater Sample ID	Geologic Material Sample ID	Treatment	Date	Day	Replicate	Dissolved Boron	Dissolved Sulfate	pH	ORP
						mg/L	mg/L	SU	mV
G313	--	Groundwater Only Control	25-Jan-22	0	G313-1a	6.5	1,372	6.98	-60
					G313-2a	6.7	1,473	6.98	-21
					Average Concentration (mg/L)	**6.6**	**1,423**	**6.98**	**-41**
			1-Feb-22	7	G313-1	6.3	1,158	6.98	113
					G313-2	6.2	1,058	6.97	40
					Average Concentration (mg/L)	**6.2**	**1,108**	**6.98**	**77**
	G313 SB-306 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 2:1-1	4.5	884	6.95	46
					SB-306:G313 2:1-2	4.7	779	6.95	44
					Average Concentration (mg/L)	**4.6**	**831**	**6.95**	**45**
		1:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:1-1	5.3	1,049	6.94	75
					SB-306:G313 1:1-2	5.3	976	6.93	44
					Average Concentration (mg/L)	**5.3**	**1,012**	**6.94**	**60**
		1:5 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:5-1	5.8	243	6.95	80
					SB-306:G313 1:5-2	6.1	1,005	6.96	-5
					Average Concentration (mg/L)	**5.9**	**624**	**6.96**	**38**
		1:10 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:10-1	6.1	958	6.96	203
					SB-306:G313 1:10-2	6.1	832	6.97	90
					Average Concentration (mg/L)	**6.1**	**895**	**6.97**	**147**
		1:20 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-306:G313 1:20-1	6.0	881	6.96	39
					SB-306:G313 1:20-2	6.0	1,409	6.94	81
					Average Concentration (mg/L)	**6.0**	**1,145**	**6.95**	**60**
	G313 SB-313 Geologic Material	2:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 2:1-1	4.3	852	6.96	164
					SB-313:G313 2:1-2	4.6	900	6.93	143
					Average Concentration (mg/L)	**4.5**	**876**	**6.95**	**154**
		1:1 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:1-1	4.9	482	6.99	78
					SB-313:G313 1:1-2	5.0	1,000	6.95	39
					Average Concentration (mg/L)	**4.9**	**741**	**6.97**	**59**
		1:5 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:5-1	6.0	1,227	6.96	23
					SB-313:G313 1:5-2	6.2	837	6.97	25
					Average Concentration (mg/L)	**6.1**	**1,032**	**6.97**	**24**
		1:10 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:10-1	6.0	1,459	6.97	63
					SB-313:G313 1:10-2	5.8	2,105	6.98	85
					Average Concentration (mg/L)	**5.9**	**1,782**	**6.98**	**74**
		1:20 Soil:Water Ratio	25-Jan-22	0					
			1-Feb-22	7	SB-313:G313 1:20-1	5.8	1,000	6.96	125
					SB-313:G313 1:20-2	6.0	1,043	6.97	47
					Average Concentration (mg/L)	**5.9**	**1,022**	**6.97**	**86**

Notes:

mg/L - milligrams per liter
mV - millivolts
SU - Standard Units
ORP - oxidation/reduction potential

Table 5 - Partition Coefficient Results, G311
Coffeen AP1

Analyte	Isotherm	Variable	Value
Sulfate	Linear	R^2	0.61
		K_D (L/kg)	10.11
	Langmuir	R^2	0.65
		q_m (mg/g)	-0.10
		K_L (L/kg)	-6.24E+02
	Freundlich	R^2	0.78
		1/n	10.27
		K_F (L/kg)	9.20E-12

Notes:

K_D - linear partition coefficient

K_L - Langmuir partition coefficient

K_F - Freundlich partition coefficient

q_m - inverse of the slope of the linearized Langmuir isotherm

n - non-linearity constant of the Freundlich isotherm

Table 6 - Partition Coefficient Results, G313
Coffeen AP1

Materials	Analyte	Isotherm	Variable	Value
G313/SB-306	Boron	Linear	R^2	0.37
			K_D (L/kg)	6.13
		Langmuir	R^2	0.76
			q_m (mg/g)	0.00
			K_L (L/kg)	-1.51E+05
		Freundlich	R^2	0.64
			1/n	6.65
			K_F (L/kg)	6.50E-01
	Sulfate	Linear	R^2	0.05
			K_D (L/kg)	3.97
		Langmuir	R^2	0.01
			q_m (mg/g)	2.20
			K_L (L/kg)	1.19E+03
		Freundlich	R^2	0.00
			1/n	-0.06
			K_F (L/kg)	1.70E+03
G313/SB-313	Boron	Linear	R^2	0.24
			K_D (L/kg)	5.68
		Langmuir	R^2	0.50
			q_m (mg/g)	0.00
			K_L (L/kg)	-1.43E+05
		Freundlich	R^2	0.46
			1/n	5.25
			K_F (L/kg)	2.03E+00
	Sulfate	Linear	R^2	0.21
			K_D (L/kg)	-6.50
		Langmuir	R^2	0.51
			q_m (mg/g)	-0.66
			K_L (L/kg)	-6.91E+02
		Freundlich	R^2	--
			1/n	--
			K_F (L/kg)	--

Notes:

The Freundlich isotherm was not calculated for G313/SB-313 because the data were not conducive to log transformation

K_D - linear partition coefficient

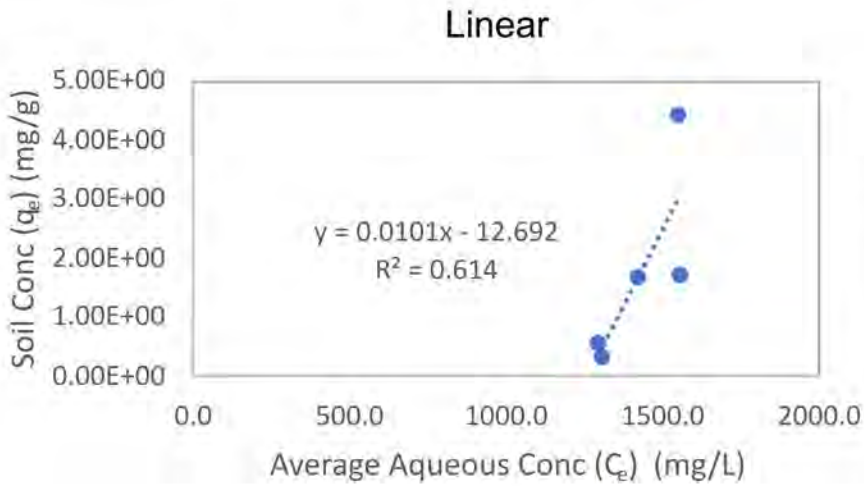
K_L - Langmuir partition coefficient

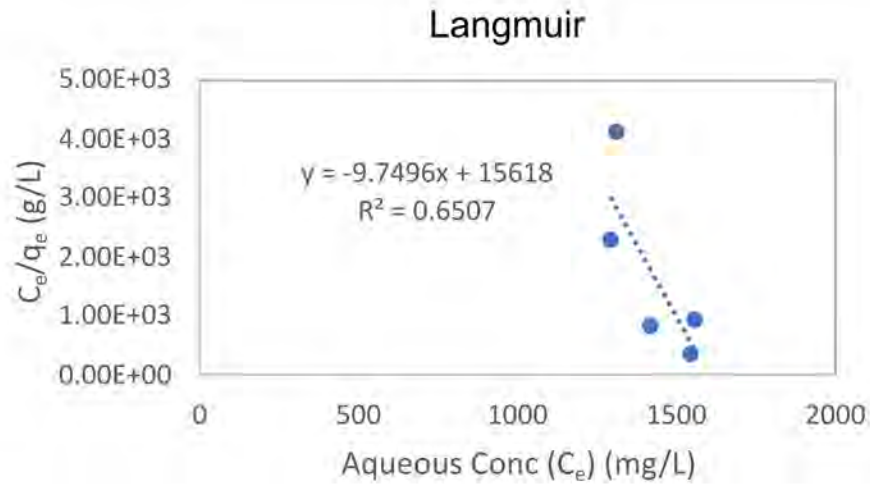
K_F - Freundlich partition coefficient

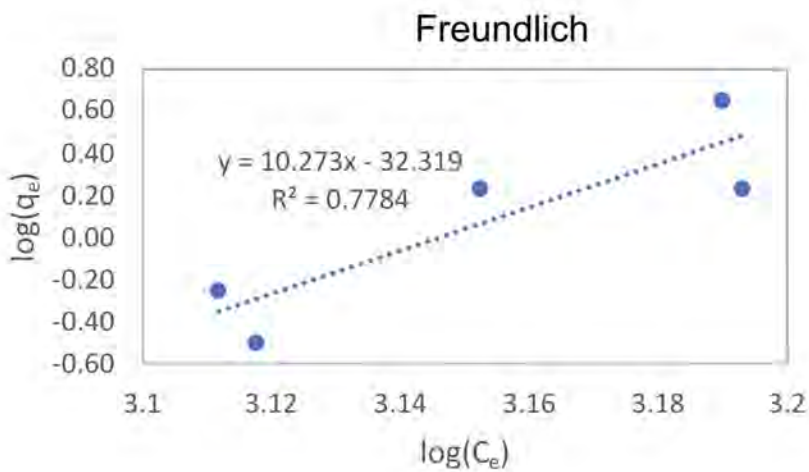
q_m - inverse of the slope of the linearized Langmuir isotherm

n - non-linearity constant of the Freundlich isotherm

APPENDIX A
BATCH TESTING ISOTHERM PLOTS







Notes:

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G311 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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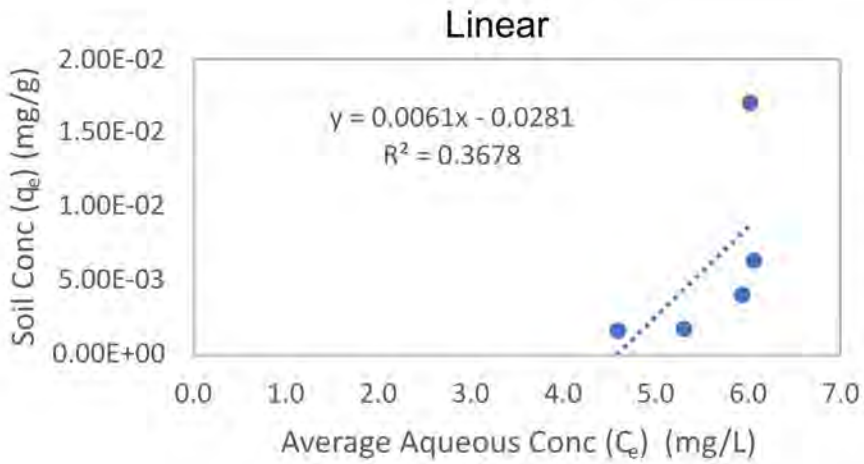
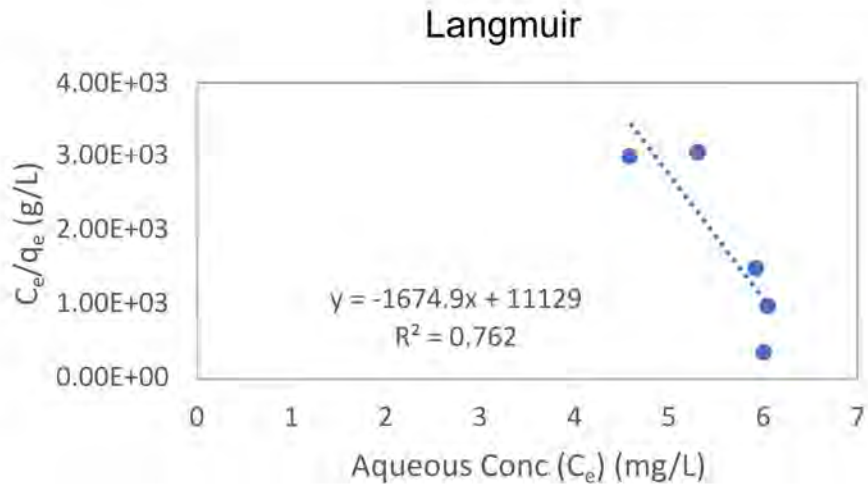
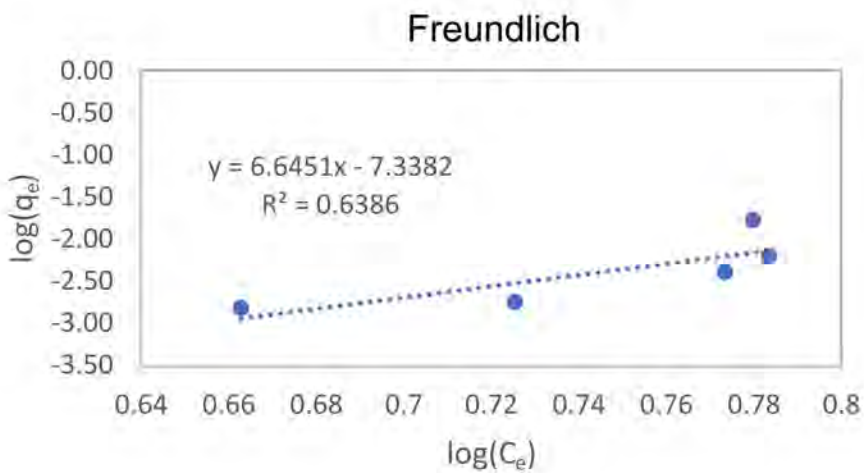
Figure 1







Notes:

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-306 Boron Partitioning Coefficients
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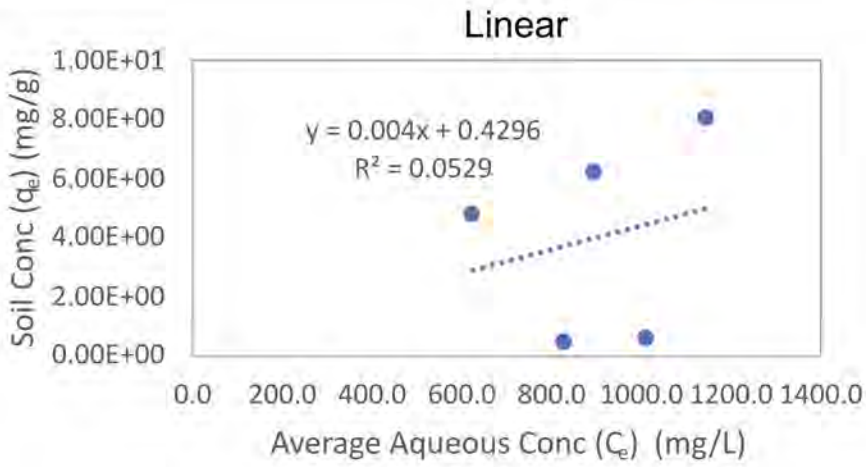
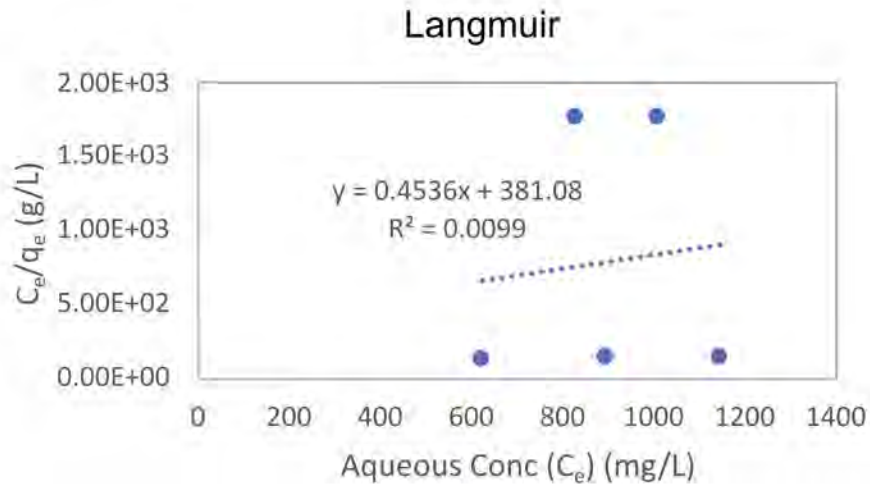
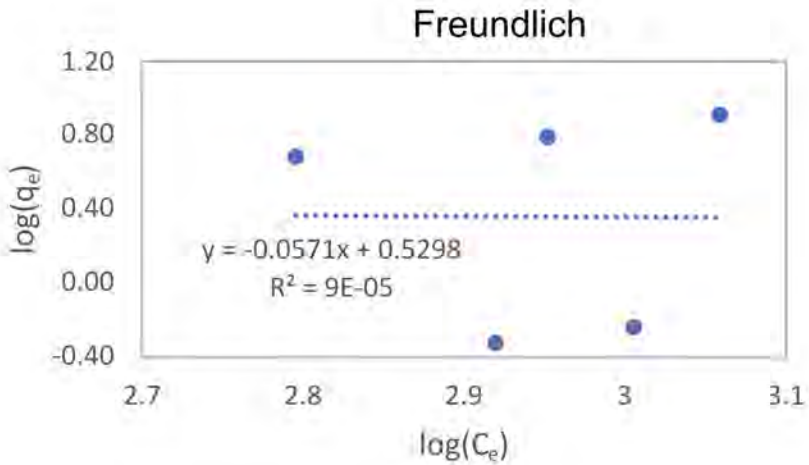
Figure 2







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G313/SB-306 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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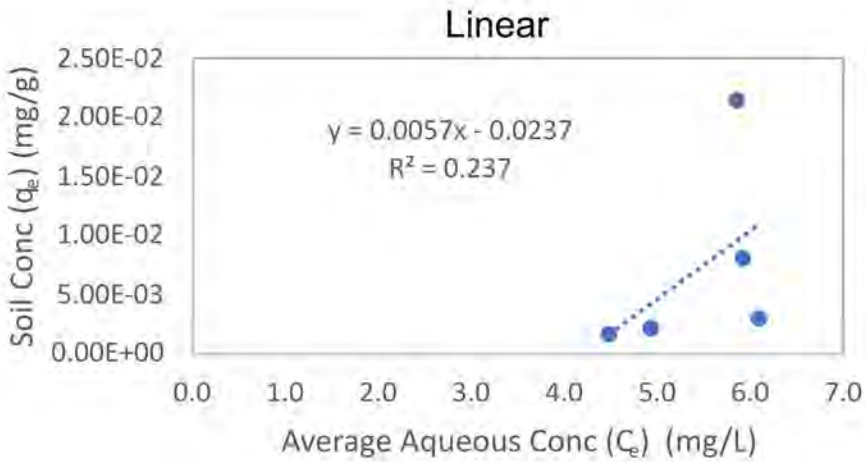
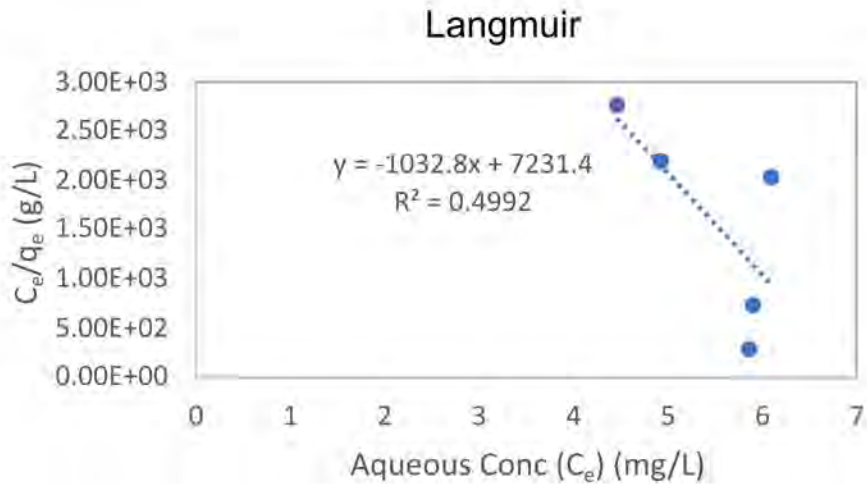
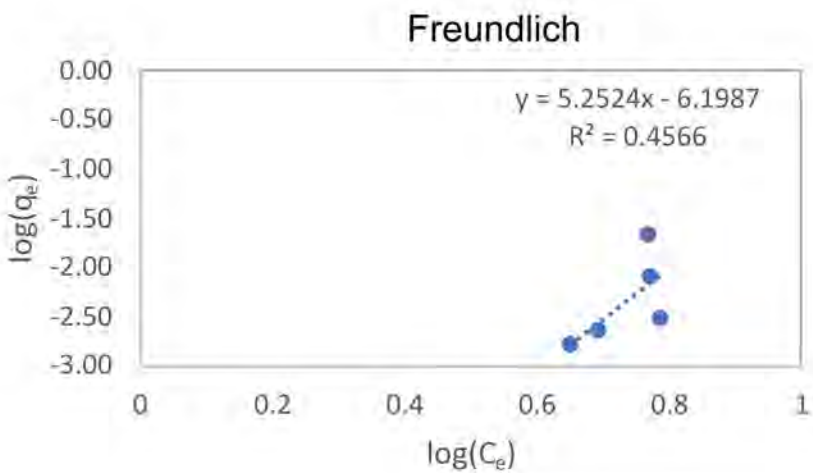
Figure 3







Notes:
q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
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g/L - grams per liter

G313/SB-313 Boron Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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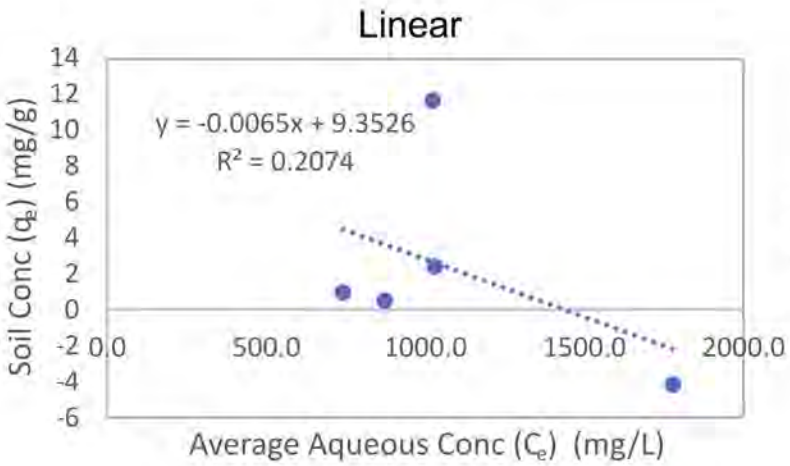
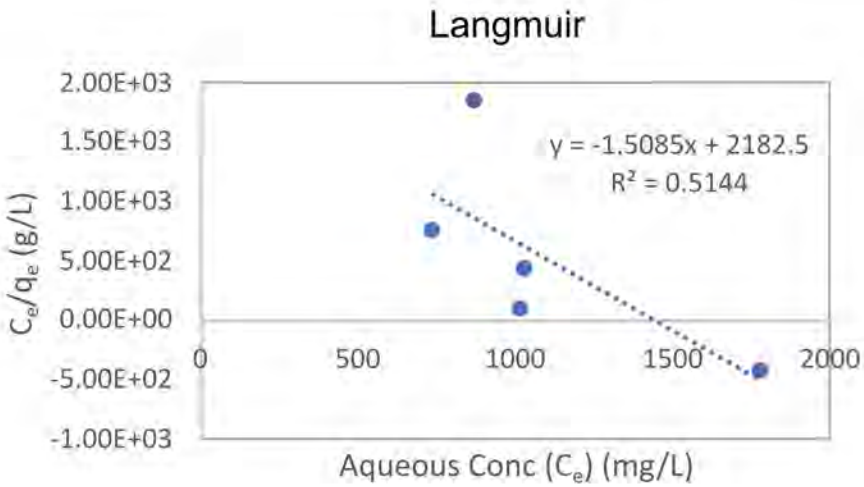
Figure 4





Notes:

The Freundlich isotherm was not calculated because the data were not conducive to log transformation.

q_e - mass of constituent adsorbed to the solid phase
C_e - remaining aqueous constituent concentration
mg/L - milligrams per liter
mg/g - milligrams per gram
g/L - grams per liter

G313/SB-313 Sulfate Partitioning Coefficients
Coffeen Power Plant AP-1
Coffeen, Illinois

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Figure 5

Appendix E

Groundwater Polishing Evaluation Report

Geosyntec consultants

engineers | scientists | innovators

Groundwater Polishing Evaluation Report

Coffeen Power Plant – Ash Pond No. 1 Unit

(IEPA ID No. W1350150004-01)

Prepared for

Illinois Power Generating Company
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Collinsville, Illinois 62234

Prepared by

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Worthington, Ohio 43085

Project Number: GLP8078

June 2025

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Attachment A	Potentiometric Surface Map – August 2023
Attachment B	PHREEQC Input File and Thermodynamic Database
Attachment C	Details of Geochemical Model Parameterization
Attachment D	Complete Geochemical Modeling Outputs

ACRONYMS AND ABBREVIATIONS

%	percent
AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
CAAA	Corrective Action Alternatives Analysis
CCR	Coal combustion residuals
COC	Constituent of concern
CPP	Coffeen Power Plant
DA	Deep aquifer
DCU	Deep confining unit
GCSM	Geochemical conceptual site model
GWPS	Groundwater protection standard
IEPA	Illinois Environmental Protection Agency
K_f	Freundlich partition coefficient
LCU	Lowermost confining unit
mg/kg	milligrams per kilogram
redox	oxidation-reduction
SEP	Sequential extraction procedure
UA	Uppermost aquifer
UCU	Uppermost confining unit
USEPA	United States Environmental Protection Agency
TDS	Total dissolved solids
XRD	X-ray diffraction

EXECUTIVE SUMMARY

This document has been prepared as an attachment to the Corrective Action Alternatives Analysis (CAAA) prepared by Gradient for Coffeen Power Plant Ash Pond No. 1 (AP1) Unit. The constituents of concern (COCs) addressed in this document are boron, sulfate, and total dissolved solids (TDS), which have been identified as having exceedances[1] of the site-specific groundwater protection standards (GWPS) at the time of this analysis. Natural geochemical processes may be appropriate as a "polishing step" for residual plume management after effective source control implementation if there are no risks to receptors and/or the contaminant plume is not expanding (United States Environmental Protection Agency [USEPA] 1999; USEPA 2015). Source control is a major component of every corrective action considered in the CAAA, and there are no risks to human health or the environment at Coffeen AP1.

Natural groundwater polishing processes, which include both physical and chemical mechanisms, reduce the concentration of COCs in the groundwater. After source control is implemented, a geochemical trailing gradient may form in the subsurface as conditions undergo a return to background water quality which could affect chemical groundwater polishing mechanisms (Savannah River National Laboratory 2011). This report supports groundwater polishing as a component of the proposed corrective action by evaluating the contribution of chemical mechanisms to groundwater polishing under current conditions and after source control implementation. The groundwater flow and transport model estimated the time to reach the GWPS based on hydraulic properties of the aquifer. The results of this groundwater polishing evaluation contextualize these estimates by evaluating the potential for attenuation of COCs and for previously attenuated COCs to be mobilized to groundwater as groundwater quality returns to background conditions.

Groundwater polishing mechanisms were assessed using speciation and reaction geochemical models: speciation models assess the distribution of constituents between solid and aqueous phases, and reaction models evaluate how that distribution may change with changing site conditions (USEPA 2015). Inputs to the model include geochemically reactive solid mineral phases, compliance well groundwater composition, and background groundwater composition based on site-specific data.

The results of the groundwater polishing evaluation indicate that some chemical attenuation of boron and sulfate is feasible under current conditions through sorption to iron and aluminum oxide solids and, in the case of sulfate, barite precipitation. Modeling indicates that boron and sulfate attenuation via sorption onto mineral surfaces should remain stable under future conditions, as iron and aluminum oxide mineral phases are predicted to experience minor (if any) dissolution with background groundwater interaction. Additionally, barite precipitation was predicted in all future

[1] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or Groundwater Protection Standards as described in the proposed groundwater monitoring program which was submitted to the IEPA on October 25, 2021 as part of Illinois Power Resource Generating, LLC's operating permit application for the Coffeen Power Plant Ash Pond No. 1. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and therefore Illinois Power Resource Generating, LLC has not identified any actual exceedances.

scenarios. Remobilization of boron and sulfate is unlikely to affect the estimated time to reach the GWPS based on modeling results. It is anticipated that attenuation of sulfate will contribute to a reduction in TDS concentrations. These results will inform corrective action groundwater monitoring and adaptive site management, critical components of every corrective action considered in the CAAA.

1. INTRODUCTION

This document has been prepared as an attachment to the Corrective Action Alternatives Analysis (CAAA) prepared by Gradient for Coffeen Power Plant (CPP) Ash Pond No. 1 (AP1) Unit. The purpose of the CAAA is to holistically evaluate potentially viable corrective actions to remediate groundwater and achieve compliance with site-specific groundwater protection standards (GWPS) for all monitored parameters under Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600. The constituents of concern (COCs) addressed in this document are boron, sulfate, and total dissolved solids (TDS)[2], which have been identified as having exceedances of the site-specific GWPS at the time of this analysis. In the CAAA, all corrective actions considered consist of source control and residual plume management. Natural geochemical processes may be appropriate as a "polishing step" for residual plume management after effective source control implementation, if there are no risks to receptors and/or the contaminant plume is not expanding (United States Environmental Protection Agency [USEPA] 1999; USEPA 2015). Source control is a major component of every corrective action considered in the CAAA, and there are no risks to human health or the environment at Coffeen AP1.[3]

Groundwater polishing processes include both physical and chemical mechanisms within the groundwater which reduce the concentration of COCs in the groundwater. Physical components of groundwater polishing, including advection, dilution, and dispersion, are assessed by groundwater flow and transport modeling (Groundwater Modeling Technical Memorandum[4]). Chemical mechanisms of groundwater polishing include sorption and mineral precipitation. After source control is implemented, a geochemical trailing gradient may form in the subsurface as conditions undergo a return to background water quality which could affect chemical groundwater polishing mechanisms (Savannah River National Laboratory [SRNL] 2011). The chemical mechanisms of groundwater polishing at Coffeen AP1 are evaluated herein using a geochemical modeling-based approach informed by site-specific data. This report uses geochemical modeling to evaluate the influence of chemical mechanisms to groundwater polishing under current conditions and after source control implementation.

The groundwater flow and transport model (Groundwater Modeling Technical Memorandum[5]) estimated the time for sulfate (as a conservative surrogate) to reach the GWPS under different potential corrective actions based on physical components of groundwater polishing and did not incorporate any potential chemical controls on parameter distribution. This geochemical modeling effort supports the assessment of groundwater polishing as a component of the proposed corrective action by evaluating the potential for chemical attenuation of boron and sulfate before and after source control as a means of contextualizing the times estimated in the flow and transport model.

---

[2] TDS measurements represent the total mass of dissolved constituents in a sample rather than a single chemical behavior. Because sulfate is the dominant contributor to TDS, results for sulfate in this analysis also apply to TDS.
[3] The Human Health and Ecological Risk Assessment serves as Appendix A of the CAAA to which this report is attached.
[4] The Groundwater Modeling Technical Memorandum serves as Appendix B.1 of the CAAA Supporting Information Report; the CAAA Supporting Information Report serves as Appendix B of the CAAA to which this report is attached.
[5] Ibid.

This analysis also provides an initial foundation for understanding groundwater chemistry to inform adaptive site management as a key component of the Corrective Action Groundwater Monitoring Program[6].

[6] The Corrective Action Groundwater Monitoring Plan serves as Appendix B to the Corrective Action Plan.

2. SITE BACKGROUND

2.1 Site Overview

A thorough overview of general site characteristics is presented in Section 1 of the CAAA to which this document is attached and summarized here. The CPP property is located approximately two miles south of the city of Coffeen, Illinois, and bordered by two lobes of Coffeen Lake to the west, east, and south, and by agricultural land to the north. The CPP AP1 impoundment is located to the south of the Ash Pond No. 2 CCR unit (IEPA ID No. W135015004-02). AP1 is a 26-acre unlined surface impoundment that received bottom ash and other non-CCR waste streams prior to November 4, 2019, at which time sluicing of waste to AP1 ceased. Closure activities have not been initiated at AP1 to date.

A groundwater monitoring network was proposed in accordance with 35 I.A.C. § 845.630 to monitor groundwater quality which passes the waste boundary as part of the Operating Permit Application to Illinois Environmental Protection Agency (IEPA) for the AP1 unit (Burns & McDonnell 2021). The proposed groundwater monitoring network is shown in **Attachment A**. The monitoring network consists of 14 compliance monitoring wells (G301, G302, G303, G305, G307, G307D, G308, G310, G312, G313, G314, G314D, G315, and G316) and 2 background wells (G281 and G306).

The geology underlying the Site in the vicinity of AP1 consists of five distinct hydrostratigraphic units (Ramboll, 2021):

- **Upper Confining Unit (UCU):** The UCU underlies AP1. It consists of a Loess Unit and the upper portion of the Hagarstown Member, which has low permeability clays and silts with generally greater than 60 percent (%) fines. The UCU was encountered across most of the CPP except for the eastern edge of AP1 where soils were excavated during construction of the pond.
- **Uppermost Aquifer (UA):** The UA is comprised of moderately permeable sands, silty sand, and clayey gravel of the Hagarstown Member and, in some portions of the Site, the Vandalia Member.
- **Lower Confining Unit (LCU):** The LCU underlies the UA. It consists of three low hydraulic conductivity soils: the sandy clay till of the Vandalia Member, the silt of the Mulberry Grove Formation, and the compacted clay till of the Smithboro Member.
- **Deep Aquifer (DA):** The DA is a thin (generally less than 5 feet thick), discontinuous unit composed of sands and silty sand units of the Yarmouth Soil.
- **Deep Confining Unit (DCU):** The DCU underlies the DA. It consists of the Lierle Clay of the Banner Formation and acts as an aquitard due to its low hydraulic conductivity.

There is a groundwater flow divide within the UA in the center of the CPP property between the two lobes of Coffeen Lake. Groundwater in the UA flows from the center of the CPP property west toward Coffeen Lake on the western side of the groundwater flow divide, and east toward the Unnamed Tributary, the eastern lobe of Coffeen Lake, and the discharge flume on the eastern side

of the groundwater flow divide. Groundwater near AP1 flows north to northeast toward a former discharge structure and the Unnamed Tributary. Groundwater flow within the UA has little vertical component due to the underlying low-permeability LCU. The flow direction in the UA is consistent and likely influenced by the proximity to and hydraulic connection with Coffeen Lake. A map showing representative groundwater flow direction at the site is shown in **Attachment A**.

2.2 Identified Exceedances of the GWPS

The following GWPS exceedances at compliance groundwater monitoring wells likely attributable to Coffeen AP1 were observed from 2023 Q2 through 2023 Q4 (Ramboll, 2024):

- Boron – Observed at monitoring well G313.
- Sulfate – Observed at monitoring wells G301, G303, G305, G307, G307D, G308, G310, G312, G313, G314, G314D, and G316.
- TDS – Observed at monitoring wells G303, G305, G308, G310, G312, G313, G314, G314D, G315, and G316.

The data set for geochemical modeling was finalized after the 2023 Q4 sampling event. Groundwater at these compliance wells is representative of groundwater conditions downgradient of the unit, and samples may be referred to as downgradient groundwater.

Modeling parameters with observed exceedances is appropriate to the scope of the CAAA. Additionally, the selected remedy will meet the performance standards of 35 I.A.C. § 845.670(d) and the Corrective Action Plan will be submitted to the Agency on or before June 12, 2025. Once implemented and completed, the selected remedy will attain the GWPSs.

AP1 network GWPS exceedances are only present within the UA for boron at one compliance well (G313) located east of the unit. Sulfate and TDS GWPS exceedances were detected in UA, LCU, and DA compliance wells.

2.3 Geochemical Conceptual Site Model

A Geochemical Conceptual Site Model (GCSM)[7] was developed for CPP AP1 to describe the geochemical processes that contribute to mobilization and attenuation of constituents in the environment under current conditions, including evaluating whether chemical interactions of COCs with aquifer solids contribute to attenuation of aqueous concentrations at compliance monitoring wells. This discussion relies on lab reports and raw data previously presented in the Nature and Extent Report previously submitted to IEPA on June 12, 2024 (Ramboll 2024) in accordance with 35 I.A.C. § 845.650(d)(1) and provided again in full as Appendix D of the CAAA to which this report is attached.

The primary source of boron and sulfate to groundwater of the UA, LCU, and DA within the monitoring network is AP1 CCR porewater, based on COC concentrations within the source and

[7] The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided as Appendix D of the CAAA to which this report is attached.

relationships to hydrogeological patterns at the Site. However, the poor correlation between boron and sulfate in groundwater and higher concentrations of sulfate in the LCU and DA than in AP1 CCR porewater indicate the potential for multiple potential sources of sulfate.

Limited variability in pH or oxidation-reduction (redox) conditions is observed between upgradient (background) and downgradient locations, with pH values in the UA, LCU, and DA observed to be generally stable and circumneutral, and redox conditions observed to fluctuate between relatively reducing to relatively oxidizing. Some wells within the UA appear to have redox fluctuations related to seasonal conditions.

Boron and sulfate in the groundwater system may be attenuated via adsorption and surface complexation reactions within portions of the UA, LCU, and DA. Boron and sulfate sorption to iron oxyhydroxide phases in particular is well-studied and is potentially occurring within the subsurface near AP1 due to the ubiquitous nature of these materials. Groundwater conditions from the UA, LCU, and DA are predicted to favor amorphous iron oxide stability at some locations, though dynamic equilibrium conditions between amorphous iron oxides and ferrous iron may impact the stability of sorbent phases. The detected presence of iron oxides in some site solids supports the potential for occurrence of this COC attenuation mechanism. Crystalline iron oxides, including magnetite, were identified in analyzed aquifer solids samples at abundances ranging from 0.1 to 0.2%.

The presence of clay minerals (e.g., kaolinite) in the UA, LCU, and DA solids material indicates that adsorption to clays may be another potential attenuation mechanism for boron at locations near AP1. Additionally, boron sorption to aluminum oxide phases is also common in natural systems with low to neutral pH conditions. Crystalline aluminum oxide mineral phases were not detected in mineralogical analyses of aquifer solids samples, although amorphous aluminum oxide solid phases are widespread in natural environments and likely constitute another boron attenuation mechanism near AP1.

Batch attenuation testing was conducted for boron and sulfate to evaluate the potential for sorption and to attempt to generate site-specific distribution coefficients between the solid and aqueous phase. Freundlich partition coefficient (K_f) values ranging from of 0.65 to 2.03 liters per kilogram were established to represent boron attenuation within the UA near AP1 based on the goodness-of-fit and comparability of the value to academic studies. This K_f value provides additional evidence of boron sorption to UA solids.

The GCSM findings suggest the potential for chemical attenuation of both boron and sulfate based on detected abundances of iron oxide and clay minerals, groundwater redox conditions that are potentially favorable for the stability of these potential sorbing surfaces, and batch testing results for boron which yielded a partition coefficient with a high goodness-of-fit. Sulfate is a major contributor to TDS concentrations at AP1 monitoring wells, so attenuation of sulfate is expected to contribute to a reduction in TDS in groundwater.

3. GROUNDWATER POLISHING REMEDY EVALUATION

This groundwater polishing evaluation uses geochemical modeling to evaluate chemical attenuation of COCs under current conditions and to predict changes in attenuation at exceedance locations following source control. This evaluation will therefore further assess if chemical mechanisms of groundwater polishing will contribute to the remedy achieving the GWPS in a reasonable amount of time. Speciation and reaction models are geochemical models that can be used to evaluate the potential for chemical attenuation in groundwater. Speciation models assess the distribution of constituents between solid and aqueous phases, and reaction models evaluate how that distribution may change with changing site conditions (USEPA 2015). The results of geochemical modeling provide insight into groundwater polishing mechanisms and additional context for the time estimated to reach the GWPS determined by the groundwater flow and transport model[8], which is based on hydraulic properties of the aquifer and does not take into account chemical interactions occurring within the hydrologic unit.

3.1 Methods

Geochemical modeling was done in PHREEQC Version 3 (USGS 2021) using a modified MINTEQ v4 thermodynamic database (as described in relevant sections below). The geochemical modeling of groundwater polishing under current/future conditions includes speciation and reaction modeling (USEPA 2015):

1. Speciation: To understand groundwater polishing mechanisms under current conditions, a solid phase representative of site conditions is equilibrated with current downgradient groundwater. The results of speciation modeling represent the association of COCs with the solid phase under current conditions through mechanisms such as sorption or precipitation.
2. Reaction: In the reaction modeling, the solid phase generated during the speciation modeling phase is reacted iteratively with background groundwater. These results represent the geochemical conditions expected after the source is controlled during which a trailing geochemical gradient may be created (SRNL 2011). The reactions with background groundwater assess the potential for a trailing geochemical gradient to drive changes in groundwater chemistry. Persistence of elevated groundwater COC concentrations over several reaction iterations suggests a trailing geochemical gradient may be more likely to affect the time to reach the GWPS.

The equilibrium thermodynamic modeling approach used herein allows that the solid and aqueous phases reach equilibrium during each step. The primary goal of this model is to inform the assessment of whether groundwater polishing is an appropriate remedy for the site by evaluating dominant geochemical reactions that may occur at time scales relevant to groundwater flow, including adsorption and certain mineral dissolution/precipitation (i.e., iron and aluminum

[8] The Groundwater Modeling Technical Memorandum serves as Appendix B.1 of the CAAA Supporting Information Report; the CAAA Supporting Information Report serves as Appendix B of the CAAA to which this report is attached.

(hydr)oxides, carbonates, and some sulfates) as identified in the GCSM[9]. The model therefore includes those parameters that are expected to contribute to those reactions (as discussed below) and does not include every constituent of the solid phase and groundwater in order to capture "the salient aspects of the system's behavior without introducing unnecessary complexity" (USEPA 2015). This model is therefore a semi-quantitative estimation of chemical behavior in the subsurface rather than a prediction of groundwater quality, consistent with USEPA guidance that geochemical modeling "is often most helpful for identifying relative changes in contaminant speciation and distribution" (USEPA 2015).

3.1.1 Model Set-Up

Inputs to the model include solid phase composition, downgradient groundwater composition for wells with boron and sulfate GWPS exceedances, and background groundwater composition. The PHREEQC input file and modified MINTEQ v4 database are provided in **Attachment B**. The data included for model parameterization is summarized in **Table 1** and discussed in greater detail in **Attachment C**. All data used in the model and discussed below are provided in the Nature and Extent Report[10].

3.1.1.1 Solid Phase Inputs

Iron hydroxide (ferrihydrite, $Fe(OH)_3$) and aluminum hydroxide (gibbsite, $Al(OH)_3$) are wide-spread in the environment and known to act as sorbing phases for many groundwater constituents, including boron and sulfate (Dzombak and Morel 1990; Karamalidis and Dzombak 2010). Model input concentrations for ferrihydrite and gibbsite are ideally derived from sequential extraction procedure (SEP) analyses of iron and aluminum respectively. Because SEP analyses for iron and aluminum were not completed for AP1 samples, model input concentrations for ferrihydrite for AP1were derived using site-specific total metals and mineralogy (X-ray diffraction [XRD]) datasets, and input concentrations for ferrihydrite were taken from an SEP dataset compiled from analogous geological systems as described in greater detail in **Attachment C**. Gibbsite input concentrations for AP1 were taken directly from the analogous compiled SEP dataset.

Metal oxide concentrations representing the 25th percentile, median, and 75th percentile of the observed data were used to test the sensitivity of the model to the amount of sorbing phase present]. Both ferrihydrite and gibbsite were allowed to dissolve or precipitate in the reaction phase of the model.

Calcite and dolomite were included as mineral phases in the model because carbonate mineral formation and dissolution are often major controls on groundwater pH (Stumm and Morgan 1996; Stackelberg et al. 2020). Calcite and dolomite are present in site aquifer solids within the UA and LCU in excess, and model input concentration were based on site-specific XRD results. Calcite

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[9] The GCSM is a component of the Nature and Extent Report previously submitted to IEPA (Ramboll 2024) and is provided as Appendix D of the CAAA to which this report is attached.

[10] The Nature and Extent Report was previously submitted to IEPA (Ramboll 2024) and is provided as Appendix D of the CAAA to which this report is attached. The Nature and Extent report contains laboratory reports and tabulated results from solid phase analysis and tabulated results from groundwater analyses. Laboratory reports for groundwater data are provided quarterly to IEPA and posted to the facility's operating record in accordance with 35 I.A.C. § 845.800(d)(15).

and dolomite were not detected in XRD samples from the DA and did not have initial concentrations provided. Both calcite and dolomite were allowed to dissolve or precipitate in the reaction phase of the model for all hydrostratigraphic units.

Barite ($BaSO_4$) and gypsum ($CaSO_4$) are minerals that contain sulfate and have the potential to form under ambient environmental conditions in a timeframe consistent with the remedial effort. These minerals therefore may affect sulfate attenuation. Neither mineral phase was observed in mineralogical results for the site; therefore, both were made available to precipitate from the aqueous solution but did not have initial concentrations provided.

3.1.1.2 Aqueous Inputs

In addition to the boron and sulfate, the following parameters are included to capture the expected attenuation and mobilization mechanisms (see **Section 2.3**):

- Temperature, pH and pe (calculated from field-measured oxidation-reduction potential based on groundwater temperature).
- Major ions: Alkalinity, chloride, fluoride, calcium, magnesium, potassium, and sodium.
- Oxyanions: Silicon and phosphate.
- Redox-active metals: Aluminum, iron, and manganese.
- Remaining constituents regulated under 35 I.A.C. § 845.600[11].

This full suite of geochemical parameters for this model was measured in Quarter 2 and Quarter 3, 2023. The medians of these results were used in the model to represent average groundwater interacting with the solid phase. For wells with exceedances of boron and/or sulfate (**Section 2.2**), the median for each parameter was calculated for each location individually. For background wells, a single median for each parameter was calculated using data from both background locations (see **Section 2.1**).

3.2 Results and Discussion

3.2.1 Model Results

Model simulations were completed for all wells with exceedances of boron and/or sulfate (see **Section 2.2**). Full modeling results are provided in **Attachment D**. Geochemical modeling results for a representative subset of wells are shown on **Figures 1 through 5** below, including at least one well screened within each hydrostratigraphic unit containing an exceedance (UA, LCU, and DA). Modeling results of wells not included on figures are generally comparable, and general discussion of visualized results applies to non-visualized results as well. Current geochemical

[11] Mercury, thallium, total dissolved solids, and radium were not included in the model. Mercury reactions within the environment are highly complex and would require a separate modeling effort, and the high frequency of non-detect concentrations in the groundwater indicate it would not contribute to model outcomes. Thallium forms a non-reactive monovalent cation and is rarely detected in the groundwater and is therefore not expected to contribute to model outcomes. Total dissolved solids are not a chemical parameter, but rather the result of other chemical abundances taken together. Radium is not included in most thermodynamic databases.

conditions are represented in model output figures as 'Speciation Model' and subsequent reaction calculation results are represented with 'First Reaction' and 'Second Reaction'.

Figure 1: Percentage of Sorbed Boron

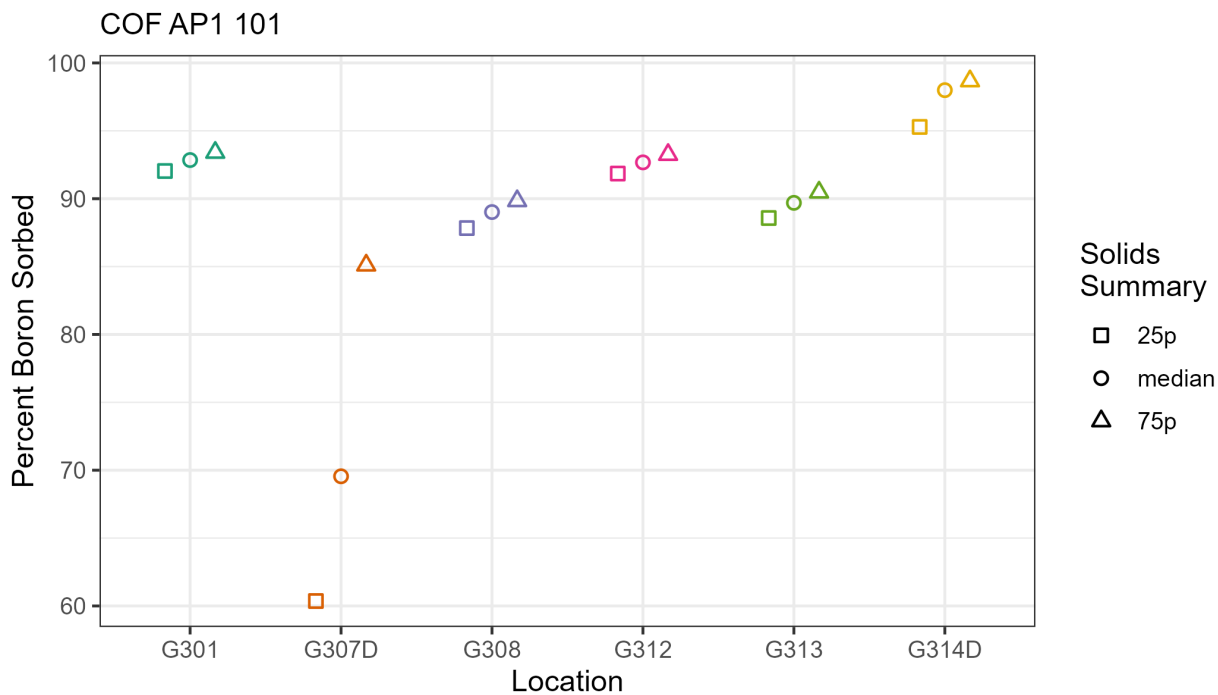


Figure 2: Modeled Boron Behavior

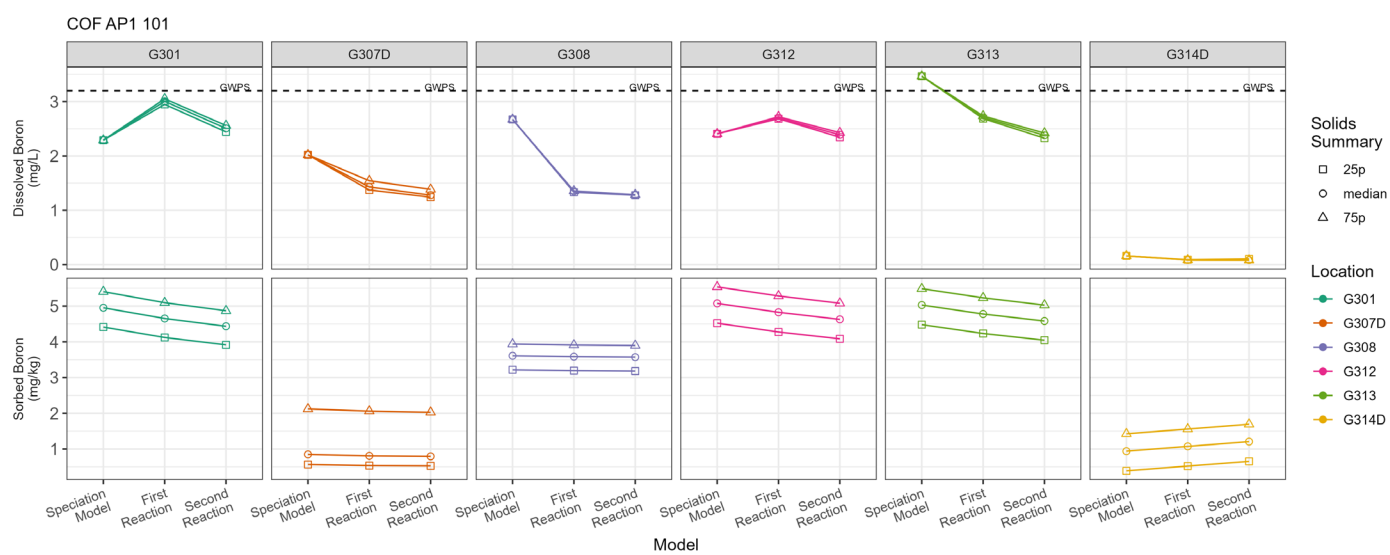


Figure 3: Percentage of Sorbed Sulfate

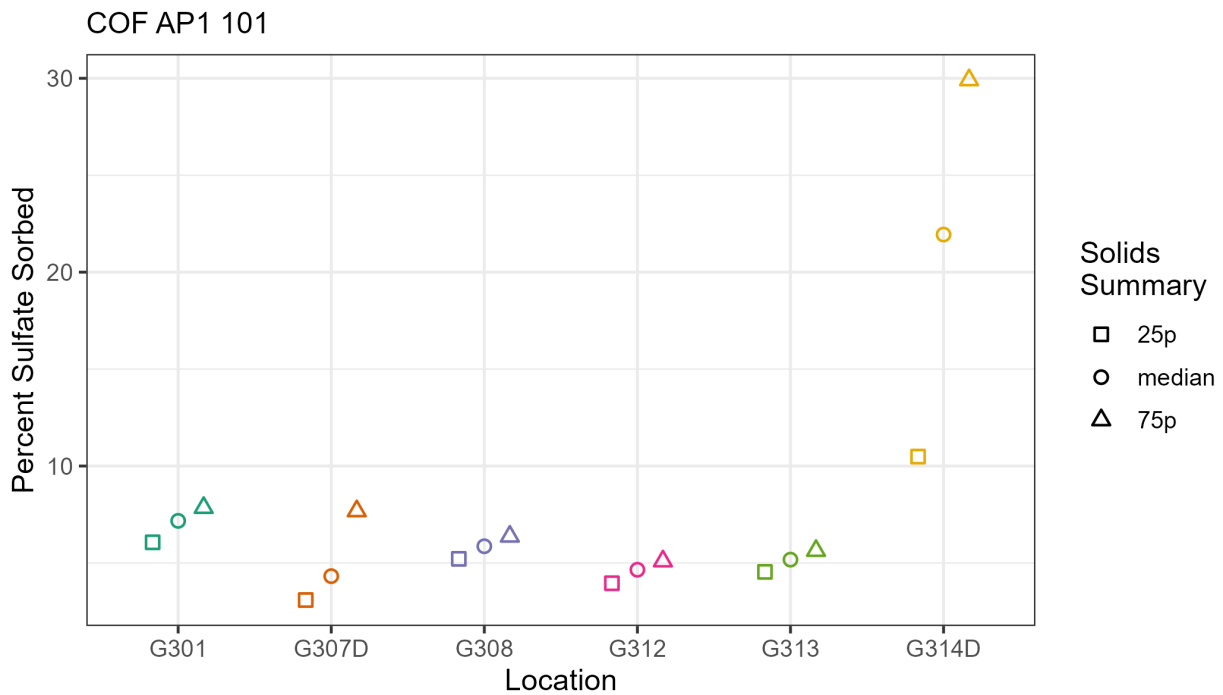


Figure 4: Modeled Sulfate Behavior

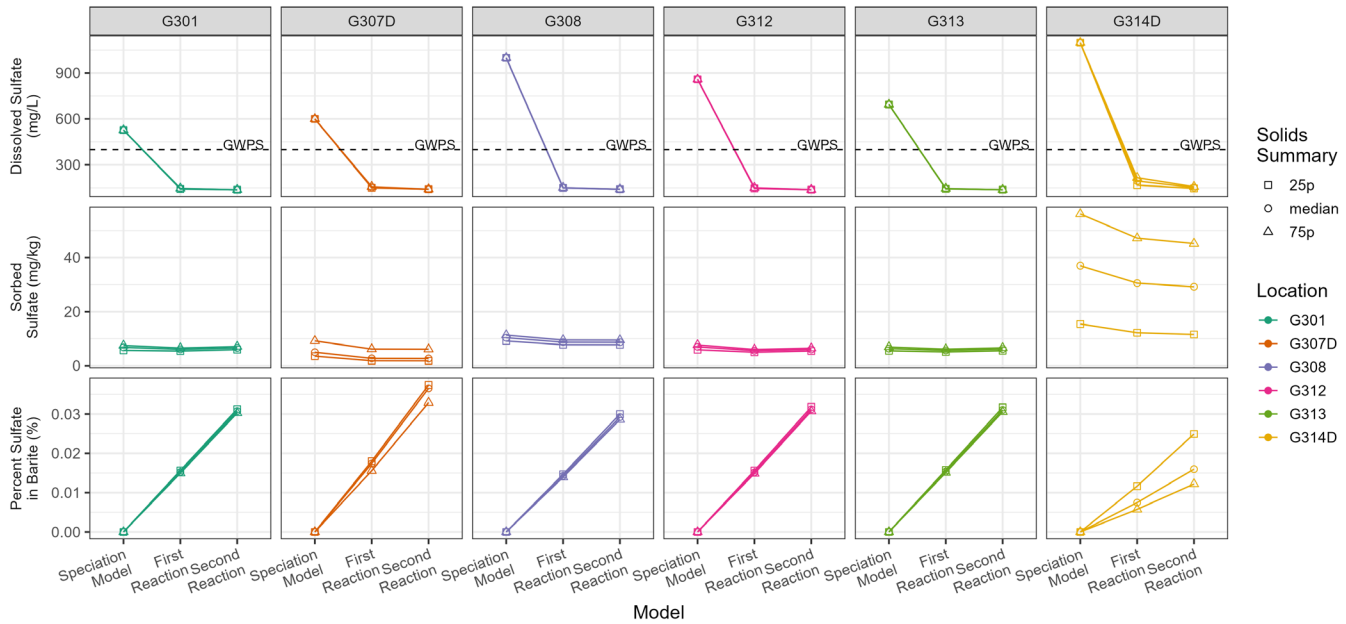
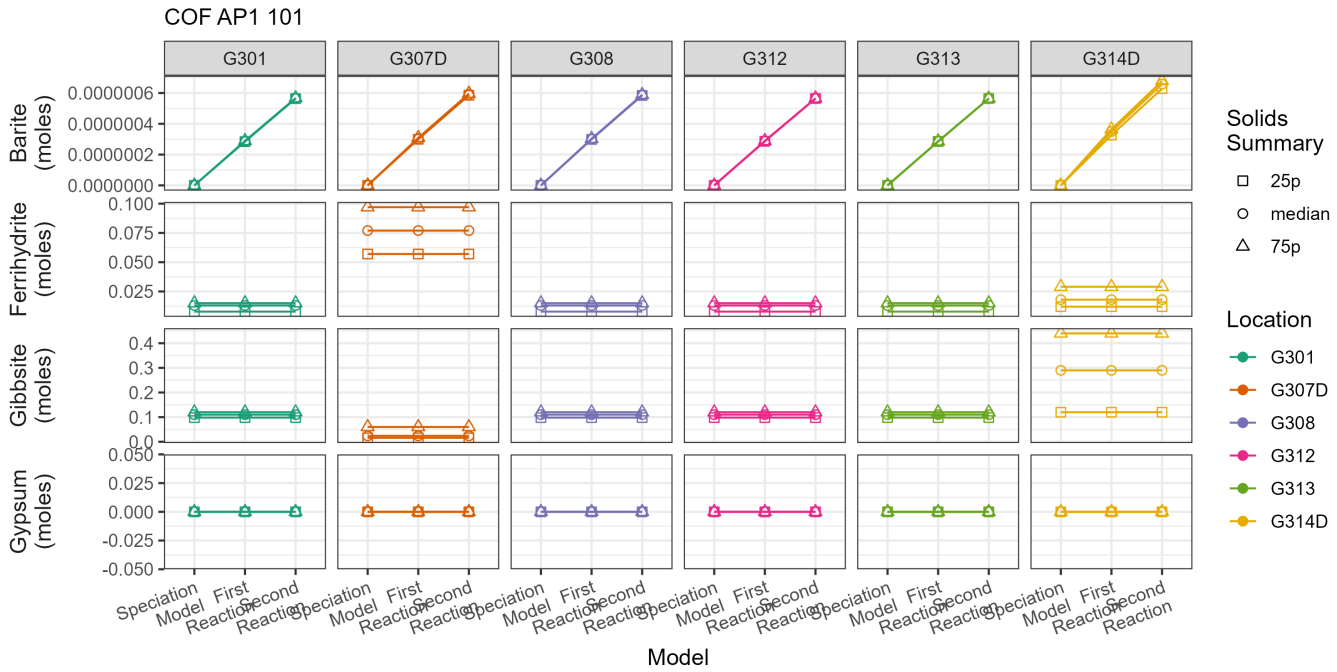


Figure 5: Modeled Sorbing Phase Behavior



3.2.2 Speciation Modeling

Results of speciation modeling support the determination of the GCSM that chemical attenuation of boron is likely to occur. Speciation calculations indicate that approximately 90% of boron present in groundwater at G313 (the well containing boron exceedances) will sorb to aquifer solids (**Figure 1**). Boron sorption is predicted at variable degrees for all modeled wells, with a minimum predicted sorbed boron percentage of 60% at LCU well G307D. Most predicted boron sorption is associated with the aluminum oxide (gibbsite) phase (**Attachment D**). Boron sorption at G313 is not notably sensitive to the absolute amount of sorbent, as little variability in sorbed boron is predicted between the 25th percentile and 75th percentile mineral mass inputs. These results suggest that boron sorption under current geochemical conditions is thermodynamically favorable.

Speciation calculations for sulfate indicate that at UA and LCU wells with sulfate exceedances between 2.5 and 7.5% of sulfate present in compliance well groundwater will sorb to mineral surfaces (**Figure 3**). Predicted sulfate sorption is comparable across UA and LCU wells. Notably greater sulfate sorption is predicted at DA well G314D, with between 11 to 33% of sulfate in groundwater predicted to sorb to mineral surfaces at this location. Sensitivity assessments demonstrate the limited influence (< 5% of aqueous sulfate sorbed) of variable sorbing mineral mass inputs on sulfate sorption for most modeled wells except for G314D, which showed approximately 20% difference in aqueous sulfate sorbed between the 25th percentile and 75th percentile values for mineral mass. These results suggest that sulfate sorption is predicted under current geochemical conditions, with notably greater sorption predicted in the DA. The DA is also predicted to be more sensitive to the absolute amount of sorbent relative to the UA and LCU.

3.2.3 Reaction modeling

Reaction modeling results of conditions following source control demonstrate that aqueous boron and sulfate concentrations change with background groundwater interaction. Aqueous boron concentrations are predicted to decrease with each iterative reaction at well G313, the only well with a boron exceedance (**Figure 2**). Some degree of boron desorption is predicted for well G313 following the second reaction; however, the impact of this desorption on aqueous boron concentrations is offset by background groundwater containing less aqueous boron. G313 is predicted to achieve the boron GWPS within one iterative reaction, indicating that mobilization of currently attenuated boron is unlikely to affect the time to reach the boron GWPS. An increase in aqueous boron concentrations following the first reaction is predicted at some wells (i.e., G301 and G312), but concentrations are not predicted to exceed the boron GWPS and are expected to decrease with continual interaction with background groundwater (**Figure 2**).

Aqueous sulfate concentrations are predicted to decrease at all wells with each iterative reaction (**Figure 4**). Some degree of sulfate desorption is predicted with background groundwater interaction depending on the model scenario; however, the impact of this desorption on aqueous sulfate concentrations is offset by background groundwater containing less aqueous sulfate. Barite precipitation is predicted in all post-source control scenarios (**Figure 5**), which provides an additional attenuation mechanism for aqueous sulfate. All modeled wells are predicted to achieve the sulfate GWPS within one iterative reaction, indicating that mobilization of currently attenuated sulfate is unlikely to affect the time to reach the GWPS.

Boron and sulfate are predicted to sorb to ferrihydrite and gibbsite. Both minerals are predicted to be stable and exhibit minor (less than 0.01%, **Table 2**) predicted dissolution under post-source control conditions (**Figure 5**). Barite is predicted to precipitate under post-source control conditions in all model scenarios. The predicted stability of sorbing mineral phases and precipitation of barite under post-source control conditions demonstrates the continued feasibility of boron and sulfate chemical attenuation mechanisms in AP1.

These results suggest that chemical attenuation of boron and sulfate should remain feasible following source control efforts. The primary chemical attenuation mechanism for boron is anticipated to be sorption to iron and aluminum oxide mineral phases which are predicted to be stable in post-source control conditions. Chemical attenuation mechanisms for sulfate are expected to include sorption to iron and aluminum oxide minerals and precipitation of barite. These results suggest that mobilization of currently attenuated boron and sulfate is unlikely to affect the modeled time to reach the GWPS. Sulfate is a major component of TDS at AP1 monitoring wells, so chemical attenuation of sulfate is also expected to contribute to a reduction in TDS at wells with TDS exceedances.

4. CONCLUSIONS

This report evaluated the contribution of chemical mechanisms to groundwater polishing via geochemical modeling. The results of the groundwater polishing evaluation also contextualize estimates of the modeled time to reach the GWPS by evaluating potential changes in boron and sulfate attenuation as groundwater quality returns to background conditions.

Geochemical modeling of current AP1 geochemical conditions demonstrates chemical attenuation of boron and sulfate via sorption to aquifer solids, particularly iron and aluminum oxides and (applicable to sulfate only) precipitation of barite. Modeling of anticipated future conditions predicts a minor component of desorption of boron and sulfate from solids that will be offset by interaction with background groundwater containing lower concentrations of these COCs, resulting in net aqueous concentration decreases at all wells with exceedances. Barite precipitation is predicted under post-source control conditions, which will provide an additional attenuation mechanism for sulfate. Modeling also predicts that iron and aluminum oxide sorbing minerals phases will remain stable in post-source control conditions, and as a result this chemical attenuation mechanism will remain viable. It is expected that attenuation of sulfate will also contribute to a reduction in TDS at all wells with TDS exceedances.

Results of the geochemical modeling suggest that mobilization of currently attenuated boron and sulfate is unlikely to affect the modeled time to reach the GWPS under future conditions. The results will inform corrective action groundwater monitoring and adaptive site management, critical components of every corrective action considered in the CAAA.

5. REFERENCES

Burns & McDonnell. 2021. Initial Operating Permit – Coffeen Ash Pond No. 1. October.

Dzombak D.A. and Morel F.M.M. 1990. Surface Complexation Modeling: Hydrous Ferric Oxide. John Wiley & Sons, New York.

Karamalidis A.K. and Dzombak D.A. 2010. Surface Complexation Modeling: Gibbsite. John Wiley & Sons, New York.

Ramboll. 2024. Nature and Extent Report – Coffeen Power Plant, Ash Pond No. 1, IEPA ID No. 101. June.

Savannah River National Laboratory. 2011. The Scenarios Approach to Attenuation-Based Remedies for Inorganic and Radionuclide Contaminants. SRNL-STI-2011-00459. August.

Stackelberg P.E., Belitz K., Brown C.J., Erickson M.L., Elliot S.M., Kauffman L.J., Ransom K.M., and Reddy J.E. 2020. Machine Learning Predictions of pH in the Glacial Aquifer System, Northern USA. Groundwater, 59(3):352-368. https://doi.org/10.1111/gwat.13063

Stumm W. and Morgan J.J. 1996. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters. Third edition. John Wiley & Sons, New York.

USEPA. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Office of Solid Waste and Emergency Response. Directive 9200.4-17P. April.

USEPA. 2015. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites. Office of Solid Waste and Emergency Response. Directive 9283.1-36. August.

United States Geological Survey (USGS). 2021. PHREEQC Version 3. December. https://www.usgs.gov/software/phreeqc-version-3

TABLES

Table 1. Summary of Geochemical Model Inputs
Groundwater Polishing Evaluation Report
Coffeen Power Plant - Ash Pond No. 1

Model Component	Parameters	Data source(s)
Solid Phase	Iron (hydr)oxides, aluminum (hydr)oxides	Site-specific total metals and X-ray diffraction results from solid samples (crystalline iron oxides). Analoguous compiled sequential extraction procedure dataset (ferrihydrite and gibbsite).
	Calcite and dolomite	X-ray diffraction results
Downgradient groundwater (COC exceedance locations)	Sulfate, iron, manganese, major ions[1], 845 constituents[1]	Median concentrations per well from data collected in Q2 and Q3 2023
Background groundwater		Median concentrations from all network background wells using data collected in Q2 and Q3 2023

[1]See Section 3.1.1.2 for details.

Table 2 - Geochemical Modeling Response of Sorbing Phases
Groundwater Polishing Evaluation Report
Coffeen Power Plant - Ash Pond No. 1

Parameter	Hydrostratigraphic Unit	Location	Summary Type	First Reaction Change		Second Reaction Change	
				mg/kg	%	mg/kg	%
Barite	DA	G314D	25p	0.00914	NA	0.0176	92.58
			median	0.00979	NA	0.0184	88.25
			75p	0.0102	NA	0.019	86.26
	LCU	G307D	25p	0.0129	NA	0.0251	95.52
			median	0.013	NA	0.0254	94.35
			75p	0.0133	NA	0.0256	92.95
	UA	G301	25p	0.0111	NA	0.0219	98.2
			median	0.0112	NA	0.022	96.91
			75p	0.0112	NA	0.0221	96.38
		G308	25p	0.0116	NA	0.0227	95.56
			median	0.0117	NA	0.0228	94.91
			75p	0.0118	NA	0.0229	94.52
		G312	25p	0.0111	NA	0.022	97.14
			median	0.0112	NA	0.022	96.14
			75p	0.0112	NA	0.022	95.59
		G313	25p	0.0111	NA	0.022	97.95
			median	0.0111	NA	0.0219	97.48
			75p	0.0111	NA	0.022	97.14
Ferrihydrite	DA	G314D	25p	154	<0.01	154	<0.01
			median	231	<0.01	231	<0.01
			75p	372	<0.01	372	<0.01
	LCU	G307D	25p	1120	<0.01	1120	<0.01
			median	1510	<0.01	1510	<0.01
			75p	1910	<0.01	1910	<0.01
	UA	G301	25p	139	<0.01	139	<0.01
			median	232	<0.01	232	<0.01
			75p	267	<0.01	267	<0.01
		G308	25p	139	<0.01	139	<0.01
			median	232	<0.01	232	<0.01
			75p	267	<0.01	267	<0.01
		G312	25p	139	<0.01	139	<0.01
			median	232	<0.01	232	<0.01
			75p	267	<0.01	267	<0.01
		G313	25p	139	<0.01	139	<0.01
			median	232	<0.01	232	<0.01
			75p	267	<0.01	267	<0.01
Gibbsite	DA	G314D	25p	1120	<0.01	1120	<0.01
			median	2710	<0.01	2710	<0.01
			75p	4120	<0.01	4120	<0.01
	LCU	G307D	25p	230	<0.01	230	<0.01
			median	344	<0.01	344	<0.01
			75p	861	<0.01	861	<0.01
	UA	G301	25p	1270	<0.01	1270	<0.01
			median	1430	<0.01	1430	<0.01
			75p	1560	<0.01	1560	<0.01
		G308	25p	1270	<0.01	1270	<0.01
			median	1430	<0.01	1430	<0.01
			75p	1560	<0.01	1560	<0.01
		G312	25p	1270	<0.01	1270	<0.01
			median	1430	<0.01	1430	<0.01
			75p	1560	<0.01	1560	<0.01
		G313	25p	1270	<0.01	1270	<0.01
			median	1430	<0.01	1430	<0.01
			75p	1560	<0.01	1560	<0.01

Notes:
% = percent
25p = 25th percentile
75p = 75th percentile
mg/kg = milligram/kilogram
UA = Uppermost Aquifer
LCU = Lower Confining Unit
DA = Deep Aquifer
NA = not applicable

ATTACHMENT A

Operating Permit Network Map and Potentiometric Surface – August 2023

- COMPLIANCE MONITORING WELL
- BACKGROUND WELL
- PORE WATER WELL
- LEACHATE WELL
- MONITORING WELL
- STAFF GAGE, CCR UNIT
- STAFF GAGE, RIVER
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 325 650 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATIONS IN BRACKETS WERE OBTAINED OUTSIDE OF THE 24-HOUR PERIOD FROM INITIATION OF DEPTH TO GROUNDWATER MEASUREMENTS BUT WITHIN THE SAME SAMPLING EVENT.
3. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

POTENTIOMETRIC SURFACE MAP
AUGUST 8, 2023

2023 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

ATTACHMENT B

PHREEQC Input Files and Thermodynamic Database

25th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file COF_845_101_25p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #G314D (C - DA)
redox pe
units mg/l
density 1
pH 6.96
pe 3.26
temp 15.05
S(6) 1095 as SO4
B 0.16
Li 0.00735
As 0.0008225
C(4) 419.5 as CO3
Cl 61
F 0.6285
Ca 522
Mg 177.15
Na 283
K 3.42
Ba 0.02555
Si 5.7
P 0.003225
Mn 1.205
Fe 2.802
Al 0.004925
Sb 0.0004575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.00355
Se 0.000335
end

SOLUTION 2 #G307D (C - LCU)
redox pe
units mg/l
density 1
```

```
pH 7.245
pe 2.66
temp 19.5
S(6) 599.5 as SO4
B 2.02
Li 0.00285
As 0.00165
C(4) 127.5 as CO3
Cl 15
F 0.5895
Ca 143
Mg 63.2
Na 96.9
K 0.5775
Ba 0.02685
Si 5.53
P 0.00775
Mn 0.4985
Fe 0.595
Al 0.004525
Sb 0.0005075
Be 0.0001975
Cd 0.000235
Cr 0.0012
Co 0.00081
Pb 0.000205
Mo 0.0048
Se 0.000335
end
SOLUTION 3 #G314 (C - LCU)
redox pe
units mg/l
density 1
pH 6.585
pe 3.295
temp 16.4
S(6) 2035 as SO4
B 0.16
Li 0.0093
As 0.0012
C(4) 411 as CO3
Cl 30.5
F 0.1975
Ca 440.5
Mg 189
Na 263
K 3.58
Ba 0.02765
Si 5.775
P 0.003225
Mn 1.82
Fe 3.32
Al 0.005325
```

```
Sb 0.0006575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00565
Pb 0.0007
Mo 0.00345
Se 0.000335
end

SOLUTION 4 #G316 (C - LCU)
redox pe
units mg/l
density 1
pH 6.96
pe 1.9
temp 15.3
S(6) 711 as SO4
B 0.4155
Li 0.0021
As 0.0081
C(4) 370.5 as CO3
Cl 26
F 0.18045
Ca 196.5
Mg 157.5
Na 104
K 2.105
Ba 0.07015
Si 9.31
P 0.036975
Mn 9.26
Fe 16.65
Al 0.005225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.0042
Se 0.000335
end

SOLUTION 5 #G301 (C - UA)
redox pe
units mg/l
density 1
pH 6.585
pe 0.595
temp 17.3
S(6) 526.5 as SO4
B 2.29
Li 0.0036
As 0.0002725
```

```
C(4) 90.2 as CO3
Cl 12.5
F 0.2535
Ca 111.5
Mg 42.3
Na 116.5
K 1.685
Ba 0.0166
Si 9.775
P 0.005975
Mn 2.17
Fe 0.11985
Al 0.007225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.0012
Co 0.00165
Pb 0.00038
Mo 0.000335
Se 0.000335
end

SOLUTION 6 #G303 (C - UA)
redox pe
units mg/l
density 1
pH 6.97
pe 2.285
temp 16.6
S(6) 731.5 as SO4
B 1.875
Li 0.0359
As 0.0026
C(4) 376 as CO3
Cl 26
F 0.16765
Ca 185
Mg 149.5
Na 164
K 2.655
Ba 0.01665
Si 10.925
P 0.019975
Mn 0.3615
Fe 0.856
Al 0.0112
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0014
Co 0.0021
Pb 0.000605
Mo 0.0018
```

```
Se 0.000335
end
SOLUTION 7 #G305 (C - UA)
redox pe
units mg/l
density 1
pH 7.325
pe 3.12
temp 15.6
S(6) 886.5 as SO4
B 2.28
Li 0.00885
As 0.0012
C(4) 124.5 as CO3
Cl 22
F 0.374
Ca 184
Mg 98.25
Na 132.5
K 0.8245
Ba 0.0317
Si 11
P 0.010975
Mn 0.1692
Fe 0.0165
Al 0.005125
Sb 0.0005575
Be 0.0001975
Cd 0.000235
Cr 0.00445
Co 0.00145
Pb 0.00315
Mo 0.001265
Se 0.000635
end
SOLUTION 8 #G307 (C - UA)
redox pe
units mg/l
density 1
pH 7.29
pe 4.37
temp 17
S(6) 530 as SO4
B 2
Li 0.0025
As 0.000345
C(4) 95.9 as CO3
Cl 9.2
F 0.325
Ca 150
Mg 49
Na 77
K 4
```

```
Ba 0.025
Si 11
P 0.00395
Mn 1.8
Fe 0.015
Al 0.0035
Sb 0.000215
Be 0.000295
Cd 0.00037
Cr 0.0014
Co 0.0023
Pb 0.00011
Mo 0.00092
Se 0.00037
end

SOLUTION 9 #G308 (C - UA)
redox pe
units mg/l
density 1
pH 7.3
pe 4.515
temp 16.5
S(6) 998 as SO4
B 2.67
Li 0.00695
As 0.00068
C(4) 141.5 as CO3
Cl 12
F 0.552
Ca 198
Mg 117.5
Na 151
K 0.41
Ba 0.0216
Si 11.1
P 0.005475
Mn 0.3365
Fe 0.00885
Al 0.006225
Sb 0.0002575
Be 0.0001975
Cd 0.000235
Cr 0.00115
Co 0.00032
Pb 0.000205
Mo 0.0015
Se 0.000335
end

SOLUTION 10 #G310 (C - UA)
redox pe
units mg/l
density 1
pH 7.005
```

```
pe 5.55
temp 16.3
S(6) 615.5 as SO4
B 1.825
Li 0.00575
As 0.000455
C(4) 145 as CO3
Cl 14
F 0.273
Ca 154
Mg 50.8
Na 147
K 0.301
Ba 0.01435
Si 9.68
P 0.004975
Mn 0.323
Fe 0.003925
Al 0.005575
Sb 0.0002075
Be 0.0002225
Cd 0.000285
Cr 0.000875
Co 0.0013
Pb 0.00046
Mo 0.000335
Se 0.000335
end

SOLUTION 11 #G312 (C - UA)
redox pe
units mg/l
density 1
pH 6.29
pe 5
temp 17.1
S(6) 857.5 as SO4
B 2.405
Li 0.01345
As 0.0004225
C(4) 304.5 as CO3
Cl 27
F 0.161
Ca 201
Mg 138
Na 105
K 0.64
Ba 0.0298
Si 11.5
P 0.005975
Mn 3.84
Fe 0.0151
Al 0.005125
Sb 0.0002075
```

```
Be 0.0002975
Cd 0.000235
Cr 0.000875
Co 0.003
Pb 0.000205
Mo 0.001685
Se 0.000335
end
SOLUTION 12 #G313 (C - UA)
redox pe
units mg/l
density 1
pH 6.81
pe 3.67
temp 18.2
S(6) 693.5 as SO4
B 3.465
Li 0.01705
As 0.0004225
C(4) 297 as CO3
Cl 22.5
F 0.243
Ca 200
Mg 103
Na 151.5
K 1.065
Ba 0.01865
Si 11.85
P 0.003225
Mn 0.378
Fe 0.07125
Al 0.009125
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0011
Co 0.000785
Pb 0.000205
Mo 0.0012
Se 0.000335
end
SOLUTION 13 #G315 (C - UA)
redox pe
units mg/l
density 1
pH 6.785
pe 5.805
temp 15.25
S(6) 601.5 as SO4
B 1.44
Li 0.00595
As 0.00068
C(4) 138 as CO3
```

```
Cl 14.5
F 0.293
Ca 143.5
Mg 65.8
Na 113.5
K 0.4195
Ba 0.02675
Si 12.45
P 0.009475
Mn 0.273
Fe 0.00618
Al 0.010125
Sb 0.0002575
Be 0.0004475
Cd 0.000235
Cr 0.00225
Co 0.00155
Pb 0.00105
Mo 0.000485
Se 0.000335
end

EQUILIBRIUM_PHASES 1 #G314D (C - DA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.012
Calcite 0 0
Dolomite(ordered) 0 0

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #G307D (C - LCU) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.016
Ferrihydrite 0 0.057
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #G314 (C - LCU) - 25p
Barite 0 0
Gypsum 0 0
```

```
Gibbsite 0 0.016
Ferrihydrite 0 0.057
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
save surface 3
end

EQUILIBRIUM_PHASES 4 #G316 (C - LCU) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.016
Ferrihydrite 0 0.057
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 4
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 4
save surface 4
end

EQUILIBRIUM_PHASES 5 #G301 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 5
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 5
save surface 5
end

EQUILIBRIUM_PHASES 6 #G303 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 6
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 6
```

```
save surface 6
end

EQUILIBRIUM_PHASES 7 #G305 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 7
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 7
save surface 7
end

EQUILIBRIUM_PHASES 8 #G307 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 8
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 8
save surface 8
end

EQUILIBRIUM_PHASES 9 #G308 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 9
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 9
save surface 9
end

EQUILIBRIUM_PHASES 10 #G310 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3
```

```
SURFACE 10
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 10
save surface 10
end

EQUILIBRIUM_PHASES 11 #G312 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 11
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 11
save surface 11
end

EQUILIBRIUM_PHASES 12 #G313 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 12
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 12
save surface 12
end

EQUILIBRIUM_PHASES 13 #G315 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 13
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 13
save surface 13
end

SOLUTION 14 #average background
redox pe
```

```
units mg/l
density 1
pH 6.765
pe 5.54
temp 17.6
S(6) 140.5
B 1.2023
Li 0.00335
As 0.0006375
C(4) 215
Cl 38 charge
F 0.228
Ca 120
Mg 50.5
Na 66.5
K 0.5695
Ba 0.07035
Si 12.2
P 0.0125
Mn 0.18715
Fe 0.009075
Al 0.010125
Sb 0.0003075
Be 0.000295
Cd 0.000235
Cr 0.00255
Co 0.000695
Pb 0.00052
Mo 0.00037
Se 0.000335

SAVE solution 14

end

#FIRST REACTION

#G314D (C - DA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G314D (C - DA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G307D (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
```

```
SAVE equilibrium_phases 2
SAVE surface 2
end

#G307D (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#G314 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G314 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G316 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G316 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G301 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
SAVE surface 5
end

#G301 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
```

```
SAVE surface 5
end

#G303 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G303 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G305 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G305 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G307 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G307 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G308 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end
```

```
#G308 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end

#G310 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G310 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G312 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G312 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G313 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G313 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G315 (C - UA) - First Reaction
USE SOLUTION 14
```

```
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end

#G315 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end
```

25th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file COF_845_101_25p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #G314D (C - DA)
redox pe
units mg/l
density 1
pH 6.96
pe 3.26
temp 15.05
S(6) 1095 as SO4
B 0.16
Li 0.00735
As 0.0008225
C(4) 419.5 as CO3
Cl 61 charge
F 0.6285
Ca 522
Mg 177.15
Na 283
K 3.42
Ba 0.02555
Si 5.7
P 0.003225
Mn 1.205
Fe 2.802
Al 0.004925
Sb 0.0004575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.00355
Se 0.000335
end

SOLUTION 2 #G307D (C - LCU)
redox pe
units mg/l
density 1
```

```
pH 7.245
pe 2.66
temp 19.5
S(6) 599.5 as SO4
B 2.02
Li 0.00285
As 0.00165
C(4) 127.5 as CO3
Cl 15 charge
F 0.5895
Ca 143
Mg 63.2
Na 96.9
K 0.5775
Ba 0.02685
Si 5.53
P 0.00775
Mn 0.4985
Fe 0.595
Al 0.004525
Sb 0.0005075
Be 0.0001975
Cd 0.000235
Cr 0.0012
Co 0.00081
Pb 0.000205
Mo 0.0048
Se 0.000335
end
SOLUTION 3 #G314 (C - LCU)
redox pe
units mg/l
density 1
pH 6.585
pe 3.295
temp 16.4
S(6) 2035 as SO4
B 0.16
Li 0.0093
As 0.0012
C(4) 411 as CO3
Cl 30.5 charge
F 0.1975
Ca 440.5
Mg 189
Na 263
K 3.58
Ba 0.02765
Si 5.775
P 0.003225
Mn 1.82
Fe 3.32
Al 0.005325
```

```
Sb 0.0006575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00565
Pb 0.0007
Mo 0.00345
Se 0.000335
end

SOLUTION 4 #G316 (C - LCU)
redox pe
units mg/l
density 1
pH 6.96
pe 1.9
temp 15.3
S(6) 711 as SO4
B 0.4155
Li 0.0021
As 0.0081
C(4) 370.5 as CO3
Cl 26 charge
F 0.18045
Ca 196.5
Mg 157.5
Na 104
K 2.105
Ba 0.07015
Si 9.31
P 0.036975
Mn 9.26
Fe 16.65
Al 0.005225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.0042
Se 0.000335
end

SOLUTION 5 #G301 (C - UA)
redox pe
units mg/l
density 1
pH 6.585
pe 0.595
temp 17.3
S(6) 526.5 as SO4
B 2.29
Li 0.0036
As 0.0002725
```

```
C(4) 90.2 as CO3
Cl 12.5 charge
F 0.2535
Ca 111.5
Mg 42.3
Na 116.5
K 1.685
Ba 0.0166
Si 9.775
P 0.005975
Mn 2.17
Fe 0.11985
Al 0.007225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.0012
Co 0.00165
Pb 0.00038
Mo 0.000335
Se 0.000335
end

SOLUTION 6 #G303 (C - UA)
redox pe
units mg/l
density 1
pH 6.97
pe 2.285
temp 16.6
S(6) 731.5 as SO4
B 1.875
Li 0.0359
As 0.0026
C(4) 376 as CO3
Cl 26 charge
F 0.16765
Ca 185
Mg 149.5
Na 164
K 2.655
Ba 0.01665
Si 10.925
P 0.019975
Mn 0.3615
Fe 0.856
Al 0.0112
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0014
Co 0.0021
Pb 0.000605
Mo 0.0018
```

```
Se 0.000335
end

SOLUTION 7 #G305 (C - UA)
redox pe
units mg/l
density 1
pH 7.325
pe 3.12
temp 15.6
S(6) 886.5 as SO4
B 2.28
Li 0.00885
As 0.0012
C(4) 124.5 as CO3
Cl 22 charge
F 0.374
Ca 184
Mg 98.25
Na 132.5
K 0.8245
Ba 0.0317
Si 11
P 0.010975
Mn 0.1692
Fe 0.0165
Al 0.005125
Sb 0.0005575
Be 0.0001975
Cd 0.000235
Cr 0.00445
Co 0.00145
Pb 0.00315
Mo 0.001265
Se 0.000635
end

SOLUTION 8 #G307 (C - UA)
redox pe
units mg/l
density 1
pH 7.29
pe 4.37
temp 17
S(6) 530 as SO4
B 2
Li 0.0025
As 0.000345
C(4) 95.9 as CO3
Cl 9.2 charge
F 0.325
Ca 150
Mg 49
Na 77
K 4
```

```
Ba 0.025
Si 11
P 0.00395
Mn 1.8
Fe 0.015
Al 0.0035
Sb 0.000215
Be 0.000295
Cd 0.00037
Cr 0.0014
Co 0.0023
Pb 0.00011
Mo 0.00092
Se 0.00037
end

SOLUTION 9 #G308 (C - UA)
redox pe
units mg/l
density 1
pH 7.3
pe 4.515
temp 16.5
S(6) 998 as SO4
B 2.67
Li 0.00695
As 0.00068
C(4) 141.5 as CO3
Cl 12 charge
F 0.552
Ca 198
Mg 117.5
Na 151
K 0.41
Ba 0.0216
Si 11.1
P 0.005475
Mn 0.3365
Fe 0.00885
Al 0.006225
Sb 0.0002575
Be 0.0001975
Cd 0.000235
Cr 0.00115
Co 0.00032
Pb 0.000205
Mo 0.0015
Se 0.000335
end

SOLUTION 10 #G310 (C - UA)
redox pe
units mg/l
density 1
pH 7.005
```

```
pe 5.55
temp 16.3
S(6) 615.5 as SO4
B 1.825
Li 0.00575
As 0.000455
C(4) 145 as CO3
Cl 14 charge
F 0.273
Ca 154
Mg 50.8
Na 147
K 0.301
Ba 0.01435
Si 9.68
P 0.004975
Mn 0.323
Fe 0.003925
Al 0.005575
Sb 0.0002075
Be 0.0002225
Cd 0.000285
Cr 0.000875
Co 0.0013
Pb 0.00046
Mo 0.000335
Se 0.000335
end

SOLUTION 11 #G312 (C - UA)
redox pe
units mg/l
density 1
pH 6.29
pe 5
temp 17.1
S(6) 857.5 as SO4
B 2.405
Li 0.01345
As 0.0004225
C(4) 304.5 as CO3
Cl 27 charge
F 0.161
Ca 201
Mg 138
Na 105
K 0.64
Ba 0.0298
Si 11.5
P 0.005975
Mn 3.84
Fe 0.0151
Al 0.005125
Sb 0.0002075
```

```
Be 0.0002975
Cd 0.000235
Cr 0.000875
Co 0.003
Pb 0.000205
Mo 0.001685
Se 0.000335
end
SOLUTION 12 #G313 (C - UA)
redox pe
units mg/l
density 1
pH 6.81
pe 3.67
temp 18.2
S(6) 693.5 as SO4
B 3.465
Li 0.01705
As 0.0004225
C(4) 297 as CO3
Cl 22.5 charge
F 0.243
Ca 200
Mg 103
Na 151.5
K 1.065
Ba 0.01865
Si 11.85
P 0.003225
Mn 0.378
Fe 0.07125
Al 0.009125
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0011
Co 0.000785
Pb 0.000205
Mo 0.0012
Se 0.000335
end
SOLUTION 13 #G315 (C - UA)
redox pe
units mg/l
density 1
pH 6.785
pe 5.805
temp 15.25
S(6) 601.5 as SO4
B 1.44
Li 0.00595
As 0.00068
C(4) 138 as CO3
```

```
Cl 14.5 charge
F 0.293
Ca 143.5
Mg 65.8
Na 113.5
K 0.4195
Ba 0.02675
Si 12.45
P 0.009475
Mn 0.273
Fe 0.00618
Al 0.010125
Sb 0.0002575
Be 0.0004475
Cd 0.000235
Cr 0.00225
Co 0.00155
Pb 0.00105
Mo 0.000485
Se 0.000335
end

EQUILIBRIUM_PHASES 1 #G314D (C - DA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.012
Calcite 0 0
Dolomite(ordered) 0 0

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #G307D (C - LCU) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.016
Ferrihydrite 0 0.057
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #G314 (C - LCU) - 25p
Barite 0 0
Gypsum 0 0
```

```
Gibbsite 0 0.016
Ferrihydrite 0 0.057
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
save surface 3
end

EQUILIBRIUM_PHASES 4 #G316 (C - LCU) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.016
Ferrihydrite 0 0.057
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 4
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 4
save surface 4
end

EQUILIBRIUM_PHASES 5 #G301 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 5
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 5
save surface 5
end

EQUILIBRIUM_PHASES 6 #G303 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 6
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 6
```

```
save surface 6
end

EQUILIBRIUM_PHASES 7 #G305 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 7
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 7
save surface 7
end

EQUILIBRIUM_PHASES 8 #G307 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 8
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 8
save surface 8
end

EQUILIBRIUM_PHASES 9 #G308 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 9
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 9
save surface 9
end

EQUILIBRIUM_PHASES 10 #G310 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3
```

```
SURFACE 10
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 10
save surface 10
end

EQUILIBRIUM_PHASES 11 #G312 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 11
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 11
save surface 11
end

EQUILIBRIUM_PHASES 12 #G313 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 12
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 12
save surface 12
end

EQUILIBRIUM_PHASES 13 #G315 (C - UA) - 25p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.098
Ferrihydrite 0 0.0078
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 13
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 13
save surface 13
end

SOLUTION 14 #average background
redox pe
```

```
units mg/l
density 1
pH 6.765
pe 5.54
temp 17.6
S(6) 140.5
B 1.2023
Li 0.00335
As 0.0006375
C(4) 215
Cl 38 charge
F 0.228
Ca 120
Mg 50.5
Na 66.5
K 0.5695
Ba 0.07035
Si 12.2
P 0.0125
Mn 0.18715
Fe 0.009075
Al 0.010125
Sb 0.0003075
Be 0.000295
Cd 0.000235
Cr 0.00255
Co 0.000695
Pb 0.00052
Mo 0.00037
Se 0.000335

SAVE solution 14

end

#FIRST REACTION

#G314D (C - DA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G314D (C - DA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G307D (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
```

```
SAVE equilibrium_phases 2
SAVE surface 2
end

#G307D (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#G314 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G314 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G316 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G316 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G301 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
SAVE surface 5
end

#G301 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
```

```
SAVE surface 5
end

#G303 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G303 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G305 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G305 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G307 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G307 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G308 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end
```

```
#G308 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end

#G310 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G310 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G312 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G312 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G313 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G313 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G315 (C - UA) - First Reaction
USE SOLUTION 14
```

```
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end

#G315 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end
```

75th Percentile Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file COF_845_101_75p_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #G314D (C - DA)
redox pe
units mg/l
density 1
pH 6.96
pe 3.26
temp 15.05
S(6) 1095 as SO4
B 0.16
Li 0.00735
As 0.0008225
C(4) 419.5 as CO3
Cl 61
F 0.6285
Ca 522
Mg 177.15
Na 283
K 3.42
Ba 0.02555
Si 5.7
P 0.003225
Mn 1.205
Fe 2.802
Al 0.004925
Sb 0.0004575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.00355
Se 0.000335
end

SOLUTION 2 #G307D (C - LCU)
redox pe
units mg/l
density 1
```

```
pH 7.245
pe 2.66
temp 19.5
S(6) 599.5 as SO4
B 2.02
Li 0.00285
As 0.00165
C(4) 127.5 as CO3
Cl 15
F 0.5895
Ca 143
Mg 63.2
Na 96.9
K 0.5775
Ba 0.02685
Si 5.53
P 0.00775
Mn 0.4985
Fe 0.595
Al 0.004525
Sb 0.0005075
Be 0.0001975
Cd 0.000235
Cr 0.0012
Co 0.00081
Pb 0.000205
Mo 0.0048
Se 0.000335
end
SOLUTION 3 #G314 (C - LCU)
redox pe
units mg/l
density 1
pH 6.585
pe 3.295
temp 16.4
S(6) 2035 as SO4
B 0.16
Li 0.0093
As 0.0012
C(4) 411 as CO3
Cl 30.5
F 0.1975
Ca 440.5
Mg 189
Na 263
K 3.58
Ba 0.02765
Si 5.775
P 0.003225
Mn 1.82
Fe 3.32
Al 0.005325
```

```
Sb 0.0006575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00565
Pb 0.0007
Mo 0.00345
Se 0.000335
end

SOLUTION 4 #G316 (C - LCU)
redox pe
units mg/l
density 1
pH 6.96
pe 1.9
temp 15.3
S(6) 711 as SO4
B 0.4155
Li 0.0021
As 0.0081
C(4) 370.5 as CO3
Cl 26
F 0.18045
Ca 196.5
Mg 157.5
Na 104
K 2.105
Ba 0.07015
Si 9.31
P 0.036975
Mn 9.26
Fe 16.65
Al 0.005225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.0042
Se 0.000335
end

SOLUTION 5 #G301 (C - UA)
redox pe
units mg/l
density 1
pH 6.585
pe 0.595
temp 17.3
S(6) 526.5 as SO4
B 2.29
Li 0.0036
As 0.0002725
```

```
C(4) 90.2 as CO3
Cl 12.5
F 0.2535
Ca 111.5
Mg 42.3
Na 116.5
K 1.685
Ba 0.0166
Si 9.775
P 0.005975
Mn 2.17
Fe 0.11985
Al 0.007225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.0012
Co 0.00165
Pb 0.00038
Mo 0.000335
Se 0.000335
end

SOLUTION 6 #G303 (C - UA)
redox pe
units mg/l
density 1
pH 6.97
pe 2.285
temp 16.6
S(6) 731.5 as SO4
B 1.875
Li 0.0359
As 0.0026
C(4) 376 as CO3
Cl 26
F 0.16765
Ca 185
Mg 149.5
Na 164
K 2.655
Ba 0.01665
Si 10.925
P 0.019975
Mn 0.3615
Fe 0.856
Al 0.0112
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0014
Co 0.0021
Pb 0.000605
Mo 0.0018
```

```
Se 0.000335
end

SOLUTION 7 #G305 (C - UA)
redox pe
units mg/l
density 1
pH 7.325
pe 3.12
temp 15.6
S(6) 886.5 as SO4
B 2.28
Li 0.00885
As 0.0012
C(4) 124.5 as CO3
Cl 22
F 0.374
Ca 184
Mg 98.25
Na 132.5
K 0.8245
Ba 0.0317
Si 11
P 0.010975
Mn 0.1692
Fe 0.0165
Al 0.005125
Sb 0.0005575
Be 0.0001975
Cd 0.000235
Cr 0.00445
Co 0.00145
Pb 0.00315
Mo 0.001265
Se 0.000635
end

SOLUTION 8 #G307 (C - UA)
redox pe
units mg/l
density 1
pH 7.29
pe 4.37
temp 17
S(6) 530 as SO4
B 2
Li 0.0025
As 0.000345
C(4) 95.9 as CO3
Cl 9.2
F 0.325
Ca 150
Mg 49
Na 77
K 4
```

```
Ba 0.025
Si 11
P 0.00395
Mn 1.8
Fe 0.015
Al 0.0035
Sb 0.000215
Be 0.000295
Cd 0.00037
Cr 0.0014
Co 0.0023
Pb 0.00011
Mo 0.00092
Se 0.00037
end

SOLUTION 9 #G308 (C - UA)
redox pe
units mg/l
density 1
pH 7.3
pe 4.515
temp 16.5
S(6) 998 as SO4
B 2.67
Li 0.00695
As 0.00068
C(4) 141.5 as CO3
Cl 12
F 0.552
Ca 198
Mg 117.5
Na 151
K 0.41
Ba 0.0216
Si 11.1
P 0.005475
Mn 0.3365
Fe 0.00885
Al 0.006225
Sb 0.0002575
Be 0.0001975
Cd 0.000235
Cr 0.00115
Co 0.00032
Pb 0.000205
Mo 0.0015
Se 0.000335
end

SOLUTION 10 #G310 (C - UA)
redox pe
units mg/l
density 1
pH 7.005
```

```
pe 5.55
temp 16.3
S(6) 615.5 as SO4
B 1.825
Li 0.00575
As 0.000455
C(4) 145 as CO3
Cl 14
F 0.273
Ca 154
Mg 50.8
Na 147
K 0.301
Ba 0.01435
Si 9.68
P 0.004975
Mn 0.323
Fe 0.003925
Al 0.005575
Sb 0.0002075
Be 0.0002225
Cd 0.000285
Cr 0.000875
Co 0.0013
Pb 0.00046
Mo 0.000335
Se 0.000335
end

SOLUTION 11 #G312 (C - UA)
redox pe
units mg/l
density 1
pH 6.29
pe 5
temp 17.1
S(6) 857.5 as SO4
B 2.405
Li 0.01345
As 0.0004225
C(4) 304.5 as CO3
Cl 27
F 0.161
Ca 201
Mg 138
Na 105
K 0.64
Ba 0.0298
Si 11.5
P 0.005975
Mn 3.84
Fe 0.0151
Al 0.005125
Sb 0.0002075
```

```
Be 0.0002975
Cd 0.000235
Cr 0.000875
Co 0.003
Pb 0.000205
Mo 0.001685
Se 0.000335
end

SOLUTION 12 #G313 (C - UA)
redox pe
units mg/l
density 1
pH 6.81
pe 3.67
temp 18.2
S(6) 693.5 as SO4
B 3.465
Li 0.01705
As 0.0004225
C(4) 297 as CO3
Cl 22.5
F 0.243
Ca 200
Mg 103
Na 151.5
K 1.065
Ba 0.01865
Si 11.85
P 0.003225
Mn 0.378
Fe 0.07125
Al 0.009125
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0011
Co 0.000785
Pb 0.000205
Mo 0.0012
Se 0.000335
end

SOLUTION 13 #G315 (C - UA)
redox pe
units mg/l
density 1
pH 6.785
pe 5.805
temp 15.25
S(6) 601.5 as SO4
B 1.44
Li 0.00595
As 0.00068
C(4) 138 as CO3
```

```
Cl 14.5
F 0.293
Ca 143.5
Mg 65.8
Na 113.5
K 0.4195
Ba 0.02675
Si 12.45
P 0.009475
Mn 0.273
Fe 0.00618
Al 0.010125
Sb 0.0002575
Be 0.0004475
Cd 0.000235
Cr 0.00225
Co 0.00155
Pb 0.00105
Mo 0.000485
Se 0.000335
end

EQUILIBRIUM_PHASES 1 #G314D (C - DA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.44
Ferrihydrite 0 0.029
Calcite 0 0
Dolomite(ordered) 0 0

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #G307D (C - LCU) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.06
Ferrihydrite 0 0.097
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #G314 (C - LCU) - 75p
Barite 0 0
Gypsum 0 0
```

```
Gibbsite 0 0.06
Ferrihydrite 0 0.097
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
save surface 3
end

EQUILIBRIUM_PHASES 4 #G316 (C - LCU) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.06
Ferrihydrite 0 0.097
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 4
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 4
save surface 4
end

EQUILIBRIUM_PHASES 5 #G301 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 5
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 5
save surface 5
end

EQUILIBRIUM_PHASES 6 #G303 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 6
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 6
```

```
save surface 6
end

EQUILIBRIUM_PHASES 7 #G305 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 7
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 7
save surface 7
end

EQUILIBRIUM_PHASES 8 #G307 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 8
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 8
save surface 8
end

EQUILIBRIUM_PHASES 9 #G308 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 9
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 9
save surface 9
end

EQUILIBRIUM_PHASES 10 #G310 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3
```

```
SURFACE 10
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 10
save surface 10
end

EQUILIBRIUM_PHASES 11 #G312 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 11
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 11
save surface 11
end

EQUILIBRIUM_PHASES 12 #G313 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 12
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 12
save surface 12
end

EQUILIBRIUM_PHASES 13 #G315 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 13
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 13
save surface 13
end

SOLUTION 14 #average background
redox pe
```

```
units mg/l
density 1
pH 6.765
pe 5.54
temp 17.6
S(6) 140.5
B 1.2023
Li 0.00335
As 0.0006375
C(4) 215
Cl 38 charge
F 0.228
Ca 120
Mg 50.5
Na 66.5
K 0.5695
Ba 0.07035
Si 12.2
P 0.0125
Mn 0.18715
Fe 0.009075
Al 0.010125
Sb 0.0003075
Be 0.000295
Cd 0.000235
Cr 0.00255
Co 0.000695
Pb 0.00052
Mo 0.00037
Se 0.000335

SAVE solution 14

end

#FIRST REACTION

#G314D (C - DA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G314D (C - DA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G307D (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
```

```
SAVE equilibrium_phases 2
SAVE surface 2
end

#G307D (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#G314 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G314 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G316 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G316 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G301 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
SAVE surface 5
end

#G301 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
```

```
SAVE surface 5
end

#G303 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G303 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G305 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G305 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G307 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G307 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G308 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end
```

```
#G308 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end

#G310 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G310 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G312 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G312 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G313 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G313 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G315 (C - UA) - First Reaction
USE SOLUTION 14
```

```
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end

#G315 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end
```

75th Percentile Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file COF_845_101_75p_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #G314D (C - DA)
redox pe
units mg/l
density 1
pH 6.96
pe 3.26
temp 15.05
S(6) 1095 as SO4
B 0.16
Li 0.00735
As 0.0008225
C(4) 419.5 as CO3
Cl 61 charge
F 0.6285
Ca 522
Mg 177.15
Na 283
K 3.42
Ba 0.02555
Si 5.7
P 0.003225
Mn 1.205
Fe 2.802
Al 0.004925
Sb 0.0004575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.00355
Se 0.000335
end

SOLUTION 2 #G307D (C - LCU)
redox pe
units mg/l
density 1
```

```
pH 7.245
pe 2.66
temp 19.5
S(6) 599.5 as SO4
B 2.02
Li 0.00285
As 0.00165
C(4) 127.5 as CO3
Cl 15 charge
F 0.5895
Ca 143
Mg 63.2
Na 96.9
K 0.5775
Ba 0.02685
Si 5.53
P 0.00775
Mn 0.4985
Fe 0.595
Al 0.004525
Sb 0.0005075
Be 0.0001975
Cd 0.000235
Cr 0.0012
Co 0.00081
Pb 0.000205
Mo 0.0048
Se 0.000335
end
SOLUTION 3 #G314 (C - LCU)
redox pe
units mg/l
density 1
pH 6.585
pe 3.295
temp 16.4
S(6) 2035 as SO4
B 0.16
Li 0.0093
As 0.0012
C(4) 411 as CO3
Cl 30.5 charge
F 0.1975
Ca 440.5
Mg 189
Na 263
K 3.58
Ba 0.02765
Si 5.775
P 0.003225
Mn 1.82
Fe 3.32
Al 0.005325
```

```
Sb 0.0006575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00565
Pb 0.0007
Mo 0.00345
Se 0.000335
end

SOLUTION 4 #G316 (C - LCU)
redox pe
units mg/l
density 1
pH 6.96
pe 1.9
temp 15.3
S(6) 711 as SO4
B 0.4155
Li 0.0021
As 0.0081
C(4) 370.5 as CO3
Cl 26 charge
F 0.18045
Ca 196.5
Mg 157.5
Na 104
K 2.105
Ba 0.07015
Si 9.31
P 0.036975
Mn 9.26
Fe 16.65
Al 0.005225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.0042
Se 0.000335
end

SOLUTION 5 #G301 (C - UA)
redox pe
units mg/l
density 1
pH 6.585
pe 0.595
temp 17.3
S(6) 526.5 as SO4
B 2.29
Li 0.0036
As 0.0002725
```

```
C(4) 90.2 as CO3
Cl 12.5 charge
F 0.2535
Ca 111.5
Mg 42.3
Na 116.5
K 1.685
Ba 0.0166
Si 9.775
P 0.005975
Mn 2.17
Fe 0.11985
Al 0.007225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.0012
Co 0.00165
Pb 0.00038
Mo 0.000335
Se 0.000335
end

SOLUTION 6 #G303 (C - UA)
redox pe
units mg/l
density 1
pH 6.97
pe 2.285
temp 16.6
S(6) 731.5 as SO4
B 1.875
Li 0.0359
As 0.0026
C(4) 376 as CO3
Cl 26 charge
F 0.16765
Ca 185
Mg 149.5
Na 164
K 2.655
Ba 0.01665
Si 10.925
P 0.019975
Mn 0.3615
Fe 0.856
Al 0.0112
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0014
Co 0.0021
Pb 0.000605
Mo 0.0018
```

```
Se 0.000335
end
SOLUTION 7 #G305 (C - UA)
redox pe
units mg/l
density 1
pH 7.325
pe 3.12
temp 15.6
S(6) 886.5 as SO4
B 2.28
Li 0.00885
As 0.0012
C(4) 124.5 as CO3
Cl 22 charge
F 0.374
Ca 184
Mg 98.25
Na 132.5
K 0.8245
Ba 0.0317
Si 11
P 0.010975
Mn 0.1692
Fe 0.0165
Al 0.005125
Sb 0.0005575
Be 0.0001975
Cd 0.000235
Cr 0.00445
Co 0.00145
Pb 0.00315
Mo 0.001265
Se 0.000635
end
SOLUTION 8 #G307 (C - UA)
redox pe
units mg/l
density 1
pH 7.29
pe 4.37
temp 17
S(6) 530 as SO4
B 2
Li 0.0025
As 0.000345
C(4) 95.9 as CO3
Cl 9.2 charge
F 0.325
Ca 150
Mg 49
Na 77
K 4
```

```
Ba 0.025
Si 11
P 0.00395
Mn 1.8
Fe 0.015
Al 0.0035
Sb 0.000215
Be 0.000295
Cd 0.00037
Cr 0.0014
Co 0.0023
Pb 0.00011
Mo 0.00092
Se 0.00037
end

SOLUTION 9 #G308 (C - UA)
redox pe
units mg/l
density 1
pH 7.3
pe 4.515
temp 16.5
S(6) 998 as SO4
B 2.67
Li 0.00695
As 0.00068
C(4) 141.5 as CO3
Cl 12 charge
F 0.552
Ca 198
Mg 117.5
Na 151
K 0.41
Ba 0.0216
Si 11.1
P 0.005475
Mn 0.3365
Fe 0.00885
Al 0.006225
Sb 0.0002575
Be 0.0001975
Cd 0.000235
Cr 0.00115
Co 0.00032
Pb 0.000205
Mo 0.0015
Se 0.000335
end

SOLUTION 10 #G310 (C - UA)
redox pe
units mg/l
density 1
pH 7.005
```

```
pe 5.55
temp 16.3
S(6) 615.5 as SO4
B 1.825
Li 0.00575
As 0.000455
C(4) 145 as CO3
Cl 14 charge
F 0.273
Ca 154
Mg 50.8
Na 147
K 0.301
Ba 0.01435
Si 9.68
P 0.004975
Mn 0.323
Fe 0.003925
Al 0.005575
Sb 0.0002075
Be 0.0002225
Cd 0.000285
Cr 0.000875
Co 0.0013
Pb 0.00046
Mo 0.000335
Se 0.000335
end

SOLUTION 11 #G312 (C - UA)
redox pe
units mg/l
density 1
pH 6.29
pe 5
temp 17.1
S(6) 857.5 as SO4
B 2.405
Li 0.01345
As 0.0004225
C(4) 304.5 as CO3
Cl 27 charge
F 0.161
Ca 201
Mg 138
Na 105
K 0.64
Ba 0.0298
Si 11.5
P 0.005975
Mn 3.84
Fe 0.0151
Al 0.005125
Sb 0.0002075
```

```
Be 0.0002975
Cd 0.000235
Cr 0.000875
Co 0.003
Pb 0.000205
Mo 0.001685
Se 0.000335
end
SOLUTION 12 #G313 (C - UA)
redox pe
units mg/l
density 1
pH 6.81
pe 3.67
temp 18.2
S(6) 693.5 as SO4
B 3.465
Li 0.01705
As 0.0004225
C(4) 297 as CO3
Cl 22.5 charge
F 0.243
Ca 200
Mg 103
Na 151.5
K 1.065
Ba 0.01865
Si 11.85
P 0.003225
Mn 0.378
Fe 0.07125
Al 0.009125
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0011
Co 0.000785
Pb 0.000205
Mo 0.0012
Se 0.000335
end
SOLUTION 13 #G315 (C - UA)
redox pe
units mg/l
density 1
pH 6.785
pe 5.805
temp 15.25
S(6) 601.5 as SO4
B 1.44
Li 0.00595
As 0.00068
C(4) 138 as CO3
```

```
Cl 14.5 charge
F 0.293
Ca 143.5
Mg 65.8
Na 113.5
K 0.4195
Ba 0.02675
Si 12.45
P 0.009475
Mn 0.273
Fe 0.00618
Al 0.010125
Sb 0.0002575
Be 0.0004475
Cd 0.000235
Cr 0.00225
Co 0.00155
Pb 0.00105
Mo 0.000485
Se 0.000335
end

EQUILIBRIUM_PHASES 1 #G314D (C - DA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.44
Ferrihydrite 0 0.029
Calcite 0 0
Dolomite(ordered) 0 0

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #G307D (C - LCU) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.06
Ferrihydrite 0 0.097
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #G314 (C - LCU) - 75p
Barite 0 0
Gypsum 0 0
```

```
Gibbsite 0 0.06
Ferrihydrite 0 0.097
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
save surface 3
end

EQUILIBRIUM_PHASES 4 #G316 (C - LCU) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.06
Ferrihydrite 0 0.097
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 4
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 4
save surface 4
end

EQUILIBRIUM_PHASES 5 #G301 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 5
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 5
save surface 5
end

EQUILIBRIUM_PHASES 6 #G303 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 6
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 6
```

```
save surface 6
end

EQUILIBRIUM_PHASES 7 #G305 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 7
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 7
save surface 7
end

EQUILIBRIUM_PHASES 8 #G307 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 8
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 8
save surface 8
end

EQUILIBRIUM_PHASES 9 #G308 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 9
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 9
save surface 9
end

EQUILIBRIUM_PHASES 10 #G310 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3
```

```
SURFACE 10
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 10
save surface 10
end

EQUILIBRIUM_PHASES 11 #G312 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 11
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 11
save surface 11
end

EQUILIBRIUM_PHASES 12 #G313 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 12
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 12
save surface 12
end

EQUILIBRIUM_PHASES 13 #G315 (C - UA) - 75p
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.12
Ferrihydrite 0 0.015
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 13
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 13
save surface 13
end

SOLUTION 14 #average background
redox pe
```

```
units mg/l
density 1
pH 6.765
pe 5.54
temp 17.6
S(6) 140.5
B 1.2023
Li 0.00335
As 0.0006375
C(4) 215
Cl 38 charge
F 0.228
Ca 120
Mg 50.5
Na 66.5
K 0.5695
Ba 0.07035
Si 12.2
P 0.0125
Mn 0.18715
Fe 0.009075
Al 0.010125
Sb 0.0003075
Be 0.000295
Cd 0.000235
Cr 0.00255
Co 0.000695
Pb 0.00052
Mo 0.00037
Se 0.000335

SAVE solution 14

end

#FIRST REACTION

#G314D (C - DA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G314D (C - DA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G307D (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
```

```
SAVE equilibrium_phases 2
SAVE surface 2
end

#G307D (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#G314 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G314 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G316 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G316 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G301 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
SAVE surface 5
end

#G301 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
```

```
SAVE surface 5
end

#G303 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G303 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G305 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G305 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G307 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G307 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G308 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end
```

```
#G308 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end

#G310 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G310 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G312 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G312 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G313 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G313 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G315 (C - UA) - First Reaction
USE SOLUTION 14
```

```
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end

#G315 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end
```

Median Metal Oxides/No Charge Balance

```
SELECTED_OUTPUT 1
-file COF_845_101_median_cb-false_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #G314D (C - DA)
redox pe
units mg/l
density 1
pH 6.96
pe 3.26
temp 15.05
S(6) 1095 as SO4
B 0.16
Li 0.00735
As 0.0008225
C(4) 419.5 as CO3
Cl 61
F 0.6285
Ca 522
Mg 177.15
Na 283
K 3.42
Ba 0.02555
Si 5.7
P 0.003225
Mn 1.205
Fe 2.802
Al 0.004925
Sb 0.0004575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.00355
Se 0.000335
end

SOLUTION 2 #G307D (C - LCU)
redox pe
units mg/l
density 1
```

```
pH 7.245
pe 2.66
temp 19.5
S(6) 599.5 as SO4
B 2.02
Li 0.00285
As 0.00165
C(4) 127.5 as CO3
Cl 15
F 0.5895
Ca 143
Mg 63.2
Na 96.9
K 0.5775
Ba 0.02685
Si 5.53
P 0.00775
Mn 0.4985
Fe 0.595
Al 0.004525
Sb 0.0005075
Be 0.0001975
Cd 0.000235
Cr 0.0012
Co 0.00081
Pb 0.000205
Mo 0.0048
Se 0.000335
end
SOLUTION 3 #G314 (C - LCU)
redox pe
units mg/l
density 1
pH 6.585
pe 3.295
temp 16.4
S(6) 2035 as SO4
B 0.16
Li 0.0093
As 0.0012
C(4) 411 as CO3
Cl 30.5
F 0.1975
Ca 440.5
Mg 189
Na 263
K 3.58
Ba 0.02765
Si 5.775
P 0.003225
Mn 1.82
Fe 3.32
Al 0.005325
```

```
Sb 0.0006575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00565
Pb 0.0007
Mo 0.00345
Se 0.000335
end

SOLUTION 4 #G316 (C - LCU)
redox pe
units mg/l
density 1
pH 6.96
pe 1.9
temp 15.3
S(6) 711 as SO4
B 0.4155
Li 0.0021
As 0.0081
C(4) 370.5 as CO3
Cl 26
F 0.18045
Ca 196.5
Mg 157.5
Na 104
K 2.105
Ba 0.07015
Si 9.31
P 0.036975
Mn 9.26
Fe 16.65
Al 0.005225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.0042
Se 0.000335
end

SOLUTION 5 #G301 (C - UA)
redox pe
units mg/l
density 1
pH 6.585
pe 0.595
temp 17.3
S(6) 526.5 as SO4
B 2.29
Li 0.0036
As 0.0002725
```

```
C(4) 90.2 as CO3
Cl 12.5
F 0.2535
Ca 111.5
Mg 42.3
Na 116.5
K 1.685
Ba 0.0166
Si 9.775
P 0.005975
Mn 2.17
Fe 0.11985
Al 0.007225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.0012
Co 0.00165
Pb 0.00038
Mo 0.000335
Se 0.000335
end

SOLUTION 6 #G303 (C - UA)
redox pe
units mg/l
density 1
pH 6.97
pe 2.285
temp 16.6
S(6) 731.5 as SO4
B 1.875
Li 0.0359
As 0.0026
C(4) 376 as CO3
Cl 26
F 0.16765
Ca 185
Mg 149.5
Na 164
K 2.655
Ba 0.01665
Si 10.925
P 0.019975
Mn 0.3615
Fe 0.856
Al 0.0112
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0014
Co 0.0021
Pb 0.000605
Mo 0.0018
```

```
Se 0.000335
end

SOLUTION 7 #G305 (C - UA)
redox pe
units mg/l
density 1
pH 7.325
pe 3.12
temp 15.6
S(6) 886.5 as SO4
B 2.28
Li 0.00885
As 0.0012
C(4) 124.5 as CO3
Cl 22
F 0.374
Ca 184
Mg 98.25
Na 132.5
K 0.8245
Ba 0.0317
Si 11
P 0.010975
Mn 0.1692
Fe 0.0165
Al 0.005125
Sb 0.0005575
Be 0.0001975
Cd 0.000235
Cr 0.00445
Co 0.00145
Pb 0.00315
Mo 0.001265
Se 0.000635
end

SOLUTION 8 #G307 (C - UA)
redox pe
units mg/l
density 1
pH 7.29
pe 4.37
temp 17
S(6) 530 as SO4
B 2
Li 0.0025
As 0.000345
C(4) 95.9 as CO3
Cl 9.2
F 0.325
Ca 150
Mg 49
Na 77
K 4
```

```
Ba 0.025
Si 11
P 0.00395
Mn 1.8
Fe 0.015
Al 0.0035
Sb 0.000215
Be 0.000295
Cd 0.00037
Cr 0.0014
Co 0.0023
Pb 0.00011
Mo 0.00092
Se 0.00037
end

SOLUTION 9 #G308 (C - UA)
redox pe
units mg/l
density 1
pH 7.3
pe 4.515
temp 16.5
S(6) 998 as SO4
B 2.67
Li 0.00695
As 0.00068
C(4) 141.5 as CO3
Cl 12
F 0.552
Ca 198
Mg 117.5
Na 151
K 0.41
Ba 0.0216
Si 11.1
P 0.005475
Mn 0.3365
Fe 0.00885
Al 0.006225
Sb 0.0002575
Be 0.0001975
Cd 0.000235
Cr 0.00115
Co 0.00032
Pb 0.000205
Mo 0.0015
Se 0.000335
end

SOLUTION 10 #G310 (C - UA)
redox pe
units mg/l
density 1
pH 7.005
```

```
pe 5.55
temp 16.3
S(6) 615.5 as SO4
B 1.825
Li 0.00575
As 0.000455
C(4) 145 as CO3
Cl 14
F 0.273
Ca 154
Mg 50.8
Na 147
K 0.301
Ba 0.01435
Si 9.68
P 0.004975
Mn 0.323
Fe 0.003925
Al 0.005575
Sb 0.0002075
Be 0.0002225
Cd 0.000285
Cr 0.000875
Co 0.0013
Pb 0.00046
Mo 0.000335
Se 0.000335
end

SOLUTION 11 #G312 (C - UA)
redox pe
units mg/l
density 1
pH 6.29
pe 5
temp 17.1
S(6) 857.5 as SO4
B 2.405
Li 0.01345
As 0.0004225
C(4) 304.5 as CO3
Cl 27
F 0.161
Ca 201
Mg 138
Na 105
K 0.64
Ba 0.0298
Si 11.5
P 0.005975
Mn 3.84
Fe 0.0151
Al 0.005125
Sb 0.0002075
```

```
Be 0.0002975
Cd 0.000235
Cr 0.000875
Co 0.003
Pb 0.000205
Mo 0.001685
Se 0.000335
end
SOLUTION 12 #G313 (C - UA)
redox pe
units mg/l
density 1
pH 6.81
pe 3.67
temp 18.2
S(6) 693.5 as SO4
B 3.465
Li 0.01705
As 0.0004225
C(4) 297 as CO3
Cl 22.5
F 0.243
Ca 200
Mg 103
Na 151.5
K 1.065
Ba 0.01865
Si 11.85
P 0.003225
Mn 0.378
Fe 0.07125
Al 0.009125
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0011
Co 0.000785
Pb 0.000205
Mo 0.0012
Se 0.000335
end
SOLUTION 13 #G315 (C - UA)
redox pe
units mg/l
density 1
pH 6.785
pe 5.805
temp 15.25
S(6) 601.5 as SO4
B 1.44
Li 0.00595
As 0.00068
C(4) 138 as CO3
```

```
Cl 14.5
F 0.293
Ca 143.5
Mg 65.8
Na 113.5
K 0.4195
Ba 0.02675
Si 12.45
P 0.009475
Mn 0.273
Fe 0.00618
Al 0.010125
Sb 0.0002575
Be 0.0004475
Cd 0.000235
Cr 0.00225
Co 0.00155
Pb 0.00105
Mo 0.000485
Se 0.000335
end

EQUILIBRIUM_PHASES 1 #G314D (C - DA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.29
Ferrihydrite 0 0.018
Calcite 0 0
Dolomite(ordered) 0 0

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #G307D (C - LCU) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.024
Ferrihydrite 0 0.077
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #G314 (C - LCU) - median
Barite 0 0
Gypsum 0 0
```

```
Gibbsite 0 0.024
Ferrihydrite 0 0.077
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
save surface 3
end

EQUILIBRIUM_PHASES 4 #G316 (C - LCU) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.024
Ferrihydrite 0 0.077
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 4
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 4
save surface 4
end

EQUILIBRIUM_PHASES 5 #G301 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 5
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 5
save surface 5
end

EQUILIBRIUM_PHASES 6 #G303 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 6
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 6
```

```
save surface 6
end

EQUILIBRIUM_PHASES 7 #G305 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 7
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 7
save surface 7
end

EQUILIBRIUM_PHASES 8 #G307 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 8
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 8
save surface 8
end

EQUILIBRIUM_PHASES 9 #G308 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 9
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 9
save surface 9
end

EQUILIBRIUM_PHASES 10 #G310 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3
```

```
SURFACE 10
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 10
save surface 10
end

EQUILIBRIUM_PHASES 11 #G312 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 11
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 11
save surface 11
end

EQUILIBRIUM_PHASES 12 #G313 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 12
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 12
save surface 12
end

EQUILIBRIUM_PHASES 13 #G315 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 13
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 13
save surface 13
end

SOLUTION 14 #average background
redox pe
```

```
units mg/l
density 1
pH 6.765
pe 5.54
temp 17.6
S(6) 140.5
B 1.2023
Li 0.00335
As 0.0006375
C(4) 215
Cl 38 charge
F 0.228
Ca 120
Mg 50.5
Na 66.5
K 0.5695
Ba 0.07035
Si 12.2
P 0.0125
Mn 0.18715
Fe 0.009075
Al 0.010125
Sb 0.0003075
Be 0.000295
Cd 0.000235
Cr 0.00255
Co 0.000695
Pb 0.00052
Mo 0.00037
Se 0.000335

SAVE solution 14

end

#FIRST REACTION

#G314D (C - DA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G314D (C - DA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G307D (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
```

```
SAVE equilibrium_phases 2
SAVE surface 2
end

#G307D (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#G314 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G314 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G316 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G316 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G301 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
SAVE surface 5
end

#G301 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
```

```
SAVE surface 5
end

#G303 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G303 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G305 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G305 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G307 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G307 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G308 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end
```

```
#G308 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end

#G310 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G310 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G312 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G312 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G313 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G313 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G315 (C - UA) - First Reaction
USE SOLUTION 14
```

```
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end

#G315 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end
```

Median Metal Oxides/Charge Balance on Chloride

```
SELECTED_OUTPUT 1
-file COF_845_101_median_cb-true_out.csv
-charge_balance true
-percent_error true
-totals S(6) B Li As C(4) Cl F Ca Mg Na K Ba Si P Mn Fe Al Sb Be Cd Cr Co Pb Mo Se Hfo_s
Hfo_w Hao_
-molalities Hfo_wOH Hfo_wOH2+ Hfo_wOHSO4-2 Hfo_wSO4- Hfo_wOSi(OH)3
Hfo_wOSiO(OH)2- Hfo_wHCO3 Hfo_wCO3- Hfo_wPO4-2
Hfo_wHPO4- Hfo_wH2PO4 Hfo_sCO3- Hfo_sHCO3
Hfo_sHPO4- Hfo_sH2BO3 Hfo_sH2PO4 Hfo_sOSi(OH)3
Hfo_sOSiO(OH)2- Hfo_sOHSO4-2 Hfo_sSO4-
Hao_SO4- Hao_OHSO4-2 Hao_H2BO3 Hao_H3BO4-
-equilibrium_phases Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum
-saturation_indices Ferrihydrite Gibbsite Barite Calcite Dolomite(ordered) Gypsum

SOLUTION 1 #G314D (C - DA)
redox pe
units mg/l
density 1
pH 6.96
pe 3.26
temp 15.05
S(6) 1095 as SO4
B 0.16
Li 0.00735
As 0.0008225
C(4) 419.5 as CO3
Cl 61 charge
F 0.6285
Ca 522
Mg 177.15
Na 283
K 3.42
Ba 0.02555
Si 5.7
P 0.003225
Mn 1.205
Fe 2.802
Al 0.004925
Sb 0.0004575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.00355
Se 0.000335
end

SOLUTION 2 #G307D (C - LCU)
redox pe
units mg/l
density 1
```

```
pH 7.245
pe 2.66
temp 19.5
S(6) 599.5 as SO4
B 2.02
Li 0.00285
As 0.00165
C(4) 127.5 as CO3
Cl 15 charge
F 0.5895
Ca 143
Mg 63.2
Na 96.9
K 0.5775
Ba 0.02685
Si 5.53
P 0.00775
Mn 0.4985
Fe 0.595
Al 0.004525
Sb 0.0005075
Be 0.0001975
Cd 0.000235
Cr 0.0012
Co 0.00081
Pb 0.000205
Mo 0.0048
Se 0.000335
end
SOLUTION 3 #G314 (C - LCU)
redox pe
units mg/l
density 1
pH 6.585
pe 3.295
temp 16.4
S(6) 2035 as SO4
B 0.16
Li 0.0093
As 0.0012
C(4) 411 as CO3
Cl 30.5 charge
F 0.1975
Ca 440.5
Mg 189
Na 263
K 3.58
Ba 0.02765
Si 5.775
P 0.003225
Mn 1.82
Fe 3.32
Al 0.005325
```

```
Sb 0.0006575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00565
Pb 0.0007
Mo 0.00345
Se 0.000335
end

SOLUTION 4 #G316 (C - LCU)
redox pe
units mg/l
density 1
pH 6.96
pe 1.9
temp 15.3
S(6) 711 as SO4
B 0.4155
Li 0.0021
As 0.0081
C(4) 370.5 as CO3
Cl 26 charge
F 0.18045
Ca 196.5
Mg 157.5
Na 104
K 2.105
Ba 0.07015
Si 9.31
P 0.036975
Mn 9.26
Fe 16.65
Al 0.005225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.000875
Co 0.00265
Pb 0.000205
Mo 0.0042
Se 0.000335
end

SOLUTION 5 #G301 (C - UA)
redox pe
units mg/l
density 1
pH 6.585
pe 0.595
temp 17.3
S(6) 526.5 as SO4
B 2.29
Li 0.0036
As 0.0002725
```

```
C(4) 90.2 as CO3
Cl 12.5 charge
F 0.2535
Ca 111.5
Mg 42.3
Na 116.5
K 1.685
Ba 0.0166
Si 9.775
P 0.005975
Mn 2.17
Fe 0.11985
Al 0.007225
Sb 0.0003575
Be 0.0002225
Cd 0.000235
Cr 0.0012
Co 0.00165
Pb 0.00038
Mo 0.000335
Se 0.000335
end

SOLUTION 6 #G303 (C - UA)
redox pe
units mg/l
density 1
pH 6.97
pe 2.285
temp 16.6
S(6) 731.5 as SO4
B 1.875
Li 0.0359
As 0.0026
C(4) 376 as CO3
Cl 26 charge
F 0.16765
Ca 185
Mg 149.5
Na 164
K 2.655
Ba 0.01665
Si 10.925
P 0.019975
Mn 0.3615
Fe 0.856
Al 0.0112
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0014
Co 0.0021
Pb 0.000605
Mo 0.0018
```

```
Se 0.000335
end

SOLUTION 7 #G305 (C - UA)
redox pe
units mg/l
density 1
pH 7.325
pe 3.12
temp 15.6
S(6) 886.5 as SO4
B 2.28
Li 0.00885
As 0.0012
C(4) 124.5 as CO3
Cl 22 charge
F 0.374
Ca 184
Mg 98.25
Na 132.5
K 0.8245
Ba 0.0317
Si 11
P 0.010975
Mn 0.1692
Fe 0.0165
Al 0.005125
Sb 0.0005575
Be 0.0001975
Cd 0.000235
Cr 0.00445
Co 0.00145
Pb 0.00315
Mo 0.001265
Se 0.000635
end

SOLUTION 8 #G307 (C - UA)
redox pe
units mg/l
density 1
pH 7.29
pe 4.37
temp 17
S(6) 530 as SO4
B 2
Li 0.0025
As 0.000345
C(4) 95.9 as CO3
Cl 9.2 charge
F 0.325
Ca 150
Mg 49
Na 77
K 4
```

```
Ba 0.025
Si 11
P 0.00395
Mn 1.8
Fe 0.015
Al 0.0035
Sb 0.000215
Be 0.000295
Cd 0.00037
Cr 0.0014
Co 0.0023
Pb 0.00011
Mo 0.00092
Se 0.00037
end

SOLUTION 9 #G308 (C - UA)
redox pe
units mg/l
density 1
pH 7.3
pe 4.515
temp 16.5
S(6) 998 as SO4
B 2.67
Li 0.00695
As 0.00068
C(4) 141.5 as CO3
Cl 12 charge
F 0.552
Ca 198
Mg 117.5
Na 151
K 0.41
Ba 0.0216
Si 11.1
P 0.005475
Mn 0.3365
Fe 0.00885
Al 0.006225
Sb 0.0002575
Be 0.0001975
Cd 0.000235
Cr 0.00115
Co 0.00032
Pb 0.000205
Mo 0.0015
Se 0.000335
end

SOLUTION 10 #G310 (C - UA)
redox pe
units mg/l
density 1
pH 7.005
```

```
pe 5.55
temp 16.3
S(6) 615.5 as SO4
B 1.825
Li 0.00575
As 0.000455
C(4) 145 as CO3
Cl 14 charge
F 0.273
Ca 154
Mg 50.8
Na 147
K 0.301
Ba 0.01435
Si 9.68
P 0.004975
Mn 0.323
Fe 0.003925
Al 0.005575
Sb 0.0002075
Be 0.0002225
Cd 0.000285
Cr 0.000875
Co 0.0013
Pb 0.00046
Mo 0.000335
Se 0.000335
end

SOLUTION 11 #G312 (C - UA)
redox pe
units mg/l
density 1
pH 6.29
pe 5
temp 17.1
S(6) 857.5 as SO4
B 2.405
Li 0.01345
As 0.0004225
C(4) 304.5 as CO3
Cl 27 charge
F 0.161
Ca 201
Mg 138
Na 105
K 0.64
Ba 0.0298
Si 11.5
P 0.005975
Mn 3.84
Fe 0.0151
Al 0.005125
Sb 0.0002075
```

```
Be 0.0002975
Cd 0.000235
Cr 0.000875
Co 0.003
Pb 0.000205
Mo 0.001685
Se 0.000335
end

SOLUTION 12 #G313 (C - UA)
redox pe
units mg/l
density 1
pH 6.81
pe 3.67
temp 18.2
S(6) 693.5 as SO4
B 3.465
Li 0.01705
As 0.0004225
C(4) 297 as CO3
Cl 22.5 charge
F 0.243
Ca 200
Mg 103
Na 151.5
K 1.065
Ba 0.01865
Si 11.85
P 0.003225
Mn 0.378
Fe 0.07125
Al 0.009125
Sb 0.0002075
Be 0.0002225
Cd 0.000235
Cr 0.0011
Co 0.000785
Pb 0.000205
Mo 0.0012
Se 0.000335
end

SOLUTION 13 #G315 (C - UA)
redox pe
units mg/l
density 1
pH 6.785
pe 5.805
temp 15.25
S(6) 601.5 as SO4
B 1.44
Li 0.00595
As 0.00068
C(4) 138 as CO3
```

```
Cl 14.5 charge
F 0.293
Ca 143.5
Mg 65.8
Na 113.5
K 0.4195
Ba 0.02675
Si 12.45
P 0.009475
Mn 0.273
Fe 0.00618
Al 0.010125
Sb 0.0002575
Be 0.0004475
Cd 0.000235
Cr 0.00225
Co 0.00155
Pb 0.00105
Mo 0.000485
Se 0.000335
end

EQUILIBRIUM_PHASES 1 #G314D (C - DA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.29
Ferrihydrite 0 0.018
Calcite 0 0
Dolomite(ordered) 0 0

SURFACE 1
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 1
save surface 1
end

EQUILIBRIUM_PHASES 2 #G307D (C - LCU) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.024
Ferrihydrite 0 0.077
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 2
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 2
save surface 2
end

EQUILIBRIUM_PHASES 3 #G314 (C - LCU) - median
Barite 0 0
Gypsum 0 0
```

```
Gibbsite 0 0.024
Ferrihydrite 0 0.077
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 3
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 3
save surface 3
end

EQUILIBRIUM_PHASES 4 #G316 (C - LCU) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.024
Ferrihydrite 0 0.077
Calcite 0 1
Dolomite(ordered) 0 2

SURFACE 4
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 4
save surface 4
end

EQUILIBRIUM_PHASES 5 #G301 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 5
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 5
save surface 5
end

EQUILIBRIUM_PHASES 6 #G303 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 6
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 6
```

```
save surface 6
end

EQUILIBRIUM_PHASES 7 #G305 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 7
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 7
save surface 7
end

EQUILIBRIUM_PHASES 8 #G307 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 8
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 8
save surface 8
end

EQUILIBRIUM_PHASES 9 #G308 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 9
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 9
save surface 9
end

EQUILIBRIUM_PHASES 10 #G310 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3
```

```
SURFACE 10
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 10
save surface 10
end

EQUILIBRIUM_PHASES 11 #G312 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 11
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 11
save surface 11
end

EQUILIBRIUM_PHASES 12 #G313 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 12
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 12
save surface 12
end

EQUILIBRIUM_PHASES 13 #G315 (C - UA) - median
Barite 0 0
Gypsum 0 0
Gibbsite 0 0.11
Ferrihydrite 0 0.013
Calcite 0 0.9
Dolomite(ordered) 0 3

SURFACE 13
Hfo_wOH Ferrihydrite equilibrium_phase 0.2 53400
Hfo_sOH Ferrihydrite equilibrium_phase 0.005 53400
Hao_OH Gibbsite equilibrium_phase 0.033 2496
-equil 13
save surface 13
end

SOLUTION 14 #average background
redox pe
```

```
units mg/l
density 1
pH 6.765
pe 5.54
temp 17.6
S(6) 140.5
B 1.2023
Li 0.00335
As 0.0006375
C(4) 215
Cl 38 charge
F 0.228
Ca 120
Mg 50.5
Na 66.5
K 0.5695
Ba 0.07035
Si 12.2
P 0.0125
Mn 0.18715
Fe 0.009075
Al 0.010125
Sb 0.0003075
Be 0.000295
Cd 0.000235
Cr 0.00255
Co 0.000695
Pb 0.00052
Mo 0.00037
Se 0.000335

SAVE solution 14

end

#FIRST REACTION

#G314D (C - DA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G314D (C - DA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 1
USE SURFACE 1
SAVE equilibrium_phases 1
SAVE surface 1
end

#G307D (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
```

```
SAVE equilibrium_phases 2
SAVE surface 2
end

#G307D (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 2
USE SURFACE 2
SAVE equilibrium_phases 2
SAVE surface 2
end

#G314 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G314 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 3
USE SURFACE 3
SAVE equilibrium_phases 3
SAVE surface 3
end

#G316 (C - LCU) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G316 (C - LCU) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 4
USE SURFACE 4
SAVE equilibrium_phases 4
SAVE surface 4
end

#G301 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
SAVE surface 5
end

#G301 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 5
USE SURFACE 5
SAVE equilibrium_phases 5
```

```
SAVE surface 5
end

#G303 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G303 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 6
USE SURFACE 6
SAVE equilibrium_phases 6
SAVE surface 6
end

#G305 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G305 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 7
USE SURFACE 7
SAVE equilibrium_phases 7
SAVE surface 7
end

#G307 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G307 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 8
USE SURFACE 8
SAVE equilibrium_phases 8
SAVE surface 8
end

#G308 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end
```

```
#G308 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 9
USE SURFACE 9
SAVE equilibrium_phases 9
SAVE surface 9
end

#G310 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G310 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 10
USE SURFACE 10
SAVE equilibrium_phases 10
SAVE surface 10
end

#G312 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G312 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 11
USE SURFACE 11
SAVE equilibrium_phases 11
SAVE surface 11
end

#G313 (C - UA) - First Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G313 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 12
USE SURFACE 12
SAVE equilibrium_phases 12
SAVE surface 12
end

#G315 (C - UA) - First Reaction
USE SOLUTION 14
```

```
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end

#G315 (C - UA) - Second Reaction
USE SOLUTION 14
USE EQUILIBRIUM_PHASES 13
USE SURFACE 13
SAVE equilibrium_phases 13
SAVE surface 13
end
```

Database

```
#$Id: minteq.v4.dat 12387 2017-02-09 16:41:47Z dlpark $
SOLUTION_MASTER_SPECIES
Alkalinity CO3-2 2.0 HCO3 61.0173
E e- 0 0 0
O H2O 0 O 16.00
O(-2) H2O 0 O
O(0) O2 0 O
Ag Ag+ 0.0 Ag 107.868
Al Al+3 0.0 Al 26.9815
As H3AsO4 -1.0 As 74.9216
As(3) H3AsO3 0.0 As
As(5) H3AsO4 -1.0 As
B H3BO3 0.0 B 10.81
Ba Ba+2 0.0 Ba 137.33
Be Be+2 0.0 Be 9.0122
Br Br- 0.0 Br 79.904
C CO3-2 2.0 CO3 12.0111
C(4) CO3-2 2.0 CO3 12.0111
Cyanide Cyanide- 1.0 Cyanide 26.0177
Dom_a Dom_a 0.0 C 12.0111
Dom_b Dom_b 0.0 C 12.0111
Dom_c Dom_c 0.0 C 12.0111
Ca Ca+2 0.0 Ca 40.078
Cd Cd+2 0.0 Cd 112.41
Cl Cl- 0.0 Cl 35.453
Co Co+3 -1.0 Co 58.9332
Co(2) Co+2 0.0 Co
Co(3) Co+3 -1.0 Co
Cr CrO4-2 1.0 Cr 51.996
Cr(2) Cr+2 0.0 Cr
Cr(3) Cr(OH)2+ 0.0 Cr
Cr(6) CrO4-2 1.0 Cr
Cu Cu+2 0.0 Cu 63.546
Cu(1) Cu+ 0.0 Cu
Cu(2) Cu+2 0.0 Cu
F F- 0.0 F 18.9984
Fe Fe+3 -2.0 Fe 55.847
Fe(2) Fe+2 0.0 Fe
Fe(3) Fe+3 -2.0 Fe
H H+ -1.0 H 1.0079
H(0) H2 0 H
H(1) H+ -1.0 H
Hg Hg(OH)2 0.0 Hg 200.59
Hg(0) Hg 0.0 Hg
Hg(1) Hg2+2 0.0 Hg
Hg(2) Hg(OH)2 0.0 Hg
I I- 0.0 I 126.904
K K+ 0.0 K 39.0983
Li Li+ 0.0 Li 6.941
Mg Mg+2 0.0 Mg 24.305
Mn Mn+3 0.0 Mn 54.938
```

Mn(2) Mn+2 0.0 Mn
Mn(3) Mn+3 0.0 Mn
Mn(6) MnO4-2 0.0 Mn
Mn(7) MnO4- 0.0 Mn
Mo MoO4-2 0.0 Mo 95.94
N NO3- 0.0 N 14.0067
N(-3) NH4+ 0.0 N
N(3) NO2- 0.0 N
N(5) NO3- 0.0 N
Na Na+ 0.0 Na 22.9898
Ni Ni+2 0.0 Ni 58.69
P PO4-3 2.0 P 30.9738
Pb Pb+2 0.0 Pb 207.2
S SO4-2 0.0 SO4 32.066
S(-2) HS- 1.0 S
#S(0) S 0.0 S
S(6) SO4-2 0.0 SO4
Sb Sb(OH)6- 0.0 Sb 121.75
Sb(3) Sb(OH)3 0.0 Sb
Sb(5) Sb(OH)6- 0.0 Sb
Se SeO4-2 0.0 Se 78.96
Se(-2) HSe- 0.0 Se
Se(4) HSeO3- 0.0 Se
Se(6) SeO4-2 0.0 Se
Si H4SiO4 0.0 SiO2 28.0843
Sn Sn(OH)6-2 0.0 Sn 118.71
Sn(2) Sn(OH)2 0.0 Sn
Sn(4) Sn(OH)6-2 0.0 Sn
Sr Sr+2 0.0 Sr 87.62
Tl Tl(OH)3 0.0 Tl 204.383
Tl(1) Tl+ 0.0 Tl
Tl(3) Tl(OH)3 0.0 Tl
U UO2+2 0.0 U 238.029
U(3) U+3 0.0 U
U(4) U+4 -4.0 U
U(5) UO2+ 0.0 U
U(6) UO2+2 0.0 U
V VO2+ -2.0 V 50.94
V(2) V+2 0.0 V
V(3) V+3 -3.0 V
V(4) VO+2 0.0 V
V(5) VO2+ -2.0 V
Zn Zn+2 0.0 Zn 65.39
Benzoate Benzoate- 0.0 121.116 121.116
Phenylacetate Phenylacetate- 0.0 135.142 135.142
Isophthalate Isophthalate-2 0.0 164.117 164.117
Diethylamine Diethylamine 1.0 73.138 73.138
Butylamine Butylamine 1.0 73.138 73.138
Methylamine Methylamine 1.0 31.057 31.057
Dimethylamine Dimethylamine 1.0 45.084 45.084
Hexylamine Hexylamine 1.0 101.192 101.192
Ethylenediamine Ethylenediamine 2.0 60.099 60.099
Propylamine Propylamine 1.0 59.111 59.111
Isopropylamine Isopropylamine 1.0 59.111 59.111

```
Trimethylamine Trimethylamine 1.0 59.111 59.111
Citrate Citrate-3 2.0 189.102 189.102
Nta Nta-3 1.0 188.117 188.117
Edta Edta-4 2.0 288.214 288.214
Propionate Propionate- 1.0 73.072 73.072
Butyrate Butyrate- 1.0 87.098 87.098
Isobutyrate Isobutyrate- 1.0 87.098 87.098
Two_picoline Two_picoline 1.0 93.128 93.128
Three_picoline Three_picoline 1.0 93.128 93.128
Four_picoline Four_picoline 1.0 93.128 93.128
Formate Formate- 0.0 45.018 45.018
Isovalerate Isovalerate- 1.0 101.125 101.125
Valerate Valerate- 1.0 101.125 101.125
Acetate Acetate- 1.0 59.045 59.045
Tartarate Tartarate-2 0.0 148.072 148.072
Glycine Glycine- 1.0 74.059 74.059
Salicylate Salicylate-2 1.0 136.107 136.107
Glutamate Glutamate-2 1.0 145.115 145.115
Phthalate Phthalate-2 1.0 164.117 164.117
SOLUTION_SPECIES
e- = e-
log_k 0
H2O = H2O
log_k 0
Ag+ = Ag+
log_k 0
Al+3 = Al+3
log_k 0
H3AsO4 = H3AsO4
log_k 0
H3BO3 = H3BO3
log_k 0
Ba+2 = Ba+2
log_k 0
Be+2 = Be+2
log_k 0
Br- = Br-
log_k 0
CO3-2 = CO3-2
log_k 0
Cyanide- = Cyanide-
log_k 0
Dom_a = Dom_a
log_k 0
Dom_b = Dom_b
log_k 0
Dom_c = Dom_c
log_k 0
Ca+2 = Ca+2
log_k 0
Cd+2 = Cd+2
log_k 0
Cl- = Cl-
log_k 0
```

Co+3 = Co+3
log_k 0
CrO4-2 = CrO4-2
log_k 0
Cu+2 = Cu+2
log_k 0
F- = F-
log_k 0
Fe+3 = Fe+3
log_k 0
H+ = H+
log_k 0
Hg(OH)2 = Hg(OH)2
log_k 0
I- = I-
log_k 0
K+ = K+
log_k 0
Li+ = Li+
log_k 0
Mg+2 = Mg+2
log_k 0
Mn+3 = Mn+3
log_k 0
MoO4-2 = MoO4-2
log_k 0
NO3- = NO3-
log_k 0
Na+ = Na+
log_k 0
Ni+2 = Ni+2
log_k 0
PO4-3 = PO4-3
log_k 0
Pb+2 = Pb+2
log_k 0
SO4-2 = SO4-2
log_k 0
Sb(OH)6- = Sb(OH)6-
log_k 0
SeO4-2 = SeO4-2
log_k 0
H4SiO4 = H4SiO4
log_k 0
Sn(OH)6-2 = Sn(OH)6-2
log_k 0
Sr+2 = Sr+2
log_k 0
Tl(OH)3 = Tl(OH)3
log_k 0
UO2+2 = UO2+2
log_k 0
VO2+ = VO2+
log_k 0

Benzoate- = Benzoate-
log_k 0
Phenylacetate- = Phenylacetate-
log_k 0
Isophthalate-2 = Isophthalate-2
log_k 0
Zn+2 = Zn+2
log_k 0
Diethylamine = Diethylamine
log_k 0
Butylamine = Butylamine
log_k 0
Methylamine = Methylamine
log_k 0
Dimethylamine = Dimethylamine
log_k 0
Hexylamine = Hexylamine
log_k 0
Ethylenediamine = Ethylenediamine
log_k 0
Propylamine = Propylamine
log_k 0
Isopropylamine = Isopropylamine
log_k 0
Trimethylamine = Trimethylamine
log_k 0
Citrate-3 = Citrate-3
log_k 0
Nta-3 = Nta-3
log_k 0
Edta-4 = Edta-4
log_k 0
Propionate- = Propionate-
log_k 0
Butyrate- = Butyrate-
log_k 0
Isobutyrate- = Isobutyrate-
log_k 0
Two_picoline = Two_picoline
log_k 0
Three_picoline = Three_picoline
log_k 0
Four_picoline = Four_picoline
log_k 0
Formate- = Formate-
log_k 0
Isovalerate- = Isovalerate-
log_k 0
Valerate- = Valerate-
log_k 0
Acetate- = Acetate-
log_k 0
Tartarate-2 = Tartarate-2
log_k 0

```
Glycine- = Glycine-
log_k 0
Salicylate-2 = Salicylate-2
log_k 0
Glutamate-2 = Glutamate-2
log_k 0
Phthalate-2 = Phthalate-2
log_k 0
SOLUTION_SPECIES
Fe+3 + e- = Fe+2
log_k 13.032
delta_h -42.7 kJ
-gamma 0 0
# Id: 2802810
# log K source: Bard85
# Delta H source: Bard85
#T and ionic strength:
H3AsO4 + 2e- + 2H+ = H3AsO3 + H2O
log_k 18.898
delta_h -125.6 kJ
-gamma 0 0
# Id: 600610
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Sb(OH)6- + 2e- + 3H+ = Sb(OH)3 + 3H2O
log_k 24.31
delta_h 0 kJ
-gamma 0 0
# Id: 7407410
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 3e- + 4H+ = U+3 + 2H2O
log_k 0.42
delta_h -42 kJ
-gamma 0 0
# Id: 8908930
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 2e- + 4H+ = U+4 + 2H2O
log_k 9.216
delta_h -144.1 kJ
-gamma 0 0
# Id: 8918930
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + e- = UO2+
log_k 2.785
delta_h -13.8 kJ
-gamma 0 0
# Id: 8928930
```

```
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
e- + Mn+3 = Mn+2
log_k 25.35
delta_h -107.8 kJ
-gamma 0 0
# Id: 4704710
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Co+3 + e- = Co+2
log_k 32.4
delta_h 0 kJ
-gamma 0 0
# Id: 2002010
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Cu+2 + e- = Cu+
log_k 2.69
delta_h 6.9 kJ
-gamma 0 0
# Id: 2302310
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
V+3 + e- = V+2
log_k -4.31
delta_h 0 kJ
-gamma 0 0
# Id: 9009010
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
VO+2 + e- + 2H+ = V+3 + H2O
log_k 5.696
delta_h 0 kJ
-gamma 0 0
# Id: 9019020
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
VO2+ + e- + 2H+ = VO+2 + H2O
log_k 16.903
delta_h -122.7 kJ
-gamma 0 0
# Id: 9029030
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
SO4-2 + 9H+ + 8e- = HS- + 4H2O
log_k 33.66
delta_h -60.14 kJ
```

-gamma 0 0
Id: 7307320
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Sn(OH)6-2 + 2e- + 4H+ = Sn(OH)2 + 4H2O
log_k 19.2
delta_h 0 kJ
-gamma 0 0
Id: 7907910
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 2e- + 3H+ = Tl+ + 3H2O
log_k 45.55
delta_h 0 kJ
-gamma 0 0
Id: 8708710
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
HSeO3- + 6e- + 6H+ = HSe- + 3H2O
log_k 44.86
delta_h 0 kJ
-gamma 0 0
Id: 7607610
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
SeO4-2 + 2e- + 3H+ = HSeO3- + H2O
log_k 36.308
delta_h -201.2 kJ
-gamma 0 0
Id: 7617620
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:
0.5Hg2+2 + e- = Hg
log_k 6.5667
delta_h -45.735 kJ
-gamma 0 0
Id: 3600000
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:

2Hg(OH)2 + 4H+ + 2e- = Hg2+2 + 4H2O
log_k 43.185
delta_h -63.59 kJ
-gamma 0 0
Id: 3603610
log K source: Bard85
Delta H source: MTQ3.11
#T and ionic strength:

```
Cr(OH)2+ + 2H+ + e- = Cr+2 + 2H2O
log_k 2.947
delta_h 6.36 kJ
-gamma 0 0
# Id: 2102110
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + 6H+ + 3e- = Cr(OH)2+ + 2H2O
log_k 67.376
delta_h -103 kJ
-gamma 0 0
# Id: 2112120
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:

2H2O = O2 + 4H+ + 4e-
# Adjusted for equation to aqueous species
log_k -85.9951
-analytic 38.0229 7.99407E-03 -2.7655e+004 -1.4506e+001 199838.45

2 H+ + 2 e- = H2
log_k -3.15
delta_h -1.759 kcal

NO3- + 2 H+ + 2 e- = NO2- + H2O
log_k 28.570
delta_h -43.760 kcal
-gamma 3.0000 0.0000

NO3- + 10 H+ + 8 e- = NH4+ + 3 H2O
log_k 119.077
delta_h -187.055 kcal
-gamma 2.5000 0.0000

Mn+2 + 4H2O = MnO4- + 8H+ + 5e-
log_k -127.794
delta_h 822.67 kJ
-gamma 3 0
# Id: 4700020
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Mn+2 + 4H2O = MnO4-2 + 8H+ + 4e-
log_k -118.422
delta_h 711.07 kJ
-gamma 5 0
# Id: 4700021
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S-2 + H+
log_k -17.3
delta_h 49.4 kJ
-gamma 5 0
# Id: 3307301
```

```
# log K source: LMa1987
# Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
HSe- = Se-2 + H+
log_k -15
delta_h 48.116 kJ
-gamma 0 0
# Id: 3307601
# log K source: SCD3.02 (1968 DKa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ = Tl+3 + 3H2O
log_k 3.291
delta_h 0 kJ
-gamma 0 0
# Id: 8713300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
0.5Hg2+2 + e- = Hg
log_k 6.5667
delta_h -45.735 kJ
-gamma 0 0
# Id: 3600000
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + 2H+ = Hg+2 + 2H2O
log_k 6.194
delta_h -39.72 kJ
-gamma 0 0
# Id: 3613300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ = Cr+3 + 2H2O
log_k 9.5688
delta_h -129.62 kJ
-gamma 0 0
# Id: 2113300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.10 20.0
H2O = OH- + H+
log_k -13.997
delta_h 55.81 kJ
-gamma 3.5 0
# Id: 3300020
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ = Sn+2 + 2H2O
log_k 7.094
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 7903301
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sn(OH)2 + H+ = SnOH+ + H2O
log_k 3.697
delta_h 0 kJ
-gamma 0 0
# Id: 7903302
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sn(OH)2 + H2O = Sn(OH)3- + H+
log_k -9.497
delta_h 0 kJ
-gamma 0 0
# Id: 7903303
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Sn(OH)2 + 2H+ = Sn2(OH)2+2 + 2H2O
log_k 9.394
delta_h 0 kJ
-gamma 0 0
# Id: 7903304
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
3Sn(OH)2 + 2H+ = Sn3(OH)4+2 + 2H2O
log_k 14.394
delta_h 0 kJ
-gamma 0 0
# Id: 7903305
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sn(OH)2 = HSnO2- + H+
log_k -8.9347
delta_h 0 kJ
-gamma 0 0
# Id: 7903306
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Sn(OH)6-2 + 6H+ = Sn+4 + 6H2O
log_k 21.2194
delta_h 0 kJ
-gamma 0 0
# Id: 7913301
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Sn(OH)6-2 = SnO3-2 + 3H2O
```

```
log_k -2.2099
delta_h 0 kJ
-gamma 0 0
# Id: 7913302
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Pb+2 + H2O = PbOH+ + H+
log_k -7.597
delta_h 0 kJ
-gamma 0 0
# Id: 6003300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 2H2O = Pb(OH)2 + 2H+
log_k -17.094
delta_h 0 kJ
-gamma 0 0
# Id: 6003301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 3H2O = Pb(OH)3- + 3H+
log_k -28.091
delta_h 0 kJ
-gamma 0 0
# Id: 6003302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Pb+2 + H2O = Pb2OH+3 + H+
log_k -6.397
delta_h 0 kJ
-gamma 0 0
# Id: 6003303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
3Pb+2 + 4H2O = Pb3(OH)4+2 + 4H+
log_k -23.888
delta_h 115.24 kJ
-gamma 0 0
# Id: 6003304
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 4H2O = Pb(OH)4-2 + 4H+
log_k -39.699
delta_h 0 kJ
-gamma 0 0
# Id: 6003305
# log K source: MTQ3.11
# Delta H source: MTQ3.11
```

```
#T and ionic strength:
4Pb+2 + 4H2O = Pb4(OH)4+4 + 4H+
log_k -19.988
delta_h 88.24 kJ
-gamma 0 0
# Id: 6003306
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H3BO3 + F- = BF(OH)3-
log_k -0.399
delta_h 7.7404 kJ
-gamma 2.5 0
# Id: 902700
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
H3BO3 + 2F- + H+ = BF2(OH)2- + H2O
log_k 7.63
delta_h 6.8408 kJ
-gamma 2.5 0
# Id: 902701
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
H3BO3 + 3F- + 2H+ = BF3OH- + 2H2O
log_k 13.22
delta_h -20.4897 kJ
-gamma 2.5 0
# Id: 902702
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Al+3 + H2O = AlOH+2 + H+
log_k -4.997
delta_h 47.81 kJ
-gamma 5.4 0
# Id: 303300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 2H2O = Al(OH)2+ + 2H+
log_k -10.094
delta_h 0 kJ
-gamma 5.4 0
# Id: 303301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Al+3 + 3H2O = Al(OH)3 + 3H+
log_k -16.791
delta_h 0 kJ
-gamma 0 0
# Id: 303303
```

```
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Al+3 + 4H2O = Al(OH)4- + 4H+
log_k -22.688
delta_h 173.24 kJ
-gamma 4.5 0
# Id: 303302
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + H2O = TlOH + H+
log_k -13.207
delta_h 56.81 kJ
-gamma 0 0
# Id: 8703300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 2H+ = TlOH+2 + 2H2O
log_k 2.694
delta_h 0 kJ
-gamma 0 0
# Id: 8713301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + H+ = Tl(OH)2+ + H2O
log_k 1.897
delta_h 0 kJ
-gamma 0 0
# Id: 8713302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl(OH)3 + H2O = Tl(OH)4- + H+
log_k -11.697
delta_h 0 kJ
-gamma 0 0
# Id: 8713303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + H2O = ZnOH+ + H+
log_k -8.997
delta_h 55.81 kJ
-gamma 0 0
# Id: 9503300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2H2O = Zn(OH)2 + 2H+
log_k -17.794
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 9503301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 3H2O = Zn(OH)3- + 3H+
log_k -28.091
delta_h 0 kJ
-gamma 0 0
# Id: 9503302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 4H2O = Zn(OH)4-2 + 4H+
log_k -40.488
delta_h 0 kJ
-gamma 0 0
# Id: 9503303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cd+2 + H2O = CdOH+ + H+
log_k -10.097
delta_h 54.81 kJ
-gamma 0 0
# Id: 1603300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2H2O = Cd(OH)2 + 2H+
log_k -20.294
delta_h 0 kJ
-gamma 0 0
# Id: 1603301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cd+2 + 3H2O = Cd(OH)3- + 3H+
log_k -32.505
delta_h 0 kJ
-gamma 0 0
# Id: 1603302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Cd+2 + 4H2O = Cd(OH)4-2 + 4H+
log_k -47.288
delta_h 0 kJ
-gamma 0 0
# Id: 1603303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Cd+2 + H2O = Cd2OH+3 + H+
```

```
log_k -9.397
delta_h 45.81 kJ
-gamma 0 0
# Id: 1603304
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + H+ = HgOH+ + H2O
log_k 2.797
delta_h -18.91 kJ
-gamma 0 0
# Id: 3613302
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + H2O = Hg(OH)3- + H+
log_k -14.897
delta_h 0 kJ
-gamma 0 0
# Id: 3613303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + H2O = CuOH+ + H+
log_k -7.497
delta_h 35.81 kJ
-gamma 4 0
# Id: 2313300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cu+2 + 2H2O = Cu(OH)2 + 2H+
log_k -16.194
delta_h 0 kJ
-gamma 0 0
# Id: 2313301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 3H2O = Cu(OH)3- + 3H+
log_k -26.879
delta_h 0 kJ
-gamma 0 0
# Id: 2313302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cu+2 + 4H2O = Cu(OH)4-2 + 4H+
log_k -39.98
delta_h 0 kJ
-gamma 0 0
# Id: 2313303
# log K source: NIST46.3
# Delta H source: MTQ3.11
```

```
#T and ionic strength: 1.00 25.0
2Cu+2 + 2H2O = Cu2(OH)2+2 + 2H+
log_k -10.594
delta_h 76.62 kJ
-gamma 0 0
# Id: 2313304
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + H2O = AgOH + H+
log_k -11.997
delta_h 0 kJ
-gamma 0 0
# Id: 203300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 2H2O = Ag(OH)2- + 2H+
log_k -24.004
delta_h 0 kJ
-gamma 0 0
# Id: 203301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + H2O = NiOH+ + H+
log_k -9.897
delta_h 51.81 kJ
-gamma 0 0
# Id: 5403300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + 2H2O = Ni(OH)2 + 2H+
log_k -18.994
delta_h 0 kJ
-gamma 0 0
# Id: 5403301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + 3H2O = Ni(OH)3- + 3H+
log_k -29.991
delta_h 0 kJ
-gamma 0 0
# Id: 5403302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + H2O = CoOH+ + H+
log_k -9.697
delta_h 0 kJ
-gamma 0 0
# Id: 2003300
```

```
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 2H2O = Co(OH)2 + 2H+
log_k -18.794
delta_h 0 kJ
-gamma 0 0
# Id: 2003301
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 3H2O = Co(OH)3- + 3H+
log_k -31.491
delta_h 0 kJ
-gamma 0 0
# Id: 2003302
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 4H2O = Co(OH)4-2 + 4H+
log_k -46.288
delta_h 0 kJ
-gamma 0 0
# Id: 2003303
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Co+2 + H2O = Co2OH+3 + H+
log_k -10.997
delta_h 0 kJ
-gamma 0 0
# Id: 2003304
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
4Co+2 + 4H2O = Co4(OH)4+4 + 4H+
log_k -30.488
delta_h 0 kJ
-gamma 0 0
# Id: 2003306
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + 2H2O = CoOOH- + 3H+
log_k -32.0915
delta_h 260.454 kJ
-gamma 0 0
# Id: 2003305
# log K source: NIST2.1.1
# Delta H source: MTQ3.11
#T and ionic strength:
Co+3 + H2O = CoOH+2 + H+
log_k -1.291
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2013300
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Fe+2 + H2O = FeOH+ + H+
log_k -9.397
delta_h 55.81 kJ
-gamma 5 0
# Id: 2803300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+2 + 2H2O = Fe(OH)2 + 2H+
log_k -20.494
delta_h 119.62 kJ
-gamma 0 0
# Id: 2803302
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+2 + 3H2O = Fe(OH)3- + 3H+
log_k -28.991
delta_h 126.43 kJ
-gamma 5 0
# Id: 2803301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + H2O = FeOH+2 + H+
log_k -2.187
delta_h 41.81 kJ
-gamma 5 0
# Id: 2813300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + 2H2O = Fe(OH)2+ + 2H+
log_k -4.594
delta_h 0 kJ
-gamma 5.4 0
# Id: 2813301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Fe+3 + 3H2O = Fe(OH)3 + 3H+
log_k -12.56
delta_h 103.8 kJ
-gamma 0 0
# Id: 2813302
# log K source: Nord90
# Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Fe+3 + 4H2O = Fe(OH)4- + 4H+
```

```
log_k -21.588
delta_h 0 kJ
-gamma 5.4 0
# Id: 2813303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Fe+3 + 2H2O = Fe2(OH)2+4 + 2H+
log_k -2.854
delta_h 57.62 kJ
-gamma 0 0
# Id: 2813304
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
3Fe+3 + 4H2O = Fe3(OH)4+5 + 4H+
log_k -6.288
delta_h 65.24 kJ
-gamma 0 0
# Id: 2813305
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Mn+2 + H2O = MnOH+ + H+
log_k -10.597
delta_h 55.81 kJ
-gamma 5 0
# Id: 4703300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Mn+2 + 3H2O = Mn(OH)3- + 3H+
log_k -34.8
delta_h 0 kJ
-gamma 5 0
# Id: 4703301
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Mn+2 + 4H2O = Mn(OH)4-2 + 4H+
log_k -48.288
delta_h 0 kJ
-gamma 5 0
# Id: 4703302
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + 4H2O = MnO4- + 8H+ + 5e-
log_k -127.794
delta_h 822.67 kJ
-gamma 3 0
# Id: 4700020
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
```

```
#T and ionic strength:
Mn+2 + 4H2O = MnO4-2 + 8H+ + 4e-
log_k -118.422
delta_h 711.07 kJ
-gamma 5 0
# Id: 4700021
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Cr(OH)2+ + H+ = Cr(OH)+2 + H2O
log_k 5.9118
delta_h -77.91 kJ
-gamma 0 0
# Id: 2113301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + H2O = Cr(OH)3 + H+
log_k -8.4222
delta_h 0 kJ
-gamma 0 0
# Id: 2113302
# log K source: SCD3.02 (1983 RCa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H2O = Cr(OH)4- + 2H+
log_k -17.8192
delta_h 0 kJ
-gamma 0 0
# Id: 2113303
# log K source: SCD3.02 (1983 RCa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ = CrO2- + 2H+
log_k -17.7456
delta_h 0 kJ
-gamma 0 0
# Id: 2113304
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
V+2 + H2O = VOH+ + H+
log_k -6.487
delta_h 59.81 kJ
-gamma 0 0
# Id: 9003300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
V+3 + H2O = VOH+2 + H+
log_k -2.297
delta_h 43.81 kJ
-gamma 0 0
# Id: 9013300
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
V+3 + 2H2O = V(OH)2+ + 2H+
log_k -6.274
delta_h 0 kJ
-gamma 0 0
# Id: 9013301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
V+3 + 3H2O = V(OH)3 + 3H+
log_k -3.0843
delta_h 0 kJ
-gamma 0 0
# Id: 9013302
# log K source: SCD3.02 (1978 TKa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
2V+3 + 2H2O = V2(OH)2+4 + 2H+
log_k -3.794
delta_h 0 kJ
-gamma 0 0
# Id: 9013304
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2V+3 + 3H2O = V2(OH)3+3 + 3H+
log_k -10.1191
delta_h 0 kJ
-gamma 0 0
# Id: 9013303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
VO+2 + 2H2O = V(OH)3+ + H+
log_k -5.697
delta_h 0 kJ
-gamma 0 0
# Id: 9023300
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2VO+2 + 2H2O = H2V2O4+2 + 2H+
log_k -6.694
delta_h 53.62 kJ
-gamma 0 0
# Id: 9023301
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
U+4 + H2O = UOH+3 + H+
log_k -0.597
delta_h 47.81 kJ
```

```
-gamma 0 0
# Id: 8913300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
U+4 + 2H2O = U(OH)2+2 + 2H+
log_k -2.27
delta_h 74.1823 kJ
-gamma 0 0
# Id: 8913301
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 3H2O = U(OH)3+ + 3H+
log_k -4.935
delta_h 94.7467 kJ
-gamma 0 0
# Id: 8913302
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 4H2O = U(OH)4 + 4H+
log_k -8.498
delta_h 103.596 kJ
-gamma 0 0
# Id: 8913303
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 5H2O = U(OH)5- + 5H+
log_k -13.12
delta_h 115.374 kJ
-gamma 0 0
# Id: 8913304
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
6U+4 + 15H2O = U6(OH)15+9 + 15H+
log_k -17.155
delta_h 0 kJ
-gamma 0 0
# Id: 8913305
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
UO2+2 + H2O = UO2OH+ + H+
log_k -5.897
delta_h 47.81 kJ
-gamma 0 0
# Id: 8933300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2UO2+2 + 2H2O = (UO2)2(OH)2+2 + 2H+
```

```
log_k -5.574
delta_h 41.82 kJ
-gamma 0 0
# Id: 8933301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
3UO2+2 + 5H2O = (UO2)3(OH)5+ + 5H+
log_k -15.585
delta_h 108.05 kJ
-gamma 0 0
# Id: 8933302
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + H2O = BeOH+ + H+
log_k -5.397
delta_h 0 kJ
-gamma 6.5 0
# Id: 1103301
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Be+2 + 2H2O = Be(OH)2 + 2H+
log_k -13.594
delta_h 0 kJ
-gamma 6.5 0
# Id: 1103302
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Be+2 + 3H2O = Be(OH)3- + 3H+
log_k -23.191
delta_h 0 kJ
-gamma 6.5 0
# Id: 1103303
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Be+2 + 4H2O = Be(OH)4-2 + 4H+
log_k -37.388
delta_h 0 kJ
-gamma 6.5 0
# Id: 1103304
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
2Be+2 + H2O = Be2OH+3 + H+
log_k -3.177
delta_h 0 kJ
-gamma 6.5 0
# Id: 1103305
# log K source: NIST46.4
# Delta H source: MTQ3.11
```

```
#T and ionic strength:  0.10 25.0
3Be+2 + 3H2O = Be3(OH)3+3 + 3H+
log_k -8.8076
delta_h 0 kJ
-gamma 6.5 0
# Id:  1103306
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 25.0
Mg+2 + H2O = MgOH+ + H+
log_k -11.397
delta_h 67.81 kJ
-gamma 6.5 0
# Id:  4603300
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ca+2 + H2O = CaOH+ + H+
log_k -12.697
delta_h 64.11 kJ
-gamma 6 0
# Id:  1503300
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Sr+2 + H2O = SrOH+ + H+
log_k -13.177
delta_h 60.81 kJ
-gamma 5 0
# Id:  8003300
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ba+2 + H2O = BaOH+ + H+
log_k -13.357
delta_h 60.81 kJ
-gamma 5 0
# Id:  1003300
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
H+ + F- = HF
log_k 3.17
delta_h 13.3 kJ
-gamma 0 0
# Id:  3302700
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
H+ + 2F- = HF2-
log_k 3.75
delta_h 17.4 kJ
-gamma 3.5 0
# Id:  3302701
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2F- + 2H+ = H2F2
log_k 6.768
delta_h 0 kJ
-gamma 0 0
# Id: 3302702
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Sb(OH)3 + F- + H+ = SbOF + 2H2O
log_k 6.1864
delta_h 0 kJ
-gamma 0 0
# Id: 7402700
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 + F- + H+ = Sb(OH)2F + H2O
log_k 6.1937
delta_h 0 kJ
-gamma 0 0
# Id: 7402702
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
H4SiO4 + 4H+ + 6F- = SiF6-2 + 4H2O
log_k 30.18
delta_h -68 kJ
-gamma 5 0
# Id: 7702700
# log K source: Nord90
# Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + F- = SnF+ + 2H2O
log_k 11.582
delta_h 0 kJ
-gamma 0 0
# Id: 7902701
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)2 + 2H+ + 2F- = SnF2 + 2H2O
log_k 14.386
delta_h 0 kJ
-gamma 0 0
# Id: 7902702
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)2 + 2H+ + 3F- = SnF3- + 2H2O
log_k 17.206
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 7902703
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)6-2 + 6H+ + 6F- = SnF6-2 + 6H2O
log_k 33.5844
delta_h 0 kJ
-gamma 0 0
# Id: 7912701
# log K source: Bard85
# Delta H source: MTQ3.11
#T and ionic strength:
Pb+2 + F- = PbF+
log_k 1.848
delta_h 0 kJ
-gamma 0 0
# Id: 6002700
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Pb+2 + 2F- = PbF2
log_k 3.142
delta_h 0 kJ
-gamma 0 0
# Id: 6002701
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Pb+2 + 3F- = PbF3-
log_k 3.42
delta_h 0 kJ
-gamma 0 0
# Id: 6002702
# log K source: SCD3.02 (1956 TKa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 4F- = PbF4-2
log_k 3.1
delta_h 0 kJ
-gamma 0 0
# Id: 6002703
# log K source: SCD3.02 (1956 TKa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
H3BO3 + 3H+ + 4F- = BF4- + 3H2O
log_k 19.912
delta_h -18.67 kJ
-gamma 2.5 0
# Id: 902703
# log K source: NIST46.3
# Delta H source: NIST2.1.1
#T and ionic strength: 1.00 25.0
Al+3 + F- = AlF+2
```

```
log_k 7
delta_h 4.6 kJ
-gamma 5.4 0
# Id: 302700
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 2F- = AlF2+
log_k 12.6
delta_h 8.3 kJ
-gamma 5.4 0
# Id: 302701
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 3F- = AlF3
log_k 16.7
delta_h 8.7 kJ
-gamma 0 0
# Id: 302702
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Al+3 + 4F- = AlF4-
log_k 19.4
delta_h 8.7 kJ
-gamma 4.5 0
# Id: 302703
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + F- = TlF
log_k 0.1
delta_h 0 kJ
-gamma 0 0
# Id: 8702700
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + F- = ZnF+
log_k 1.3
delta_h 11 kJ
-gamma 0 0
# Id: 9502700
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + F- = CdF+
log_k 1.2
delta_h 5 kJ
-gamma 0 0
# Id: 1602700
# log K source: NIST46.3
# Delta H source: NIST46.3
```

```
#T and ionic strength:  0.00 25.0
Cd+2 + 2F- = CdF2
log_k 1.5
delta_h 0 kJ
-gamma 0 0
# Id:  1602701
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2H+ + F- = HgF+ + 2H2O
log_k 7.763
delta_h -35.72 kJ
-gamma 0 0
# Id:  3612701
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.50 25.0
Cu+2 + F- = CuF+
log_k 1.8
delta_h 13 kJ
-gamma 0 0
# Id:  2312700
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ag+ + F- = AgF
log_k 0.4
delta_h 12 kJ
-gamma 0 0
# Id:  202700
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ni+2 + F- = NiF+
log_k 1.4
delta_h 7.1 kJ
-gamma 0 0
# Id:  5402700
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Co+2 + F- = CoF+
log_k 1.5
delta_h 9.2 kJ
-gamma 0 0
# Id:  2002700
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
Fe+3 + F- = FeF+2
log_k 6.04
delta_h 10 kJ
-gamma 5 0
# Id:  2812700
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + 2F- = FeF2+
log_k 10.4675
delta_h 17 kJ
-gamma 5 0
# Id: 2812701
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Fe+3 + 3F- = FeF3
log_k 13.617
delta_h 29 kJ
-gamma 0 0
# Id: 2812702
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Mn+2 + F- = MnF+
log_k 1.6
delta_h 11 kJ
-gamma 5 0
# Id: 4702700
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + F- = CrF+2 + 2H2O
log_k 14.7688
delta_h -70.2452 kJ
-gamma 0 0
# Id: 2112700
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
VO+2 + F- = VOF+
log_k 3.778
delta_h 7.9 kJ
-gamma 0 0
# Id: 9022700
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO+2 + 2F- = VOF2
log_k 6.352
delta_h 14 kJ
-gamma 0 0
# Id: 9022701
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO+2 + 3F- = VOF3-
log_k 7.902
delta_h 20 kJ
```

```
-gamma 0 0
# Id: 9022702
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO+2 + 4F- = VOF4-2
log_k 8.508
delta_h 26 kJ
-gamma 0 0
# Id: 9022703
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
VO2+ + F- = VO2F
log_k 3.244
delta_h 0 kJ
-gamma 0 0
# Id: 9032700
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
VO2+ + 2F- = VO2F2-
log_k 5.804
delta_h 0 kJ
-gamma 0 0
# Id: 9032701
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
VO2+ + 3F- = VO2F3-2
log_k 6.9
delta_h 0 kJ
-gamma 0 0
# Id: 9032702
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
VO2+ + 4F- = VO2F4-3
log_k 6.592
delta_h 0 kJ
-gamma 0 0
# Id: 9032703
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
U+4 + F- = UF+3
log_k 9.3
delta_h 21.1292 kJ
-gamma 0 0
# Id: 8912700
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
U+4 + 2F- = UF2+2
```

```
log_k 16.4
delta_h 30.1248 kJ
-gamma 0 0
# Id: 8912701
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
U+4 + 3F- = UF3+
log_k 21.6
delta_h 29.9156 kJ
-gamma 0 0
# Id: 8912702
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
U+4 + 4F- = UF4
log_k 23.64
delta_h 19.2464 kJ
-gamma 0 0
# Id: 8912703
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 5F- = UF5-
log_k 25.238
delta_h 20.2924 kJ
-gamma 0 0
# Id: 8912704
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 6F- = UF6-2
log_k 27.718
delta_h 13.8072 kJ
-gamma 0 0
# Id: 8912705
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + F- = UO2F+
log_k 5.14
delta_h 1 kJ
-gamma 0 0
# Id: 8932700
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 2F- = UO2F2
log_k 8.6
delta_h 2 kJ
-gamma 0 0
# Id: 8932701
# log K source: NIST46.3
# Delta H source: NIST46.3
```

```
#T and ionic strength:  0.00 25.0
UO2+2 + 3F- = UO2F3-
log_k 11
delta_h 2 kJ
-gamma 0 0
# Id:  8932702
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
UO2+2 + 4F- = UO2F4-2
log_k 11.9
delta_h 0.4 kJ
-gamma 0 0
# Id:  8932703
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Be+2 + F- = BeF+
log_k 5.249
delta_h 0 kJ
-gamma 0 0
# Id:  1102701
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.50 25.0
Be+2 + 2F- = BeF2
log_k 9.1285
delta_h -4 kJ
-gamma 0 0
# Id:  1102702
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.50 25.0
Be+2 + 3F- = BeF3-
log_k 11.9085
delta_h -8 kJ
-gamma 0 0
# Id:  1102703
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.50 25.0
Mg+2 + F- = MgF+
log_k 2.05
delta_h 13 kJ
-gamma 4.5 0
# Id:  4602700
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ca+2 + F- = CaF+
log_k 1.038
delta_h 14 kJ
-gamma 5 0
# Id:  1502700
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Sr+2 + F- = SrF+
log_k 0.548
delta_h 16 kJ
-gamma 0 0
# Id: 8002701
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
Na+ + F- = NaF
log_k -0.2
delta_h 12 kJ
-gamma 0 0
# Id: 5002700
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + Cl- = SnCl+ + 2H2O
log_k 8.734
delta_h 0 kJ
-gamma 0 0
# Id: 7901801
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 2Cl- = SnCl2 + 2H2O
log_k 9.524
delta_h 0 kJ
-gamma 0 0
# Id: 7901802
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 3Cl- = SnCl3- + 2H2O
log_k 8.3505
delta_h 0 kJ
-gamma 0 0
# Id: 7901803
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 2.00 25.0
Pb+2 + Cl- = PbCl+
log_k 1.55
delta_h 8.7 kJ
-gamma 0 0
# Id: 6001800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2Cl- = PbCl2
log_k 2.2
delta_h 12 kJ
```

```
-gamma 0 0
# Id: 6001801
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 3Cl- = PbCl3-
log_k 1.8
delta_h 4 kJ
-gamma 0 0
# Id: 6001802
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 4Cl- = PbCl4-2
log_k 1.46
delta_h 14.7695 kJ
-gamma 0 0
# Id: 6001803
# log K source: SCD3.02 (1984 SEa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl+ + Cl- = TlCl
log_k 0.51
delta_h -6.2 kJ
-gamma 0 0
# Id: 8701800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + 2Cl- = TlCl2-
log_k 0.28
delta_h 0 kJ
-gamma 0 0
# Id: 8701801
# log K source: SCD3.02 (1992 RAb)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + Cl- = TlCl+2 + 3H2O
log_k 11.011
delta_h 0 kJ
-gamma 0 0
# Id: 8711800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + 2Cl- = TlCl2+ + 3H2O
log_k 16.771
delta_h 0 kJ
-gamma 0 0
# Id: 8711801
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + 3Cl- = TlCl3 + 3H2O
```

```
log_k 19.791
delta_h 0 kJ
-gamma 0 0
# Id: 8711802
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + 3H+ + 4Cl- = TlCl4- + 3H2O
log_k 21.591
delta_h 0 kJ
-gamma 0 0
# Id: 8711803
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + Cl- + 2H+ = TlOHCl+ + 2H2O
log_k 10.629
delta_h 0 kJ
-gamma 0 0
# Id: 8711804
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + Cl- = ZnCl+
log_k 0.4
delta_h 5.4 kJ
-gamma 4 0
# Id: 9501800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2Cl- = ZnCl2
log_k 0.6
delta_h 37 kJ
-gamma 0 0
# Id: 9501801
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 3Cl- = ZnCl3-
log_k 0.5
delta_h 39.999 kJ
-gamma 4 0
# Id: 9501802
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + 4Cl- = ZnCl4-2
log_k 0.199
delta_h 45.8566 kJ
-gamma 5 0
# Id: 9501803
# log K source: MTQ3.11
# Delta H source: MTQ3.11
```

```
#T and ionic strength:
Zn+2 + H2O + Cl- = ZnOHCl + H+
log_k -7.48
delta_h 0 kJ
-gamma 0 0
# Id: 9501804
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + Cl- = CdCl+
log_k 1.98
delta_h 1 kJ
-gamma 0 0
# Id: 1601800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2Cl- = CdCl2
log_k 2.6
delta_h 3 kJ
-gamma 0 0
# Id: 1601801
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 3Cl- = CdCl3-
log_k 2.4
delta_h 10 kJ
-gamma 0 0
# Id: 1601802
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + H2O + Cl- = CdOHCl + H+
log_k -7.404
delta_h 18.2213 kJ
-gamma 0 0
# Id: 1601803
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2H+ + Cl- = HgCl+ + 2H2O
log_k 13.494
delta_h -62.72 kJ
-gamma 0 0
# Id: 3611800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 2Cl- = HgCl2 + 2H2O
log_k 20.194
delta_h -92.42 kJ
-gamma 0 0
# Id: 3611801
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 3Cl- = HgCl3- + 2H2O
log_k 21.194
delta_h -94.02 kJ
-gamma 0 0
# Id: 3611802
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 4Cl- = HgCl4-2 + 2H2O
log_k 21.794
delta_h -100.72 kJ
-gamma 0 0
# Id: 3611803
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + Cl- + I- + 2H+ = HgClI + 2H2O
log_k 25.532
delta_h -135.3 kJ
-gamma 0 0
# Id: 3611804
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + H+ + Cl- = HgClOH + H2O
log_k 10.444
delta_h -42.72 kJ
-gamma 0 0
# Id: 3611805
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Cu+2 + Cl- = CuCl+
log_k 0.2
delta_h 8.3 kJ
-gamma 4 0
# Id: 2311800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cu+2 + 2Cl- = CuCl2
log_k -0.26
delta_h 44.183 kJ
-gamma 0 0
# Id: 2311801
# log K source: SCD3.02 (1989 IPa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 3Cl- = CuCl3-
log_k -2.29
delta_h 57.279 kJ
```

```
-gamma 4 0
# Id: 2311802
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cu+2 + 4Cl- = CuCl4-2
log_k -4.59
delta_h 32.5515 kJ
-gamma 5 0
# Id: 2311803
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cu+ + 2Cl- = CuCl2-
log_k 5.42
delta_h -1.7573 kJ
-gamma 4 0
# Id: 2301800
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+ + 3Cl- = CuCl3-2
log_k 4.75
delta_h 1.0878 kJ
-gamma 5 0
# Id: 2301801
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+ + Cl- = CuCl
log_k 3.1
delta_h 0 kJ
-gamma 0 0
# Id: 2301802
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + Cl- = AgCl
log_k 3.31
delta_h -12 kJ
-gamma 0 0
# Id: 201800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + 2Cl- = AgCl2-
log_k 5.25
delta_h -16 kJ
-gamma 0 0
# Id: 201801
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + 3Cl- = AgCl3-2
```

```
log_k 5.2
delta_h 0 kJ
-gamma 0 0
# Id: 201802
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 4Cl- = AgCl4-3
log_k 5.51
delta_h 0 kJ
-gamma 0 0
# Id: 201803
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Ni+2 + Cl- = NiCl+
log_k 0.408
delta_h 2 kJ
-gamma 0 0
# Id: 5401800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Ni+2 + 2Cl- = NiCl2
log_k -1.89
delta_h 0 kJ
-gamma 0 0
# Id: 5401801
# log K source: SCD3.02 (1989 IPa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + Cl- = CoCl+
log_k 0.539
delta_h 2 kJ
-gamma 0 0
# Id: 2001800
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Co+3 + Cl- = CoCl+2
log_k 2.3085
delta_h 16 kJ
-gamma 0 0
# Id: 2011800
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Fe+3 + Cl- = FeCl+2
log_k 1.48
delta_h 23 kJ
-gamma 5 0
# Id: 2811800
# log K source: NIST46.3
# Delta H source: NIST46.3
```

#T and ionic strength: 0.00 25.0
Fe+3 + 2Cl- = FeCl2+
log_k 2.13
delta_h 0 kJ
-gamma 5 0
Id: 2811801
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Fe+3 + 3Cl- = FeCl3
log_k 1.13
delta_h 0 kJ
-gamma 0 0
Id: 2811802
log K source: Nord90
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + Cl- = MnCl+
log_k 0.1
delta_h 0 kJ
-gamma 5 0
Id: 4701800
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 0.00 20.0
Mn+2 + 2Cl- = MnCl2
log_k 0.25
delta_h 0 kJ
-gamma 0 0
Id: 4701801
log K source: Nord90
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + 3Cl- = MnCl3-
log_k -0.31
delta_h 0 kJ
-gamma 5 0
Id: 4701802
log K source: Nord90
Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + Cl- = CrCl+2 + 2H2O
log_k 9.6808
delta_h -103.62 kJ
-gamma 0 0
Id: 2111800
log K source: NIST46.3
Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
Cr(OH)2+ + 2Cl- + 2H+ = CrCl2+ + 2H2O
log_k 8.658
delta_h -39.2208 kJ
-gamma 0 0
Id: 2111801

```
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 2Cl- + H+ = CrOHCl2 + H2O
log_k 2.9627
delta_h 0 kJ
-gamma 0 0
# Id: 2111802
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
VO+2 + Cl- = VOCl+
log_k 0.448
delta_h 0 kJ
-gamma 0 0
# Id: 9021800
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
U+4 + Cl- = UCl+3
log_k 1.7
delta_h -20 kJ
-gamma 0 0
# Id: 8911800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + Cl- = UO2Cl+
log_k 0.21
delta_h 16 kJ
-gamma 0 0
# Id: 8931800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + Cl- = BeCl+
log_k 0.2009
delta_h 0 kJ
-gamma 5 0
# Id: 1101801
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.70 20.0
Sn(OH)2 + 2H+ + Br- = SnBr+ + 2H2O
log_k 8.254
delta_h 0 kJ
-gamma 0 0
# Id: 7901301
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 2Br- = SnBr2 + 2H2O
log_k 8.794
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 7901302
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + 3Br- = SnBr3- + 2H2O
log_k 7.48
delta_h 0 kJ
-gamma 0 0
# Id: 7901303
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 3.00 25.0
Pb+2 + Br- = PbBr+
log_k 1.7
delta_h 8 kJ
-gamma 0 0
# Id: 6001300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2Br- = PbBr2
log_k 2.6
delta_h -4 kJ
-gamma 0 0
# Id: 6001301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + Br- = TlBr
log_k 0.91
delta_h -12 kJ
-gamma 0 0
# Id: 8701300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl+ + 2Br- = TlBr2-
log_k -0.384
delta_h 12.36 kJ
-gamma 0 0
# Id: 8701301
# log K source: NIST46.3
# Delta H source: NIST2.1.1
#T and ionic strength: 4.00 25.0
Tl+ + Br- + Cl- = TlBrCl-
log_k 0.8165
delta_h 0 kJ
-gamma 0 0
# Id: 8701302
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Tl+ + I- + Br- = TlIBr-
```

```
log_k 2.185
delta_h 0 kJ
-gamma 0 0
# Id: 8703802
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 3H+ + Br- = TlBr+2 + 3H2O
log_k 12.803
delta_h 0 kJ
-gamma 0 0
# Id: 8711300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Tl(OH)3 + 3H+ + 2Br- = TlBr2+ + 3H2O
log_k 20.711
delta_h 0 kJ
-gamma 0 0
# Id: 8711301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Tl(OH)3 + 3Br- + 3H+ = TlBr3 + 3H2O
log_k 27.0244
delta_h 0 kJ
-gamma 0 0
# Id: 8711302
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 4Br- + 3H+ = TlBr4- + 3H2O
log_k 31.1533
delta_h 0 kJ
-gamma 0 0
# Id: 8711303
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + Br- = ZnBr+
log_k -0.07
delta_h 1 kJ
-gamma 0 0
# Id: 9501300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Zn+2 + 2Br- = ZnBr2
log_k -0.98
delta_h 0 kJ
-gamma 0 0
# Id: 9501301
# log K source: MTQ3.11
# Delta H source: MTQ3.11
```

```
#T and ionic strength:
Cd+2 + Br- = CdBr+
log_k 2.15
delta_h -3 kJ
-gamma 0 0
# Id: 1601300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2Br- = CdBr2
log_k 3
delta_h -3 kJ
-gamma 0 0
# Id: 1601301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + Br- = HgBr+ + 2H2O
log_k 15.803
delta_h -81.92 kJ
-gamma 0 0
# Id: 3611301
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 2Br- = HgBr2 + 2H2O
log_k 24.2725
delta_h -127.12 kJ
-gamma 0 0
# Id: 3611302
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 3Br- = HgBr3- + 2H2O
log_k 26.7025
delta_h -138.82 kJ
-gamma 0 0
# Id: 3611303
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 4Br- = HgBr4-2 + 2H2O
log_k 27.933
delta_h -153.72 kJ
-gamma 0 0
# Id: 3611304
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.50 25.0
Hg(OH)2 + Br- + Cl- + 2H+ = HgBrCl + 2H2O
log_k 22.1811
delta_h -113.77 kJ
-gamma 0 0
# Id: 3611305
```

```
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + Br- + I- + 2H+ = HgBrI + 2H2O
log_k 27.3133
delta_h -151.27 kJ
-gamma 0 0
# Id: 3611306
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Hg(OH)2 + Br- + 3I- + 2H+ = HgBrI3-2 + 2H2O
log_k 34.2135
delta_h 0 kJ
-gamma 0 0
# Id: 3611307
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2Br- + 2I- + 2H+ = HgBr2I2-2 + 2H2O
log_k 32.3994
delta_h 0 kJ
-gamma 0 0
# Id: 3611308
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 3Br- + I- + 2H+ = HgBr3I-2 + 2H2O
log_k 30.1528
delta_h 0 kJ
-gamma 0 0
# Id: 3611309
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + H+ + Br- = HgBrOH + H2O
log_k 12.433
delta_h 0 kJ
-gamma 0 0
# Id: 3613301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Ag+ + Br- = AgBr
log_k 4.6
delta_h 0 kJ
-gamma 0 0
# Id: 201300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 2Br- = AgBr2-
log_k 7.5
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 201301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + 3Br- = AgBr3-2
log_k 8.1
delta_h 0 kJ
-gamma 0 0
# Id: 201302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + Br- = NiBr+
log_k 0.5
delta_h 0 kJ
-gamma 0 0
# Id: 5401300
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + Br- + 2H+ = CrBr+2 + 2H2O
log_k 7.5519
delta_h -46.9068 kJ
-gamma 0 0
# Id: 2111300
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Be+2 + Br- = BeBr+
log_k 0.1009
delta_h 0 kJ
-gamma 5 0
# Id: 1101301
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.70 20.0
Pb+2 + I- = PbI+
log_k 2
delta_h 0 kJ
-gamma 0 0
# Id: 6003800
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Pb+2 + 2I- = PbI2
log_k 3.2
delta_h 0 kJ
-gamma 0 0
# Id: 6003801
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Tl+ + I- = TlI
```

```
log_k 1.4279
delta_h 0 kJ
-gamma 0 0
# Id: 8703800
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Tl+ + 2I- = TlI2-
log_k 1.8588
delta_h 0 kJ
-gamma 0 0
# Id: 8703801
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Tl(OH)3 + 4I- + 3H+ = TlI4- + 3H2O
log_k 34.7596
delta_h 0 kJ
-gamma 0 0
# Id: 8713800
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + I- = ZnI+
log_k -2.0427
delta_h -4 kJ
-gamma 0 0
# Id: 9503800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 3.00 25.0
Zn+2 + 2I- = ZnI2
log_k -1.69
delta_h 0 kJ
-gamma 0 0
# Id: 9503801
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + I- = CdI+
log_k 2.28
delta_h -9.6 kJ
-gamma 0 0
# Id: 1603800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2I- = CdI2
log_k 3.92
delta_h -12 kJ
-gamma 0 0
# Id: 1603801
# log K source: NIST46.3
# Delta H source: NIST46.3
```

```
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + I- = HgI+ + 2H2O
log_k 19.603
delta_h -111.22 kJ
-gamma 0 0
# Id: 3613801
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 2I- = HgI2 + 2H2O
log_k 30.8225
delta_h -182.72 kJ
-gamma 0 0
# Id: 3613802
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 3I- = HgI3- + 2H2O
log_k 34.6025
delta_h -194.22 kJ
-gamma 0 0
# Id: 3613803
# log K source: NIST46.4
# Delta H source: NIST2.1.1
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 4I- = HgI4-2 + 2H2O
log_k 36.533
delta_h -220.72 kJ
-gamma 0 0
# Id: 3613804
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Ag+ + I- = AgI
log_k 6.6
delta_h 0 kJ
-gamma 0 0
# Id: 203800
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 18.0
Ag+ + 2I- = AgI2-
log_k 11.7
delta_h 0 kJ
-gamma 0 0
# Id: 203801
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 18.0
Ag+ + 3I- = AgI3-2
log_k 12.6
delta_h -122 kJ
-gamma 0 0
# Id: 203802
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + 4I- = AgI4-3
log_k 14.229
delta_h 0 kJ
-gamma 0 0
# Id: 203803
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 2.00 25.0
Cr(OH)2+ + I- + 2H+ = CrI+2 + 2H2O
log_k 4.8289
delta_h 0 kJ
-gamma 0 0
# Id: 2113800
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
H+ + HS- = H2S
log_k 7.02
delta_h -22 kJ
-gamma 0 0
# Id: 3307300
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2HS- = Pb(HS)2
log_k 15.27
delta_h 0 kJ
-gamma 0 0
# Id: 6007300
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Pb+2 + 3HS- = Pb(HS)3-
log_k 16.57
delta_h 0 kJ
-gamma 0 0
# Id: 6007301
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Tl+ + HS- = TlHS
log_k 2.474
delta_h 0 kJ
-gamma 0 0
# Id: 8707300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
2Tl+ + HS- = Tl2HS+
log_k 5.974
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 8707301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
2Tl+ + 3HS- + H2O = Tl2OH(HS)3-2 + H+
log_k 1.0044
delta_h 0 kJ
-gamma 0 0
# Id: 8707302
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
2Tl+ + 2HS- + 2H2O = Tl2(OH)2(HS)2-2 + 2H+
log_k -11.0681
delta_h 0 kJ
-gamma 0 0
# Id: 8707303
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + 2HS- = Zn(HS)2
log_k 12.82
delta_h 0 kJ
-gamma 0 0
# Id: 9507300
# log K source: DHa1993
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 3HS- = Zn(HS)3-
log_k 16.1
delta_h 0 kJ
-gamma 0 0
# Id: 9507301
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + 3HS- = ZnS(HS)2-2 + H+
log_k 6.12
delta_h 0 kJ
-gamma 0 0
# Id: 9507302
# log K source: DHa1993
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 2HS- + 2HS- = Zn(HS)4-2
log_k 14.64
delta_h 0 kJ
-gamma 0 0
# Id: 9507303
# log K source: DHa1993
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 2HS- = ZnS(HS)- + H+
```

```
log_k 6.81
delta_h 0 kJ
-gamma 0 0
# Id: 9507304
# log K source: DHa1993
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cd+2 + HS- = CdHS+
log_k 8.008
delta_h 0 kJ
-gamma 0 0
# Id: 1607300
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + 2HS- = Cd(HS)2
log_k 15.212
delta_h 0 kJ
-gamma 0 0
# Id: 1607301
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + 3HS- = Cd(HS)3-
log_k 17.112
delta_h 0 kJ
-gamma 0 0
# Id: 1607302
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + 4HS- = Cd(HS)4-2
log_k 19.308
delta_h 0 kJ
-gamma 0 0
# Id: 1607303
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Hg(OH)2 + 2HS- = HgS2-2 + 2H2O
log_k 29.414
delta_h 0 kJ
-gamma 0 0
# Id: 3617300
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
Hg(OH)2 + 2H+ + 2HS- = Hg(HS)2 + 2H2O
log_k 44.516
delta_h 0 kJ
-gamma 0 0
# Id: 3617301
# log K source: NIST46.3
# Delta H source: MTQ3.11
```

```
#T and ionic strength:  1.00 20.0
Hg(OH)2 + H+ + 2HS- = HgHS2- + 2H2O
log_k 38.122
delta_h 0 kJ
-gamma 0 0
# Id:  3617302
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  1.00 20.0
Cu+2 + 3HS- = Cu(HS)3-
log_k 25.899
delta_h 0 kJ
-gamma 0 0
# Id:  2317300
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
Ag+ + HS- = AgHS
log_k 13.8145
delta_h 0 kJ
-gamma 0 0
# Id:  207300
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 20.0
Ag+ + 2HS- = Ag(HS)2-
log_k 17.9145
delta_h 0 kJ
-gamma 0 0
# Id:  207301
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 20.0
Fe+2 + 2HS- = Fe(HS)2
log_k 8.95
delta_h 0 kJ
-gamma 0 0
# Id:  2807300
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
Fe+2 + 3HS- = Fe(HS)3-
log_k 10.987
delta_h 0 kJ
-gamma 0 0
# Id:  2807301
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
HS- = S2-2 + H+
log_k -11.7828
delta_h 46.4 kJ
-gamma 0 0
-no_check
```

```
# Id: 7317300
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S3-2 + H+
log_k -10.7667
delta_h 42.2 kJ
-gamma 0 0
-no_check
# Id: 7317301
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S4-2 + H+
log_k -9.9608
delta_h 39.3 kJ
-gamma 0 0
-no_check
# Id: 7317302
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S5-2 + H+
log_k -9.3651
delta_h 37.6 kJ
-gamma 0 0
-no_check
# Id: 7317303
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
HS- = S6-2 + H+
log_k -9.881
delta_h 0 kJ
-gamma 0 0
-no_check
# Id: 7317304
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
2Sb(OH)3 + 4HS- + 2H+ = Sb2S4-2 + 6H2O
log_k 49.3886
delta_h -321.78 kJ
-gamma 0 0
# Id: 7407300
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Cu+ + 2HS- = Cu(S4)2-3 + 2H+
log_k 3.39
delta_h 0 kJ
-gamma 23 0
-no_check
# Id: 2307300
```

```
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cu+ + 2HS- = CuS4S5-3 + 2H+
log_k 2.66
delta_h 0 kJ
-gamma 25 0
-no_check
# Id: 2307301
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + 2HS- = Ag(S4)2-3 + 2H+
log_k 0.991
delta_h 0 kJ
-gamma 22 0
-no_check
# Id: 207302
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + 2HS- = AgS4S5-3 + 2H+
log_k 0.68
delta_h 0 kJ
-gamma 24 0
-no_check
# Id: 207303
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Ag+ + 2HS- = Ag(HS)S4-2 + H+
log_k 10.431
delta_h 0 kJ
-gamma 15 0
-no_check
# Id: 207304
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
H+ + SO4-2 = HSO4-
log_k 1.99
delta_h 22 kJ
-gamma 4.5 0
# Id: 3307320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
NH4+ + SO4-2 = NH4SO4-
log_k 1.03
delta_h 0 kJ
-gamma 5 0
# Id: 4907320
# log K source: NIST46.3
# Delta H source: MTQ3.11
```

```
#T and ionic strength:  0.00 25.0
Pb+2 + SO4-2 = PbSO4
log_k 2.69
delta_h 0 kJ
-gamma 0 0
# Id:  6007320
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Pb+2 + 2SO4-2 = Pb(SO4)2-2
log_k 3.47
delta_h 0 kJ
-gamma 0 0
# Id:  6007321
# log K source:  SCD3.02 (1960 RKa)
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Al+3 + SO4-2 = AlSO4+
log_k 3.89
delta_h 28 kJ
-gamma 4.5 0
# Id:  307320
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Al+3 + 2SO4-2 = Al(SO4)2-
log_k 4.92
delta_h 11.9 kJ
-gamma 4.5 0
# Id:  307321
# log K source:  Nord90
# Delta H source:  Nord90
#T and ionic strength:  0.00 25.0
Tl+ + SO4-2 = TlSO4-
log_k 1.37
delta_h -0.8 kJ
-gamma 0 0
# Id:  8707320
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Zn+2 + SO4-2 = ZnSO4
log_k 2.34
delta_h 6.2 kJ
-gamma 0 0
# Id:  9507320
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Zn+2 + 2SO4-2 = Zn(SO4)2-2
log_k 3.28
delta_h 0 kJ
-gamma 0 0
# Id:  9507321
```

```
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + SO4-2 = CdSO4
log_k 2.37
delta_h 8.7 kJ
-gamma 0 0
# Id: 1607320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2SO4-2 = Cd(SO4)2-2
log_k 3.5
delta_h 0 kJ
-gamma 0 0
# Id: 1607321
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Hg(OH)2 + 2H+ + SO4-2 = HgSO4 + 2H2O
log_k 8.612
delta_h 0 kJ
-gamma 0 0
# Id: 3617320
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Cu+2 + SO4-2 = CuSO4
log_k 2.36
delta_h 8.7 kJ
-gamma 0 0
# Id: 2317320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ag+ + SO4-2 = AgSO4-
log_k 1.3
delta_h 6.2 kJ
-gamma 0 0
# Id: 207320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + SO4-2 = NiSO4
log_k 2.3
delta_h 5.8 kJ
-gamma 0 0
# Id: 5407320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + 2SO4-2 = Ni(SO4)2-2
log_k 0.82
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 5407321
# log K source: SCD3.02 (1978 BLa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + SO4-2 = CoSO4
log_k 2.3
delta_h 6.2 kJ
-gamma 0 0
# Id: 2007320
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Fe+2 + SO4-2 = FeSO4
log_k 2.39
delta_h 8 kJ
-gamma 0 0
# Id: 2807320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + SO4-2 = FeSO4+
log_k 4.05
delta_h 25 kJ
-gamma 5 0
# Id: 2817320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Fe+3 + 2SO4-2 = Fe(SO4)2-
log_k 5.38
delta_h 19.2 kJ
-gamma 0 0
# Id: 2817321
# log K source: Nord90
# Delta H source: Nord90
#T and ionic strength: 0.00 25.0
Mn+2 + SO4-2 = MnSO4
log_k 2.25
delta_h 8.7 kJ
-gamma 0 0
# Id: 4707320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + SO4-2 = CrSO4+ + 2H2O
log_k 12.9371
delta_h -98.62 kJ
-gamma 0 0
# Id: 2117320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 50.0
Cr(OH)2+ + H+ + SO4-2 = CrOHSO4 + H2O
```

```
log_k 8.2871
delta_h 0 kJ
-gamma 0 0
# Id: 2117321
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
2Cr(OH)2+ + SO4-2 + 2H+ = Cr2(OH)2SO4+2 + 2H2O
log_k 16.155
delta_h 0 kJ
-gamma 0 0
# Id: 2117323
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
2Cr(OH)2+ + 2SO4-2 + 2H+ = Cr2(OH)2(SO4)2 + 2H2O
log_k 17.9288
delta_h 0 kJ
-gamma 0 0
# Id: 2117324
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + SO4-2 = USO4+2
log_k 6.6
delta_h 8 kJ
-gamma 0 0
# Id: 8917320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
U+4 + 2SO4-2 = U(SO4)2
log_k 10.5
delta_h 33 kJ
-gamma 0 0
# Id: 8917321
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + SO4-2 = UO2SO4
log_k 3.18
delta_h 20 kJ
-gamma 0 0
# Id: 8937320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 2SO4-2 = UO2(SO4)2-2
log_k 4.3
delta_h 38 kJ
-gamma 0 0
# Id: 8937321
# log K source: NIST46.3
# Delta H source: NIST46.3
```

```
#T and ionic strength:  0.00 25.0
V+3 + SO4-2 = VSO4+
log_k 2.674
delta_h 0 kJ
-gamma 0 0
# Id:  9017320
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  1.00 25.0
VO+2 + SO4-2 = VOSO4
log_k 2.44
delta_h 17 kJ
-gamma 0 0
# Id:  9027320
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
VO2+ + SO4-2 = VO2SO4-
log_k 1.378
delta_h 0 kJ
-gamma 0 0
# Id:  9037320
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  1.00 20.0
Be+2 + SO4-2 = BeSO4
log_k 2.19
delta_h 29 kJ
-gamma 0 0
# Id:  1107321
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
Be+2 + 2SO4-2 = Be(SO4)2-2
log_k 2.596
delta_h 0 kJ
-gamma 0 0
# Id:  1107322
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  1.00 25.0
Mg+2 + SO4-2 = MgSO4
log_k 2.26
delta_h 5.8 kJ
-gamma 0 0
# Id:  4607320
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ca+2 + SO4-2 = CaSO4
log_k 2.36
delta_h 7.1 kJ
-gamma 0 0
# Id:  1507320
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + SO4-2 = SrSO4
log_k 2.3
delta_h 8 kJ
-gamma 0 0
# Id: 8007321
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Li+ + SO4-2 = LiSO4-
log_k 0.64
delta_h 0 kJ
-gamma 5 0
# Id: 4407320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Na+ + SO4-2 = NaSO4-
log_k 0.73
delta_h 1 kJ
-gamma 5.4 0
# Id: 5007320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
K+ + SO4-2 = KSO4-
log_k 0.85
delta_h 4.1 kJ
-gamma 5.4 0
# Id: 4107320
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
HSe- + H+ = H2Se
log_k 3.89
delta_h 3.3 kJ
-gamma 0 0
# Id: 3307600
# log K source: NIST46.3
# Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
2Ag+ + HSe- = Ag2Se + H+
log_k 34.911
delta_h 0 kJ
-gamma 0 0
# Id: 207600
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Ag+ + H2O + 2HSe- = AgOH(Se)2-4 + 3H+
log_k -20.509
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 207601
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Mn+2 + HSe- = MnSe + H+
log_k -5.385
delta_h 0 kJ
-gamma 0 0
# Id: 4707600
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
HSeO3- = SeO3-2 + H+
log_k -8.4
delta_h 5.02 kJ
-gamma 0 0
# Id: 3307611
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
HSeO3- + H+ = H2SeO3
log_k 2.63
delta_h 6.2 kJ
-gamma 0 0
# Id: 3307610
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2HSeO3- = Cd(SeO3)2-2 + 2H+
log_k -10.884
delta_h 0 kJ
-gamma 0 0
# Id: 1607610
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Ag+ + HSeO3- = AgSeO3- + H+
log_k -5.592
delta_h 0 kJ
-gamma 0 0
# Id: 207610
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Ag+ + 2HSeO3- = Ag(SeO3)2-3 + 2H+
log_k -13.04
delta_h 0 kJ
-gamma 0 0
# Id: 207611
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Fe+3 + HSeO3- = FeHSeO3+2
```

```
log_k 3.422
delta_h 25 kJ
-gamma 0 0
# Id: 2817610
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 1.00 25.0
SeO4-2 + H+ = HSeO4-
log_k 1.7
delta_h 23 kJ
-gamma 0 0
# Id: 3307620
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Zn+2 + SeO4-2 = ZnSeO4
log_k 2.19
delta_h 0 kJ
-gamma 0 0
# Id: 9507620
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + 2SeO4-2 = Zn(SeO4)2-2
log_k 2.196
delta_h 0 kJ
-gamma 0 0
# Id: 9507621
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Cd+2 + SeO4-2 = CdSeO4
log_k 2.27
delta_h 0 kJ
-gamma 0 0
# Id: 1607620
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + SeO4-2 = NiSeO4
log_k 2.67
delta_h 14 kJ
-gamma 0 0
# Id: 5407620
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + SeO4-2 = CoSeO4
log_k 2.7
delta_h 12 kJ
-gamma 0 0
# Id: 2007621
# log K source: NIST46.4
# Delta H source: NIST46.4
```

```
#T and ionic strength:  0.00 25.0
Mn+2 + SeO4-2 = MnSeO4
log_k 2.43
delta_h 14 kJ
-gamma 0 0
# Id:  4707620
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
NH4+ = NH3 + H+
log_k -9.244
delta_h 52 kJ
-gamma 0 0
# Id:  3304900
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Ag+ + NH4+ = AgNH3+ + H+
log_k -5.934
delta_h -72 kJ
-gamma 0 0
# Id:  204901
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
Ag+ + 2NH4+ = Ag(NH3)2+ + 2H+
log_k -11.268
delta_h -160 kJ
-gamma 0 0
# Id:  204902
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
Hg(OH)2 + H+ + NH4+ = HgNH3+2 + 2H2O
log_k 5.75
delta_h 0 kJ
-gamma 0 0
# Id:  3614900
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  2.00 22.0
Hg(OH)2 + 2NH4+ = Hg(NH3)2+2 + 2H2O
log_k 5.506
delta_h -246.72 kJ
-gamma 0 0
# Id:  3614901
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  1.00 25.0
Hg(OH)2 + 3NH4+ = Hg(NH3)3+2 + 2H2O + H+
log_k -3.138
delta_h -312.72 kJ
-gamma 0 0
# Id:  3614902
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 2.00 25.0
Hg(OH)2 + 4NH4+ = Hg(NH3)4+2 + 2H2O + 2H+
log_k -11.482
delta_h -379.72 kJ
-gamma 0 0
# Id: 3614903
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.10 25.0
Cu+2 + NH4+ = CuNH3+2 + H+
log_k -5.234
delta_h -72 kJ
-gamma 0 0
# Id: 2314901
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ni+2 + NH4+ = NiNH3+2 + H+
log_k -6.514
delta_h -67 kJ
-gamma 0 0
# Id: 5404901
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Ni+2 + 2NH4+ = Ni(NH3)2+2 + 2H+
log_k -13.598
delta_h -111.6 kJ
-gamma 0 0
# Id: 5404902
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + NH4+ = Co(NH3)+2 + H+
log_k -7.164
delta_h -65 kJ
-gamma 0 0
# Id: 2004900
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 2NH4+ = Co(NH3)2+2 + 2H+
log_k -14.778
delta_h 0 kJ
-gamma 0 0
# Id: 2004901
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 2.00 25.0
Co+2 + 3NH4+ = Co(NH3)3+2 + 3H+
log_k -22.922
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2004902
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 2.00 25.0
Co+2 + 4NH4+ = Co(NH3)4+2 + 4H+
log_k -31.446
delta_h 0 kJ
-gamma 0 0
# Id: 2004903
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 2.00 30.0
Co+2 + 5NH4+ = Co(NH3)5+2 + 5H+
log_k -40.47
delta_h 0 kJ
-gamma 0 0
# Id: 2004904
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 2.00 30.0
Co+3 + 6NH4+ + H2O = Co(NH3)6OH+2 + 7H+
log_k -43.7148
delta_h 0 kJ
-gamma 0 0
# Id: 2014901
# log K source: NIST2.1.1
# Delta H source: MTQ3.11
#T and ionic strength:
Co+3 + 5NH4+ + Cl- = Co(NH3)5Cl+2 + 5H+
log_k -17.9584
delta_h 113.38 kJ
-gamma 0 0
# Id: 2014902
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + Cl- = Co(NH3)6Cl+2 + 6H+
log_k -33.9179
delta_h 104.34 kJ
-gamma 0 0
# Id: 2014903
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + Br- = Co(NH3)6Br+2 + 6H+
log_k -33.8884
delta_h 110.57 kJ
-gamma 0 0
# Id: 2014904
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + I- = Co(NH3)6I+2 + 6H+
```

log_k -33.4808
delta_h 115.44 kJ
-gamma 0 0
Id: 2014905
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Co+3 + 6NH4+ + SO4-2 = Co(NH3)6SO4+ + 6H+
log_k -28.9926
delta_h 124.5 kJ
-gamma 0 0
Id: 2014906
log K source: NIST2.1.1
Delta H source: NIST2.1.1
#T and ionic strength:
Cr(OH)2+ + 6NH4+ = Cr(NH3)6+3 + 2H2O + 4H+
log_k -32.8952
delta_h 0 kJ
-gamma 0 0
Id: 2114900
log K source: NIST46.3
Delta H source: MTQ3.11
#T and ionic strength: 4.50 25.0
Cr(OH)2+ + 5NH4+ = Cr(NH3)5OH+2 + 4H+ + H2O
log_k -30.2759
delta_h 0 kJ
-gamma 0 0
Id: 2114901
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 6NH4+ + Cl- = Cr(NH3)6Cl+2 + 2H2O + 4H+
log_k -31.7932
delta_h 0 kJ
-gamma 0 0
Id: 2114904
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 6NH4+ + Br- = Cr(NH3)6Br+2 + 4H+ + 2H2O
log_k -31.887
delta_h 0 kJ
-gamma 0 0
Id: 2114905
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Cr(OH)2+ + 6NH4+ + I- = Cr(NH3)6I+2 + 4H+ + 2H2O
log_k -32.008
delta_h 0 kJ
-gamma 0 0
Id: 2114906
log K source: MTQ3.11
Delta H source: MTQ3.11

#T and ionic strength:
#Cr(OH)2+ + 4NH4+ = cis+ + 4H+
log_k -29.8574
delta_h 0 kJ
-gamma 0 0
Id: 4902113
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
#Cr(OH)2+ + 4NH4+ = trans+ + 4H+
log_k -30.5537
delta_h 0 kJ
-gamma 0 0
Id: 4902114
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
Ca+2 + NH4+ = CaNH3+2 + H+
log_k -9.144
delta_h 0 kJ
-gamma 0 0
Id: 1504901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Ca+2 + 2NH4+ = Ca(NH3)2+2 + 2H+
log_k -18.788
delta_h 0 kJ
-gamma 0 0
Id: 1504902
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Sr+2 + NH4+ = SrNH3+2 + H+
log_k -9.344
delta_h 0 kJ
-gamma 0 0
Id: 8004901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Ba+2 + NH4+ = BaNH3+2 + H+
log_k -9.444
delta_h 0 kJ
-gamma 0 0
Id: 1004901
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Tl+ + NO2- = TlNO2
log_k 0.83
delta_h 0 kJ
-gamma 0 0
Id: 8704910

```
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + NO2- = AgNO2
log_k 2.32
delta_h -29 kJ
-gamma 0 0
# Id: 204911
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2NO2- = Ag(NO2)2-
log_k 2.51
delta_h -46 kJ
-gamma 0 0
# Id: 204910
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cu+2 + NO2- = CuNO2+
log_k 2.02
delta_h 0 kJ
-gamma 0 0
# Id: 2314911
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Cu+2 + 2NO2- = Cu(NO2)2
log_k 3.03
delta_h 0 kJ
-gamma 0 0
# Id: 2314912
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Co+2 + NO2- = CoNO2+
log_k 0.848
delta_h 0 kJ
-gamma 0 0
# Id: 2004911
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Sn(OH)2 + 2H+ + NO3- = SnNO3+ + 2H2O
log_k 7.942
delta_h 0 kJ
-gamma 0 0
# Id: 7904921
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 25.0
Pb+2 + NO3- = PbNO3+
log_k 1.17
delta_h 2 kJ
```

```
-gamma 0 0
# Id: 6004920
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Pb+2 + 2NO3- = Pb(NO3)2
log_k 1.4
delta_h -6.6 kJ
-gamma 0 0
# Id: 6004921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Tl+ + NO3- = TlNO3
log_k 0.33
delta_h -2 kJ
-gamma 0 0
# Id: 8704920
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Tl(OH)3 + NO3- + 3H+ = TlNO3+2 + 3H2O
log_k 7.0073
delta_h 0 kJ
-gamma 0 0
# Id: 8714920
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Cd+2 + NO3- = CdNO3+
log_k 0.5
delta_h -21 kJ
-gamma 0 0
# Id: 1604920
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Cd+2 + 2NO3- = Cd(NO3)2
log_k 0.2
delta_h 0 kJ
-gamma 0 0
# Id: 1604921
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + NO3- = HgNO3+ + 2H2O
log_k 5.7613
delta_h 0 kJ
-gamma 0 0
# Id: 3614920
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Hg(OH)2 + 2H+ + 2NO3- = Hg(NO3)2 + 2H2O
```

```
log_k 5.38
delta_h 0 kJ
-gamma 0 0
# Id: 3614921
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Cu+2 + NO3- = CuNO3+
log_k 0.5
delta_h -4.1 kJ
-gamma 0 0
# Id: 2314921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 2NO3- = Cu(NO3)2
log_k -0.4
delta_h 0 kJ
-gamma 0 0
# Id: 2314922
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + NO3- = ZnNO3+
log_k 0.4
delta_h -4.6 kJ
-gamma 0 0
# Id: 9504921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Zn+2 + 2NO3- = Zn(NO3)2
log_k -0.3
delta_h 0 kJ
-gamma 0 0
# Id: 9504922
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ag+ + NO3- = AgNO3
log_k -0.1
delta_h 22.6 kJ
-gamma 0 0
# Id: 204920
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ni+2 + NO3- = NiNO3+
log_k 0.4
delta_h 0 kJ
-gamma 0 0
# Id: 5404921
# log K source: NIST46.4
# Delta H source: MTQ3.11
```

```
#T and ionic strength:  0.00 25.0
Co+2 + NO3- = CoNO3+
log_k 0.2
delta_h 0 kJ
-gamma 0 0
# Id:  2004921
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Co+2 + 2NO3- = Co(NO3)2
log_k 0.5085
delta_h 0 kJ
-gamma 0 0
# Id:  2004922
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.50 25.0
Fe+3 + NO3- = FeNO3+2
log_k 1
delta_h -37 kJ
-gamma 0 0
# Id:  2814921
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
Mn+2 + NO3- = MnNO3+
log_k 0.2
delta_h 0 kJ
-gamma 0 0
# Id:  4704921
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Mn+2 + 2NO3- = Mn(NO3)2
log_k 0.6
delta_h -1.6569 kJ
-gamma 0 0
# Id:  4704920
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Cr(OH)2+ + NO3- + 2H+ = CrNO3+2 + 2H2O
log_k 8.2094
delta_h -65.4378 kJ
-gamma 0 0
# Id:  2114920
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
UO2+2 + NO3- = UO2NO3+
log_k 0.3
delta_h -12 kJ
-gamma 0 0
# Id:  8934921
```

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
VO2+ + NO3- = VO2NO3
log_k -0.296
delta_h 0 kJ
-gamma 0 0
# Id: 9034920
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 1.00 20.0
Ca+2 + NO3- = CaNO3+
log_k 0.5
delta_h -5.4 kJ
-gamma 0 0
# Id: 1504921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + NO3- = SrNO3+
log_k 0.6
delta_h -10 kJ
-gamma 0 0
# Id: 8004921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + NO3- = BaNO3+
log_k 0.7
delta_h -13 kJ
-gamma 0 0
# Id: 1004921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H+ + Cyanide- = HCyanide
log_k 9.21
delta_h -43.63 kJ
-gamma 0 0
# Id: 3301431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + Cyanide- = CdCyanide+
log_k 6.01
delta_h -30 kJ
-gamma 0 0
# Id: 1601431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 2Cyanide- = Cd(Cyanide)2
log_k 11.12
delta_h -54.3 kJ
```

```
-gamma 0 0
# Id: 1601432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 3Cyanide- = Cd(Cyanide)3-
log_k 15.65
delta_h -90.3 kJ
-gamma 0 0
# Id: 1601433
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 4Cyanide- = Cd(Cyanide)4-2
log_k 17.92
delta_h -112 kJ
-gamma 0 0
# Id: 1601434
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + Cyanide- = HgCyanide+ + 2H2O
log_k 23.194
delta_h -136.72 kJ
-gamma 0 0
# Id: 3611431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 2Cyanide- = Hg(Cyanide)2 + 2H2O
log_k 38.944
delta_h 154.28 kJ
-gamma 0 0
# Id: 3611432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 3Cyanide- = Hg(Cyanide)3- + 2H2O
log_k 42.504
delta_h -262.72 kJ
-gamma 0 0
# Id: 3611433
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 4Cyanide- = Hg(Cyanide)4-2 + 2H2O
log_k 45.164
delta_h -288.72 kJ
-gamma 0 0
# Id: 3611434
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+ + 2Cyanide- = Cu(Cyanide)2-
```

```
log_k 21.9145
delta_h -121 kJ
-gamma 0 0
# Id: 2301432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Cu+ + 3Cyanide- = Cu(Cyanide)3-2
log_k 27.2145
delta_h -167.4 kJ
-gamma 0 0
# Id: 2301433
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+ + 4Cyanide- = Cu(Cyanide)4-3
log_k 28.7145
delta_h -214.2 kJ
-gamma 0 0
# Id: 2301431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2Cyanide- = Ag(Cyanide)2-
log_k 20.48
delta_h -137 kJ
-gamma 0 0
# Id: 201432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 3Cyanide- = Ag(Cyanide)3-2
log_k 21.7
delta_h -140 kJ
-gamma 0 0
# Id: 201433
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + H2O + Cyanide- = Ag(Cyanide)OH- + H+
log_k -0.777
delta_h 0 kJ
-gamma 0 0
# Id: 201431
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ni+2 + 4Cyanide- = Ni(Cyanide)4-2
log_k 30.2
delta_h -180 kJ
-gamma 0 0
# Id: 5401431
# log K source: NIST46.4
# Delta H source: NIST46.4
```

```
#T and ionic strength:  0.00 25.0
Ni+2 + 4Cyanide- + H+ = NiH(Cyanide)4-
log_k 36.0289
delta_h 0 kJ
-gamma 0 0
# Id:  5401432
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 25.0
Ni+2 + 4Cyanide- + 2H+ = NiH2Cyanide4
log_k 40.7434
delta_h 0 kJ
-gamma 0 0
# Id:  5401433
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 25.0
Ni+2 + 4Cyanide- + 3H+ = NiH3(Cyanide)4+
log_k 43.3434
delta_h 0 kJ
-gamma 0 0
# Id:  5401434
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 25.0
Co+2 + 3Cyanide- = Co(Cyanide)3-
log_k 14.312
delta_h 0 kJ
-gamma 0 0
# Id:  2001431
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  1.00 25.0
Co+2 + 5Cyanide- = Co(Cyanide)5-3
log_k 23
delta_h -257 kJ
-gamma 0 0
# Id:  2001432
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  1.00 25.0
Fe+2 + 6Cyanide- = Fe(Cyanide)6-4
log_k 35.4
delta_h -358 kJ
-gamma 0 0
# Id:  2801431
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
H+ + Fe+2 + 6Cyanide- = HFe(Cyanide)6-3
log_k 39.71
delta_h -356 kJ
-gamma 0 0
# Id:  2801432
```

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2H+ + Fe+2 + 6Cyanide- = H2Fe(Cyanide)6-2
log_k 42.11
delta_h -352 kJ
-gamma 0 0
# Id: 2801433
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Fe+3 + 6Cyanide- = Fe(Cyanide)6-3
log_k 43.6
delta_h -293 kJ
-gamma 0 0
# Id: 2811431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2Fe+3 + 6Cyanide- = Fe2(Cyanide)6
log_k 47.6355
delta_h -218 kJ
-gamma 0 0
# Id: 2811432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Sn(OH)2 + Fe+3 + 6Cyanide- + 2H+ = SnFe(Cyanide)6- + 2H2O
log_k 53.54
delta_h 0 kJ
-gamma 0 0
# Id: 7901431
# log K source: Ba1987
# Delta H source:
#T and ionic strength: 0.00 25.0
NH4+ + Fe+2 + 6Cyanide- = NH4Fe(Cyanide)6-3
log_k 37.7
delta_h -354 kJ
-gamma 0 0
# Id: 4901431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Tl+ + Fe+2 + 6Cyanide- = TlFe(Cyanide)6-3
log_k 38.4
delta_h -365.5 kJ
-gamma 0 0
# Id: 8701432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Mg+2 + Fe+3 + 6Cyanide- = MgFe(Cyanide)6-
log_k 46.39
delta_h -290 kJ
```

```
-gamma 0 0
# Id: 4601431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Mg+2 + Fe+2 + 6Cyanide- = MgFe(Cyanide)6-2
log_k 39.21
delta_h -346 kJ
-gamma 0 0
# Id: 4601432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ca+2 + Fe+3 + 6Cyanide- = CaFe(Cyanide)6-
log_k 46.43
delta_h -291 kJ
-gamma 0 0
# Id: 1501431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ca+2 + Fe+2 + 6Cyanide- = CaFe(Cyanide)6-2
log_k 39.1
delta_h -347 kJ
-gamma 0 0
# Id: 1501432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2Ca+2 + Fe+2 + 6Cyanide- = Ca2Fe(Cyanide)6
log_k 40.6
delta_h -350.201 kJ
-gamma 0 0
# Id: 1501433
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Sr+2 + Fe+3 + 6Cyanide- = SrFe(Cyanide)6-
log_k 46.45
delta_h -292 kJ
-gamma 0 0
# Id: 8001431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + Fe+2 + 6Cyanide- = SrFe(Cyanide)6-2
log_k 39.1
delta_h -350 kJ
-gamma 0 0
# Id: 8001432
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + Fe+2 + 6Cyanide- = BaFe(Cyanide)6-2
```

```
log_k 39.19
delta_h -342 kJ
-gamma 0 0
# Id: 1001430
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + Fe+3 + 6Cyanide- = BaFe(Cyanide)6-
log_k 46.48
delta_h -292 kJ
-gamma 0 0
# Id: 1001431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Na+ + Fe+2 + 6Cyanide- = NaFe(Cyanide)6-3
log_k 37.6
delta_h -354 kJ
-gamma 0 0
# Id: 5001431
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
K+ + Fe+2 + 6Cyanide- = KFe(Cyanide)6-3
log_k 37.75
delta_h -353.9 kJ
-gamma 0 0
# Id: 4101433
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
K+ + Fe+3 + 6Cyanide- = KFe(Cyanide)6-2
log_k 45.04
delta_h -291 kJ
-gamma 0 0
# Id: 4101430
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H+ + PO4-3 = HPO4-2
log_k 12.375
delta_h -15 kJ
-gamma 5 0
# Id: 3305800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
2H+ + PO4-3 = H2PO4-
log_k 19.573
delta_h -18 kJ
-gamma 5.4 0
# Id: 3305801
# log K source: NIST46.3
# Delta H source: NIST46.3
```

```
#T and ionic strength:  0.00 25.0
3H+ + PO4-3 = H3PO4
log_k 21.721
delta_h -10.1 kJ
-gamma 0 0
# Id:  3305802
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
Co+2 + H+ + PO4-3 = CoHPO4
log_k 15.4128
delta_h 0 kJ
-gamma 0 0
# Id:  2005800
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.10 25.0
Fe+2 + 2H+ + PO4-3 = FeH2PO4+
log_k 22.273
delta_h 0 kJ
-gamma 5.4 0
# Id:  2805800
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Fe+2 + H+ + PO4-3 = FeHPO4
log_k 15.975
delta_h 0 kJ
-gamma 0 0
# Id:  2805801
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Fe+3 + 2H+ + PO4-3 = FeH2PO4+2
log_k 23.8515
delta_h 0 kJ
-gamma 5.4 0
# Id:  2815801
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.50 25.0
Fe+3 + H+ + PO4-3 = FeHPO4+
log_k 22.292
delta_h -30.5432 kJ
-gamma 5.4 0
# Id:  2815800
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.50 25.0
Cr(OH)2+ + 4H+ + PO4-3 = CrH2PO4+2 + 2H2O
log_k 31.9068
delta_h 0 kJ
-gamma 0 0
# Id:  2115800
```

```
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + PO4-3 + H+ = UHPO4+2
log_k 24.443
delta_h 31.38 kJ
-gamma 0 0
# Id: 8915800
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 2PO4-3 + 2H+ = U(HPO4)2
log_k 46.833
delta_h 7.1128 kJ
-gamma 0 0
# Id: 8915801
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 3PO4-3 + 3H+ = U(HPO4)3-2
log_k 67.564
delta_h -32.6352 kJ
-gamma 0 0
# Id: 8915802
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
U+4 + 4PO4-3 + 4H+ = U(HPO4)4-4
log_k 88.483
delta_h -110.876 kJ
-gamma 0 0
# Id: 8915803
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + H+ + PO4-3 = UO2HPO4
log_k 19.655
delta_h -8.7864 kJ
-gamma 0 0
# Id: 8935800
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
UO2+2 + 2PO4-3 + 2H+ = UO2(HPO4)2-2
log_k 42.988
delta_h -47.6934 kJ
-gamma 0 0
# Id: 8935801
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 2H+ + PO4-3 = UO2H2PO4+
log_k 22.833
delta_h -15.4808 kJ
```

```
-gamma 0 0
# Id: 8935802
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
UO2+2 + 2PO4-3 + 4H+ = UO2(H2PO4)2
log_k 44.7
delta_h -69.036 kJ
-gamma 0 0
# Id: 8935803
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + 3PO4-3 + 6H+ = UO2(H2PO4)3-
log_k 66.245
delta_h -119.662 kJ
-gamma 0 0
# Id: 8935804
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
UO2+2 + PO4-3 = UO2PO4-
log_k 13.25
delta_h 0 kJ
-gamma 0 0
# Id: 8935805
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mg+2 + PO4-3 = MgPO4-
log_k 4.654
delta_h 12.9704 kJ
-gamma 5.4 0
# Id: 4605800
# log K source: SCD3.02 (1993 GMa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.20 25.0
Mg+2 + 2H+ + PO4-3 = MgH2PO4+
log_k 21.2561
delta_h -4.6861 kJ
-gamma 5.4 0
# Id: 4605801
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 37.0
Mg+2 + H+ + PO4-3 = MgHPO4
log_k 15.175
delta_h -3 kJ
-gamma 0 0
# Id: 4605802
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + H+ + PO4-3 = CaHPO4
```

```
log_k 15.035
delta_h -3 kJ
-gamma 0 0
# Id: 1505800
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + PO4-3 = CaPO4-
log_k 6.46
delta_h 12.9704 kJ
-gamma 5.4 0
# Id: 1505801
# log K source: SCD3.02 (1993 GMa)
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Ca+2 + 2H+ + PO4-3 = CaH2PO4+
log_k 20.923
delta_h -6 kJ
-gamma 5.4 0
# Id: 1505802
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + H+ + PO4-3 = SrHPO4
log_k 14.8728
delta_h 0 kJ
-gamma 0 0
# Id: 8005800
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Sr+2 + 2H+ + PO4-3 = SrH2PO4+
log_k 20.4019
delta_h 0 kJ
-gamma 0 0
# Id: 8005801
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
Na+ + H+ + PO4-3 = NaHPO4-
log_k 13.445
delta_h 0 kJ
-gamma 5.4 0
# Id: 5005800
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
K+ + H+ + PO4-3 = KHPO4-
log_k 13.255
delta_h 0 kJ
-gamma 5.4 0
# Id: 4105800
# log K source: NIST46.3
# Delta H source: MTQ3.11
```

```
#T and ionic strength:  0.00 25.0
H3AsO3 = AsO3-3 + 3H+
log_k -34.744
delta_h 84.726 kJ
-gamma 0 0
# Id:  3300602
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
H3AsO3 = HAsO3-2 + 2H+
log_k -21.33
delta_h 59.4086 kJ
-gamma 0 0
# Id:  3300601
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
H3AsO3 = H2AsO3- + H+
log_k -9.29
delta_h 27.41 kJ
-gamma 0 0
# Id:  3300600
# log K source:  NIST46.4
# Delta H source:  NIST2.1.1
#T and ionic strength:  0.00 25.0
H3AsO3 + H+ = H4AsO3+
log_k -0.305
delta_h 0 kJ
-gamma 0 0
# Id:  3300603
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
H3AsO4 = AsO4-3 + 3H+
log_k -20.7
delta_h 12.9 kJ
-gamma 0 0
# Id:  3300613
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
H3AsO4 = HAsO4-2 + 2H+
log_k -9.2
delta_h -4.1 kJ
-gamma 0 0
# Id:  3300612
# log K source:  NIST46.4
# Delta H source:  NIST46.4
#T and ionic strength:  0.00 25.0
H3AsO4 = H2AsO4- + H+
log_k -2.24
delta_h -7.1 kJ
-gamma 0 0
# Id:  3300611
```

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sb(OH)3 + H2O = Sb(OH)4- + H+
log_k -12.0429
delta_h 69.8519 kJ
-gamma 0 0
# Id: 7400020
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 + H+ = Sb(OH)2+ + H2O
log_k 1.3853
delta_h 0 kJ
-gamma 0 0
# Id: 7403302
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 = HSbO2 + H2O
log_k -0.0105
delta_h -0.13 kJ
-gamma 0 0
# Id: 7400021
# log K source: NIST2.1.1
# Delta H source: NIST2.1.1
#T and ionic strength:
Sb(OH)3 = SbO2- + H2O + H+
log_k -11.8011
delta_h 70.1866 kJ
-gamma 0 0
# Id: 7403301
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
Sb(OH)3 + H+ = SbO+ + 2H2O
log_k 0.9228
delta_h 8.2425 kJ
-gamma 0 0
# Id: 7403300
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
Sb(OH)6- = SbO3- + 3H2O
log_k 2.9319
delta_h 0 kJ
-gamma 0 0
# Id: 7410021
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
Sb(OH)6- + 2H+ = SbO2+ + 4H2O
log_k 2.3895
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 7413300
# log K source: PNL89
# Delta H source: PNL89
#T and ionic strength:
H+ + CO3-2 = HCO3-
log_k 10.329
delta_h -14.6 kJ
-gamma 5.4 0
# Id: 3301400
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
2H+ + CO3-2 = H2CO3
log_k 16.681
delta_h -23.76 kJ
-gamma 0 0
# Id: 3301401
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Pb+2 + 2CO3-2 = Pb(CO3)2-2
log_k 9.938
delta_h 0 kJ
-gamma 0 0
# Id: 6001400
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Pb+2 + CO3-2 = PbCO3
log_k 6.478
delta_h 0 kJ
-gamma 0 0
# Id: 6001401
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Pb+2 + CO3-2 + H+ = PbHCO3+
log_k 13.2
delta_h 0 kJ
-gamma 0 0
# Id: 6001402
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
Zn+2 + CO3-2 = ZnCO3
log_k 4.76
delta_h 0 kJ
-gamma 0 0
# Id: 9501401
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Zn+2 + H+ + CO3-2 = ZnHCO3+
```

```
log_k 11.829
delta_h 0 kJ
-gamma 0 0
# Id: 9501400
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + CO3-2 = HgCO3 + 2H2O
log_k 18.272
delta_h 0 kJ
-gamma 0 0
# Id: 3611401
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 2H+ + 2CO3-2 = Hg(CO3)2-2 + 2H2O
log_k 21.772
delta_h 0 kJ
-gamma 0 0
# Id: 3611402
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Hg(OH)2 + 3H+ + CO3-2 = HgHCO3+ + 2H2O
log_k 22.542
delta_h 0 kJ
-gamma 0 0
# Id: 3611403
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
Cd+2 + CO3-2 = CdCO3
log_k 4.3578
delta_h 0 kJ
-gamma 0 0
# Id: 1601401
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
Cd+2 + H+ + CO3-2 = CdHCO3+
log_k 10.6863
delta_h 0 kJ
-gamma 0 0
# Id: 1601400
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Cd+2 + 2CO3-2 = Cd(CO3)2-2
log_k 7.2278
delta_h 0 kJ
-gamma 0 0
# Id: 1601403
# log K source: NIST46.4
# Delta H source: MTQ3.11
```

```
#T and ionic strength:  0.10 20.0
Cu+2 + CO3-2 = CuCO3
log_k 6.77
delta_h 0 kJ
-gamma 0 0
# Id:  2311400
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Cu+2 + H+ + CO3-2 = CuHCO3+
log_k 12.129
delta_h 0 kJ
-gamma 0 0
# Id:  2311402
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Cu+2 + 2CO3-2 = Cu(CO3)2-2
log_k 10.2
delta_h 0 kJ
-gamma 0 0
# Id:  2311401
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
Ni+2 + CO3-2 = NiCO3
log_k 4.5718
delta_h 0 kJ
-gamma 0 0
# Id:  5401401
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.70 25.0
Ni+2 + H+ + CO3-2 = NiHCO3+
log_k 12.4199
delta_h 0 kJ
-gamma 0 0
# Id:  5401400
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.70 25.0
Co+2 + CO3-2 = CoCO3
log_k 4.228
delta_h 0 kJ
-gamma 0 0
# Id:  2001400
# log K source:  NIST46.4
# Delta H source:  MTQ3.11
#T and ionic strength:  0.50 25.0
Co+2 + H+ + CO3-2 = CoHCO3+
log_k 12.2199
delta_h 0 kJ
-gamma 0 0
# Id:  2001401
```

```
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.70 25.0
Fe+2 + H+ + CO3-2 = FeHCO3+
log_k 11.429
delta_h 0 kJ
-gamma 6 0
# Id: 2801400
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mn+2 + H+ + CO3-2 = MnHCO3+
log_k 11.629
delta_h -10.6 kJ
-gamma 5 0
# Id: 4701400
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
UO2+2 + CO3-2 = UO2CO3
log_k 9.6
delta_h 4 kJ
-gamma 0 0
# Id: 8931400
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 2CO3-2 = UO2(CO3)2-2
log_k 16.9
delta_h 16 kJ
-gamma 0 0
# Id: 8931401
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
UO2+2 + 3CO3-2 = UO2(CO3)3-4
log_k 21.6
delta_h -40 kJ
-gamma 0 0
# Id: 8931402
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Be+2 + CO3-2 = BeCO3
log_k 6.2546
delta_h 0 kJ
-gamma 0 0
# Id: 1101401
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 3.00 25.0
Mg+2 + CO3-2 = MgCO3
log_k 2.92
delta_h 12 kJ
```

```
-gamma 0 0
# Id: 4601400
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Mg+2 + H+ + CO3-2 = MgHCO3+
log_k 11.339
delta_h -10.6 kJ
-gamma 4 0
# Id: 4601401
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Ca+2 + H+ + CO3-2 = CaHCO3+
log_k 11.599
delta_h 5.4 kJ
-gamma 6 0
# Id: 1501400
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
CO3-2 + Ca+2 = CaCO3
log_k 3.2
delta_h 16 kJ
-gamma 0 0
# Id: 1501401
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
Sr+2 + CO3-2 = SrCO3
log_k 2.81
delta_h 20 kJ
-gamma 0 0
# Id: 8001401
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + H+ + CO3-2 = SrHCO3+
log_k 11.539
delta_h 10.4 kJ
-gamma 6 0
# Id: 8001400
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + CO3-2 = BaCO3
log_k 2.71
delta_h 16 kJ
-gamma 0 0
# Id: 1001401
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + H+ + CO3-2 = BaHCO3+
```

```
log_k 11.309
delta_h 10.4 kJ
-gamma 6 0
# Id: 1001400
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Na+ + CO3-2 = NaCO3-
log_k 1.27
delta_h -20.35 kJ
-gamma 5.4 0
# Id: 5001400
# log K source: NIST46.3
# Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
Na+ + H+ + CO3-2 = NaHCO3
log_k 10.079
delta_h -28.3301 kJ
-gamma 0 0
# Id: 5001401
# log K source: NIST46.3
# Delta H source: NIST2.1.1
#T and ionic strength: 0.00 25.0
H4SiO4 = H2SiO4-2 + 2H+
log_k -23.04
delta_h 61 kJ
-gamma 5.4 0
# Id: 3307701
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
H4SiO4 = H3SiO4- + H+
log_k -9.84
delta_h 20 kJ
-gamma 4 0
# Id: 3307700
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
UO2+2 + H4SiO4 = UO2H3SiO4+ + H+
log_k -1.9111
delta_h 0 kJ
-gamma 0 0
# Id: 8937700
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 25.0
H3BO3 = H2BO3- + H+
log_k -9.236
delta_h 13 kJ
-gamma 2.5 0
# Id: 3300900
# log K source: NIST46.4
# Delta H source: NIST46.4
```

```
#T and ionic strength: 0.00 25.0
2H3BO3 = H5(BO3)2- + H+
log_k -9.306
delta_h 8.4 kJ
-gamma 2.5 0
# Id: 3300901
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
3H3BO3 = H8(BO3)3- + H+
log_k -7.306
delta_h 29.4 kJ
-gamma 2.5 0
# Id: 3300902
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + H3BO3 = AgH2BO3 + H+
log_k -8.036
delta_h 0 kJ
-gamma 2.5 0
# Id: 200901
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Mg+2 + H3BO3 = MgH2BO3+ + H+
log_k -7.696
delta_h 13 kJ
-gamma 2.5 0
# Id: 4600901
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ca+2 + H3BO3 = CaH2BO3+ + H+
log_k -7.476
delta_h 17 kJ
-gamma 2.5 0
# Id: 1500901
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + H3BO3 = SrH2BO3+ + H+
log_k -7.686
delta_h 17 kJ
-gamma 2.5 0
# Id: 8000901
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + H3BO3 = BaH2BO3+ + H+
log_k -7.746
delta_h 17 kJ
-gamma 2.5 0
# Id: 1000901
```

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Na+ + H3BO3 = NaH2BO3 + H+
log_k -9.036
delta_h 0 kJ
-gamma 2.5 0
# Id: 5000901
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
CrO4-2 + H+ = HCrO4-
log_k 6.51
delta_h 2 kJ
-gamma 0 0
# Id: 2123300
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
CrO4-2 + 2H+ = H2CrO4
log_k 6.4188
delta_h 39 kJ
-gamma 0 0
# Id: 2123301
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 20.0
2CrO4-2 + 2H+ = Cr2O7-2 + H2O
log_k 14.56
delta_h -15 kJ
-gamma 0 0
# Id: 2123302
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
CrO4-2 + Cl- + 2H+ = CrO3Cl- + H2O
log_k 7.3086
delta_h 0 kJ
-gamma 0 0
# Id: 2121800
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + SO4-2 + 2H+ = CrO3SO4-2 + H2O
log_k 8.9937
delta_h 0 kJ
-gamma 0 0
# Id: 2127320
# log K source: MTQ3.11
# Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + 4H+ + PO4-3 = CrO3H2PO4- + H2O
log_k 29.3634
delta_h 0 kJ
```

-gamma 0 0
Id: 2125800
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + 3H+ + PO4-3 = CrO3HPO4-2 + H2O
log_k 26.6806
delta_h 0 kJ
-gamma 0 0
Id: 2125801
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
CrO4-2 + Na+ = NaCrO4-
log_k 0.6963
delta_h 0 kJ
-gamma 0 0
Id: 5002120
log K source: MTQ3.11
Delta H source: MTQ3.11
#T and ionic strength:
K+ + CrO4-2 = KCrO4-
log_k 0.57
delta_h 0 kJ
-gamma 0 0
Id: 4102120
log K source: NIST46.4
Delta H source: MTQ3.11
#T and ionic strength: 0.00 18.0
MoO4-2 + H+ = HMoO4-
log_k 4.2988
delta_h 20 kJ
-gamma 0 0
Id: 3304801
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 20.0
MoO4-2 + 2H+ = H2MoO4
log_k 8.1636
delta_h -26 kJ
-gamma 0 0
Id: 3304802
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 20.0
7MoO4-2 + 8H+ = Mo7O24-6 + 4H2O
log_k 52.99
delta_h -228 kJ
-gamma 0 0
Id: 3304803
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
7MoO4-2 + 9H+ = HMo7O24-5 + 4H2O

```
log_k 59.3768
delta_h -218 kJ
-gamma 0 0
# Id: 3304804
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
7MoO4-2 + 10H+ = H2Mo7O24-4 + 4H2O
log_k 64.159
delta_h -215 kJ
-gamma 0 0
# Id: 3304805
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
7MoO4-2 + 11H+ = H3Mo7O24-3 + 4H2O
log_k 67.405
delta_h -217 kJ
-gamma 0 0
# Id: 3304806
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
6MoO4-2 + Al+3 + 6H+ = AlMo6O21-3 + 3H2O
log_k 54.9925
delta_h 0 kJ
-gamma 0 0
# Id: 304801
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.50 25.0
MoO4-2 + 2Ag+ = Ag2MoO4
log_k -0.4219
delta_h -1.18 kJ
-gamma 0 0
# Id: 204801
# log K source: Bard85
# Delta H source: Bard85
#T and ionic strength:
VO2+ + 2H2O = VO4-3 + 4H+
log_k -30.2
delta_h -25 kJ
-gamma 0 0
# Id: 9033303
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
VO2+ + 2H2O = HVO4-2 + 3H+
log_k -15.9
delta_h 0 kJ
-gamma 0 0
# Id: 9033302
# log K source: NIST46.3
# Delta H source: NIST46.3
```

```
#T and ionic strength:  0.00 25.0
VO2+ + 2H2O = H2VO4- + 2H+
log_k -7.3
delta_h 0 kJ
-gamma 0 0
# Id:  9033301
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
VO2+ + 2H2O = H3VO4 + H+
log_k -3.3
delta_h 44.4759 kJ
-gamma 0 0
# Id:  9033300
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
2VO2+ + 3H2O = V2O7-4 + 6H+
log_k -31.24
delta_h -28 kJ
-gamma 0 0
# Id:  9030020
# log K source:  NIST46.3
# Delta H source:  NIST46.3
#T and ionic strength:  0.00 25.0
2VO2+ + 3H2O = HV2O7-3 + 5H+
log_k -20.67
delta_h 0 kJ
-gamma 0 0
# Id:  9030021
# log K source:  NIST46.3
# Delta H source:  MTQ3.11
#T and ionic strength:  0.00 25.0
2VO2+ + 3H2O = H3V2O7- + 3H+
log_k -3.79
delta_h 0 kJ
-gamma 0 0
# Id:  9030022
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
3VO2+ + 3H2O = V3O9-3 + 6H+
log_k -15.88
delta_h 0 kJ
-gamma 0 0
# Id:  9030023
# log K source:  MTQ3.11
# Delta H source:  MTQ3.11
#T and ionic strength:
4VO2+ + 4H2O = V4O12-4 + 8H+
log_k -20.56
delta_h -87 kJ
-gamma 0 0
# Id:  9030024
```

```
# log K source: NIST46.3
# Delta H source: NIST46.3
#T and ionic strength: 0.00 25.0
10VO2+ + 8H2O = V10O28-6 + 16H+
log_k -24.0943
delta_h 0 kJ
-gamma 0 0
# Id: 9030025
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
10VO2+ + 8H2O = HV10O28-5 + 15H+
log_k -15.9076
delta_h 90.0397 kJ
-gamma 0 0
# Id: 9030026
# log K source: NIST46.4
# Delta H source: MTQ3.11
#T and ionic strength: 0.10 20.0
10VO2+ + 8H2O = H2V10O28-4 + 14H+
log_k -10.7
delta_h 0 kJ
-gamma 0 0
# Id: 9030027
# log K source: NIST46.3
# Delta H source: MTQ3.11
#T and ionic strength: 0.00 25.0
Benzoate- + H+ = H(Benzoate)
log_k 4.202
delta_h -0.4602 kJ
-gamma 0 0
# Id: 3309171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Pb+2 = Pb(Benzoate)+
log_k 2.4
delta_h 0 kJ
-gamma 0 0
# Id: 6009171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Al+3 = Al(Benzoate)+2
log_k 2.05
delta_h 0 kJ
-gamma 0 0
# Id: 309171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Al+3 + H2O = AlOH(Benzoate)+ + H+
log_k -0.56
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 309172
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Zn+2 = Zn(Benzoate)+
log_k 1.7
delta_h 0 kJ
-gamma 0 0
# Id: 9509171
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Benzoate- + Cd+2 = Cd(Benzoate)+
log_k 1.8
delta_h 0 kJ
-gamma 0 0
# Id: 1609171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2Benzoate- + Cd+2 = Cd(Benzoate)2
log_k 1.82
delta_h 0 kJ
-gamma 0 0
# Id: 1609172
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Benzoate- + Cu+2 = Cu(Benzoate)+
log_k 2.19
delta_h 0 kJ
-gamma 0 0
# Id: 2319171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Ag+ = Ag(Benzoate)
log_k 0.91
delta_h 0 kJ
-gamma 0 0
# Id: 209171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Ni+2 = Ni(Benzoate)+
log_k 1.86
delta_h 0 kJ
-gamma 0 0
# Id: 5409171
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Benzoate- = Co(Benzoate)+
```

```
log_k 1.0537
delta_h 12 kJ
-gamma 0 0
# Id: 2009171
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 30.0
Benzoate- + Mn+2 = Mn(Benzoate)+
log_k 2.06
delta_h 0 kJ
-gamma 0 0
# Id: 4709171
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Benzoate- + Mg+2 = Mg(Benzoate)+
log_k 1.26
delta_h 0 kJ
-gamma 0 0
# Id: 4609171
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Benzoate- + Ca+2 = Ca(Benzoate)+
log_k 1.55
delta_h 0 kJ
-gamma 0 0
# Id: 1509171
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Phenylacetate- + H+ = H(Phenylacetate)
log_k 4.31
delta_h 2.1757 kJ
-gamma 0 0
# Id: 3309181
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Phenylacetate- + Zn+2 = Zn(Phenylacetate)+
log_k 1.57
delta_h 0 kJ
-gamma 0 0
# Id: 9509181
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Phenylacetate- + Cu+2 = Cu(Phenylacetate)+
log_k 1.97
delta_h 0 kJ
-gamma 0 0
# Id: 2319181
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Co+2 + Phenylacetate- = Co(Phenylacetate)+
log_k 0.591
delta_h 0 kJ
-gamma 0 0
# Id: 2009181
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Co+2 + 2Phenylacetate- = Co(Phenylacetate)2
log_k 0.4765
delta_h 0 kJ
-gamma 0 0
# Id: 2009182
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Isophthalate-2 + H+ = H(Isophthalate)-
log_k 4.5
delta_h 1.6736 kJ
-gamma 0 0
# Id: 3309201
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + 2H+ = H2(Isophthalate)
log_k 8
delta_h 1.6736 kJ
-gamma 0 0
# Id: 3309202
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Pb+2 = Pb(Isophthalate)
log_k 2.99
delta_h 0 kJ
-gamma 0 0
# Id: 6009201
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2Isophthalate-2 + Pb+2 = Pb(Isophthalate)2-2
log_k 4.18
delta_h 0 kJ
-gamma 0 0
# Id: 6009202
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Pb+2 + H+ = PbH(Isophthalate)+
log_k 6.69
delta_h 0 kJ
-gamma 0 0
# Id: 6009203
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Cd+2 = Cd(Isophthalate)
log_k 2.15
delta_h 0 kJ
-gamma 0 0
# Id: 1609201
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2Isophthalate-2 + Cd+2 = Cd(Isophthalate)2-2
log_k 2.99
delta_h 0 kJ
-gamma 0 0
# Id: 1609202
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Cd+2 + H+ = CdH(Isophthalate)+
log_k 5.73
delta_h 0 kJ
-gamma 0 0
# Id: 1609203
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Ca+2 = Ca(Isophthalate)
log_k 2
delta_h 0 kJ
-gamma 0 0
# Id: 1509200
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Isophthalate-2 + Ba+2 = Ba(Isophthalate)
log_k 1.55
delta_h 0 kJ
-gamma 0 0
# Id: 1009201
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Diethylamine = H(Diethylamine)+
log_k 10.933
delta_h -53.1368 kJ
-gamma 0 0
# Id: 3309551
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Diethylamine = Zn(Diethylamine)+2
log_k 2.74
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 9509551
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Diethylamine = Zn(Diethylamine)2+2
log_k 5.27
delta_h 0 kJ
-gamma 0 0
# Id: 9509552
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Diethylamine = Zn(Diethylamine)3+2
log_k 7.71
delta_h 0 kJ
-gamma 0 0
# Id: 9509553
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 4Diethylamine = Zn(Diethylamine)4+2
log_k 9.84
delta_h 0 kJ
-gamma 0 0
# Id: 9509554
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Diethylamine = Cd(Diethylamine)+2
log_k 2.73
delta_h 0 kJ
-gamma 0 0
# Id: 1609551
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Diethylamine = Cd(Diethylamine)2+2
log_k 4.86
delta_h 0 kJ
-gamma 0 0
# Id: 1609552
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Diethylamine = Cd(Diethylamine)3+2
log_k 6.37
delta_h 0 kJ
-gamma 0 0
# Id: 1609553
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 4Diethylamine = Cd(Diethylamine)4+2
```

```
log_k 7.32
delta_h 0 kJ
-gamma 0 0
# Id: 1609554
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ag+ + Diethylamine = Ag(Diethylamine)+
log_k 2.98
delta_h 0 kJ
-gamma 0 0
# Id: 209551
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Diethylamine = Ag(Diethylamine)2+
log_k 6.38
delta_h -44.7688 kJ
-gamma 0 0
# Id: 209552
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Diethylamine = Ni(Diethylamine)+2
log_k 2.78
delta_h 0 kJ
-gamma 0 0
# Id: 5409551
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 2Diethylamine = Ni(Diethylamine)2+2
log_k 4.97
delta_h 0 kJ
-gamma 0 0
# Id: 5409552
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 3Diethylamine = Ni(Diethylamine)3+2
log_k 6.72
delta_h 0 kJ
-gamma 0 0
# Id: 5409553
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 4Diethylamine = Ni(Diethylamine)4+2
log_k 7.93
delta_h 0 kJ
-gamma 0 0
# Id: 5409554
# log K source: SCD2.62
# Delta H source: SCD2.62
```

#T and ionic strength:
Ni+2 + 5Diethylamine = Ni(Diethylamine)5+2
log_k 8.87
delta_h 0 kJ
-gamma 0 0
Id: 5409555
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
H+ + Butylamine = H(Butylamine)+
log_k 10.64
delta_h -58.2831 kJ
-gamma 0 0
Id: 3309561
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Butylamine + 2H+ = Hg(Butylamine)+2 + 2H2O
log_k 14.84
delta_h 0 kJ
-gamma 0 0
Id: 3619561
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Butylamine + 2H+ = Hg(Butylamine)2+2 + 2H2O
log_k 24.24
delta_h 0 kJ
-gamma 0 0
Id: 3619562
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 3Butylamine + 2H+ = Hg(Butylamine)3+2 + 2H2O
log_k 25.1
delta_h 0 kJ
-gamma 0 0
Id: 3619563
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 4Butylamine + 2H+ = Hg(Butylamine)4+2 + 2H2O
log_k 26.1
delta_h 0 kJ
-gamma 0 0
Id: 3619564
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Butylamine = Ag(Butylamine)+
log_k 3.42
delta_h -16.736 kJ
-gamma 0 0
Id: 209561

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Butylamine = Ag(Butylamine)2+
log_k 7.47
delta_h -52.7184 kJ
-gamma 0 0
# Id: 209562
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Methylamine = H(Methylamine)+
log_k 10.64
delta_h -55.2288 kJ
-gamma 0 0
# Id: 3309581
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Methylamine = Cd(Methylamine)+2
log_k 2.75
delta_h 0 kJ
-gamma 0 0
# Id: 1609581
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Methylamine = Cd(Methylamine)2+2
log_k 4.81
delta_h -29.288 kJ
-gamma 0 0
# Id: 1609582
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 3Methylamine = Cd(Methylamine)3+2
log_k 5.94
delta_h 0 kJ
-gamma 0 0
# Id: 1609583
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 4Methylamine = Cd(Methylamine)4+2
log_k 6.55
delta_h -58.576 kJ
-gamma 0 0
# Id: 1609584
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Methylamine + 2H+ = Hg(Methylamine)+2 + 2H2O
log_k 14.76
delta_h 0 kJ
```

-gamma 0 0
Id: 3619581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Methylamine + 2H+ = Hg(Methylamine)2+2 + 2H2O
log_k 23.96
delta_h 0 kJ
-gamma 0 0
Id: 3619582
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 3Methylamine + 2H+ = Hg(Methylamine)3+2 + 2H2O
log_k 24.3
delta_h 0 kJ
-gamma 0 0
Id: 3619583
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 4Methylamine + 2H+ = Hg(Methylamine)4+2 + 2H2O
log_k 24.6
delta_h 0 kJ
-gamma 0 0
Id: 3619584
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Methylamine = Cu(Methylamine)+2
log_k 4.11
delta_h 0 kJ
-gamma 0 0
Id: 2319581
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Methylamine = Cu(Methylamine)2+2
log_k 7.51
delta_h 0 kJ
-gamma 0 0
Id: 2319582
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 3Methylamine = Cu(Methylamine)3+2
log_k 10.21
delta_h 0 kJ
-gamma 0 0
Id: 2319583
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 4Methylamine = Cu(Methylamine)4+2

```
log_k 12.08
delta_h 0 kJ
-gamma 0 0
# Id: 2319584
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Methylamine = Ag(Methylamine)+
log_k 3.07
delta_h -12.552 kJ
-gamma 0 0
# Id: 209581
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Methylamine = Ag(Methylamine)2+
log_k 6.89
delta_h -48.9528 kJ
-gamma 0 0
# Id: 209582
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Methylamine = Ni(Methylamine)+2
log_k 2.23
delta_h 0 kJ
-gamma 0 0
# Id: 5409581
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Dimethylamine = H(Dimethylamine)+
log_k 10.774
delta_h -50.208 kJ
-gamma 0 0
# Id: 3309591
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Dimethylamine = Ag(Dimethylamine)2+
log_k 5.37
delta_h -40.5848 kJ
-gamma 0 0
# Id: 209591
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Dimethylamine = Ni(Dimethylamine)+2
log_k 1.47
delta_h 0 kJ
-gamma 0 0
# Id: 5409591
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
H+ + Hexylamine = H(Hexylamine)+
log_k 10.63
delta_h -58.576 kJ
-gamma 0 0
# Id: 3309611
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Hexylamine = Ag(Hexylamine)+
log_k 3.54
delta_h -25.104 kJ
-gamma 0 0
# Id: 209611
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Hexylamine = Ag(Hexylamine)2+
log_k 7.55
delta_h -53.1368 kJ
-gamma 0 0
# Id: 209612
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Ethylenediamine = H(Ethylenediamine)+
log_k 9.928
delta_h -49.7896 kJ
-gamma 0 0
# Id: 3309631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Ethylenediamine = H2(Ethylenediamine)+2
log_k 16.776
delta_h -95.3952 kJ
-gamma 0 0
# Id: 3309632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Ethylenediamine = Pb(Ethylenediamine)+2
log_k 5.04
delta_h 0 kJ
-gamma 0 0
# Id: 6009631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + 2Ethylenediamine = Pb(Ethylenediamine)2+2
log_k 8.5
delta_h 0 kJ
-gamma 0 0
# Id: 6009632
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Ethylenediamine = Zn(Ethylenediamine)+2
log_k 5.66
delta_h -29.288 kJ
-gamma 0 0
# Id: 9509631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Ethylenediamine = Zn(Ethylenediamine)2+2
log_k 10.6
delta_h -48.116 kJ
-gamma 0 0
# Id: 9509632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Ethylenediamine = Zn(Ethylenediamine)3+2
log_k 13.9
delta_h -71.5464 kJ
-gamma 0 0
# Id: 9509633
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Ethylenediamine = Cd(Ethylenediamine)+2
log_k 5.41
delta_h -28.4512 kJ
-gamma 0 0
# Id: 1609631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Ethylenediamine = Cd(Ethylenediamine)2+2
log_k 9.9
delta_h -55.6472 kJ
-gamma 0 0
# Id: 1609632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 3Ethylenediamine = Cd(Ethylenediamine)3+2
log_k 11.6
delta_h -82.4248 kJ
-gamma 0 0
# Id: 1609633
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Ethylenediamine + 2H+ = Hg(Ethylenediamine)+2 + 2H2O
log_k 20.4
delta_h 0 kJ
```

-gamma 0 0
Id: 3619631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Ethylenediamine + 2H+ = Hg(Ethylenediamine)2+2 + 2H2O
log_k 29.3
delta_h -173.218 kJ
-gamma 0 0
Id: 3619632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Ethylenediamine + 3H+ = HgH(Ethylenediamine)2+3 + 2H2O
log_k 34.7
delta_h 0 kJ
-gamma 0 0
Id: 3619633
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Ethylenediamine = Cu(Ethylenediamine)2+
log_k 11.2
delta_h 0 kJ
-gamma 0 0
Id: 2309631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Ethylenediamine = Cu(Ethylenediamine)+2
log_k 10.5
delta_h -52.7184 kJ
-gamma 0 0
Id: 2319631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Ethylenediamine = Cu(Ethylenediamine)2+2
log_k 19.6
delta_h -105.437 kJ
-gamma 0 0
Id: 2319632
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Ethylenediamine = Ag(Ethylenediamine)+
log_k 4.6
delta_h -48.9528 kJ
-gamma 0 0
Id: 209631
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Ethylenediamine = Ag(Ethylenediamine)2+

```
log_k 7.5
delta_h -52.3 kJ
-gamma 0 0
# Id: 209632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Ethylenediamine + H+ = AgH(Ethylenediamine)+2
log_k 11.99
delta_h -75.312 kJ
-gamma 0 0
# Id: 209633
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2Ag+ + Ethylenediamine = Ag2(Ethylenediamine)+2
log_k 6.5
delta_h 0 kJ
-gamma 0 0
# Id: 209634
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2Ag+ + 2Ethylenediamine = Ag2(Ethylenediamine)2+2
log_k 12.7
delta_h -97.0688 kJ
-gamma 0 0
# Id: 209635
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Ethylenediamine + 2H+ = Ag(HEthylenediamine)2+3
log_k 24
delta_h -150.206 kJ
-gamma 0 0
# Id: 209636
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Ethylenediamine + H+ = AgH(Ethylenediamine)2+2
log_k 8.4
delta_h -47.6976 kJ
-gamma 0 0
# Id: 209637
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Ethylenediamine = Ni(Ethylenediamine)+2
log_k 7.32
delta_h -37.656 kJ
-gamma 0 0
# Id: 5409631
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Ni+2 + 2Ethylenediamine = Ni(Ethylenediamine)2+2
log_k 13.5
delta_h -76.5672 kJ
-gamma 0 0
# Id: 5409632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Ethylenediamine = Ni(Ethylenediamine)3+2
log_k 17.6
delta_h -117.152 kJ
-gamma 0 0
# Id: 5409633
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Ethylenediamine = Co(Ethylenediamine)+2
log_k 5.5
delta_h -28 kJ
-gamma 0 0
# Id: 2009631
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 2Ethylenediamine = Co(Ethylenediamine)2+2
log_k 10.1
delta_h -58.5 kJ
-gamma 0 0
# Id: 2009632
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 3Ethylenediamine = Co(Ethylenediamine)3+2
log_k 13.2
delta_h -92.8 kJ
-gamma 0 0
# Id: 2009633
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+3 + 2Ethylenediamine = Co(Ethylenediamine)2+3
log_k 34.7
delta_h 0 kJ
-gamma 0 0
# Id: 2019631
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Co+3 + 3Ethylenediamine = Co(Ethylenediamine)3+3
log_k 48.69
delta_h 0 kJ
-gamma 0 0
# Id: 2019632
```

```
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.50 30.0
Fe+2 + Ethylenediamine = Fe(Ethylenediamine)+2
log_k 4.26
delta_h 0 kJ
-gamma 0 0
# Id: 2809631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Ethylenediamine = Fe(Ethylenediamine)2+2
log_k 7.73
delta_h 0 kJ
-gamma 0 0
# Id: 2809632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 3Ethylenediamine = Fe(Ethylenediamine)3+2
log_k 10.17
delta_h 0 kJ
-gamma 0 0
# Id: 2809633
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Ethylenediamine = Mn(Ethylenediamine)+2
log_k 2.74
delta_h -11.7152 kJ
-gamma 0 0
# Id: 4709631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Ethylenediamine = Mn(Ethylenediamine)2+2
log_k 4.8
delta_h -25.104 kJ
-gamma 0 0
# Id: 4709632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + 2Ethylenediamine + 2H+ = Cr(Ethylenediamine)2+3 + 2H2O
log_k 22.57
delta_h 0 kJ
-gamma 0 0
# Id: 2119631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + 3Ethylenediamine + 2H+ = Cr(Ethylenediamine)3+3 + 2H2O
log_k 29
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2119632
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Ethylenediamine = Mg(Ethylenediamine)+2
log_k 0.37
delta_h 0 kJ
-gamma 0 0
# Id: 4609631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Ethylenediamine = Ca(Ethylenediamine)+2
log_k 0.11
delta_h 0 kJ
-gamma 0 0
# Id: 1509631
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Propylamine = H(Propylamine)+
log_k 10.566
delta_h -57.53 kJ
-gamma 0 0
# Id: 3309641
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Propylamine = Zn(Propylamine)+2
log_k 2.42
delta_h 0 kJ
-gamma 0 0
# Id: 9509641
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Propylamine = Zn(Propylamine)2+2
log_k 4.85
delta_h 0 kJ
-gamma 0 0
# Id: 9509642
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Propylamine = Zn(Propylamine)3+2
log_k 7.38
delta_h 0 kJ
-gamma 0 0
# Id: 9509643
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 4Propylamine = Zn(Propylamine)4+2
```

```
log_k 9.49
delta_h 0 kJ
-gamma 0 0
# Id: 9509644
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Propylamine = Cd(Propylamine)+2
log_k 2.62
delta_h 0 kJ
-gamma 0 0
# Id: 1609641
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Propylamine = Cd(Propylamine)2+2
log_k 4.64
delta_h 0 kJ
-gamma 0 0
# Id: 1609642
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Propylamine = Cd(Propylamine)3+2
log_k 6.03
delta_h 0 kJ
-gamma 0 0
# Id: 1609643
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ag+ + Propylamine = Ag(Propylamine)+
log_k 3.45
delta_h -12.552 kJ
-gamma 0 0
# Id: 209641
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Propylamine = Ag(Propylamine)2+
log_k 7.44
delta_h -53.1368 kJ
-gamma 0 0
# Id: 209642
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Propylamine = Ni(Propylamine)+2
log_k 2.81
delta_h 0 kJ
-gamma 0 0
# Id: 5409641
# log K source: SCD2.62
# Delta H source: SCD2.62
```

```
#T and ionic strength:
Ni+2 + 2Propylamine = Ni(Propylamine)2+2
log_k 5.02
delta_h 0 kJ
-gamma 0 0
# Id: 5409642
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 3Propylamine = Ni(Propylamine)3+2
log_k 6.79
delta_h 0 kJ
-gamma 0 0
# Id: 5409643
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 4Propylamine = Ni(Propylamine)4+2
log_k 8.31
delta_h 0 kJ
-gamma 0 0
# Id: 5409644
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Isopropylamine = H(Isopropylamine)+
log_k 10.67
delta_h -58.3668 kJ
-gamma 0 0
# Id: 3309651
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Isopropylamine = Zn(Isopropylamine)+2
log_k 2.37
delta_h 0 kJ
-gamma 0 0
# Id: 9509651
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Isopropylamine = Zn(Isopropylamine)2+2
log_k 4.67
delta_h 0 kJ
-gamma 0 0
# Id: 9509652
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Isopropylamine = Zn(Isopropylamine)3+2
log_k 7.14
delta_h 0 kJ
-gamma 0 0
# Id: 9509653
```

```
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 4Isopropylamine = Zn(Isopropylamine)4+2
log_k 9.44
delta_h 0 kJ
-gamma 0 0
# Id: 9509654
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Isopropylamine = Cd(Isopropylamine)+2
log_k 2.55
delta_h 0 kJ
-gamma 0 0
# Id: 1609651
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Isopropylamine = Cd(Isopropylamine)2+2
log_k 4.57
delta_h 0 kJ
-gamma 0 0
# Id: 1609652
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Isopropylamine = Cd(Isopropylamine)3+2
log_k 6.07
delta_h 0 kJ
-gamma 0 0
# Id: 1609653
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 4Isopropylamine = Cd(Isopropylamine)4+2
log_k 6.9
delta_h 0 kJ
-gamma 0 0
# Id: 1609654
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + Isopropylamine + 2H+ = Hg(Isopropylamine)+2 + 2H2O
log_k 14.85
delta_h 0 kJ
-gamma 0 0
# Id: 3619651
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + 2Isopropylamine + 2H+ = Hg(Isopropylamine)2+2 + 2H2O
log_k 24.37
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 3619652
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Isopropylamine = Ag(Isopropylamine)+
log_k 3.67
delta_h -23.8488 kJ
-gamma 0 0
# Id: 209651
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Isopropylamine = Ag(Isopropylamine)2+
log_k 7.77
delta_h -59.8312 kJ
-gamma 0 0
# Id: 209652
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Isopropylamine = Ni(Isopropylamine)+2
log_k 2.71
delta_h 0 kJ
-gamma 0 0
# Id: 5409651
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 2Isopropylamine = Ni(Isopropylamine)2+2
log_k 4.86
delta_h 0 kJ
-gamma 0 0
# Id: 5409652
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 3Isopropylamine = Ni(Isopropylamine)3+2
log_k 6.57
delta_h 0 kJ
-gamma 0 0
# Id: 5409653
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 4Isopropylamine = Ni(Isopropylamine)4+2
log_k 7.83
delta_h 0 kJ
-gamma 0 0
# Id: 5409654
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + 5Isopropylamine = Ni(Isopropylamine)5+2
```

```
log_k 8.43
delta_h 0 kJ
-gamma 0 0
# Id: 5409655
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Trimethylamine = H(Trimethylamine)+
log_k 9.8
delta_h -36.8192 kJ
-gamma 0 0
# Id: 3309661
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Trimethylamine = Ag(Trimethylamine)+
log_k 1.701
delta_h 0 kJ
-gamma 0 0
# Id: 209661
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Citrate-3 = H(Citrate)-2
log_k 6.396
delta_h 3.3472 kJ
-gamma 0 0
# Id: 3309671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Citrate-3 = H2(Citrate)-
log_k 11.157
delta_h 1.297 kJ
-gamma 0 0
# Id: 3309672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
3H+ + Citrate-3 = H3(Citrate)
log_k 14.285
delta_h -2.7614 kJ
-gamma 0 0
# Id: 3309673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Citrate-3 = Pb(Citrate)-
log_k 7.27
delta_h 0 kJ
-gamma 0 0
# Id: 6009671
# log K source: SCD2.62
# Delta H source: SCD2.62
```

```
#T and ionic strength:
Pb+2 + 2Citrate-3 = Pb(Citrate)2-4
log_k 6.53
delta_h 0 kJ
-gamma 0 0
# Id: 6009672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Citrate-3 = Al(Citrate)
log_k 9.97
delta_h 0 kJ
-gamma 0 0
# Id: 309671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + 2Citrate-3 = Al(Citrate)2-3
log_k 14.8
delta_h 0 kJ
-gamma 0 0
# Id: 309672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Citrate-3 + H+ = AlH(Citrate)+
log_k 12.85
delta_h 0 kJ
-gamma 0 0
# Id: 309673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Citrate-3 = Tl(Citrate)-2
log_k 1.48
delta_h 0 kJ
-gamma 0 0
# Id: 8709671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Citrate-3 = Zn(Citrate)-
log_k 6.21
delta_h 8.368 kJ
-gamma 0 0
# Id: 9509671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Citrate-3 = Zn(Citrate)2-4
log_k 7.4
delta_h 25.104 kJ
-gamma 0 0
# Id: 9509672
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Citrate-3 + H+ = ZnH(Citrate)
log_k 10.2
delta_h 3.3472 kJ
-gamma 0 0
# Id: 9509673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Citrate-3 + 2H+ = ZnH2(Citrate)+
log_k 12.84
delta_h 0 kJ
-gamma 0 0
# Id: 9509674
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Citrate-3 = Cd(Citrate)-
log_k 4.98
delta_h 8.368 kJ
-gamma 0 0
# Id: 1609671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Citrate-3 + H+ = CdH(Citrate)
log_k 9.44
delta_h 3.3472 kJ
-gamma 0 0
# Id: 1609672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Citrate-3 + 2H+ = CdH2(Citrate)+
log_k 12.9
delta_h 0 kJ
-gamma 0 0
# Id: 1609673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Citrate-3 = Cd(Citrate)2-4
log_k 5.9
delta_h 20.92 kJ
-gamma 0 0
# Id: 1609674
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Citrate-3 + 2H+ = Hg(Citrate)- + 2H2O
log_k 18.3
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 3619671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Citrate-3 = Cu(Citrate)-
log_k 7.57
delta_h 0 kJ
-gamma 0 0
# Id: 2319671
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cu+2 + 2Citrate-3 = Cu(Citrate)2-4
log_k 8.9
delta_h 0 kJ
-gamma 0 0
# Id: 2319672
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cu+2 + Citrate-3 + H+ = CuH(Citrate)
log_k 10.87
delta_h 11.7152 kJ
-gamma 0 0
# Id: 2319673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Citrate-3 + 2H+ = CuH2(Citrate)+
log_k 13.23
delta_h 0 kJ
-gamma 0 0
# Id: 2319674
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
2Cu+2 + 2Citrate-3 = Cu2(Citrate)2-2
log_k 16.9
delta_h 41.84 kJ
-gamma 0 0
# Id: 2319675
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Citrate-3 = Ni(Citrate)-
log_k 6.59
delta_h 16.736 kJ
-gamma 0 0
# Id: 5409671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Citrate-3 + H+ = NiH(Citrate)
```

```
log_k 10.5
delta_h 15.8992 kJ
-gamma 0 0
# Id: 5409672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Citrate-3 + 2H+ = NiH2(Citrate)+
log_k 13.3
delta_h 0 kJ
-gamma 0 0
# Id: 5409673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Citrate-3 = Ni(Citrate)2-4
log_k 8.77
delta_h 12.552 kJ
-gamma 0 0
# Id: 5409674
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Citrate-3 + H+ = NiH(Citrate)2-3
log_k 14.9
delta_h 32.6352 kJ
-gamma 0 0
# Id: 5409675
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Citrate-3 = Co(Citrate)-
log_k 6.1867
delta_h 0 kJ
-gamma 0 0
# Id: 2009671
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Co+2 + H+ + Citrate-3 = CoHCitrate
log_k 10.4438
delta_h 0 kJ
-gamma 0 0
# Id: 2009672
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Co+2 + 2H+ + Citrate-3 = CoH2Citrate+
log_k 12.7859
delta_h 0 kJ
-gamma 0 0
# Id: 2009673
# log K source: NIST46.4
# Delta H source: NIST46.2
```

```
#T and ionic strength:  0.10 20.0
Fe+2 + Citrate-3 = Fe(Citrate)-
log_k 6.1
delta_h 0 kJ
-gamma 0 0
# Id:  2809671
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Fe+2 + Citrate-3 + H+ = FeH(Citrate)
log_k 10.2
delta_h 0 kJ
-gamma 0 0
# Id:  2809672
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Fe+3 + Citrate-3 = Fe(Citrate)
log_k 13.1
delta_h 0 kJ
-gamma 0 0
# Id:  2819671
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Fe+3 + Citrate-3 + H+ = FeH(Citrate)+
log_k 14.4
delta_h 0 kJ
-gamma 0 0
# Id:  2819672
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Mn+2 + Citrate-3 = Mn(Citrate)-
log_k 4.28
delta_h 0 kJ
-gamma 0 0
# Id:  4709671
# log K source:  SCD2.62
# Delta H source:  SCD2.62
#T and ionic strength:
Mn+2 + Citrate-3 + H+ = MnH(Citrate)
log_k 9.6
delta_h 0 kJ
-gamma 0 0
# Id:  4709672
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Be+2 + Citrate-3 = Be(Citrate)-
log_k 5.534
delta_h 0 kJ
-gamma 0 0
# Id:  1109671
```

```
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Be+2 + H+ + Citrate-3 = BeH(Citrate)
log_k 9.442
delta_h 0 kJ
-gamma 0 0
# Id: 1109672
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Ca+2 + Citrate-3 = Ca(Citrate)-
log_k 4.87
delta_h -8.368 kJ
-gamma 0 0
# Id: 1509671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Citrate-3 + H+ = CaH(Citrate)
log_k 9.26
delta_h -0.8368 kJ
-gamma 0 0
# Id: 1509672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Citrate-3 + 2H+ = CaH2(Citrate)+
log_k 12.257
delta_h 0 kJ
-gamma 0 0
# Id: 1509673
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Mg+2 + Citrate-3 = Mg(Citrate)-
log_k 4.89
delta_h 8.368 kJ
-gamma 0 0
# Id: 4609671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Citrate-3 + H+ = MgH(Citrate)
log_k 8.91
delta_h 3.3472 kJ
-gamma 0 0
# Id: 4609672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Citrate-3 + 2H+ = MgH2(Citrate)+
log_k 12.2
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 4609673
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Sr+2 + Citrate-3 = Sr(Citrate)-
log_k 4.3367
delta_h 0 kJ
-gamma 0 0
# Id: 8009671
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Sr+2 + H+ + Citrate-3 = SrH(Citrate)
log_k 8.9738
delta_h 0 kJ
-gamma 0 0
# Id: 8009672
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Sr+2 + 2H+ + Citrate-3 = SrH2(Citrate)+
log_k 12.4859
delta_h 0 kJ
-gamma 0 0
# Id: 8009673
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Citrate-3 = Ba(Citrate)-
log_k 4.1
delta_h 0 kJ
-gamma 0 0
# Id: 1009671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Citrate-3 + H+ = BaH(Citrate)
log_k 8.74
delta_h 0 kJ
-gamma 0 0
# Id: 1009672
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Citrate-3 + 2H+ = BaH2(Citrate)+
log_k 12.3
delta_h 0 kJ
-gamma 0 0
# Id: 1009673
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Na+ + Citrate-3 = Na(Citrate)-2
```

```
log_k 1.03
delta_h -2.8033 kJ
-gamma 0 0
# Id: 5009671
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
2Na+ + Citrate-3 = Na2(Citrate)-
log_k 1.5
delta_h -5.1045 kJ
-gamma 0 0
# Id: 5009672
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Na+ + Citrate-3 + H+ = NaH(Citrate)-
log_k 6.45
delta_h -3.5982 kJ
-gamma 0 0
# Id: 5009673
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
K+ + Citrate-3 = K(Citrate)-2
log_k 1.1
delta_h 5.4392 kJ
-gamma 0 0
# Id: 4109671
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Nta-3 = H(Nta)-2
log_k 10.278
delta_h -18.828 kJ
-gamma 0 0
# Id: 3309681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Nta-3 = H2(Nta)-
log_k 13.22
delta_h -17.9912 kJ
-gamma 0 0
# Id: 3309682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
3H+ + Nta-3 = H3(Nta)
log_k 15.22
delta_h -16.3176 kJ
-gamma 0 0
# Id: 3309683
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
4H+ + Nta-3 = H4(Nta)+
log_k 16.22
delta_h -16.3176 kJ
-gamma 0 0
# Id: 3309684
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Nta-3 = Pb(Nta)-
log_k 12.7
delta_h -15.8992 kJ
-gamma 0 0
# Id: 6009681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Nta-3 + H+ = PbH(Nta)
log_k 15.3
delta_h 0 kJ
-gamma 0 0
# Id: 6009682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Nta-3 = Al(Nta)
log_k 13.3
delta_h 0 kJ
-gamma 0 0
# Id: 309681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Nta-3 + H+ = AlH(Nta)+
log_k 15.2
delta_h 0 kJ
-gamma 0 0
# Id: 309682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Nta-3 + H2O = AlOH(Nta)- + H+
log_k 8
delta_h 0 kJ
-gamma 0 0
# Id: 309683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Nta-3 = Tl(Nta)-2
log_k 5.39
delta_h 0 kJ
-gamma 0 0
# Id: 8709681
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Nta-3 = Zn(Nta)-
log_k 11.95
delta_h -3.7656 kJ
-gamma 0 0
# Id: 9509681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Nta-3 = Zn(Nta)2-4
log_k 14.88
delta_h -15.0624 kJ
-gamma 0 0
# Id: 9509682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Nta-3 + H2O = ZnOH(Nta)-2 + H+
log_k 1.46
delta_h 46.4424 kJ
-gamma 0 0
# Id: 9509683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Nta-3 = Cd(Nta)-
log_k 11.07
delta_h -16.736 kJ
-gamma 0 0
# Id: 1609681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Nta-3 = Cd(Nta)2-4
log_k 15.03
delta_h -38.0744 kJ
-gamma 0 0
# Id: 1609682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Nta-3 + H2O = CdOH(Nta)-2 + H+
log_k -0.61
delta_h 29.288 kJ
-gamma 0 0
# Id: 1609683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Nta-3 + 2H+ = Hg(Nta)- + 2H2O
log_k 21.7
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 3619681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Nta-3 = Cu(Nta)-
log_k 14.4
delta_h -7.9496 kJ
-gamma 0 0
# Id: 2319681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Nta-3 = Cu(Nta)2-4
log_k 18.1
delta_h -37.2376 kJ
-gamma 0 0
# Id: 2319682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Nta-3 + H+ = CuH(Nta)
log_k 16.2
delta_h 0 kJ
-gamma 0 0
# Id: 2319683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Nta-3 + H2O = CuOH(Nta)-2 + H+
log_k 4.8
delta_h 25.5224 kJ
-gamma 0 0
# Id: 2319684
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Nta-3 = Ag(Nta)-2
log_k 6
delta_h -26.3592 kJ
-gamma 0 0
# Id: 209681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Nta-3 = Ni(Nta)-
log_k 12.79
delta_h -10.0416 kJ
-gamma 0 0
# Id: 5409681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Nta-3 = Ni(Nta)2-4
```

```
log_k 16.96
delta_h -32.6352 kJ
-gamma 0 0
# Id: 5409682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Nta-3 + H2O = NiOH(Nta)-2 + H+
log_k 1.5
delta_h 15.0624 kJ
-gamma 0 0
# Id: 5409683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Nta-3 = Co(Nta)-
log_k 11.6667
delta_h -0.4 kJ
-gamma 0 0
# Id: 2009681
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + 2Nta-3 = Co(Nta)2-4
log_k 14.9734
delta_h -20 kJ
-gamma 0 0
# Id: 2009682
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + Nta-3 + H2O = CoOH(Nta)-2 + H+
log_k 0.4378
delta_h 45.6 kJ
-gamma 0 0
# Id: 2009683
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Fe+2 + Nta-3 = Fe(Nta)-
log_k 10.19
delta_h 0 kJ
-gamma 0 0
# Id: 2809681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Nta-3 = Fe(Nta)2-4
log_k 12.62
delta_h 0 kJ
-gamma 0 0
# Id: 2809682
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Fe+2 + Nta-3 + H+ = FeH(Nta)
log_k 12.29
delta_h 0 kJ
-gamma 0 0
# Id: 2809683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + Nta-3 + H2O = FeOH(Nta)-2 + H+
log_k -1.06
delta_h 0 kJ
-gamma 0 0
# Id: 2809684
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Nta-3 = Fe(Nta)
log_k 17.8
delta_h 13.3888 kJ
-gamma 0 0
# Id: 2819681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + 2Nta-3 = Fe(Nta)2-3
log_k 25.9
delta_h 0 kJ
-gamma 0 0
# Id: 2819682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Nta-3 + H2O = FeOH(Nta)- + H+
log_k 13.23
delta_h 0 kJ
-gamma 0 0
# Id: 2819683
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Nta-3 = Mn(Nta)-
log_k 8.573
delta_h 5.8576 kJ
-gamma 0 0
# Id: 4709681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Nta-3 = Mn(Nta)2-4
log_k 11.58
delta_h -17.1544 kJ
-gamma 0 0
# Id: 4709682
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Nta-3 + 2H+ = Cr(Nta) + 2H2O
log_k 21.2
delta_h 0 kJ
-gamma 0 0
# Id: 2119681
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Nta-3 + 2H+ = Cr(Nta)2-3 + 2H2O
log_k 29.5
delta_h 0 kJ
-gamma 0 0
# Id: 2119682
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
MoO4-2 + 2H+ + Nta-3 = MoO3(Nta)-3 + H2O
log_k 19.5434
delta_h -69 kJ
-gamma 0 0
# Id: 4809681
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
MoO4-2 + 3H+ + Nta-3 = MoO3H(Nta)-2 + H2O
log_k 23.3954
delta_h -71 kJ
-gamma 0 0
# Id: 4809682
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
MoO4-2 + 4H+ + Nta-3 = MoO3H2(Nta)- + H2O
log_k 25.3534
delta_h -71 kJ
-gamma 0 0
# Id: 4809683
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 1.00 25.0
Be+2 + Nta-3 = Be(Nta)-
log_k 9.0767
delta_h 25 kJ
-gamma 0 0
# Id: 1109681
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Mg+2 + Nta-3 = Mg(Nta)-
log_k 6.5
delta_h 17.9912 kJ
```

```
-gamma 0 0
# Id: 4609681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Nta-3 = Ca(Nta)-
log_k 7.608
delta_h -5.6902 kJ
-gamma 0 0
# Id: 1509681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + 2Nta-3 = Ca(Nta)2-4
log_k 8.81
delta_h -32.6352 kJ
-gamma 0 0
# Id: 1509682
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Nta-3 = Sr(Nta)-
log_k 6.2767
delta_h -2.2 kJ
-gamma 0 0
# Id: 8009681
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Ba+2 + Nta-3 = Ba(Nta)-
log_k 5.875
delta_h -6.025 kJ
-gamma 0 0
# Id: 1009681
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Edta-4 = H(Edta)-3
log_k 10.948
delta_h -23.4304 kJ
-gamma 0 0
# Id: 3309691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Edta-4 = H2(Edta)-2
log_k 17.221
delta_h -41.0032 kJ
-gamma 0 0
# Id: 3309692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
3H+ + Edta-4 = H3(Edta)-
```

```
log_k 20.34
delta_h -35.564 kJ
-gamma 0 0
# Id: 3309693
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
4H+ + Edta-4 = H4(Edta)
log_k 22.5
delta_h -34.3088 kJ
-gamma 0 0
# Id: 3309694
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
5H+ + Edta-4 = H5(Edta)+
log_k 24
delta_h -32.2168 kJ
-gamma 0 0
# Id: 3309695
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sn(OH)2 + 2H+ + Edta-4 = Sn(Edta)-2 + 2H2O
log_k 27.026
delta_h 0 kJ
-gamma 0 0
# Id: 7909691
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Sn(OH)2 + 3H+ + Edta-4 = SnH(Edta)- + 2H2O
log_k 29.934
delta_h 0 kJ
-gamma 0 0
# Id: 7909692
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Sn(OH)2 + 4H+ + Edta-4 = SnH2(Edta) + 2H2O
log_k 31.638
delta_h 0 kJ
-gamma 0 0
# Id: 7909693
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Pb+2 + Edta-4 = Pb(Edta)-2
log_k 19.8
delta_h -54.8104 kJ
-gamma 0 0
# Id: 6009691
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Pb+2 + Edta-4 + H+ = PbH(Edta)-
log_k 23
delta_h 0 kJ
-gamma 0 0
# Id: 6009692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Edta-4 + 2H+ = PbH2(Edta)
log_k 24.9
delta_h 0 kJ
-gamma 0 0
# Id: 6009693
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Edta-4 = Al(Edta)-
log_k 19.1
delta_h 52.7184 kJ
-gamma 0 0
# Id: 309690
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Edta-4 + H+ = AlH(Edta)
log_k 21.8
delta_h 36.4008 kJ
-gamma 0 0
# Id: 309691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Edta-4 + H2O = AlOH(Edta)-2 + H+
log_k 12.8
delta_h 73.6384 kJ
-gamma 0 0
# Id: 309692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Edta-4 = Tl(Edta)-3
log_k 7.27
delta_h -43.5136 kJ
-gamma 0 0
# Id: 8709691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Edta-4 + H+ = TlH(Edta)-2
log_k 13.68
delta_h 0 kJ
-gamma 0 0
# Id: 8709692
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Edta-4 = Zn(Edta)-2
log_k 18
delta_h -19.2464 kJ
-gamma 0 0
# Id: 9509691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Edta-4 + H+ = ZnH(Edta)-
log_k 21.4
delta_h -28.4512 kJ
-gamma 0 0
# Id: 9509692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Edta-4 + H2O = ZnOH(Edta)-3 + H+
log_k 5.8
delta_h 0 kJ
-gamma 0 0
# Id: 9509693
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Edta-4 = Cd(Edta)-2
log_k 18.2
delta_h -38.0744 kJ
-gamma 0 0
# Id: 1609691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Edta-4 + H+ = CdH(Edta)-
log_k 21.5
delta_h -39.748 kJ
-gamma 0 0
# Id: 1609692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Edta-4 + 2H+ = Hg(Edta)-2 + 2H2O
log_k 29.3
delta_h -125.102 kJ
-gamma 0 0
# Id: 3619691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Edta-4 + 3H+ = HgH(Edta)- + 2H2O
log_k 32.9
delta_h -128.449 kJ
```

```
-gamma 0 0
# Id: 3619692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 = Cu(Edta)-2
log_k 20.5
delta_h -34.7272 kJ
-gamma 0 0
# Id: 2319691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 + H+ = CuH(Edta)-
log_k 24
delta_h -43.0952 kJ
-gamma 0 0
# Id: 2319692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 + 2H+ = CuH2(Edta)
log_k 26.2
delta_h 0 kJ
-gamma 0 0
# Id: 2319693
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Edta-4 + H2O = CuOH(Edta)-3 + H+
log_k 8.5
delta_h 0 kJ
-gamma 0 0
# Id: 2319694
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Edta-4 = Ag(Edta)-3
log_k 8.08
delta_h -31.38 kJ
-gamma 0 0
# Id: 209691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Edta-4 + H+ = AgH(Edta)-2
log_k 15.21
delta_h 0 kJ
-gamma 0 0
# Id: 209693
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ni+2 + Edta-4 = Ni(Edta)-2
```

```
log_k 20.1
delta_h -30.9616 kJ
-gamma 0 0
# Id: 5409691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Edta-4 + H+ = NiH(Edta)-
log_k 23.6
delta_h -38.4928 kJ
-gamma 0 0
# Id: 5409692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Edta-4 + H2O = NiOH(Edta)-3 + H+
log_k 7.6
delta_h 0 kJ
-gamma 0 0
# Id: 5409693
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Edta-4 = Co(Edta)-2
log_k 18.1657
delta_h -15 kJ
-gamma 0 0
# Id: 2009691
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + Edta-4 + H+ = CoH(Edta)-
log_k 21.5946
delta_h -22.9 kJ
-gamma 0 0
# Id: 2009692
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Co+2 + Edta-4 + 2H+ = CoH2(Edta)
log_k 23.4986
delta_h 0 kJ
-gamma 0 0
# Id: 2009693
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Co+3 + Edta-4 = Co(Edta)-
log_k 43.9735
delta_h 0 kJ
-gamma 0 0
# Id: 2019691
# log K source: NIST46.4
# Delta H source: NIST46.2
```

```
#T and ionic strength:  0.10 25.0
Co+3 + Edta-4 + H+ = CoH(Edta)
log_k 47.168
delta_h 0 kJ
-gamma 0 0
# Id:  2019692
# log K source:  NIST46.4
# Delta H source:  NIST46.2
#T and ionic strength:  0.10 20.0
Fe+2 + Edta-4 = Fe(Edta)-2
log_k 16
delta_h -16.736 kJ
-gamma 0 0
# Id:  2809690
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Fe+2 + Edta-4 + H+ = FeH(Edta)-
log_k 19.06
delta_h -27.6144 kJ
-gamma 0 0
# Id:  2809691
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Fe+2 + Edta-4 + H2O = FeOH(Edta)-3 + H+
log_k 6.5
delta_h 0 kJ
-gamma 0 0
# Id:  2809692
# log K source:  SCD2.62
# Delta H source:  SCD2.62
#T and ionic strength:
Fe+2 + Edta-4 + 2H2O = Fe(OH)2(Edta)-4 + 2H+
log_k -4
delta_h 0 kJ
-gamma 0 0
# Id:  2809693
# log K source:  SCD2.62
# Delta H source:  SCD2.62
#T and ionic strength:
Fe+3 + Edta-4 = Fe(Edta)-
log_k 27.7
delta_h -11.2968 kJ
-gamma 0 0
# Id:  2819690
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
Fe+3 + Edta-4 + H+ = FeH(Edta)
log_k 29.2
delta_h -11.7152 kJ
-gamma 0 0
# Id:  2819691
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Edta-4 + H2O = FeOH(Edta)-2 + H+
log_k 19.9
delta_h 0 kJ
-gamma 0 0
# Id: 2819692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Edta-4 + 2H2O = Fe(OH)2(Edta)-3 + 2H+
log_k 9.85
delta_h 0 kJ
-gamma 0 0
# Id: 2819693
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Mn+2 + Edta-4 = Mn(Edta)-2
log_k 15.6
delta_h -19.2464 kJ
-gamma 0 0
# Id: 4709691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Edta-4 + H+ = MnH(Edta)-
log_k 19.1
delta_h -24.2672 kJ
-gamma 0 0
# Id: 4709692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr+2 + Edta-4 = Cr(Edta)-2
log_k 15.3
delta_h 0 kJ
-gamma 0 0
# Id: 2109691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr+2 + Edta-4 + H+ = CrH(Edta)-
log_k 19.1
delta_h 0 kJ
-gamma 0 0
# Id: 2109692
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + Edta-4 + 2H+ = Cr(Edta)- + 2H2O
log_k 35.5
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2119691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Edta-4 + 3H+ = CrH(Edta) + 2H2O
log_k 37.4
delta_h 0 kJ
-gamma 0 0
# Id: 2119692
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Edta-4 + H+ = CrOH(Edta)-2 + H2O
log_k 27.7
delta_h 0 kJ
-gamma 0 0
# Id: 2119693
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Edta-4 = Be(Edta)-2
log_k 11.4157
delta_h 41 kJ
-gamma 0 0
# Id: 1109691
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Mg+2 + Edta-4 = Mg(Edta)-2
log_k 10.57
delta_h 13.8072 kJ
-gamma 0 0
# Id: 4609690
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Edta-4 + H+ = MgH(Edta)-
log_k 14.97
delta_h 0 kJ
-gamma 0 0
# Id: 4609691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Edta-4 = Ca(Edta)-2
log_k 12.42
delta_h -25.5224 kJ
-gamma 0 0
# Id: 1509690
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Edta-4 + H+ = CaH(Edta)-
```

```
log_k 15.9
delta_h 0 kJ
-gamma 0 0
# Id: 1509691
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Edta-4 = Sr(Edta)-2
log_k 10.4357
delta_h -17 kJ
-gamma 0 0
# Id: 8009691
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Sr+2 + Edta-4 + H+ = SrH(Edta)-
log_k 14.7946
delta_h 0 kJ
-gamma 0 0
# Id: 8009692
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Ba+2 + Edta-4 = Ba(Edta)-2
log_k 7.72
delta_h -20.5016 kJ
-gamma 0 0
# Id: 1009691
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Na+ + Edta-4 = Na(Edta)-3
log_k 2.7
delta_h -5.8576 kJ
-gamma 0 0
# Id: 5009690
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
K+ + Edta-4 = K(Edta)-3
log_k 1.7
delta_h 0 kJ
-gamma 0 0
# Id: 4109690
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Propionate- = H(Propionate)
log_k 4.874
delta_h 0.66 kJ
-gamma 0 0
# Id: 3309711
# log K source: NIST46.4
# Delta H source: NIST46.4
```

#T and ionic strength: 0.00 25.0
Pb+2 + Propionate- = Pb(Propionate)+
log_k 2.64
delta_h 0 kJ
-gamma 0 0
Id: 6009711
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 0.00 35.0
Pb+2 + 2Propionate- = Pb(Propionate)2
log_k 3.1765
delta_h 0 kJ
-gamma 0 0
Id: 6009712
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 2.00 25.0
Zn+2 + Propionate- = Zn(Propionate)+
log_k 1.4389
delta_h 0 kJ
-gamma 0 0
Id: 9509711
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Zn+2 + 2Propionate- = Zn(Propionate)2
log_k 1.842
delta_h 0 kJ
-gamma 0 0
Id: 9509712
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Cd+2 + Propionate- = Cd(Propionate)+
log_k 1.598
delta_h 0 kJ
-gamma 0 0
Id: 1609711
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Cd+2 + 2Propionate- = Cd(Propionate)2
log_k 2.472
delta_h 0 kJ
-gamma 0 0
Id: 1609712
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 1.00 25.0
Hg(OH)2 + 2H+ + Propionate- = Hg(Propionate)+ + 2H2O
log_k 10.594
delta_h 0 kJ
-gamma 0 0
Id: 3619711

```
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cu+2 + Propionate- = Cu(Propionate)+
log_k 2.22
delta_h 4.1 kJ
-gamma 0 0
# Id: 2319711
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 2Propionate- = Cu(Propionate)2
log_k 3.5
delta_h 0 kJ
-gamma 0 0
# Id: 2319712
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ni+2 + Propionate- = Ni(Propionate)+
log_k 0.908
delta_h 0 kJ
-gamma 0 0
# Id: 5409711
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 1.00 25.0
Co+2 + Propionate- = Co(Propionate)+
log_k 0.671
delta_h 4.6 kJ
-gamma 0 0
# Id: 2009711
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 2.00 25.0
Co+2 + 2Propionate- = Co(Propionate)2
log_k 0.5565
delta_h 16 kJ
-gamma 0 0
# Id: 2009712
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 2.00 25.0
Fe+3 + Propionate- = Fe(Propionate)+2
log_k 4.012
delta_h 0 kJ
-gamma 0 0
# Id: 2819711
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Cr(OH)2+ + 2H+ + Propionate- = Cr(Propionate)+2 + 2H2O
log_k 15.0773
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2119711
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 2Propionate- = Cr(Propionate)2+ + 2H2O
log_k 17.9563
delta_h 0 kJ
-gamma 0 0
# Id: 2119712
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 3Propionate- = Cr(Propionate)3 + 2H2O
log_k 20.8858
delta_h 0 kJ
-gamma 0 0
# Id: 2119713
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.50 25.0
Mg+2 + Propionate- = Mg(Propionate)+
log_k 0.9689
delta_h 4.2677 kJ
-gamma 0 0
# Id: 4609710
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ca+2 + Propionate- = Ca(Propionate)+
log_k 0.9289
delta_h 3.3472 kJ
-gamma 0 0
# Id: 1509710
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Sr+2 + Propionate- = Sr(Propionate)+
log_k 0.8589
delta_h 0 kJ
-gamma 0 0
# Id: 8009711
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Propionate- = Ba(Propionate)+
log_k 0.7689
delta_h 0 kJ
-gamma 0 0
# Id: 1009711
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ba+2 + 2Propionate- = Ba(Propionate)2
```

```
log_k 0.9834
delta_h 0 kJ
-gamma 0 0
# Id: 1009712
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
H+ + Butyrate- = H(Butyrate)
log_k 4.819
delta_h 2.8 kJ
-gamma 0 0
# Id: 3309721
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Pb+2 + Butyrate- = Pb(Butyrate)+
log_k 2.101
delta_h 0 kJ
-gamma 0 0
# Id: 6009721
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 2.00 25.0
Zn+2 + Butyrate- = Zn(Butyrate)+
log_k 1.4289
delta_h 0 kJ
-gamma 0 0
# Id: 9509721
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Hg(OH)2 + 2H+ + Butyrate- = Hg(Butyrate)+ + 2H2O
log_k 10.3529
delta_h 0 kJ
-gamma 0 0
# Id: 3619721
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Cu+2 + Butyrate- = Cu(Butyrate)+
log_k 2.14
delta_h 0 kJ
-gamma 0 0
# Id: 2319721
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ni+2 + Butyrate- = Ni(Butyrate)+
log_k 0.691
delta_h 0 kJ
-gamma 0 0
# Id: 5409721
# log K source: NIST46.4
# Delta H source: SCD2.62
```

```
#T and ionic strength: 2.00 25.0
Co+2 + Butyrate- = Co(Butyrate)+
log_k 0.591
delta_h 0 kJ
-gamma 0 0
# Id: 2009721
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Co+2 + 2Butyrate- = Co(Butyrate)2
log_k 0.7765
delta_h 0 kJ
-gamma 0 0
# Id: 2009722
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Mg+2 + Butyrate- = Mg(Butyrate)+
log_k 0.9589
delta_h 0 kJ
-gamma 0 0
# Id: 4609720
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ca+2 + Butyrate- = Ca(Butyrate)+
log_k 0.9389
delta_h 3.3472 kJ
-gamma 0 0
# Id: 1509720
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Sr+2 + Butyrate- = Sr(Butyrate)+
log_k 0.7889
delta_h 0 kJ
-gamma 0 0
# Id: 8009721
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Butyrate- = Ba(Butyrate)+
log_k 0.7389
delta_h 0 kJ
-gamma 0 0
# Id: 1009721
# log K source: NIST46.4
# Delta H source: SCD2.62
#T and ionic strength: 0.10 25.0
Ba+2 + 2Butyrate- = Ba(Butyrate)2
log_k 0.88
delta_h 0 kJ
-gamma 0 0
# Id: 1009722
```

```
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Isobutyrate- = H(Isobutyrate)
log_k 4.849
delta_h 3.2217 kJ
-gamma 0 0
# Id: 3309731
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Isobutyrate- = Zn(Isobutyrate)+
log_k 1.44
delta_h 0 kJ
-gamma 0 0
# Id: 9509731
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Isobutyrate- = Cu(Isobutyrate)+
log_k 2.17
delta_h 0 kJ
-gamma 0 0
# Id: 2319731
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Isobutyrate- = Cu(Isobutyrate)2
log_k 3.3
delta_h 0 kJ
-gamma 0 0
# Id: 2319732
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Isobutyrate- = Fe(Isobutyrate)+2
log_k 4.2
delta_h 0 kJ
-gamma 0 0
# Id: 2819731
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Isobutyrate- = Ca(Isobutyrate)+
log_k 0.51
delta_h 0 kJ
-gamma 0 0
# Id: 1509731
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Two_picoline = H(Two_picoline)+
log_k 5.95
delta_h -25.5224 kJ
```

```
-gamma 0 0
# Id: 3309801
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Two_picoline = Cu(Two_picoline)+2
log_k 1.3
delta_h 0 kJ
-gamma 0 0
# Id: 2319801
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Two_picoline = Cu(Two_picoline)2+2
log_k 2.8
delta_h 0 kJ
-gamma 0 0
# Id: 2319802
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + Two_picoline = Cu(Two_picoline)+
log_k 5.4
delta_h 0 kJ
-gamma 0 0
# Id: 2309801
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Two_picoline = Cu(Two_picoline)2+
log_k 7.65
delta_h 0 kJ
-gamma 0 0
# Id: 2309802
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 3Two_picoline = Cu(Two_picoline)3+
log_k 8.5
delta_h 0 kJ
-gamma 0 0
# Id: 2309803
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Two_picoline = Ag(Two_picoline)+
log_k 2.32
delta_h -24.2672 kJ
-gamma 0 0
# Id: 209801
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Two_picoline = Ag(Two_picoline)2+
```

```
log_k 4.68
delta_h -42.6768 kJ
-gamma 0 0
# Id: 209802
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Two_picoline = Ni(Two_picoline)+2
log_k 0.4
delta_h 0 kJ
-gamma 0 0
# Id: 5409801
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Three_picoline = H(Three_picoline)+
log_k 5.7
delta_h -23.8488 kJ
-gamma 0 0
# Id: 3309811
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Three_picoline = Zn(Three_picoline)+2
log_k 1
delta_h 0 kJ
-gamma 0 0
# Id: 9509811
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Three_picoline = Zn(Three_picoline)2+2
log_k 2.1
delta_h 0 kJ
-gamma 0 0
# Id: 9509812
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Three_picoline = Zn(Three_picoline)3+2
log_k 2.6
delta_h 0 kJ
-gamma 0 0
# Id: 9509813
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 4Three_picoline = Zn(Three_picoline)4+2
log_k 3.7
delta_h 0 kJ
-gamma 0 0
# Id: 9509814
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Cd+2 + Three_picoline = Cd(Three_picoline)+2
log_k 1.42
delta_h 0 kJ
-gamma 0 0
# Id: 1609811
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Three_picoline = Cd(Three_picoline)2+2
log_k 2.27
delta_h 0 kJ
-gamma 0 0
# Id: 1609812
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 3Three_picoline = Cd(Three_picoline)3+2
log_k 3.6
delta_h 0 kJ
-gamma 0 0
# Id: 1609813
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 4Three_picoline = Cd(Three_picoline)4+2
log_k 4
delta_h 0 kJ
-gamma 0 0
# Id: 1609814
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + Three_picoline = Cu(Three_picoline)+
log_k 5.6
delta_h 0 kJ
-gamma 0 0
# Id: 2309811
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Three_picoline = Cu(Three_picoline)2+
log_k 7.78
delta_h 0 kJ
-gamma 0 0
# Id: 2309812
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 3Three_picoline = Cu(Three_picoline)3+
log_k 8.6
delta_h 0 kJ
-gamma 0 0
# Id: 2309813
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 4Three_picoline = Cu(Three_picoline)4+
log_k 9
delta_h 0 kJ
-gamma 0 0
# Id: 2309814
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Three_picoline = Cu(Three_picoline)+2
log_k 2.77
delta_h 0 kJ
-gamma 0 0
# Id: 2319811
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Three_picoline = Cu(Three_picoline)2+2
log_k 4.8
delta_h 0 kJ
-gamma 0 0
# Id: 2319812
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 3Three_picoline = Cu(Three_picoline)3+2
log_k 6.3
delta_h 0 kJ
-gamma 0 0
# Id: 2319813
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 4Three_picoline = Cu(Three_picoline)4+2
log_k 7.2
delta_h 0 kJ
-gamma 0 0
# Id: 2319814
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Three_picoline = Ag(Three_picoline)+
log_k 2.2
delta_h -21.7568 kJ
-gamma 0 0
# Id: 209811
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Three_picoline = Ag(Three_picoline)2+
log_k 4.46
delta_h -49.7896 kJ
```

```
-gamma 0 0
# Id: 209812
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Three_picoline = Ni(Three_picoline)+2
log_k 1.87
delta_h 0 kJ
-gamma 0 0
# Id: 5409811
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Three_picoline = Ni(Three_picoline)2+2
log_k 3.3
delta_h 0 kJ
-gamma 0 0
# Id: 5409812
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Three_picoline = Ni(Three_picoline)3+2
log_k 4.1
delta_h 0 kJ
-gamma 0 0
# Id: 5409813
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 4Three_picoline = Ni(Three_picoline)4+2
log_k 4.6
delta_h 0 kJ
-gamma 0 0
# Id: 5409814
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Three_picoline = Co(Three_picoline)+2
log_k 1.4
delta_h 0 kJ
-gamma 0 0
# Id: 2009811
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 2Three_picoline = Co(Three_picoline)2+2
log_k 2.2
delta_h 0 kJ
-gamma 0 0
# Id: 2009812
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 3Three_picoline = Co(Three_picoline)3+2
```

```
log_k 2.5
delta_h 0 kJ
-gamma 0 0
# Id: 2009813
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
H+ + Four_picoline = H(Four_picoline)+
log_k 6.03
delta_h -25.3132 kJ
-gamma 0 0
# Id: 3309821
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Four_picoline = Zn(Four_picoline)+2
log_k 1.4
delta_h 0 kJ
-gamma 0 0
# Id: 9509821
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Four_picoline = Zn(Four_picoline)2+2
log_k 2.11
delta_h 0 kJ
-gamma 0 0
# Id: 9509822
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Four_picoline = Zn(Four_picoline)3+2
log_k 2.85
delta_h 0 kJ
-gamma 0 0
# Id: 9509823
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Four_picoline = Cd(Four_picoline)+2
log_k 1.59
delta_h 0 kJ
-gamma 0 0
# Id: 1609821
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 2Four_picoline = Cd(Four_picoline)2+2
log_k 2.4
delta_h 0 kJ
-gamma 0 0
# Id: 1609822
# log K source: SCD2.62
# Delta H source: SCD2.62
```

```
#T and ionic strength:
Cd+2 + 3Four_picoline = Cd(Four_picoline)3+2
log_k 3.18
delta_h 0 kJ
-gamma 0 0
# Id: 1609823
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + 4Four_picoline = Cd(Four_picoline)4+2
log_k 4
delta_h 0 kJ
-gamma 0 0
# Id: 1609824
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + Four_picoline = Cu(Four_picoline)+
log_k 5.65
delta_h 0 kJ
-gamma 0 0
# Id: 2309821
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 2Four_picoline = Cu(Four_picoline)2+
log_k 8.2
delta_h 0 kJ
-gamma 0 0
# Id: 2309822
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 3Four_picoline = Cu(Four_picoline)3+
log_k 8.8
delta_h 0 kJ
-gamma 0 0
# Id: 2309823
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+ + 4Four_picoline = Cu(Four_picoline)4+
log_k 9.2
delta_h 0 kJ
-gamma 0 0
# Id: 2309824
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Four_picoline = Cu(Four_picoline)+2
log_k 2.88
delta_h 0 kJ
-gamma 0 0
# Id: 2319821
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Four_picoline = Cu(Four_picoline)2+2
log_k 5.16
delta_h 0 kJ
-gamma 0 0
# Id: 2319822
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 3Four_picoline = Cu(Four_picoline)3+2
log_k 6.77
delta_h 0 kJ
-gamma 0 0
# Id: 2319823
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 4Four_picoline = Cu(Four_picoline)4+2
log_k 8.08
delta_h 0 kJ
-gamma 0 0
# Id: 2319824
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 5Four_picoline = Cu(Four_picoline)5+2
log_k 8.3
delta_h 0 kJ
-gamma 0 0
# Id: 2319825
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Four_picoline = Ag(Four_picoline)+
log_k 2.03
delta_h -25.5224 kJ
-gamma 0 0
# Id: 209821
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Four_picoline = Ag(Four_picoline)2+
log_k 4.39
delta_h -53.5552 kJ
-gamma 0 0
# Id: 209822
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Four_picoline = Ni(Four_picoline)+2
log_k 2.11
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 5409821
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Four_picoline = Ni(Four_picoline)2+2
log_k 3.59
delta_h 0 kJ
-gamma 0 0
# Id: 5409822
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Four_picoline = Ni(Four_picoline)3+2
log_k 4.34
delta_h 0 kJ
-gamma 0 0
# Id: 5409823
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 4Four_picoline = Ni(Four_picoline)4+2
log_k 4.7
delta_h 0 kJ
-gamma 0 0
# Id: 5409824
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Four_picoline = Co(Four_picoline)+2
log_k 1.56
delta_h 0 kJ
-gamma 0 0
# Id: 2009821
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 2Four_picoline = Co(Four_picoline)2+2
log_k 2.51
delta_h 0 kJ
-gamma 0 0
# Id: 2009822
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 3Four_picoline = Co(Four_picoline)3+2
log_k 2.94
delta_h 0 kJ
-gamma 0 0
# Id: 2009823
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Co+2 + 4Four_picoline = Co(Four_picoline)4+2
```

```
log_k 3.17
delta_h 0 kJ
-gamma 0 0
# Id: 2009824
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
H+ + Formate- = H(Formate)
log_k 3.745
delta_h 0.1674 kJ
-gamma 0 0
# Id: 3309831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Formate- = Pb(Formate)+
log_k 2.2
delta_h 0 kJ
-gamma 0 0
# Id: 6009831
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + Formate- = Zn(Formate)+
log_k 1.44
delta_h 0 kJ
-gamma 0 0
# Id: 9509831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Formate- = Cd(Formate)+
log_k 1.7
delta_h 0 kJ
-gamma 0 0
# Id: 1609831
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + Formate- + 2H+ = Hg(Formate)+ + 2H2O
log_k 9.6
delta_h 0 kJ
-gamma 0 0
# Id: 3619831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Formate- = Cu(Formate)+
log_k 2
delta_h 0 kJ
-gamma 0 0
# Id: 2319831
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Ni+2 + Formate- = Ni(Formate)+
log_k 1.22
delta_h 0 kJ
-gamma 0 0
# Id: 5409831
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Formate- = Co(Formate)+
log_k 1.209
delta_h 0 kJ
-gamma 0 0
# Id: 2009831
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 30.0
Co+2 + 2Formate- = Co(Formate)2
log_k 1.1365
delta_h 0 kJ
-gamma 0 0
# Id: 2009832
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Cr+2 + Formate- = Cr(Formate)+
log_k 1.07
delta_h 0 kJ
-gamma 0 0
# Id: 2109831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Formate- = Mg(Formate)+
log_k 1.43
delta_h 0 kJ
-gamma 0 0
# Id: 4609831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Formate- = Ca(Formate)+
log_k 1.43
delta_h 4.184 kJ
-gamma 0 0
# Id: 1509831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Formate- = Sr(Formate)+
log_k 1.39
delta_h 4 kJ
-gamma 0 0
# Id: 8009831
```

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ba+2 + Formate- = Ba(Formate)+
log_k 1.38
delta_h 0 kJ
-gamma 0 0
# Id: 1009831
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Isovalerate- = H(Isovalerate)
log_k 4.781
delta_h 4.5606 kJ
-gamma 0 0
# Id: 3309841
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Isovalerate- = Zn(Isovalerate)+
log_k 1.39
delta_h 0 kJ
-gamma 0 0
# Id: 9509841
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Isovalerate- = Cu(Isovalerate)+
log_k 2.08
delta_h 0 kJ
-gamma 0 0
# Id: 2319841
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Isovalerate- = Ca(Isovalerate)+
log_k 0.2
delta_h 0 kJ
-gamma 0 0
# Id: 1509841
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Valerate- = H(Valerate)
log_k 4.843
delta_h 2.887 kJ
-gamma 0 0
# Id: 3309851
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Valerate- = Cu(Valerate)+
log_k 2.12
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2319851
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Valerate- = Ca(Valerate)+
log_k 0.3
delta_h 0 kJ
-gamma 0 0
# Id: 1509851
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ba+2 + Valerate- = Ba(Valerate)+
log_k -0.2
delta_h 0 kJ
-gamma 0 0
# Id: 1009851
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Acetate- = H(Acetate)
log_k 4.757
delta_h 0.41 kJ
-gamma 0 0
# Id: 3309921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sn(OH)2 + 2H+ + Acetate- = Sn(Acetate)+ + 2H2O
log_k 10.0213
delta_h 0 kJ
-gamma 0 0
# Id: 7909921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 3.00 25.0
Sn(OH)2 + 2H+ + 2Acetate- = Sn(Acetate)2 + 2H2O
log_k 12.32
delta_h 0 kJ
-gamma 0 0
# Id: 7909922
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 3.00 25.0
Sn(OH)2 + 2H+ + 3Acetate- = Sn(Acetate)3- + 2H2O
log_k 13.55
delta_h 0 kJ
-gamma 0 0
# Id: 7909923
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 3.00 25.0
Pb+2 + Acetate- = Pb(Acetate)+
```

```
log_k 2.68
delta_h -0.4 kJ
-gamma 0 0
# Id: 6009921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Pb+2 + 2Acetate- = Pb(Acetate)2
log_k 4.08
delta_h -0.8 kJ
-gamma 0 0
# Id: 6009922
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Tl+ + Acetate- = Tl(Acetate)
log_k -0.11
delta_h 0 kJ
-gamma 0 0
# Id: 8709921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Zn+2 + Acetate- = Zn(Acetate)+
log_k 1.58
delta_h 8.3 kJ
-gamma 0 0
# Id: 9509921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Zn+2 + 2Acetate- = Zn(Acetate)2
log_k 2.6434
delta_h 22 kJ
-gamma 0 0
# Id: 9509922
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Cd+2 + Acetate- = Cd(Acetate)+
log_k 1.93
delta_h 9.6 kJ
-gamma 0 0
# Id: 1609921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cd+2 + 2Acetate- = Cd(Acetate)2
log_k 2.86
delta_h 15 kJ
-gamma 0 0
# Id: 1609922
# log K source: NIST46.4
# Delta H source: NIST46.4
```

#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + Acetate- = Hg(Acetate)+ + 2H2O
log_k 10.494
delta_h 0 kJ
-gamma 0 0
Id: 3619920
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Hg(OH)2 + 2H+ + 2Acetate- = Hg(Acetate)2 + 2H2O
log_k 13.83
delta_h 0 kJ
-gamma 0 0
Id: 3619921
log K source: NIST46.4
Delta H source: SCD2.62
#T and ionic strength: 3.00 25.0
Cu+2 + Acetate- = Cu(Acetate)+
log_k 2.21
delta_h 7.1 kJ
-gamma 0 0
Id: 2319921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 2Acetate- = Cu(Acetate)2
log_k 3.4
delta_h 12 kJ
-gamma 0 0
Id: 2319922
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Cu+2 + 3Acetate- = Cu(Acetate)3-
log_k 3.9434
delta_h 6.2 kJ
-gamma 0 0
Id: 2319923
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Ag+ + Acetate- = Ag(Acetate)
log_k 0.73
delta_h 3 kJ
-gamma 0 0
Id: 209921
log K source: NIST46.4
Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ag+ + 2Acetate- = Ag(Acetate)2-
log_k 0.64
delta_h 3 kJ
-gamma 0 0
Id: 209922

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ni+2 + Acetate- = Ni(Acetate)+
log_k 1.37
delta_h 8.7 kJ
-gamma 0 0
# Id: 5409921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Ni+2 + 2Acetate- = Ni(Acetate)2
log_k 2.1
delta_h 10 kJ
-gamma 0 0
# Id: 5409922
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + Acetate- = Co(Acetate)+
log_k 1.38
delta_h 0 kJ
-gamma 0 0
# Id: 2009921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Co+2 + 2Acetate- = Co(Acetate)2
log_k 0.7565
delta_h 0 kJ
-gamma 0 0
# Id: 2009922
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 2.00 25.0
Fe+2 + Acetate- = Fe(Acetate)+
log_k 1.4
delta_h 0 kJ
-gamma 0 0
# Id: 2809920
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Fe+3 + Acetate- = Fe(Acetate)+2
log_k 4.0234
delta_h 0 kJ
-gamma 0 0
# Id: 2819920
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+3 + 2Acetate- = Fe(Acetate)2+
log_k 7.5723
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2819921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+3 + 3Acetate- = Fe(Acetate)3
log_k 9.5867
delta_h 0 kJ
-gamma 0 0
# Id: 2819922
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Mn+2 + Acetate- = Mn(Acetate)+
log_k 1.4
delta_h 0 kJ
-gamma 0 0
# Id: 4709920
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cr+2 + Acetate- = Cr(Acetate)+
log_k 1.8
delta_h 0 kJ
-gamma 0 0
# Id: 2109921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cr+2 + 2Acetate- = Cr(Acetate)2
log_k 2.92
delta_h 0 kJ
-gamma 0 0
# Id: 2109922
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Cr(OH)2+ + 2H+ + Acetate- = Cr(Acetate)+2 + 2H2O
log_k 15.0073
delta_h -125.62 kJ
-gamma 0 0
# Id: 2119921
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 2Acetate- = Cr(Acetate)2+ + 2H2O
log_k 17.9963
delta_h -117.62 kJ
-gamma 0 0
# Id: 2119922
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Cr(OH)2+ + 2H+ + 3Acetate- = Cr(Acetate)3 + 2H2O
```

```
log_k 20.7858
delta_h -96.62 kJ
-gamma 0 0
# Id: 2119923
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.50 25.0
Be+2 + Acetate- = Be(Acetate)+
log_k 2.0489
delta_h 0 kJ
-gamma 0 0
# Id: 1109921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Be+2 + 2Acetate- = Be(Acetate)2
log_k 3.0034
delta_h 0 kJ
-gamma 0 0
# Id: 1109922
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mg+2 + Acetate- = Mg(Acetate)+
log_k 1.27
delta_h 0 kJ
-gamma 0 0
# Id: 4609920
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ca+2 + Acetate- = Ca(Acetate)+
log_k 1.18
delta_h 4 kJ
-gamma 0 0
# Id: 1509920
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Sr+2 + Acetate- = Sr(Acetate)+
log_k 1.14
delta_h 0 kJ
-gamma 0 0
# Id: 8009921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ba+2 + Acetate- = Ba(Acetate)+
log_k 1.07
delta_h 0 kJ
-gamma 0 0
# Id: 1009921
# log K source: NIST46.4
# Delta H source: NIST46.2
```

```
#T and ionic strength: 0.00 25.0
Na+ + Acetate- = Na(Acetate)
log_k -0.18
delta_h 12 kJ
-gamma 0 0
# Id: 5009920
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
K+ + Acetate- = K(Acetate)
log_k -0.1955
delta_h 4.184 kJ
-gamma 0 0
# Id: 4109921
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
H+ + Tartarate-2 = H(Tartarate)-
log_k 4.366
delta_h -0.7531 kJ
-gamma 0 0
# Id: 3309931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Tartarate-2 = H2(Tartarate)
log_k 7.402
delta_h -3.6819 kJ
-gamma 0 0
# Id: 3309932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sn(OH)2 + 2H+ + Tartarate-2 = Sn(Tartarate) + 2H2O
log_k 13.1518
delta_h 0 kJ
-gamma 0 0
# Id: 7909931
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Pb+2 + Tartarate-2 = Pb(Tartarate)
log_k 3.98
delta_h 0 kJ
-gamma 0 0
# Id: 6009931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + 2Tartarate-2 = Al(Tartarate)2-
log_k 9.37
delta_h 0 kJ
-gamma 0 0
# Id: 309931
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Tartarate-2 = Tl(Tartarate)-
log_k 1.4
delta_h 0 kJ
-gamma 0 0
# Id: 8709931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Tl+ + Tartarate-2 + H+ = TlH(Tartarate)
log_k 4.8
delta_h 0 kJ
-gamma 0 0
# Id: 8709932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Tartarate-2 = Zn(Tartarate)
log_k 3.43
delta_h 0 kJ
-gamma 0 0
# Id: 9509931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Tartarate-2 = Zn(Tartarate)2-2
log_k 5.5
delta_h 0 kJ
-gamma 0 0
# Id: 9509932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Tartarate-2 + H+ = ZnH(Tartarate)+
log_k 5.9
delta_h 0 kJ
-gamma 0 0
# Id: 9509933
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Tartarate-2 = Cd(Tartarate)
log_k 2.7
delta_h 0 kJ
-gamma 0 0
# Id: 1609931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Tartarate-2 = Cd(Tartarate)2-2
log_k 4.1
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 1609932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Tartarate-2 + 2H+ = Hg(Tartarate) + 2H2O
log_k 14
delta_h 0 kJ
-gamma 0 0
# Id: 3619931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Tartarate-2 = Cu(Tartarate)
log_k 3.97
delta_h 0 kJ
-gamma 0 0
# Id: 2319931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Tartarate-2 + H+ = CuH(Tartarate)+
log_k 6.7
delta_h 0 kJ
-gamma 0 0
# Id: 2319932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Tartarate-2 = Ni(Tartarate)
log_k 3.46
delta_h 0 kJ
-gamma 0 0
# Id: 5409931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Tartarate-2 + H+ = NiH(Tartarate)+
log_k 5.89
delta_h 0 kJ
-gamma 0 0
# Id: 5409932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Tartarate-2 = Co(Tartarate)
log_k 3.05
delta_h 0 kJ
-gamma 0 0
# Id: 2009931
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Co+2 + 2Tartarate-2 = Co(Tartarate)2-2
```

```
log_k 4
delta_h 0 kJ
-gamma 0 0
# Id: 2009932
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Co+2 + H+ + Tartarate-2 = CoH(Tartarate)+
log_k 5.754
delta_h 0 kJ
-gamma 0 0
# Id: 2009933
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 1.00 20.0
Fe+2 + Tartarate-2 = Fe(Tartarate)
log_k 3.1
delta_h 0 kJ
-gamma 0 0
# Id: 2809931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Tartarate-2 = Fe(Tartarate)+
log_k 7.78
delta_h 0 kJ
-gamma 0 0
# Id: 2819931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Tartarate-2 = Mn(Tartarate)
log_k 3.38
delta_h 0 kJ
-gamma 0 0
# Id: 4709931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Tartarate-2 + H+ = MnH(Tartarate)+
log_k 6
delta_h 0 kJ
-gamma 0 0
# Id: 4709932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Tartarate-2 = Mg(Tartarate)
log_k 2.3
delta_h 0 kJ
-gamma 0 0
# Id: 4609931
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Mg+2 + Tartarate-2 + H+ = MgH(Tartarate)+
log_k 5.75
delta_h 0 kJ
-gamma 0 0
# Id: 4609932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Tartarate-2 = Be(Tartarate)
log_k 2.768
delta_h 0 kJ
-gamma 0 0
# Id: 1109931
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Be+2 + 2Tartarate-2 = Be(Tartarate)2-2
log_k 4.008
delta_h 0 kJ
-gamma 0 0
# Id: 1109932
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Ca+2 + Tartarate-2 = Ca(Tartarate)
log_k 2.8
delta_h -8.368 kJ
-gamma 0 0
# Id: 1509931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Tartarate-2 + H+ = CaH(Tartarate)+
log_k 5.86
delta_h -9.1211 kJ
-gamma 0 0
# Id: 1509932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Tartarate-2 = Sr(Tartarate)
log_k 2.55
delta_h 0 kJ
-gamma 0 0
# Id: 8009931
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 20.0
Sr+2 + H+ + Tartarate-2 = SrH(Tartarate)+
log_k 5.8949
delta_h 0 kJ
-gamma 0 0
# Id: 8009932
```

```
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Tartarate-2 = Ba(Tartarate)
log_k 2.54
delta_h 0 kJ
-gamma 0 0
# Id: 1009931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Tartarate-2 + H+ = BaH(Tartarate)+
log_k 5.77
delta_h 0 kJ
-gamma 0 0
# Id: 1009932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Na+ + Tartarate-2 = Na(Tartarate)-
log_k 0.9
delta_h -0.8368 kJ
-gamma 0 0
# Id: 5009931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Na+ + Tartarate-2 + H+ = NaH(Tartarate)
log_k 4.58
delta_h -2.8451 kJ
-gamma 0 0
# Id: 5009932
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
K+ + Tartarate-2 = K(Tartarate)-
log_k 0.8
delta_h 0 kJ
-gamma 0 0
# Id: 4109931
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Glycine- = H(Glycine)
log_k 9.778
delta_h -44.3504 kJ
-gamma 0 0
# Id: 3309941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Glycine- = H2(Glycine)+
log_k 12.128
delta_h -48.4507 kJ
```

```
-gamma 0 0
# Id: 3309942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Glycine- = Pb(Glycine)+
log_k 5.47
delta_h 0 kJ
-gamma 0 0
# Id: 6009941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + 2Glycine- = Pb(Glycine)2
log_k 8.86
delta_h 0 kJ
-gamma 0 0
# Id: 6009942
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Tl+ + Glycine- = Tl(Glycine)
log_k 1.72
delta_h 0 kJ
-gamma 0 0
# Id: 8709941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Glycine- = Zn(Glycine)+
log_k 5.38
delta_h -11.7152 kJ
-gamma 0 0
# Id: 9509941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Glycine- = Zn(Glycine)2
log_k 9.81
delta_h -24.2672 kJ
-gamma 0 0
# Id: 9509942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 3Glycine- = Zn(Glycine)3-
log_k 12.3
delta_h -39.748 kJ
-gamma 0 0
# Id: 9509943
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Glycine- = Cd(Glycine)+
```

```
log_k 4.69
delta_h -8.7864 kJ
-gamma 0 0
# Id: 1609941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Glycine- = Cd(Glycine)2
log_k 8.4
delta_h -22.5936 kJ
-gamma 0 0
# Id: 1609942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 3Glycine- = Cd(Glycine)3-
log_k 10.7
delta_h -35.9824 kJ
-gamma 0 0
# Id: 1609943
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Glycine- + 2H+ = Hg(Glycine)+ + 2H2O
log_k 17
delta_h 0 kJ
-gamma 0 0
# Id: 3619941
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + 2Glycine- + 2H+ = Hg(Glycine)2 + 2H2O
log_k 25.8
delta_h 0 kJ
-gamma 0 0
# Id: 3619942
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cu+ + 2Glycine- = Cu(Glycine)2-
log_k 10.3
delta_h 0 kJ
-gamma 0 0
# Id: 2309941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Glycine- = Cu(Glycine)+
log_k 8.57
delta_h -25.104 kJ
-gamma 0 0
# Id: 2319941
# log K source: NIST46.2
# Delta H source: NIST46.2
```

```
#T and ionic strength:
Cu+2 + 2Glycine- = Cu(Glycine)2
log_k 15.7
delta_h -54.8104 kJ
-gamma 0 0
# Id: 2319942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Glycine- = Ag(Glycine)
log_k 3.51
delta_h -19.2464 kJ
-gamma 0 0
# Id: 209941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Glycine- = Ag(Glycine)2-
log_k 6.89
delta_h -48.116 kJ
-gamma 0 0
# Id: 209942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Glycine- = Ni(Glycine)+
log_k 6.15
delta_h -18.828 kJ
-gamma 0 0
# Id: 5409941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Glycine- = Ni(Glycine)2
log_k 11.12
delta_h -38.0744 kJ
-gamma 0 0
# Id: 5409942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 3Glycine- = Ni(Glycine)3-
log_k 14.63
delta_h -62.3416 kJ
-gamma 0 0
# Id: 5409943
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Glycine- = Co(Glycine)+
log_k 5.07
delta_h -12 kJ
-gamma 0 0
# Id: 2009941
```

```
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + 2Glycine- = Co(Glycine)2
log_k 9.07
delta_h -26 kJ
-gamma 0 0
# Id: 2009942
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + 3Glycine- = Co(Glycine)3-
log_k 11.6
delta_h -41 kJ
-gamma 0 0
# Id: 2009943
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + Glycine- + H2O = CoOH(Glycine) + H+
log_k -5.02
delta_h 0 kJ
-gamma 0 0
# Id: 2009944
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Fe+2 + Glycine- = Fe(Glycine)+
log_k 4.31
delta_h -15.0624 kJ
-gamma 0 0
# Id: 2809941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Glycine- = Fe(Glycine)2
log_k 8.29
delta_h 0 kJ
-gamma 0 0
# Id: 2809942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Glycine- = Fe(Glycine)+2
log_k 9.38
delta_h 0 kJ
-gamma 0 0
# Id: 2819941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Glycine- + H+ = FeH(Glycine)+3
log_k 11.55
delta_h 0 kJ
```

-gamma 0 0
Id: 2819942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Glycine- = Mn(Glycine)+
log_k 3.19
delta_h -1.2552 kJ
-gamma 0 0
Id: 4709941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Glycine- = Mn(Glycine)2
log_k 5.4
delta_h 0 kJ
-gamma 0 0
Id: 4709942
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Glycine- + 2H+ = Cr(Glycine)+2 + 2H2O
log_k 18.7
delta_h 0 kJ
-gamma 0 0
Id: 2119941
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Glycine- + 2H+ = Cr(Glycine)2+ + 2H2O
log_k 25.6
delta_h 0 kJ
-gamma 0 0
Id: 2119942
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 3Glycine- + 2H+ = Cr(Glycine)3 + 2H2O
log_k 31.6
delta_h 0 kJ
-gamma 0 0
Id: 2119943
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mg+2 + Glycine- = Mg(Glycine)+
log_k 2.08
delta_h 4.184 kJ
-gamma 0 0
Id: 4609941
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Glycine- = Ca(Glycine)+

```
log_k 1.39
delta_h -4.184 kJ
-gamma 0 0
# Id: 1509941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Glycine- + H+ = CaH(Glycine)+2
log_k 10.1
delta_h -35.9824 kJ
-gamma 0 0
# Id: 1509942
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Glycine- = Sr(Glycine)+
log_k 0.91
delta_h 0 kJ
-gamma 0 0
# Id: 8009941
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.00 25.0
Ba+2 + Glycine- = Ba(Glycine)+
log_k 0.77
delta_h 0 kJ
-gamma 0 0
# Id: 1009941
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Salicylate-2 = H(Salicylate)-
log_k 13.7
delta_h -35.7732 kJ
-gamma 0 0
# Id: 3309951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Salicylate-2 = H2(Salicylate)
log_k 16.8
delta_h -38.7857 kJ
-gamma 0 0
# Id: 3309952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Salicylate-2 = Zn(Salicylate)
log_k 7.71
delta_h 0 kJ
-gamma 0 0
# Id: 9509951
# log K source: SCD2.62
# Delta H source: SCD2.62
```

```
#T and ionic strength:
Zn+2 + Salicylate-2 + H+ = ZnH(Salicylate)+
log_k 15.5
delta_h 0 kJ
-gamma 0 0
# Id: 9509952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Salicylate-2 = Cd(Salicylate)
log_k 6.2
delta_h 0 kJ
-gamma 0 0
# Id: 1609951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Salicylate-2 + H+ = CdH(Salicylate)+
log_k 16
delta_h 0 kJ
-gamma 0 0
# Id: 1609952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Salicylate-2 = Cu(Salicylate)
log_k 11.3
delta_h -17.9912 kJ
-gamma 0 0
# Id: 2319951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Salicylate-2 = Cu(Salicylate)2-2
log_k 19.3
delta_h 0 kJ
-gamma 0 0
# Id: 2319952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Salicylate-2 + H+ = CuH(Salicylate)+
log_k 14.8
delta_h 0 kJ
-gamma 0 0
# Id: 2319953
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Salicylate-2 = Ni(Salicylate)
log_k 8.2
delta_h 0 kJ
-gamma 0 0
# Id: 5409951
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Salicylate-2 = Ni(Salicylate)2-2
log_k 12.64
delta_h 0 kJ
-gamma 0 0
# Id: 5409952
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Co+2 + Salicylate-2 = Co(Salicylate)
log_k 7.4289
delta_h 0 kJ
-gamma 0 0
# Id: 2009951
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Co+2 + 2Salicylate-2 = Co(Salicylate)2-2
log_k 11.8
delta_h 0 kJ
-gamma 0 0
# Id: 2009952
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 20.0
Fe+2 + Salicylate-2 = Fe(Salicylate)
log_k 7.2
delta_h 0 kJ
-gamma 0 0
# Id: 2809951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+2 + 2Salicylate-2 = Fe(Salicylate)2-2
log_k 11.6
delta_h 0 kJ
-gamma 0 0
# Id: 2809952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + Salicylate-2 = Fe(Salicylate)+
log_k 17.6
delta_h 0 kJ
-gamma 0 0
# Id: 2819951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Fe+3 + 2Salicylate-2 = Fe(Salicylate)2-
log_k 29.3
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 2819952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + Salicylate-2 = Mn(Salicylate)
log_k 6.5
delta_h 0 kJ
-gamma 0 0
# Id: 4709951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mn+2 + 2Salicylate-2 = Mn(Salicylate)2-2
log_k 10.1
delta_h 0 kJ
-gamma 0 0
# Id: 4709952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Be+2 + Salicylate-2 = Be(Salicylate)
log_k 13.3889
delta_h -31.7732 kJ
-gamma 0 0
# Id: 1109951
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.10 25.0
Be+2 + 2Salicylate-2 = Be(Salicylate)2-2
log_k 23.25
delta_h 0 kJ
-gamma 0 0
# Id: 1109952
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mg+2 + Salicylate-2 = Mg(Salicylate)
log_k 5.76
delta_h 0 kJ
-gamma 0 0
# Id: 4609951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Mg+2 + Salicylate-2 + H+ = MgH(Salicylate)+
log_k 15.3
delta_h 0 kJ
-gamma 0 0
# Id: 4609952
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Ca+2 + Salicylate-2 = Ca(Salicylate)
```

```
log_k 4.05
delta_h 0 kJ
-gamma 0 0
# Id: 1509951
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Salicylate-2 + H+ = CaH(Salicylate)+
log_k 14.3
delta_h 0 kJ
-gamma 0 0
# Id: 1509952
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Salicylate-2 + H+ = BaH(Salicylate)+
log_k 13.9
delta_h 0 kJ
-gamma 0 0
# Id: 1009951
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
H+ + Glutamate-2 = H(Glutamate)-
log_k 9.96
delta_h -41.0032 kJ
-gamma 0 0
# Id: 3309961
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Glutamate-2 = H2(Glutamate)
log_k 14.26
delta_h -43.5136 kJ
-gamma 0 0
# Id: 3309962
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
3H+ + Glutamate-2 = H3(Glutamate)+
log_k 16.42
delta_h -46.8608 kJ
-gamma 0 0
# Id: 3309963
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Glutamate-2 = Pb(Glutamate)
log_k 6.43
delta_h 0 kJ
-gamma 0 0
# Id: 6009961
# log K source: SCD2.62
# Delta H source: SCD2.62
```

#T and ionic strength:
Pb+2 + 2Glutamate-2 = Pb(Glutamate)2-2
log_k 8.61
delta_h 0 kJ
-gamma 0 0
Id: 6009962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Pb+2 + Glutamate-2 + H+ = PbH(Glutamate)+
log_k 14.08
delta_h 0 kJ
-gamma 0 0
Id: 6009963
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Al+3 + Glutamate-2 + H+ = AlH(Glutamate)+2
log_k 13.07
delta_h 0 kJ
-gamma 0 0
Id: 309961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Glutamate-2 = Zn(Glutamate)
log_k 6.2
delta_h 0 kJ
-gamma 0 0
Id: 9509961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 2Glutamate-2 = Zn(Glutamate)2-2
log_k 9.13
delta_h 0 kJ
-gamma 0 0
Id: 9509962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Zn+2 + 3Glutamate-2 = Zn(Glutamate)3-4
log_k 9.8
delta_h 0 kJ
-gamma 0 0
Id: 9509963
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cd+2 + Glutamate-2 = Cd(Glutamate)
log_k 4.7
delta_h 0 kJ
-gamma 0 0
Id: 1609961

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Glutamate-2 = Cd(Glutamate)2-2
log_k 7.59
delta_h 0 kJ
-gamma 0 0
# Id: 1609962
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Hg(OH)2 + Glutamate-2 + 2H+ = Hg(Glutamate) + 2H2O
log_k 19.8
delta_h 0 kJ
-gamma 0 0
# Id: 3619961
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Hg(OH)2 + 2Glutamate-2 + 2H+ = Hg(Glutamate)2-2 + 2H2O
log_k 26.2
delta_h 0 kJ
-gamma 0 0
# Id: 3619962
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cu+2 + Glutamate-2 = Cu(Glutamate)
log_k 9.17
delta_h -20.92 kJ
-gamma 0 0
# Id: 2319961
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Glutamate-2 = Cu(Glutamate)2-2
log_k 15.78
delta_h -48.116 kJ
-gamma 0 0
# Id: 2319962
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Glutamate-2 + H+ = CuH(Glutamate)+
log_k 13.3
delta_h -28.0328 kJ
-gamma 0 0
# Id: 2319963
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + Glutamate-2 = Ag(Glutamate)-
log_k 4.22
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 209961
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ag+ + 2Glutamate-2 = Ag(Glutamate)2-3
log_k 7.36
delta_h 0 kJ
-gamma 0 0
# Id: 209962
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
2Ag+ + Glutamate-2 = Ag2(Glutamate)
log_k 3.4
delta_h 0 kJ
-gamma 0 0
# Id: 209963
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Glutamate-2 = Ni(Glutamate)
log_k 6.47
delta_h 0 kJ
-gamma 0 0
# Id: 5409961
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + 2Glutamate-2 = Ni(Glutamate)2-2
log_k 10.7
delta_h -30.9616 kJ
-gamma 0 0
# Id: 5409962
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Glutamate-2 = Co(Glutamate)
log_k 5.4178
delta_h 0 kJ
-gamma 0 0
# Id: 2009961
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Co+2 + 2Glutamate-2 = Co(Glutamate)2-2
log_k 8.7178
delta_h 0 kJ
-gamma 0 0
# Id: 2009962
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mn+2 + Glutamate-2 = Mn(Glutamate)
```

log_k 4.95
delta_h 0 kJ
-gamma 0 0
Id: 4709961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mn+2 + 2Glutamate-2 = Mn(Glutamate)2-2
log_k 8.48
delta_h 0 kJ
-gamma 0 0
Id: 4709962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + Glutamate-2 + 2H+ = Cr(Glutamate)+ + 2H2O
log_k 22.6
delta_h 0 kJ
-gamma 0 0
Id: 2119961
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Glutamate-2 + 2H+ = Cr(Glutamate)2- + 2H2O
log_k 30.7
delta_h 0 kJ
-gamma 0 0
Id: 2119962
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + Glutamate-2 + 3H+ = CrH(Glutamate)+2 + 2H2O
log_k 25.2
delta_h 0 kJ
-gamma 0 0
Id: 2119963
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Mg+2 + Glutamate-2 = Mg(Glutamate)
log_k 2.8
delta_h 0 kJ
-gamma 0 0
Id: 4609961
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Glutamate-2 = Ca(Glutamate)
log_k 2.06
delta_h 0 kJ
-gamma 0 0
Id: 1509961
log K source: NIST46.2
Delta H source: NIST46.2

```
#T and ionic strength:
Ca+2 + Glutamate-2 + H+ = CaH(Glutamate)+
log_k 11.13
delta_h 0 kJ
-gamma 0 0
# Id: 1509962
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Sr+2 + Glutamate-2 = Sr(Glutamate)
log_k 2.2278
delta_h 0 kJ
-gamma 0 0
# Id: 8009961
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Ba+2 + Glutamate-2 = Ba(Glutamate)
log_k 2.14
delta_h 0 kJ
-gamma 0 0
# Id: 1009961
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
H+ + Phthalate-2 = H(Phthalate)-
log_k 5.408
delta_h 2.1757 kJ
-gamma 0 0
# Id: 3309971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
2H+ + Phthalate-2 = H2(Phthalate)
log_k 8.358
delta_h 4.8534 kJ
-gamma 0 0
# Id: 3309972
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Phthalate-2 = Pb(Phthalate)
log_k 4.26
delta_h 0 kJ
-gamma 0 0
# Id: 6009971
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Pb+2 + 2Phthalate-2 = Pb(Phthalate)2-2
log_k 4.83
delta_h 0 kJ
-gamma 0 0
# Id: 6009972
```

```
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Pb+2 + Phthalate-2 + H+ = PbH(Phthalate)+
log_k 6.98
delta_h 0 kJ
-gamma 0 0
# Id: 6009973
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + Phthalate-2 = Al(Phthalate)+
log_k 4.56
delta_h 0 kJ
-gamma 0 0
# Id: 309971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Al+3 + 2Phthalate-2 = Al(Phthalate)2-
log_k 7.2
delta_h 0 kJ
-gamma 0 0
# Id: 309972
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + Phthalate-2 = Zn(Phthalate)
log_k 2.91
delta_h 13.3888 kJ
-gamma 0 0
# Id: 9509971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Zn+2 + 2Phthalate-2 = Zn(Phthalate)2-2
log_k 4.2
delta_h 0 kJ
-gamma 0 0
# Id: 9509972
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Phthalate-2 = Cd(Phthalate)
log_k 3.43
delta_h 0 kJ
-gamma 0 0
# Id: 1609971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + Phthalate-2 + H+ = CdH(Phthalate)+
log_k 6.3
delta_h 0 kJ
```

```
-gamma 0 0
# Id: 1609973
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cd+2 + 2Phthalate-2 = Cd(Phthalate)2-2
log_k 3.7
delta_h 0 kJ
-gamma 0 0
# Id: 1609972
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Phthalate-2 = Cu(Phthalate)
log_k 4.02
delta_h 8.368 kJ
-gamma 0 0
# Id: 2319971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + Phthalate-2 + H+ = CuH(Phthalate)+
log_k 7.1
delta_h 3.8493 kJ
-gamma 0 0
# Id: 2319970
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cu+2 + 2Phthalate-2 = Cu(Phthalate)2-2
log_k 5.3
delta_h 15.8992 kJ
-gamma 0 0
# Id: 2319972
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Phthalate-2 = Ni(Phthalate)
log_k 2.95
delta_h 7.5312 kJ
-gamma 0 0
# Id: 5409971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Ni+2 + Phthalate-2 + H+ = NiH(Phthalate)+
log_k 6.6
delta_h 0 kJ
-gamma 0 0
# Id: 5409972
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Co+2 + Phthalate-2 = Co(Phthalate)
```

```
log_k 2.83
delta_h 7.9 kJ
-gamma 0 0
# Id: 2009971
# log K source: NIST46.4
# Delta H source: NIST46.4
#T and ionic strength: 0.00 25.0
Co+2 + H+ + Phthalate-2 = CoH(Phthalate)+
log_k 7.227
delta_h 0 kJ
-gamma 0 0
# Id: 2009972
# log K source: NIST46.4
# Delta H source: NIST46.2
#T and ionic strength: 0.50 25.0
Mn+2 + Phthalate-2 = Mn(Phthalate)
log_k 2.74
delta_h 10.0416 kJ
-gamma 0 0
# Id: 4709971
# log K source: NIST46.2
# Delta H source: NIST46.2
#T and ionic strength:
Cr(OH)2+ + Phthalate-2 + 2H+ = Cr(Phthalate)+ + 2H2O
log_k 16.3
delta_h 0 kJ
-gamma 0 0
# Id: 2119971
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 2Phthalate-2 + 2H+ = Cr(Phthalate)2- + 2H2O
log_k 21.2
delta_h 0 kJ
-gamma 0 0
# Id: 2119972
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Cr(OH)2+ + 3Phthalate-2 + 2H+ = Cr(Phthalate)3-3 + 2H2O
log_k 23.3
delta_h 0 kJ
-gamma 0 0
# Id: 2119973
# log K source: SCD2.62
# Delta H source: SCD2.62
#T and ionic strength:
Be+2 + Phthalate-2 = Be(Phthalate)
log_k 4.8278
delta_h 0 kJ
-gamma 0 0
# Id: 1109971
# log K source: NIST46.4
# Delta H source: NIST46.2
```

#T and ionic strength: 0.10 25.0
Be+2 + 2Phthalate-2 = Be(Phthalate)2-2
log_k 6.5478
delta_h 0 kJ
-gamma 0 0
Id: 1109972
log K source: NIST46.4
Delta H source: NIST46.2
#T and ionic strength: 0.10 25.0
Mg+2 + Phthalate-2 = Mg(Phthalate)
log_k 2.49
delta_h 0 kJ
-gamma 0 0
Id: 4609971
log K source: SCD2.62
Delta H source: SCD2.62
#T and ionic strength:
Ca+2 + Phthalate-2 = Ca(Phthalate)
log_k 2.45
delta_h 0 kJ
-gamma 0 0
Id: 1509970
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ca+2 + Phthalate-2 + H+ = CaH(Phthalate)+
log_k 6.43
delta_h 0 kJ
-gamma 0 0
Id: 1509971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Ba+2 + Phthalate-2 = Ba(Phthalate)
log_k 2.33
delta_h 0 kJ
-gamma 0 0
Id: 1009971
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
Na+ + Phthalate-2 = Na(Phthalate)-
log_k 0.8
delta_h 4.184 kJ
-gamma 0 0
Id: 5009970
log K source: NIST46.2
Delta H source: NIST46.2
#T and ionic strength:
K+ + Phthalate-2 = K(Phthalate)-
log_k 0.7
delta_h 3.7656 kJ
-gamma 0 0
Id: 4109971

```
# log K source:  NIST46.2
# Delta H source:  NIST46.2
#T and ionic strength:
PHASES
Sulfur
S + H+ + 2e- = HS-
log_k -2.1449
delta_h -16.3 kJ
Semetal(hex
Se + H+ + 2e- = HSe-
log_k -7.7084
delta_h 15.9 kJ
Semetal(am)
Se + H+ + 2e- = HSe-
log_k -7.1099
delta_h 10.8784 kJ
Sbmetal
Sb + 3H2O = Sb(OH)3 + 3H+ + 3e-
log_k -11.6889
delta_h 83.89 kJ
Snmetal(wht)
Sn + 2H2O = Sn(OH)2 + 2H+ + 2e-
log_k -2.3266
delta_h -0 kJ
Pbmetal
Pb = Pb+2 + 2e-
log_k 4.2462
delta_h 0.92 kJ
Tlmetal
Tl = Tl+ + e-
log_k 5.6762
delta_h 5.36 kJ
Znmetal
Zn = Zn+2 + 2e-
log_k 25.7886
delta_h -153.39 kJ
Cdmetal(alpha)
Cd = Cd+2 + 2e-
log_k 13.5147
delta_h -75.33 kJ
Cdmetal(gamma)
Cd = Cd+2 + 2e-
log_k 13.618
delta_h -75.92 kJ
Hgmetal(l)
Hg = 0.5Hg2+2 + e-
log_k -13.4517
delta_h 83.435 kJ
Cumetal
Cu = Cu+ + e-
log_k -8.756
delta_h 71.67 kJ
Agmetal
Ag = Ag+ + e-
```

log_k -13.5065
delta_h 105.79 kJ
Crmetal
Cr = Cr+2 + 2e-
log_k 30.4831
delta_h -172 kJ
Vmetal
V = V+3 + 3e-
log_k 44.0253
delta_h -259 kJ
Stibnite
Sb2S3 + 6H2O = 2Sb(OH)3 + 3H+ + 3HS-
log_k -50.46
delta_h 293.78 kJ
Orpiment
As2S3 + 6H2O = 2H3AsO3 + 3HS- + 3H+
log_k -61.0663
delta_h 350.68 kJ
Realgar
AsS + 3H2O = H3AsO3 + HS- + 2H+ + e-
log_k -19.747
delta_h 127.8 kJ
SnS
SnS + 2H2O = Sn(OH)2 + H+ + HS-
log_k -19.114
delta_h -0 kJ
SnS2
SnS2 + 6H2O = Sn(OH)6-2 + 4H+ + 2HS-
log_k -57.4538
delta_h -0 kJ
Galena
PbS + H+ = Pb+2 + HS-
log_k -13.97
delta_h 80 kJ
Tl2S
Tl2S + H+ = 2Tl+ + HS-
log_k -7.19
delta_h 91.52 kJ
ZnS(am)
ZnS + H+ = Zn+2 + HS-
log_k -9.052
delta_h 15.3553 kJ
Sphalerite
ZnS + H+ = Zn+2 + HS-
log_k -11.45
delta_h 30 kJ
Wurtzite
ZnS + H+ = Zn+2 + HS-
log_k -8.95
delta_h 21.171 kJ
Greenockite
CdS + H+ = Cd+2 + HS-
log_k -14.36
delta_h 55 kJ

Hg2S
Hg2S + H+ = Hg2+2 + HS-
log_k -11.6765
delta_h 69.7473 kJ
Cinnabar
HgS + 2H2O = Hg(OH)2 + H+ + HS-
log_k -45.694
delta_h 253.76 kJ
Metacinnabar
HgS + 2H2O = Hg(OH)2 + H+ + HS-
log_k -45.094
delta_h 253.72 kJ
Chalcocite
Cu2S + H+ = 2Cu+ + HS-
log_k -34.92
delta_h 168 kJ
Djurleite
Cu0.066Cu1.868S + H+ = 0.066Cu+2 + 1.868Cu+ + HS-
log_k -33.92
delta_h 200.334 kJ
Anilite
Cu0.25Cu1.5S + H+ = 0.25Cu+2 + 1.5Cu+ + HS-
log_k -31.878
delta_h 182.15 kJ
BlaubleiII
Cu0.6Cu0.8S + H+ = 0.6Cu+2 + 0.8Cu+ + HS-
log_k -27.279
delta_h -0 kJ
BlaubleiI
Cu0.9Cu0.2S + H+ = 0.9Cu+2 + 0.2Cu+ + HS-
log_k -24.162
delta_h -0 kJ
Covellite
CuS + H+ = Cu+2 + HS-
log_k -22.3
delta_h 97 kJ
Chalcopyrite
CuFeS2 + 2H+ = Cu+2 + Fe+2 + 2HS-
log_k -35.27
delta_h 148.448 kJ
Acanthite
Ag2S + H+ = 2Ag+ + HS-
log_k -36.22
delta_h 227 kJ
NiS(alpha)
NiS + H+ = Ni+2 + HS-
log_k -5.6
delta_h -0 kJ
NiS(beta)
NiS + H+ = Ni+2 + HS-
log_k -11.1
delta_h -0 kJ
NiS(gamma)
NiS + H+ = Ni+2 + HS-

log_k -12.8
delta_h -0 kJ
CoS(alpha)
CoS + H+ = Co+2 + HS-
log_k -7.44
delta_h -0 kJ
CoS(beta)
CoS + H+ = Co+2 + HS-
log_k -11.07
delta_h -0 kJ
FeS(ppt)
FeS + H+ = Fe+2 + HS-
log_k -2.95
delta_h -11 kJ
Greigite
Fe3S4 + 4H+ = 2Fe+3 + Fe+2 + 4HS-
log_k -45.035
delta_h -0 kJ
Mackinawite
FeS + H+ = Fe+2 + HS-
log_k -3.6
delta_h -0 kJ
Pyrite
FeS2 + 2H+ + 2e- = Fe+2 + 2HS-
log_k -18.5082
delta_h 49.844 kJ
MnS(grn)
MnS + H+ = Mn+2 + HS-
log_k 0.17
delta_h -32 kJ
MnS(pnk)
MnS + H+ = Mn+2 + HS-
log_k 3.34
delta_h -0 kJ
MoS2
MoS2 + 4H2O = MoO4-2 + 6H+ + 2HS- + 2e-
log_k -70.2596
delta_h 389.02 kJ
BeS
BeS + H+ = Be+2 + HS-
log_k 19.38
delta_h -0 kJ
BaS
BaS + H+ = Ba+2 + HS-
log_k 16.18
delta_h -0 kJ
Hg2(Cyanide)2
Hg2(Cyanide)2 = Hg2+2 + 2Cyanide-
log_k -39.3
delta_h -0 kJ
CuCyanide
CuCyanide = Cu+ + Cyanide-
log_k -19.5
delta_h -19 kJ

AgCyanide
AgCyanide = Ag+ + Cyanide-
log_k -15.74
delta_h 110.395 kJ
Ag2(Cyanide)2
Ag2(Cyanide)2 = 2Ag+ + 2Cyanide-
log_k -11.3289
delta_h -0 kJ
NaCyanide(cubic)
NaCyanide = Cyanide- + Na+
log_k 1.6012
delta_h 0.969 kJ
KCyanide(cubic)
KCyanide = Cyanide- + K+
log_k 1.4188
delta_h 11.93 kJ
Pb2Fe(Cyanide)6
Pb2Fe(Cyanide)6 = 2Pb+2 + Fe+2 + 6Cyanide-
log_k -53.42
delta_h -0 kJ
Zn2Fe(Cyanide)6
Zn2Fe(Cyanide)6 = 2Zn+2 + Fe+2 + 6Cyanide-
log_k -51.08
delta_h -0 kJ
Cd2Fe(Cyanide)6
Cd2Fe(Cyanide)6 = 2Cd+2 + Fe+2 + 6Cyanide-
log_k -52.78
delta_h -0 kJ
Ag4Fe(Cyanide)6
Ag4Fe(Cyanide)6 = 4Ag+ + Fe+2 + 6Cyanide-
log_k -79.47
delta_h -0 kJ
Ag3Fe(Cyanide)6
Ag3Fe(Cyanide)6 = 3Ag+ + Fe+3 + 6Cyanide-
log_k -72.7867
delta_h -0 kJ
Mn3(Fe(Cyanide)6)2
Mn3(Fe(Cyanide)6)2 = 3Mn+2 + 2Fe+3 + 12Cyanide-
log_k -105.4
delta_h -0 kJ
Sb2Se3
Sb2Se3 + 6H2O = 2Sb(OH)3 + 3HSe- + 3H+
log_k -67.7571
delta_h 343.046 kJ
SnSe
SnSe + 2H2O = Sn(OH)2 + H+ + HSe-
log_k -30.494
delta_h -0 kJ
SnSe2
SnSe2 + 6H2O = Sn(OH)6-2 + 4H+ + 2HSe-
log_k -65.1189
delta_h -0 kJ
Clausthalite
PbSe + H+ = Pb+2 + HSe-

log_k -27.1
delta_h 119.72 kJ
Tl2Se
Tl2Se + H+ = 2Tl+ + HSe-
log_k -18.1
delta_h 85.62 kJ
ZnSe
ZnSe + H+ = Zn+2 + HSe-
log_k -14.4
delta_h 25.51 kJ
CdSe
CdSe + H+ = Cd+2 + HSe-
log_k -20.2
delta_h 75.9814 kJ
HgSe
HgSe + 2H2O = Hg(OH)2 + H+ + HSe-
log_k -55.694
delta_h -0 kJ
Cu2Se(alpha)
Cu2Se + H+ = 2Cu+ + HSe-
log_k -45.8
delta_h 214.263 kJ
Cu3Se2
Cu3Se2 + 2H+ = 2HSe- + 2Cu+ + Cu+2
log_k -63.4911
delta_h 340.327 kJ
CuSe
CuSe + H+ = Cu+2 + HSe-
log_k -33.1
delta_h 121.127 kJ
CuSe2
CuSe2 + 2H+ + 2e- = 2HSe- + Cu+2
log_k -33.3655
delta_h 140.582 kJ
Ag2Se
Ag2Se + H+ = 2Ag+ + HSe-
log_k -48.7
delta_h 265.48 kJ
NiSe
NiSe + H+ = Ni+2 + HSe-
log_k -17.7
delta_h -0 kJ
CoSe
CoSe + H+ = Co+2 + HSe-
log_k -16.2
delta_h -0 kJ
FeSe
FeSe + H+ = Fe+2 + HSe-
log_k -11
delta_h 2.092 kJ
Ferroselite
FeSe2 + 2H+ + 2e- = 2HSe- + Fe+2
log_k -18.5959
delta_h 47.2792 kJ

MnSe
MnSe + H+ = Mn+2 + HSe-
log_k 3.5
delta_h -98.15 kJ
AlSb
AlSb + 3H2O = Sb(OH)3 + 6e- + Al+3 + 3H+
log_k 65.6241
delta_h -0 kJ
ZnSb
ZnSb + 3H2O = Sb(OH)3 + 5e- + Zn+2 + 3H+
log_k 11.0138
delta_h -54.8773 kJ
CdSb
CdSb + 3H2O = Sb(OH)3 + 5e- + 3H+ + Cd+2
log_k -0.3501
delta_h 22.36 kJ
Cu2Sb:3H2O
Cu2Sb:3H2O = Sb(OH)3 + 6e- + 3H+ + Cu+ + Cu+2
log_k -34.8827
delta_h 233.237 kJ
Cu3Sb
Cu3Sb + 3H2O = Sb(OH)3 + 6e- + 3H+ + 3Cu+
log_k -42.5937
delta_h 308.131 kJ
#Ag4Sb
Ag4Sb + 3H2O = Sb(OH)3 + 6e- + 3Ag+ + 3H+
log_k -56.1818
delta_h -0 kJ
Breithauptite
NiSb + 3H2O = Sb(OH)3 + 5e- + 3H+ + Ni+2
log_k -18.5225
delta_h 96.0019 kJ
MnSb
MnSb + 3H2O = Mn+3 + Sb(OH)3 + 6e- + 3H+
log_k -2.9099
delta_h 21.1083 kJ
Mn2Sb
Mn2Sb + 3H2O = 2Mn+2 + Sb(OH)3 + 7e- + 3H+
log_k 61.0796
delta_h -0 kJ
USb2
USb2 + 8H2O = UO2+2 + 2Sb(OH)3 + 12e- + 10H+
log_k 29.5771
delta_h -103.56 kJ
U3Sb4
U3Sb4 + 12H2O = 3U+4 + 4Sb(OH)3 + 24e- + 12H+
log_k 152.383
delta_h -986.04 kJ
Mg2Sb3
Mg2Sb3 + 9H2O = 2Mg+2 + 3Sb(OH)3 + 9H+ + 13e-
log_k 74.6838
delta_h -0 kJ
Ca3Sb2
Ca3Sb2 + 6H2O = 3Ca+2 + 2Sb(OH)3 + 6H+ + 12e-

log_k 142.974
delta_h -732.744 kJ
NaSb
NaSb + 3H2O = Na+ + Sb(OH)3 + 3H+ + 4e-
log_k 23.1658
delta_h -93.45 kJ
Na3Sb
Na3Sb + 3H2O = 3Na+ + Sb(OH)3 + 3H+ + 6e-
log_k 94.4517
delta_h -432.13 kJ
SeO2
SeO2 + H2O = HSeO3- + H+
log_k 0.1246
delta_h 1.4016 kJ
SeO3
SeO3 + H2O = SeO4-2 + 2H+
log_k 21.044
delta_h -146.377 kJ
Sb2O5
Sb2O5 + 7H2O = 2Sb(OH)6- + 2H+
log_k -9.6674
delta_h -0 kJ
SbO2
SbO2 + 4H2O = Sb(OH)6- + e- + 2H+
log_k -27.8241
delta_h -0 kJ
Sb2O4
Sb2O4 + 2H2O + 2H+ + 2e- = 2Sb(OH)3
log_k 3.4021
delta_h -68.04 kJ
Sb4O6(cubic)
Sb4O6 + 6H2O = 4Sb(OH)3
log_k -18.2612
delta_h 61.1801 kJ
Sb4O6(orth)
Sb4O6 + 6H2O = 4Sb(OH)3
log_k -17.9012
delta_h 37.6801 kJ
Sb(OH)3
Sb(OH)3 = Sb(OH)3
log_k -7.1099
delta_h 30.1248 kJ
Senarmontite
Sb2O3 + 3H2O = 2Sb(OH)3
log_k -12.3654
delta_h 30.6478 kJ
Valentinite
Sb2O3 + 3H2O = 2Sb(OH)3
log_k -8.4806
delta_h 19.0163 kJ
Chalcedony
SiO2 + 2H2O = H4SiO4
log_k -3.55
delta_h 19.7 kJ

Cristobalite
SiO2 + 2H2O = H4SiO4
log_k -3.35
delta_h 20.006 kJ
Quartz
SiO2 + 2H2O = H4SiO4
log_k -4
delta_h 22.36 kJ
SiO2(am-gel)
SiO2 + 2H2O = H4SiO4
log_k -2.71
delta_h 14 kJ
SiO2(am-ppt)
SiO2 + 2H2O = H4SiO4
log_k -2.74
delta_h 15.15 kJ
SnO
SnO + H2O = Sn(OH)2
log_k -4.9141
delta_h -0 kJ
SnO2
SnO2 + 4H2O = Sn(OH)6-2 + 2H+
log_k -28.9749
delta_h -0 kJ
Sn(OH)2
Sn(OH)2 = Sn(OH)2
log_k -5.4309
delta_h -0 kJ
Sn(OH)4
Sn(OH)4 + 2H2O = Sn(OH)6-2 + 2H+
log_k -22.2808
delta_h -0 kJ
H2Sn(OH)6
H2Sn(OH)6 = Sn(OH)6-2 + 2H+
log_k -23.5281
delta_h -0 kJ
Massicot
PbO + 2H+ = Pb+2 + H2O
log_k 12.894
delta_h -66.848 kJ
Litharge
PbO + 2H+ = Pb+2 + H2O
log_k 12.694
delta_h -65.501 kJ
PbO:0.3H2O
PbO:0.33H2O + 2H+ = Pb+2 + 1.33H2O
log_k 12.98
delta_h -0 kJ
Plattnerite
PbO2 + 4H+ + 2e- = Pb+2 + 2H2O
log_k 49.6001
delta_h -296.27 kJ
Pb(OH)2
Pb(OH)2 + 2H+ = Pb+2 + 2H2O

log_k 8.15
delta_h -58.5342 kJ
Pb2O(OH)2
Pb2O(OH)2 + 4H+ = 2Pb+2 + 3H2O
log_k 26.188
delta_h -0 kJ
Al(OH)3(am)
Al(OH)3 + 3H+ = Al+3 + 3H2O
log_k 10.8
delta_h -111 kJ
Boehmite
AlOOH + 3H+ = Al+3 + 2H2O
log_k 8.578
delta_h -117.696 kJ
Diaspore
AlOOH + 3H+ = Al+3 + 2H2O
log_k 6.873
delta_h -103.052 kJ
Gibbsite
Al(OH)3 + 3H+ = Al+3 + 3H2O
log_k 8.291
delta_h -95.3952 kJ
Tl2O
Tl2O + 2H+ = 2Tl+ + H2O
log_k 27.0915
delta_h -96.41 kJ
TlOH
TlOH + H+ = Tl+ + H2O
log_k 12.9186
delta_h -41.57 kJ
Avicennite
Tl2O3 + 3H2O = 2Tl(OH)3
log_k -13
delta_h -0 kJ
Tl(OH)3
Tl(OH)3 = Tl(OH)3
log_k -5.441
delta_h -0 kJ
Zn(OH)2(am)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 12.474
delta_h -80.62 kJ
Zn(OH)2
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 12.2
delta_h -0 kJ
Zn(OH)2(beta)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 11.754
delta_h -83.14 kJ
Zn(OH)2(gamma)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 11.734
delta_h -0 kJ

Zn(OH)2(epsilon)
Zn(OH)2 + 2H+ = Zn+2 + 2H2O
log_k 11.534
delta_h -81.8 kJ
ZnO(active)
ZnO + 2H+ = Zn+2 + H2O
log_k 11.1884
delta_h -88.76 kJ
Zincite
ZnO + 2H+ = Zn+2 + H2O
log_k 11.334
delta_h -89.62 kJ
Cd(OH)2(am)
Cd(OH)2 + 2H+ = Cd+2 + 2H2O
log_k 13.73
delta_h -86.9017 kJ
Cd(OH)2
Cd(OH)2 + 2H+ = Cd+2 + 2H2O
log_k 13.644
delta_h -94.62 kJ
Monteponite
CdO + 2H+ = Cd+2 + H2O
log_k 15.1034
delta_h -103.4 kJ
Hg2(OH)2
Hg2(OH)2 + 2H+ = Hg2+2 + 2H2O
log_k 5.2603
delta_h -0 kJ
Montroydite
HgO + H2O = Hg(OH)2
log_k -3.64
delta_h -38.9 kJ
Hg(OH)2
Hg(OH)2 = Hg(OH)2
log_k -3.4963
delta_h -0 kJ
Cuprite
Cu2O + 2H+ = 2Cu+ + H2O
log_k -1.406
delta_h -124.02 kJ
Cu(OH)2
Cu(OH)2 + 2H+ = Cu+2 + 2H2O
log_k 8.674
delta_h -56.42 kJ
Tenorite
CuO + 2H+ = Cu+2 + H2O
log_k 7.644
delta_h -64.867 kJ
Ag2O
Ag2O + 2H+ = 2Ag+ + H2O
log_k 12.574
delta_h -45.62 kJ
Ni(OH)2
Ni(OH)2 + 2H+ = Ni+2 + 2H2O

log_k 12.794
delta_h -95.96 kJ
Bunsenite
NiO + 2H+ = Ni+2 + H2O
log_k 12.4456
delta_h -100.13 kJ
CoO
CoO + 2H+ = Co+2 + H2O
log_k 13.5864
delta_h -106.295 kJ
Co(OH)2
Co(OH)2 + 2H+ = Co+2 + 2H2O
log_k 13.094
delta_h -0 kJ
Co(OH)3
Co(OH)3 + 3H+ = Co+3 + 3H2O
log_k -2.309
delta_h -92.43 kJ
#Wustite-0.11
WUSTITE-0.11 + 2H+ = 0.947Fe+2 + H2O
log_k 11.6879
delta_h -103.938 kJ
Fe(OH)2
Fe(OH)2 + 2H+ = Fe+2 + 2H2O
log_k 13.564
delta_h -0 kJ
Ferrihydrite
Fe(OH)3 + 3H+ = Fe+3 + 3H2O
log_k 3.191
delta_h -73.374 kJ
Fe3(OH)8
Fe3(OH)8 + 8H+ = 2Fe+3 + Fe+2 + 8H2O
log_k 20.222
delta_h -0 kJ
Goethite
FeOOH + 3H+ = Fe+3 + 2H2O
log_k 0.491
delta_h -60.5843 kJ
Pyrolusite
MnO2 + 4H+ + 2e- = Mn+2 + 2H2O
log_k 41.38
delta_h -272 kJ
Birnessite
MnO2 + 4H+ + e- = Mn+3 + 2H2O
log_k 18.091
delta_h -0 kJ
Nsutite
MnO2 + 4H+ + e- = Mn+3 + 2H2O
log_k 17.504
delta_h -0 kJ
Pyrochroite
Mn(OH)2 + 2H+ = Mn+2 + 2H2O
log_k 15.194
delta_h -97.0099 kJ

Manganite
MnOOH + 3H+ + e- = Mn+2 + 2H2O
log_k 25.34
delta_h -0 kJ
Cr(OH)2
Cr(OH)2 + 2H+ = Cr+2 + 2H2O
log_k 10.8189
delta_h -35.6058 kJ
Cr(OH)3(am)
Cr(OH)3 + H+ = Cr(OH)2+ + H2O
log_k -0.75
delta_h -0 kJ
Cr(OH)3
Cr(OH)3 + H+ = Cr(OH)2+ + H2O
log_k 1.3355
delta_h -29.7692 kJ
CrO3
CrO3 + H2O = CrO4-2 + 2H+
log_k -3.2105
delta_h -5.2091 kJ
MoO3
MoO3 + H2O = MoO4-2 + 2H+
log_k -8
delta_h -0 kJ
VO
VO + 2H+ = V+3 + H2O + e-
log_k 14.7563
delta_h -113.041 kJ
V(OH)3
V(OH)3 + 3H+ = V+3 + 3H2O
log_k 7.591
delta_h -0 kJ
VO(OH)2
VO(OH)2 + 2H+ = VO+2 + 2H2O
log_k 5.1506
delta_h -0 kJ
Uraninite
UO2 + 4H+ = U+4 + 2H2O
log_k -4.6693
delta_h -77.86 kJ
UO2(am)
UO2 + 4H+ = U+4 + 2H2O
log_k 0.934
delta_h -109.746 kJ
UO3
UO3 + 2H+ = UO2+2 + H2O
log_k 7.7
delta_h -81.0299 kJ
Gummite
UO3 + 2H+ = UO2+2 + H2O
log_k 7.6718
delta_h -81.0299 kJ
UO2(OH)2(beta)
UO2(OH)2 + 2H+ = UO2+2 + 2H2O

log_k 5.6116
delta_h -56.7599 kJ
Schoepite
UO2(OH)2:H2O + 2H+ = UO2+2 + 3H2O
log_k 5.994
delta_h -49.79 kJ
Be(OH)2(am)
Be(OH)2 + 2H+ = Be+2 + 2H2O
log_k 7.194
delta_h -0 kJ
Be(OH)2(alpha)
Be(OH)2 + 2H+ = Be+2 + 2H2O
log_k 6.894
delta_h -0 kJ
Be(OH)2(beta)
Be(OH)2 + 2H+ = Be+2 + 2H2O
log_k 6.494
delta_h -0 kJ
Brucite
Mg(OH)2 + 2H+ = Mg+2 + 2H2O
log_k 16.844
delta_h -113.996 kJ
Periclase
MgO + 2H+ = Mg+2 + H2O
log_k 21.5841
delta_h -151.23 kJ
Mg(OH)2(active)
Mg(OH)2 + 2H+ = Mg+2 + 2H2O
log_k 18.794
delta_h -0 kJ
Lime
CaO + 2H+ = Ca+2 + H2O
log_k 32.6993
delta_h -193.91 kJ
Portlandite
Ca(OH)2 + 2H+ = Ca+2 + 2H2O
log_k 22.804
delta_h -128.62 kJ
Ba(OH)2:8H2O
Ba(OH)2:8H2O + 2H+ = Ba+2 + 10H2O
log_k 24.394
delta_h -54.32 kJ
Cu(SbO3)2
Cu(SbO3)2 + 6H+ + 4e- = 2Sb(OH)3 + Cu+2
log_k 45.2105
delta_h -0 kJ
Arsenolite
As4O6 + 6H2O = 4H3AsO3
log_k -2.76
delta_h 59.9567 kJ
Claudetite
As4O6 + 6H2O = 4H3AsO3
log_k -3.065
delta_h 55.6054 kJ

As2O5
As2O5 + 3H2O = 2H3AsO4
log_k 6.7061
delta_h -22.64 kJ
Pb2O3
Pb2O3 + 6H+ + 2e- = 2Pb+2 + 3H2O
log_k 61.04
delta_h -0 kJ
Minium
Pb3O4 + 8H+ + 2e- = 3Pb+2 + 4H2O
log_k 73.5219
delta_h -421.874 kJ
Al2O3
Al2O3 + 6H+ = 2Al+3 + 3H2O
log_k 19.6524
delta_h -258.59 kJ
Co3O4
Co3O4 + 8H+ = Co+2 + 2Co+3 + 4H2O
log_k -10.4956
delta_h -107.5 kJ
CoFe2O4
CoFe2O4 + 8H+ = Co+2 + 2Fe+3 + 4H2O
log_k -3.5281
delta_h -158.82 kJ
Magnetite
Fe3O4 + 8H+ = 2Fe+3 + Fe+2 + 4H2O
log_k 3.4028
delta_h -208.526 kJ
Hercynite
FeAl2O4 + 8H+ = Fe+2 + 2Al+3 + 4H2O
log_k 22.893
delta_h -313.92 kJ
Hematite
Fe2O3 + 6H+ = 2Fe+3 + 3H2O
log_k -1.418
delta_h -128.987 kJ
Maghemite
Fe2O3 + 6H+ = 2Fe+3 + 3H2O
log_k 6.386
delta_h -0 kJ
Lepidocrocite
FeOOH + 3H+ = Fe+3 + 2H2O
log_k 1.371
delta_h -0 kJ
Hausmannite
Mn3O4 + 8H+ + 2e- = 3Mn+2 + 4H2O
log_k 61.03
delta_h -421 kJ
Bixbyite
Mn2O3 + 6H+ = 2Mn+3 + 3H2O
log_k -0.6445
delta_h -124.49 kJ
Cr2O3
Cr2O3 + H2O + 2H+ = 2Cr(OH)2+

log_k -2.3576
delta_h -50.731 kJ
#V2O3
V2O3 + 3H+ = V+3 + 1.5H2O
log_k 4.9
delta_h -82.5085 kJ
V3O5
V3O5 + 4H+ = 3VO+2 + 2H2O + 2e-
log_k 1.8361
delta_h -98.46 kJ
#V2O4
V2O4 + 2H+ = VO+2 + H2O
log_k 4.27
delta_h -58.8689 kJ
V4O7
V4O7 + 6H+ = 4VO+2 + 3H2O + 2e-
log_k 7.1865
delta_h -163.89 kJ
V6O13
V6O13 + 2H+ = 6VO2+ + H2O + 4e-
log_k -60.86
delta_h 271.5 kJ
V2O5
V2O5 + 2H+ = 2VO2+ + H2O
log_k -1.36
delta_h 34 kJ
U4O9
U4O9 + 18H+ + 2e- = 4U+4 + 9H2O
log_k -3.0198
delta_h -426.87 kJ
U3O8
U3O8 + 16H+ + 4e- = 3U+4 + 8H2O
log_k 21.0834
delta_h -485.44 kJ
Spinel
MgAl2O4 + 8H+ = Mg+2 + 2Al+3 + 4H2O
log_k 36.8476
delta_h -388.012 kJ
Magnesioferrite
Fe2MgO4 + 8H+ = Mg+2 + 2Fe+3 + 4H2O
log_k 16.8597
delta_h -278.92 kJ
Natron
Na2CO3:10H2O = 2Na+ + CO3-2 + 10H2O
log_k -1.311
delta_h 65.8771 kJ
Cuprousferrite
CuFeO2 + 4H+ = Cu+ + Fe+3 + 2H2O
log_k -8.9171
delta_h -15.89 kJ
Cupricferrite
CuFe2O4 + 8H+ = Cu+2 + 2Fe+3 + 4H2O
log_k 5.9882
delta_h -210.21 kJ

FeCr2O4
FeCr2O4 + 4H+ = 2Cr(OH)2+ + Fe+2
log_k 7.2003
delta_h -140.4 kJ
MgCr2O4
MgCr2O4 + 4H+ = 2Cr(OH)2+ + Mg+2
log_k 16.2007
delta_h -179.4 kJ
SbF3
SbF3 + 3H2O = Sb(OH)3 + 3H+ + 3F-
log_k -10.2251
delta_h -6.7279 kJ
PbF2
PbF2 = Pb+2 + 2F-
log_k -7.44
delta_h 20 kJ
ZnF2
ZnF2 = Zn+2 + 2F-
log_k -0.5343
delta_h -59.69 kJ
CdF2
CdF2 = Cd+2 + 2F-
log_k -1.2124
delta_h -46.22 kJ
Hg2F2
Hg2F2 = Hg2+2 + 2F-
log_k -10.3623
delta_h -18.486 kJ
CuF
CuF = Cu+ + F-
log_k -4.9056
delta_h 16.648 kJ
CuF2
CuF2 = Cu+2 + 2F-
log_k 1.115
delta_h -66.901 kJ
CuF2:2H2O
CuF2:2H2O = Cu+2 + 2F- + 2H2O
log_k -4.55
delta_h -15.2716 kJ
AgF:4H2O
AgF:4H2O = Ag+ + F- + 4H2O
log_k 1.0491
delta_h 15.4202 kJ
CoF2
CoF2 = Co+2 + 2F-
log_k -1.5969
delta_h -57.368 kJ
CoF3
CoF3 = Co+3 + 3F-
log_k -1.4581
delta_h -123.692 kJ
CrF3
CrF3 + 2H2O = Cr(OH)2+ + 3F- + 2H+

log_k -11.3367
delta_h -23.3901 kJ
VF4
VF4 + H2O = VO+2 + 4F- + 2H+
log_k 14.93
delta_h -199.117 kJ
UF4
UF4 = U+4 + 4F-
log_k -29.5371
delta_h -79.0776 kJ
UF4:2.5H2O
UF4:2.5H2O = U+4 + 4F- + 2.5H2O
log_k -32.7179
delta_h 24.325 kJ
MgF2
MgF2 = Mg+2 + 2F-
log_k -8.13
delta_h -8 kJ
Fluorite
CaF2 = Ca+2 + 2F-
log_k -10.5
delta_h 8 kJ
SrF2
SrF2 = Sr+2 + 2F-
log_k -8.58
delta_h 4 kJ
BaF2
BaF2 = Ba+2 + 2F-
log_k -5.82
delta_h 4 kJ
Cryolite
Na3AlF6 = 3Na+ + Al+3 + 6F-
log_k -33.84
delta_h 38 kJ
SbCl3
SbCl3 + 3H2O = Sb(OH)3 + 3Cl- + 3H+
log_k 0.5719
delta_h -35.18 kJ
SnCl2
SnCl2 + 2H2O = Sn(OH)2 + 2H+ + 2Cl-
log_k -9.2752
delta_h -0 kJ
Cotunnite
PbCl2 = Pb+2 + 2Cl-
log_k -4.78
delta_h 26.166 kJ
Matlockite
PbClF = Pb+2 + Cl- + F-
log_k -8.9733
delta_h 33.19 kJ
Phosgenite
PbCl2:PbCO3 = 2Pb+2 + 2Cl- + CO3-2
log_k -19.81
delta_h -0 kJ

Laurionite
PbOHCl + H+ = Pb+2 + Cl- + H2O
log_k 0.623
delta_h -0 kJ
Pb2(OH)3Cl
Pb2(OH)3Cl + 3H+ = 2Pb+2 + 3H2O + Cl-
log_k 8.793
delta_h -0 kJ
TlCl
TlCl = Tl+ + Cl-
log_k -3.74
delta_h 41 kJ
ZnCl2
ZnCl2 = Zn+2 + 2Cl-
log_k 7.05
delta_h -72.5 kJ
Zn2(OH)3Cl
Zn2(OH)3Cl + 3H+ = 2Zn+2 + 3H2O + Cl-
log_k 15.191
delta_h -0 kJ
Zn5(OH)8Cl2
Zn5(OH)8Cl2 + 8H+ = 5Zn+2 + 8H2O + 2Cl-
log_k 38.5
delta_h -0 kJ
CdCl2
CdCl2 = Cd+2 + 2Cl-
log_k -0.6588
delta_h -18.58 kJ
CdCl2:1H2O
CdCl2:1H2O = Cd+2 + 2Cl- + H2O
log_k -1.6932
delta_h -7.47 kJ
CdCl2:2.5H2O
CdCl2:2.5H2O = Cd+2 + 2Cl- + 2.5H2O
log_k -1.913
delta_h 7.2849 kJ
CdOHCl
CdOHCl + H+ = Cd+2 + H2O + Cl-
log_k 3.5373
delta_h -30.93 kJ
Calomel
Hg2Cl2 = Hg2+2 + 2Cl-
log_k -17.91
delta_h 92 kJ
HgCl2
HgCl2 + 2H2O = Hg(OH)2 + 2Cl- + 2H+
log_k -21.2621
delta_h 107.82 kJ
Nantokite
CuCl = Cu+ + Cl-
log_k -6.73
delta_h 42.662 kJ
Melanothallite
CuCl2 = Cu+2 + 2Cl-

log_k 6.2572
delta_h -63.407 kJ
Atacamite
Cu2(OH)3Cl + 3H+ = 2Cu+2 + 3H2O + Cl-
log_k 7.391
delta_h -93.43 kJ
Cerargyrite
AgCl = Ag+ + Cl-
log_k -9.75
delta_h 65.2 kJ
CoCl2
CoCl2 = Co+2 + 2Cl-
log_k 8.2672
delta_h -79.815 kJ
CoCl2:6H2O
CoCl2:6H2O = Co+2 + 2Cl- + 6H2O
log_k 2.5365
delta_h 8.0598 kJ
(Co(NH3)6)Cl3
(Co(NH3)6)Cl3 + 6H+ = Co+3 + 6NH4+ + 3Cl-
log_k 20.0317
delta_h -33.1 kJ
(Co(NH3)5OH2)Cl3
(Co(NH3)5OH2)Cl3 + 5H+ = Co+3 + 5NH4+ + 3Cl- + H2O
log_k 11.7351
delta_h -25.37 kJ
(Co(NH3)5Cl)Cl2
(Co(NH3)5Cl)Cl2 + 5H+ = Co+3 + 5NH4+ + 3Cl-
log_k 4.5102
delta_h -10.74 kJ
Fe(OH)2.7Cl.3
Fe(OH)2.7Cl.3 + 2.7H+ = Fe+3 + 2.7H2O + 0.3Cl-
log_k -3.04
delta_h -0 kJ
MnCl2:4H2O
MnCl2:4H2O = Mn+2 + 2Cl- + 4H2O
log_k 2.7151
delta_h -10.83 kJ
CrCl2
CrCl2 = Cr+2 + 2Cl-
log_k 14.0917
delta_h -110.76 kJ
CrCl3
CrCl3 + 2H2O = Cr(OH)2+ + 3Cl- + 2H+
log_k 15.1145
delta_h -121.08 kJ
VCl2
VCl2 = V+3 + 2Cl- + e-
log_k 18.8744
delta_h -141.16 kJ
VCl3
VCl3 = V+3 + 3Cl-
log_k 23.4326
delta_h -179.54 kJ

VOCl
VOCl + 2H+ = V+3 + Cl- + H2O
log_k 11.1524
delta_h -104.91 kJ
VOCl2
VOCl2 = VO+2 + 2Cl-
log_k 12.7603
delta_h -117.76 kJ
VO2Cl
VO2Cl = VO2+ + Cl-
log_k 2.8413
delta_h -40.28 kJ
Halite
NaCl = Na+ + Cl-
log_k 1.6025
delta_h 3.7 kJ
SbBr3
SbBr3 + 3H2O = Sb(OH)3 + 3Br- + 3H+
log_k 0.9689
delta_h -20.94 kJ
SnBr2
SnBr2 + 2H2O = Sn(OH)2 + 2H+ + 2Br-
log_k -9.5443
delta_h -0 kJ
SnBr4
SnBr4 + 6H2O = Sn(OH)6-2 + 6H+ + 4Br-
log_k -28.8468
delta_h -0 kJ
PbBr2
PbBr2 = Pb+2 + 2Br-
log_k -5.3
delta_h 35.499 kJ
PbBrF
PbBrF = Pb+2 + Br- + F-
log_k -8.49
delta_h -0 kJ
TlBr
TlBr = Tl+ + Br-
log_k -5.44
delta_h 54 kJ
ZnBr2:2H2O
ZnBr2:2H2O = Zn+2 + 2Br- + 2H2O
log_k 5.2005
delta_h -30.67 kJ
CdBr2:4H2O
CdBr2:4H2O = Cd+2 + 2Br- + 4H2O
log_k -2.425
delta_h 30.5001 kJ
Hg2Br2
Hg2Br2 = Hg2+2 + 2Br-
log_k -22.25
delta_h 133 kJ
HgBr2
HgBr2 + 2H2O = Hg(OH)2 + 2Br- + 2H+

log_k -25.2734
delta_h 138.492 kJ
CuBr
CuBr = Cu+ + Br-
log_k -8.3
delta_h 54.86 kJ
Cu2(OH)3Br
Cu2(OH)3Br + 3H+ = 2Cu+2 + 3H2O + Br-
log_k 7.9085
delta_h -93.43 kJ
Bromyrite
AgBr = Ag+ + Br-
log_k -12.3
delta_h 84.5 kJ
(Co(NH3)6)Br3
(Co(NH3)6)Br3 + 6H+ = Co+3 + 6NH4+ + 3Br-
log_k 18.3142
delta_h -21.1899 kJ
(Co(NH3)5Cl)Br2
(Co(NH3)5Cl)Br2 + 5H+ = Co+3 + 5NH4+ + Cl- + 2Br-
log_k 5.0295
delta_h -6.4 kJ
CrBr3
CrBr3 + 2H2O = Cr(OH)2+ + 3Br- + 2H+
log_k 19.9086
delta_h -141.323 kJ
AsI3
AsI3 + 3H2O = H3AsO3 + 3I- + 3H+
log_k 4.2307
delta_h 3.15 kJ
SbI3
SbI3 + 3H2O = Sb(OH)3 + 3H+ + 3I-
log_k -0.538
delta_h 13.5896 kJ
PbI2
PbI2 = Pb+2 + 2I-
log_k -8.1
delta_h 62 kJ
TlI
TlI = Tl+ + I-
log_k -7.23
delta_h 75 kJ
ZnI2
ZnI2 = Zn+2 + 2I-
log_k 7.3055
delta_h -58.92 kJ
CdI2
CdI2 = Cd+2 + 2I-
log_k -3.5389
delta_h 13.82 kJ
Hg2I2
Hg2I2 = Hg2+2 + 2I-
log_k -28.34
delta_h 163 kJ

Coccinite
HgI2 + 2H2O = Hg(OH)2 + 2H+ + 2I-
log_k -34.9525
delta_h 210.72 kJ
HgI2:2NH3
HgI2:2NH3 + 2H2O = Hg(OH)2 + 2I- + 2NH4+
log_k -16.2293
delta_h 132.18 kJ
HgI2:6NH3
HgI2:6NH3 + 2H2O + 4H+ = Hg(OH)2 + 2I- + 6NH4+
log_k 33.7335
delta_h -90.3599 kJ
CuI
CuI = Cu+ + I-
log_k -12
delta_h 82.69 kJ
Iodyrite
AgI = Ag+ + I-
log_k -16.08
delta_h 110 kJ
(Co(NH3)6)I3
(Co(NH3)6)I3 + 6H+ = Co+3 + 6NH4+ + 3I-
log_k 16.5831
delta_h -9.6999 kJ
(Co(NH3)5Cl)I2
(Co(NH3)5Cl)I2 + 5H+ = Co+3 + 5NH4+ + Cl- + 2I-
log_k 5.5981
delta_h 0.66 kJ
CrI3
CrI3 + 2H2O = Cr(OH)2+ + 3I- + 2H+
log_k 20.4767
delta_h -134.419 kJ
Cerussite
PbCO3 = Pb+2 + CO3-2
log_k -13.13
delta_h 24.79 kJ
Pb2OCO3
Pb2OCO3 + 2H+ = 2Pb+2 + H2O + CO3-2
log_k -0.5578
delta_h -40.8199 kJ
Pb3O2CO3
Pb3O2CO3 + 4H+ = 3Pb+2 + CO3-2 + 2H2O
log_k 11.02
delta_h -110.583 kJ
Hydrocerussite
Pb3(OH)2(CO3)2 + 2H+ = 3Pb+2 + 2H2O + 2CO3-2
log_k -18.7705
delta_h -0 kJ
Pb10(OH)6O(CO3)6
Pb10(OH)6O(CO3)6 + 8H+ = 10Pb+2 + 6CO3-2 + 7H2O
log_k -8.76
delta_h -0 kJ
Tl2CO3
Tl2CO3 = 2Tl+ + CO3-2

log_k -3.8367
delta_h 35.49 kJ
Smithsonite
ZnCO3 = Zn+2 + CO3-2
log_k -10
delta_h -15.84 kJ
ZnCO3:1H2O
ZnCO3:1H2O = Zn+2 + CO3-2 + H2O
log_k -10.26
delta_h -0 kJ
Otavite
CdCO3 = Cd+2 + CO3-2
log_k -12
delta_h -0.55 kJ
Hg2CO3
Hg2CO3 = Hg2+2 + CO3-2
log_k -16.05
delta_h 45.14 kJ
Hg3O2CO3
Hg3O2CO3 + 4H2O = 3Hg(OH)2 + 2H+ + CO3-2
log_k -29.682
delta_h -0 kJ
CuCO3
CuCO3 = Cu+2 + CO3-2
log_k -11.5
delta_h -0 kJ
Malachite
Cu2(OH)2CO3 + 2H+ = 2Cu+2 + 2H2O + CO3-2
log_k -5.306
delta_h 76.38 kJ
Azurite
Cu3(OH)2(CO3)2 + 2H+ = 3Cu+2 + 2H2O + 2CO3-2
log_k -16.906
delta_h -95.22 kJ
Ag2CO3
Ag2CO3 = 2Ag+ + CO3-2
log_k -11.09
delta_h 42.15 kJ
NiCO3
NiCO3 = Ni+2 + CO3-2
log_k -6.87
delta_h -41.589 kJ
CoCO3
CoCO3 = Co+2 + CO3-2
log_k -9.98
delta_h -12.7612 kJ
Siderite
FeCO3 = Fe+2 + CO3-2
log_k -10.24
delta_h -16 kJ
Rhodochrosite
MnCO3 = Mn+2 + CO3-2
log_k -10.58
delta_h -1.88 kJ

Rutherfordine
UO2CO3 = UO2+2 + CO3-2
log_k -14.5
delta_h -3.03 kJ
Artinite
MgCO3:Mg(OH)2:3H2O + 2H+ = 2Mg+2 + CO3-2 + 5H2O
log_k 9.6
delta_h -120.257 kJ
Hydromagnesite
Mg5(CO3)4(OH)2:4H2O + 2H+ = 5Mg+2 + 4CO3-2 + 6H2O
log_k -8.766
delta_h -218.447 kJ
Magnesite
MgCO3 = Mg+2 + CO3-2
log_k -7.46
delta_h 20 kJ
Nesquehonite
MgCO3:3H2O = Mg+2 + CO3-2 + 3H2O
log_k -4.67
delta_h -24.2212 kJ
Aragonite
CaCO3 = Ca+2 + CO3-2
log_k -8.3
delta_h -12 kJ
Calcite
CaCO3 = Ca+2 + CO3-2
log_k -8.48
delta_h -8 kJ
Dolomite(ordered)
CaMg(CO3)2 = Ca+2 + Mg+2 + 2CO3-2
log_k -17.09
delta_h -39.5 kJ
Dolomite(disordered)
CaMg(CO3)2 = Ca+2 + Mg+2 + 2CO3-2
log_k -16.54
delta_h -46.4 kJ
Huntite
CaMg3(CO3)4 = 3Mg+2 + Ca+2 + 4CO3-2
log_k -29.968
delta_h -107.78 kJ
Strontianite
SrCO3 = Sr+2 + CO3-2
log_k -9.27
delta_h -0 kJ
Witherite
BaCO3 = Ba+2 + CO3-2
log_k -8.57
delta_h 4 kJ
Thermonatrite
Na2CO3:H2O = 2Na+ + CO3-2 + H2O
log_k 0.637
delta_h -10.4799 kJ
TlNO3
TlNO3 = Tl+ + NO3-

log_k -1.6127
delta_h 42.44 kJ
Zn(NO3)2:6H2O
Zn(NO3)2:6H2O = Zn+2 + 2NO3- + 6H2O
log_k 3.3153
delta_h 24.5698 kJ
Cu2(OH)3NO3
Cu2(OH)3NO3 + 3H+ = 2Cu+2 + 3H2O + NO3-
log_k 9.251
delta_h -72.5924 kJ
(Co(NH3)6)(NO3)3
(Co(NH3)6)(NO3)3 + 6H+ = Co+3 + 6NH4+ + 3NO3-
log_k 17.9343
delta_h 1.59 kJ
(Co(NH3)5Cl)(NO3)2
(Co(NH3)5Cl)(NO3)2 + 5H+ = Co+3 + 5NH4+ + Cl- + 2NO3-
log_k 6.2887
delta_h 6.4199 kJ
UO2(NO3)2
UO2(NO3)2 = UO2+2 + 2NO3-
log_k 12.1476
delta_h -83.3999 kJ
UO2(NO3)2:2H2O
UO2(NO3)2:2H2O = UO2+2 + 2NO3- + 2H2O
log_k 4.851
delta_h -25.355 kJ
UO2(NO3)2:3H2O
UO2(NO3)2:3H2O = UO2+2 + 2NO3- + 3H2O
log_k 3.39
delta_h -9.1599 kJ
UO2(NO3)2:6H2O
UO2(NO3)2:6H2O = UO2+2 + 2NO3- + 6H2O
log_k 2.0464
delta_h 20.8201 kJ
Pb(BO2)2
Pb(BO2)2 + 2H2O + 2H+ = Pb+2 + 2H3BO3
log_k 6.5192
delta_h -15.6119 kJ
Zn(BO2)2
Zn(BO2)2 + 2H2O + 2H+ = Zn+2 + 2H3BO3
log_k 8.29
delta_h -0 kJ
Cd(BO2)2
Cd(BO2)2 + 2H2O + 2H+ = Cd+2 + 2H3BO3
log_k 9.84
delta_h -0 kJ
Co(BO2)2
Co(BO2)2 + 2H2O + 2H+ = Co+2 + 2H3BO3
log_k 27.0703
delta_h -0 kJ
SnSO4
SnSO4 + 2H2O = Sn(OH)2 + 2H+ + SO4-2
log_k -56.9747
delta_h -0 kJ

Sn(SO4)2
Sn(SO4)2 + 6H2O = Sn(OH)6-2 + 6H+ + 2SO4-2
log_k -15.2123
delta_h -0 kJ
Larnakite
PbO:PbSO4 + 2H+ = 2Pb+2 + SO4-2 + H2O
log_k -0.4344
delta_h -21.83 kJ
Pb3O2SO4
Pb3O2SO4 + 4H+ = 3Pb+2 + SO4-2 + 2H2O
log_k 10.6864
delta_h -79.14 kJ
Pb4O3SO4
Pb4O3SO4 + 6H+ = 4Pb+2 + SO4-2 + 3H2O
log_k 21.8772
delta_h -136.45 kJ
Anglesite
PbSO4 = Pb+2 + SO4-2
log_k -7.79
delta_h 12 kJ
Pb4(OH)6SO4
Pb4(OH)6SO4 + 6H+ = 4Pb+2 + SO4-2 + 6H2O
log_k 21.1
delta_h -0 kJ
AlOHSO4
AlOHSO4 + H+ = Al+3 + SO4-2 + H2O
log_k -3.23
delta_h -0 kJ
Al4(OH)10SO4
Al4(OH)10SO4 + 10H+ = 4Al+3 + SO4-2 + 10H2O
log_k 22.7
delta_h -0 kJ
Tl2SO4
Tl2SO4 = 2Tl+ + SO4-2
log_k -3.7868
delta_h 33.1799 kJ
Zn2(OH)2SO4
Zn2(OH)2SO4 + 2H+ = 2Zn+2 + 2H2O + SO4-2
log_k 7.5
delta_h -0 kJ
Zn4(OH)6SO4
Zn4(OH)6SO4 + 6H+ = 4Zn+2 + 6H2O + SO4-2
log_k 28.4
delta_h -0 kJ
Zn3O(SO4)2
Zn3O(SO4)2 + 2H+ = 3Zn+2 + 2SO4-2 + H2O
log_k 18.9135
delta_h -258.08 kJ
Zincosite
ZnSO4 = Zn+2 + SO4-2
log_k 3.9297
delta_h -82.586 kJ
ZnSO4:1H2O
ZnSO4:1H2O = Zn+2 + SO4-2 + H2O

log_k -0.638
delta_h -44.0699 kJ
Bianchite
ZnSO4:6H2O = Zn+2 + SO4-2 + 6H2O
log_k -1.765
delta_h -0.6694 kJ
Goslarite
ZnSO4:7H2O = Zn+2 + SO4-2 + 7H2O
log_k -2.0112
delta_h 14.21 kJ
Cd3(OH)4SO4
Cd3(OH)4SO4 + 4H+ = 3Cd+2 + 4H2O + SO4-2
log_k 22.56
delta_h -0 kJ
Cd3(OH)2(SO4)2
Cd3(OH)2(SO4)2 + 2H+ = 3Cd+2 + 2H2O + 2SO4-2
log_k 6.71
delta_h -0 kJ
Cd4(OH)6SO4
Cd4(OH)6SO4 + 6H+ = 4Cd+2 + 6H2O + SO4-2
log_k 28.4
delta_h -0 kJ
CdSO4
CdSO4 = Cd+2 + SO4-2
log_k -0.1722
delta_h -51.98 kJ
CdSO4:1H2O
CdSO4:1H2O = Cd+2 + SO4-2 + H2O
log_k -1.7261
delta_h -31.5399 kJ
CdSO4:2.67H2O
CdSO4:2.67H2O = Cd+2 + SO4-2 + 2.67H2O
log_k -1.873
delta_h -17.9912 kJ
Hg2SO4
Hg2SO4 = Hg2+2 + SO4-2
log_k -6.13
delta_h 5.4 kJ
HgSO4
HgSO4 + 2H2O = Hg(OH)2 + SO4-2 + 2H+
log_k -9.4189
delta_h 14.6858 kJ
Cu2SO4
Cu2SO4 = 2Cu+ + SO4-2
log_k -1.95
delta_h -19.079 kJ
Antlerite
Cu3(OH)4SO4 + 4H+ = 3Cu+2 + 4H2O + SO4-2
log_k 8.788
delta_h -0 kJ
Brochantite
Cu4(OH)6SO4 + 6H+ = 4Cu+2 + 6H2O + SO4-2
log_k 15.222
delta_h -202.86 kJ

Langite
Cu4(OH)6SO4:H2O + 6H+ = 4Cu+2 + 7H2O + SO4-2
log_k 17.4886
delta_h -165.55 kJ
CuOCuSO4
CuOCuSO4 + 2H+ = 2Cu+2 + H2O + SO4-2
log_k 10.3032
delta_h -137.777 kJ
CuSO4
CuSO4 = Cu+2 + SO4-2
log_k 2.9395
delta_h -73.04 kJ
Chalcanthite
CuSO4:5H2O = Cu+2 + SO4-2 + 5H2O
log_k -2.64
delta_h 6.025 kJ
Ag2SO4
Ag2SO4 = 2Ag+ + SO4-2
log_k -4.82
delta_h 17 kJ
Ni4(OH)6SO4
Ni4(OH)6SO4 + 6H+ = 4Ni+2 + SO4-2 + 6H2O
log_k 32
delta_h -0 kJ
Retgersite
NiSO4:6H2O = Ni+2 + SO4-2 + 6H2O
log_k -2.04
delta_h 4.6024 kJ
Morenosite
NiSO4:7H2O = Ni+2 + SO4-2 + 7H2O
log_k -2.1449
delta_h 12.1802 kJ
CoSO4
CoSO4 = Co+2 + SO4-2
log_k 2.8024
delta_h -79.277 kJ
CoSO4:6H2O
CoSO4:6H2O = Co+2 + SO4-2 + 6H2O
log_k -2.4726
delta_h 1.0801 kJ
Melanterite
FeSO4:7H2O = Fe+2 + SO4-2 + 7H2O
log_k -2.209
delta_h 20.5 kJ
Fe2(SO4)3
Fe2(SO4)3 = 2Fe+3 + 3SO4-2
log_k -3.7343
delta_h -242.028 kJ
H-Jarosite
(H3O)Fe3(SO4)2(OH)6 + 5H+ = 3Fe+3 + 2SO4-2 + 7H2O
log_k -12.1
delta_h -230.748 kJ
Na-Jarosite
NaFe3(SO4)2(OH)6 + 6H+ = Na+ + 3Fe+3 + 2SO4-2 + 6H2O

log_k -11.2
delta_h -151.377 kJ
K-Jarosite
KFe3(SO4)2(OH)6 + 6H+ = K+ + 3Fe+3 + 2SO4-2 + 6H2O
log_k -14.8
delta_h -130.875 kJ
MnSO4
MnSO4 = Mn+2 + SO4-2
log_k 2.5831
delta_h -64.8401 kJ
Mn2(SO4)3
Mn2(SO4)3 = 2Mn+3 + 3SO4-2
log_k -5.711
delta_h -163.427 kJ
VOSO4
VOSO4 = VO+2 + SO4-2
log_k 3.6097
delta_h -86.7401 kJ
Epsomite
MgSO4:7H2O = Mg+2 + SO4-2 + 7H2O
log_k -2.1265
delta_h 11.5601 kJ
Anhydrite
CaSO4 = Ca+2 + SO4-2
log_k -4.36
delta_h -7.2 kJ
Gypsum
CaSO4:2H2O = Ca+2 + SO4-2 + 2H2O
log_k -4.61
delta_h 1 kJ
Celestite
SrSO4 = Sr+2 + SO4-2
log_k -6.62
delta_h 2 kJ
Barite
BaSO4 = Ba+2 + SO4-2
log_k -9.98
delta_h 23 kJ
Mirabilite
Na2SO4:10H2O = 2Na+ + SO4-2 + 10H2O
log_k -1.114
delta_h 79.4416 kJ
Thenardite
Na2SO4 = 2Na+ + SO4-2
log_k 0.3217
delta_h -9.121 kJ
K-Alum
KAl(SO4)2:12H2O = K+ + Al+3 + 2SO4-2 + 12H2O
log_k -5.17
delta_h 30.2085 kJ
Alunite
KAl3(SO4)2(OH)6 + 6H+ = K+ + 3Al+3 + 2SO4-2 + 6H2O
log_k -1.4
delta_h -210 kJ

(NH4)2CrO4
(NH4)2CrO4 = CrO4-2 + 2NH4+
log_k 0.4046
delta_h 9.163 kJ
PbCrO4
PbCrO4 = Pb+2 + CrO4-2
log_k -12.6
delta_h 44.18 kJ
Tl2CrO4
Tl2CrO4 = 2Tl+ + CrO4-2
log_k -12.01
delta_h 74.27 kJ
Hg2CrO4
Hg2CrO4 = Hg2+2 + CrO4-2
log_k -8.7
delta_h -0 kJ
CuCrO4
CuCrO4 = Cu+2 + CrO4-2
log_k -5.44
delta_h -0 kJ
Ag2CrO4
Ag2CrO4 = 2Ag+ + CrO4-2
log_k -11.59
delta_h 62 kJ
MgCrO4
MgCrO4 = CrO4-2 + Mg+2
log_k 5.3801
delta_h -88.9518 kJ
CaCrO4
CaCrO4 = Ca+2 + CrO4-2
log_k -2.2657
delta_h -26.945 kJ
SrCrO4
SrCrO4 = Sr+2 + CrO4-2
log_k -4.65
delta_h -10.1253 kJ
BaCrO4
BaCrO4 = Ba+2 + CrO4-2
log_k -9.67
delta_h 33 kJ
Li2CrO4
Li2CrO4 = CrO4-2 + 2Li+
log_k 4.8568
delta_h -45.2792 kJ
Na2CrO4
Na2CrO4 = CrO4-2 + 2Na+
log_k 2.9302
delta_h -19.6301 kJ
Na2Cr2O7
Na2Cr2O7 + H2O = 2CrO4-2 + 2Na+ + 2H+
log_k -9.8953
delta_h 22.1961 kJ
K2CrO4
K2CrO4 = CrO4-2 + 2K+

log_k -0.5134
delta_h 18.2699 kJ
K2Cr2O7
K2Cr2O7 + H2O = 2CrO4-2 + 2K+ + 2H+
log_k -17.2424
delta_h 80.7499 kJ
Hg2SeO3
Hg2SeO3 + H+ = Hg2+2 + HSeO3-
log_k -4.657
delta_h -0 kJ
HgSeO3
HgSeO3 + 2H2O = Hg(OH)2 + H+ + HSeO3-
log_k -12.43
delta_h -0 kJ
Ag2SeO3
Ag2SeO3 + H+ = 2Ag+ + HSeO3-
log_k -7.15
delta_h 39.68 kJ
CuSeO3:2H2O
CuSeO3:2H2O + H+ = Cu+2 + HSeO3- + 2H2O
log_k 0.5116
delta_h -36.861 kJ
NiSeO3:2H2O
NiSeO3:2H2O + H+ = HSeO3- + Ni+2 + 2H2O
log_k 2.8147
delta_h -31.0034 kJ
CoSeO3
CoSeO3 + H+ = Co+2 + HSeO3-
log_k 1.32
delta_h -0 kJ
Fe2(SeO3)3:2H2O
Fe2(SeO3)3:2H2O + 3H+ = 3HSeO3- + 2Fe+3 + 2H2O
log_k -20.6262
delta_h -0 kJ
Fe2(OH)4SeO3
Fe2(OH)4SeO3 + 5H+ = HSeO3- + 2Fe+3 + 4H2O
log_k 1.5539
delta_h -0 kJ
MnSeO3
MnSeO3 + H+ = Mn+2 + HSeO3-
log_k 1.13
delta_h -0 kJ
MnSeO3:2H2O
MnSeO3:2H2O + H+ = HSeO3- + Mn+2 + 2H2O
log_k 0.9822
delta_h 8.4935 kJ
MgSeO3:6H2O
MgSeO3:6H2O + H+ = Mg+2 + HSeO3- + 6H2O
log_k 3.0554
delta_h 5.23 kJ
CaSeO3:2H2O
CaSeO3:2H2O + H+ = HSeO3- + Ca+2 + 2H2O
log_k 2.8139
delta_h -19.4556 kJ

SrSeO3
SrSeO3 + H+ = Sr+2 + HSeO3-
log_k 2.3
delta_h -0 kJ
BaSeO3
BaSeO3 + H+ = Ba+2 + HSeO3-
log_k 1.83
delta_h 11.98 kJ
Na2SeO3:5H2O
Na2SeO3:5H2O + H+ = 2Na+ + HSeO3- + 5H2O
log_k 10.3
delta_h -0 kJ
PbSeO4
PbSeO4 = Pb+2 + SeO4-2
log_k -6.84
delta_h 15 kJ
Tl2SeO4
Tl2SeO4 = 2Tl+ + SeO4-2
log_k -4.1
delta_h 43 kJ
ZnSeO4:6H2O
ZnSeO4:6H2O = Zn+2 + SeO4-2 + 6H2O
log_k -1.52
delta_h -0 kJ
CdSeO4:2H2O
CdSeO4:2H2O = Cd+2 + SeO4-2 + 2H2O
log_k -1.85
delta_h -0 kJ
Ag2SeO4
Ag2SeO4 = 2Ag+ + SeO4-2
log_k -8.91
delta_h -43.5 kJ
CuSeO4:5H2O
CuSeO4:5H2O = Cu+2 + SeO4-2 + 5H2O
log_k -2.44
delta_h -0 kJ
NiSeO4:6H2O
NiSeO4:6H2O = Ni+2 + SeO4-2 + 6H2O
log_k -1.52
delta_h -0 kJ
CoSeO4:6H2O
CoSeO4:6H2O = Co+2 + SeO4-2 + 6H2O
log_k -1.53
delta_h -0 kJ
MnSeO4:5H2O
MnSeO4:5H2O = Mn+2 + SeO4-2 + 5H2O
log_k -2.05
delta_h -0 kJ
UO2SeO4:4H2O
UO2SeO4:4H2O = UO2+2 + SeO4-2 + 4H2O
log_k -2.25
delta_h -0 kJ
MgSeO4:6H2O
MgSeO4:6H2O = Mg+2 + SeO4-2 + 6H2O

log_k -1.2
delta_h -0 kJ
CaSeO4:2H2O
CaSeO4:2H2O = Ca+2 + SeO4-2 + 2H2O
log_k -3.02
delta_h -8.3 kJ
SrSeO4
SrSeO4 = Sr+2 + SeO4-2
log_k -4.4
delta_h 0.4 kJ
BaSeO4
BaSeO4 = Ba+2 + SeO4-2
log_k -7.46
delta_h 22 kJ
BeSeO4:4H2O
BeSeO4:4H2O = Be+2 + SeO4-2 + 4H2O
log_k -2.94
delta_h -0 kJ
Na2SeO4
Na2SeO4 = 2Na+ + SeO4-2
log_k 1.28
delta_h -0 kJ
K2SeO4
K2SeO4 = 2K+ + SeO4-2
log_k -0.73
delta_h -0 kJ
(NH4)2SeO4
(NH4)2SeO4 = 2NH4+ + SeO4-2
log_k 0.45
delta_h -0 kJ
H2MoO4
H2MoO4 = MoO4-2 + 2H+
log_k -12.8765
delta_h 49 kJ
PbMoO4
PbMoO4 = Pb+2 + MoO4-2
log_k -15.62
delta_h 53.93 kJ
Al2(MoO4)3
Al2(MoO4)3 = 3MoO4-2 + 2Al+3
log_k 2.3675
delta_h -260.8 kJ
Tl2MoO4
Tl2MoO4 = MoO4-2 + 2Tl+
log_k -7.9887
delta_h -0 kJ
ZnMoO4
ZnMoO4 = MoO4-2 + Zn+2
log_k -10.1254
delta_h -10.6901 kJ
CdMoO4
CdMoO4 = MoO4-2 + Cd+2
log_k -14.1497
delta_h 19.48 kJ

CuMoO4
CuMoO4 = MoO4-2 + Cu+2
log_k -13.0762
delta_h 12.2 kJ
Ag2MoO4
Ag2MoO4 = 2Ag+ + MoO4-2
log_k -11.55
delta_h 52.7 kJ
NiMoO4
NiMoO4 = MoO4-2 + Ni+2
log_k -11.1421
delta_h 1.3 kJ
CoMoO4
CoMoO4 = MoO4-2 + Co+2
log_k -7.7609
delta_h -23.3999 kJ
FeMoO4
FeMoO4 = MoO4-2 + Fe+2
log_k -10.091
delta_h -11.1 kJ
BeMoO4
BeMoO4 = MoO4-2 + Be+2
log_k -1.7817
delta_h -56.4 kJ
MgMoO4
MgMoO4 = Mg+2 + MoO4-2
log_k -1.85
delta_h -0 kJ
CaMoO4
CaMoO4 = Ca+2 + MoO4-2
log_k -7.95
delta_h -2 kJ
BaMoO4
BaMoO4 = MoO4-2 + Ba+2
log_k -6.9603
delta_h 10.96 kJ
Li2MoO4
Li2MoO4 = MoO4-2 + 2Li+
log_k 2.4416
delta_h -33.9399 kJ
Na2MoO4
Na2MoO4 = MoO4-2 + 2Na+
log_k 1.4901
delta_h -9.98 kJ
Na2MoO4:2H2O
Na2MoO4:2H2O = MoO4-2 + 2Na+ + 2H2O
log_k 1.224
delta_h -0 kJ
Na2Mo2O7
Na2Mo2O7 + H2O = 2MoO4-2 + 2Na+ + 2H+
log_k -16.5966
delta_h 56.2502 kJ
K2MoO4
K2MoO4 = MoO4-2 + 2K+

log_k 3.2619
delta_h -3.38 kJ
PbHPO4
PbHPO4 = Pb+2 + H+ + PO4-3
log_k -23.805
delta_h -0 kJ
Pb3(PO4)2
Pb3(PO4)2 = 3Pb+2 + 2PO4-3
log_k -43.53
delta_h -0 kJ
Pyromorphite
Pb5(PO4)3Cl = 5Pb+2 + 3PO4-3 + Cl-
log_k -84.43
delta_h -0 kJ
Hydroxylpyromorphite
Pb5(PO4)3OH + H+ = 5Pb+2 + 3PO4-3 + H2O
log_k -62.79
delta_h -0 kJ
Plumbgummite
PbAl3(PO4)2(OH)5:H2O + 5H+ = Pb+2 + 3Al+3 + 2PO4-3 + 6H2O
log_k -32.79
delta_h -0 kJ
Hinsdalite
PbAl3PO4SO4(OH)6 + 6H+ = Pb+2 + 3Al+3 + PO4-3 + SO4-2 + 6H2O
log_k -2.5
delta_h -0 kJ
Tsumebite
Pb2CuPO4(OH)3:3H2O + 3H+ = 2Pb+2 + Cu+2 + PO4-3 + 6H2O
log_k -9.79
delta_h -0 kJ
Zn3(PO4)2:4H2O
Zn3(PO4)2:4H2O = 3Zn+2 + 2PO4-3 + 4H2O
log_k -35.42
delta_h -0 kJ
Cd3(PO4)2
Cd3(PO4)2 = 3Cd+2 + 2PO4-3
log_k -32.6
delta_h -0 kJ
Hg2HPO4
Hg2HPO4 = Hg2+2 + H+ + PO4-3
log_k -24.775
delta_h -0 kJ
Cu3(PO4)2
Cu3(PO4)2 = 3Cu+2 + 2PO4-3
log_k -36.85
delta_h -0 kJ
Cu3(PO4)2:3H2O
Cu3(PO4)2:3H2O = 3Cu+2 + 2PO4-3 + 3H2O
log_k -35.12
delta_h -0 kJ
Ag3PO4
Ag3PO4 = 3Ag+ + PO4-3
log_k -17.59
delta_h -0 kJ

Ni3(PO4)2
Ni3(PO4)2 = 3Ni+2 + 2PO4-3
log_k -31.3
delta_h -0 kJ
CoHPO4
CoHPO4 = Co+2 + PO4-3 + H+
log_k -19.0607
delta_h -0 kJ
Co3(PO4)2
Co3(PO4)2 = 3Co+2 + 2PO4-3
log_k -34.6877
delta_h -0 kJ
Vivianite
Fe3(PO4)2:8H2O = 3Fe+2 + 2PO4-3 + 8H2O
log_k -36
delta_h -0 kJ
Strengite
FePO4:2H2O = Fe+3 + PO4-3 + 2H2O
log_k -26.4
delta_h -9.3601 kJ
Mn3(PO4)2
Mn3(PO4)2 = 3Mn+2 + 2PO4-3
log_k -23.827
delta_h 8.8701 kJ
MnHPO4
MnHPO4 = Mn+2 + PO4-3 + H+
log_k -25.4
delta_h -0 kJ
(VO)3(PO4)2
(VO)3(PO4)2 = 3VO+2 + 2PO4-3
log_k -25.1
delta_h -0 kJ
Mg3(PO4)2
Mg3(PO4)2 = 3Mg+2 + 2PO4-3
log_k -23.28
delta_h -0 kJ
MgHPO4:3H2O
MgHPO4:3H2O = Mg+2 + H+ + PO4-3 + 3H2O
log_k -18.175
delta_h -0 kJ
FCO3Apatite
Ca9.316Na0.36Mg0.144(PO4)4.8(CO3)1.2F2.48 = 9.316Ca+2 + 0.36Na+ + 0.144Mg+2 + 4.8PO4-3 + 1.2CO3-2 + 2.48F-
log_k -114.4
delta_h 164.808 kJ
Hydroxylapatite
Ca5(PO4)3OH + H+ = 5Ca+2 + 3PO4-3 + H2O
log_k -44.333
delta_h -0 kJ
CaHPO4:2H2O
CaHPO4:2H2O = Ca+2 + H+ + PO4-3 + 2H2O
log_k -18.995
delta_h 23 kJ
CaHPO4

CaHPO4 = Ca+2 + H+ + PO4-3
log_k -19.275
delta_h 31 kJ
Ca3(PO4)2(beta)
Ca3(PO4)2 = 3Ca+2 + 2PO4-3
log_k -28.92
delta_h 54 kJ
Ca4H(PO4)3:3H2O
Ca4H(PO4)3:3H2O = 4Ca+2 + H+ + 3PO4-3 + 3H2O
log_k -47.08
delta_h -0 kJ
SrHPO4
SrHPO4 = Sr+2 + H+ + PO4-3
log_k -19.295
delta_h -0 kJ
BaHPO4
BaHPO4 = Ba+2 + H+ + PO4-3
log_k -19.775
delta_h -0 kJ
U(HPO4)2:4H2O
U(HPO4)2:4H2O = U+4 + 2PO4-3 + 2H+ + 4H2O
log_k -51.584
delta_h 16.0666 kJ
(UO2)3(PO4)2
(UO2)3(PO4)2 = 3UO2+2 + 2PO4-3
log_k -49.4
delta_h 397.062 kJ
UO2HPO4
UO2HPO4 = UO2+2 + H+ + PO4-3
log_k -24.225
delta_h -0 kJ
Uramphite
(NH4)2(UO2)2(PO4)2 = 2UO2+2 + 2NH4+ + 2PO4-3
log_k -51.749
delta_h 40.5848 kJ
Przhevalskite
Pb(UO2)2(PO4)2 = 2UO2+2 + Pb+2 + 2PO4-3
log_k -44.365
delta_h -46.024 kJ
Torbernite
Cu(UO2)2(PO4)2 = 2UO2+2 + Cu+2 + 2PO4-3
log_k -45.279
delta_h -66.5256 kJ
Bassetite
Fe(UO2)2(PO4)2 = 2UO2+2 + Fe+2 + 2PO4-3
log_k -44.485
delta_h -83.2616 kJ
Saleeite
Mg(UO2)2(PO4)2 = 2UO2+2 + Mg+2 + 2PO4-3
log_k -43.646
delta_h -84.4331 kJ
Ningyoite
CaU(PO4)2:2H2O = U+4 + Ca+2 + 2PO4-3 + 2H2O
log_k -53.906

delta_h -9.4977 kJ
H-Autunite
H2(UO2)2(PO4)2 = 2UO2+2 + 2H+ + 2PO4-3
log_k -47.931
delta_h -15.0624 kJ
Autunite
Ca(UO2)2(PO4)2 = 2UO2+2 + Ca+2 + 2PO4-3
log_k -43.927
delta_h -59.9986 kJ
Sr-Autunite
Sr(UO2)2(PO4)2 = 2UO2+2 + Sr+2 + 2PO4-3
log_k -44.457
delta_h -54.6012 kJ
Na-Autunite
Na2(UO2)2(PO4)2 = 2UO2+2 + 2Na+ + 2PO4-3
log_k -47.409
delta_h -1.9246 kJ
K-Autunite
K2(UO2)2(PO4)2 = 2UO2+2 + 2K+ + 2PO4-3
log_k -48.244
delta_h 24.5182 kJ
Uranocircite
Ba(UO2)2(PO4)2 = 2UO2+2 + Ba+2 + 2PO4-3
log_k -44.631
delta_h -42.2584 kJ
Pb3(AsO4)2
Pb3(AsO4)2 + 6H+ = 3Pb+2 + 2H3AsO4
log_k 5.8
delta_h -0 kJ
AlAsO4:2H2O
AlAsO4:2H2O + 3H+ = Al+3 + H3AsO4 + 2H2O
log_k 4.8
delta_h -0 kJ
Zn3(AsO4)2:2.5H2O
Zn3(AsO4)2:2.5H2O + 6H+ = 3Zn+2 + 2H3AsO4 + 2.5H2O
log_k 13.65
delta_h -0 kJ
Cu3(AsO4)2:2H2O
Cu3(AsO4)2:2H2O + 6H+ = 3Cu+2 + 2H3AsO4 + 2H2O
log_k 6.1
delta_h -0 kJ
Ag3AsO3
Ag3AsO3 + 3H+ = 3Ag+ + H3AsO3
log_k 2.1573
delta_h -0 kJ
Ag3AsO4
Ag3AsO4 + 3H+ = 3Ag+ + H3AsO4
log_k -2.7867
delta_h -0 kJ
Ni3(AsO4)2:8H2O
Ni3(AsO4)2:8H2O + 6H+ = 3Ni+2 + 2H3AsO4 + 8H2O
log_k 15.7
delta_h -0 kJ
Co3(AsO4)2

Co3(AsO4)2 + 6H+ = 3Co+2 + 2H3AsO4
log_k 13.0341
delta_h -0 kJ
FeAsO4:2H2O
FeAsO4:2H2O + 3H+ = Fe+3 + H3AsO4 + 2H2O
log_k 0.4
delta_h -0 kJ
Mn3(AsO4)2:8H2O
Mn3(AsO4)2:8H2O + 6H+ = 3Mn+2 + 2H3AsO4 + 8H2O
log_k 12.5
delta_h -0 kJ
Ca3(AsO4)2:4H2O
Ca3(AsO4)2:4H2O + 6H+ = 3Ca+2 + 2H3AsO4 + 4H2O
log_k 22.3
delta_h -0 kJ
Ba3(AsO4)2
Ba3(AsO4)2 + 6H+ = 3Ba+2 + 2H3AsO4
log_k -8.91
delta_h 11.0458 kJ
#NH4VO3
NH4VO3 + 2H+ = 2VO2+ + H2O
log_k 3.8
delta_h 30 kJ
Pb3(VO4)2
Pb3(VO4)2 + 8H+ = 3Pb+2 + 2VO2+ + 4H2O
log_k 6.14
delta_h -72.6342 kJ
Pb2V2O7
Pb2V2O7 + 6H+ = 2Pb+2 + 2VO2+ + 3H2O
log_k -1.9
delta_h -26.945 kJ
AgVO3
AgVO3 + 2H+ = Ag+ + VO2+ + H2O
log_k 0.77
delta_h -0 kJ
Ag2HVO4
Ag2HVO4 + 3H+ = 2Ag+ + VO2+ + 2H2O
log_k 1.48
delta_h -0 kJ
Ag3H2VO5
Ag3H2VO5 + 4H+ = 3Ag+ + VO2+ + 3H2O
log_k 5.18
delta_h -0 kJ
Fe(VO3)2
Fe(VO3)2 + 4H+ = Fe+2 + 2VO2+ + 2H2O
log_k -3.72
delta_h -61.6722 kJ
Mn(VO3)2
Mn(VO3)2 + 4H+ = Mn+2 + 2VO2+ + 2H2O
log_k 4.9
delta_h -92.4664 kJ
Mg(VO3)2
Mg(VO3)2 + 4H+ = Mg+2 + 2VO2+ + 2H2O
log_k 11.28

delta_h -136.649 kJ
Mg2V2O7
Mg2V2O7 + 6H+ = 2Mg+2 + 2VO2+ + 3H2O
log_k 26.36
delta_h -255.224 kJ
Carnotite
KUO2VO4 + 4H+ = K+ + UO2+2 + VO2+ + 2H2O
log_k 0.23
delta_h -36.4008 kJ
Tyuyamunite
Ca(UO2)2(VO4)2 + 8H+ = Ca+2 + 2UO2+2 + 2VO2+ + 4H2O
log_k 4.08
delta_h -153.134 kJ
Ca(VO3)2
Ca(VO3)2 + 4H+ = Ca+2 + 2VO2+ + 2H2O
log_k 5.66
delta_h -84.7678 kJ
Ca3(VO4)2
Ca3(VO4)2 + 8H+ = 3Ca+2 + 2VO2+ + 4H2O
log_k 38.96
delta_h -293.466 kJ
Ca2V2O7
Ca2V2O7 + 6H+ = 2Ca+2 + 2VO2+ + 3H2O
log_k 17.5
delta_h -159.494 kJ
Ca3(VO4)2:4H2O
Ca3(VO4)2:4H2O + 8H+ = 3Ca+2 + 2VO2+ + 8H2O
log_k 39.86
delta_h -0 kJ
Ca2V2O7:2H2O
Ca2V2O7:2H2O + 6H+ = 2Ca+2 + 2VO2+ + 5H2O
log_k 21.552
delta_h -0 kJ
Ba3(VO4)2:4H2O
Ba3(VO4)2:4H2O + 8H+ = 3Ba+2 + 2VO2+ + 8H2O
log_k 32.94
delta_h -0 kJ
Ba2V2O7:2H2O
Ba2V2O7:2H2O + 6H+ = 2Ba+2 + 2VO2+ + 5H2O
log_k 15.872
delta_h -0 kJ
NaVO3
NaVO3 + 2H+ = Na+ + VO2+ + H2O
log_k 3.8582
delta_h -30.1799 kJ
Na3VO4
Na3VO4 + 4H+ = 3Na+ + VO2+ + 2H2O
log_k 36.6812
delta_h -184.61 kJ
Na4V2O7
Na4V2O7 + 6H+ = 4Na+ + 2VO2+ + 3H2O
log_k 37.4
delta_h -201.083 kJ
Halloysite

Al2Si2O5(OH)4 + 6H+ = 2Al+3 + 2H4SiO4 + H2O
log_k 9.5749
delta_h -181.43 kJ
Kaolinite
Al2Si2O5(OH)4 + 6H+ = 2Al+3 + 2H4SiO4 + H2O
log_k 7.435
delta_h -148 kJ
Greenalite
Fe3Si2O5(OH)4 + 6H+ = 3Fe+2 + 2H4SiO4 + H2O
log_k 20.81
delta_h -0 kJ
Chrysotile
Mg3Si2O5(OH)4 + 6H+ = 3Mg+2 + 2H4SiO4 + H2O
log_k 32.2
delta_h -196 kJ
Sepiolite
Mg2Si3O7.5OH:3H2O + 4H+ + 0.5H2O = 2Mg+2 + 3H4SiO4
log_k 15.76
delta_h -114.089 kJ
Sepiolite(A)
Mg2Si3O7.5OH:3H2O + 0.5H2O + 4H+ = 2Mg+2 + 3H4SiO4
log_k 18.78
delta_h -0 kJ
PHASES
O2(g)
O2 + 4H+ + 4e- = 2H2O
log_k 83.0894
delta_h -571.66 kJ
CH4(g)
CH4 + 3H2O = CO3-2 + 8e- + 10H+
log_k -41.0452
delta_h 257.133 kJ
CO2(g)
CO2 + H2O = 2H+ + CO3-2
log_k -18.147
delta_h 4.06 kJ
H2S(g)
H2S = H+ + HS-
log_k -8.01
delta_h -0 kJ
H2Se(g)
H2Se = HSe- + H+
log_k -4.96
delta_h -15.3 kJ
Hg(g)
Hg = 0.5Hg2+2 + e-
log_k -7.8733
delta_h 22.055 kJ
Hg2(g)
Hg2 = Hg2+2 + 2e-
log_k -14.9554
delta_h 58.07 kJ
Hg(CH3)2(g)
Hg(CH3)2 + 8H2O = Hg(OH)2 + 2CO3-2 + 16e- + 20H+

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log_k -73.7066
delta_h 481.99 kJ
HgF(g)
HgF = 0.5Hg2+2 + F-
log_k 32.6756
delta_h -254.844 kJ
HgF2(g)
HgF2 + 2H2O = Hg(OH)2 + 2F- + 2H+
log_k 12.5652
delta_h -165.186 kJ
HgCl(g)
HgCl = 0.5Hg2+2 + Cl-
log_k 19.4966
delta_h -162.095 kJ
HgBr(g)
HgBr = 0.5Hg2+2 + Br-
log_k 16.7566
delta_h -142.157 kJ
HgBr2(g)
HgBr2 + 2H2O = Hg(OH)2 + 2Br- + 2H+
log_k -18.3881
delta_h 54.494 kJ
HgI(g)
HgI = 0.5Hg2+2 + I-
log_k 11.3322
delta_h -106.815 kJ
HgI2(g)
HgI2 + 2H2O = Hg(OH)2 + 2I- + 2H+
log_k -27.2259
delta_h 114.429 kJ
SURFACE_MASTER_SPECIES
Hfo_s Hfo_sOH
Hfo_w Hfo_wOH
Hao_ Hao_OH #hydrous aluminum oxides - gibbsite
SURFACE_SPECIES
Hfo_wOH = Hfo_wOH
log_k 0.0
Hfo_sOH = Hfo_sOH
log_k 0.0
Hao_OH = Hao_OH
log_k 0.0

Hfo_sOH + H+ = Hfo_sOH2+
log_k 7.29
delta_h 0 kJ
# Id: 8113302
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH = Hfo_sO- + H+
log_k -8.93
delta_h 0 kJ
# Id: 8113301
# log K source:
```

```
# Delta H source:
#T and ionic strength:
Hfo_wOH + H+ = Hfo_wOH2+
log_k 7.29
delta_h 0 kJ
# Id: 8123302
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH = Hfo_wO- + H+
log_k -8.93
delta_h 0 kJ
# Id: 8123301
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Ba+2 = Hfo_sOHBa+2
log_k 5.46
delta_h 0 kJ
# Id: 8111000
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Ba+2 = Hfo_wOBa+ + H+
log_k -7.2
delta_h 0 kJ
# Id: 8121000
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Ca+2 = Hfo_sOHCa+2
log_k 4.97
delta_h 0 kJ
# Id: 8111500
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Ca+2 = Hfo_wOCa+ + H+
log_k -5.85
delta_h 0 kJ
# Id: 8121500
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Mg+2 = Hfo_wOMg+ + H+
log_k -4.6
delta_h 0 kJ
# Id: 8124600
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Ag+ = Hfo_sOAg + H+
log_k -1.72
delta_h 0 kJ
```

```
# Id: 8110200
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Ag+ = Hfo_wOAg + H+
log_k -5.3
delta_h 0 kJ
# Id: 8120200
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Ni+2 = Hfo_sONi+ + H+
log_k 0.37
delta_h 0 kJ
# Id: 8115400
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Ni+2 = Hfo_wONi+ + H+
log_k -2.5
delta_h 0 kJ
# Id: 8125400
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Cd+2 = Hfo_sOCd+ + H+
log_k 0.47
delta_h 0 kJ
# Id: 8111600
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Cd+2 = Hfo_wOCd+ + H+
log_k -2.9
delta_h 0 kJ
# Id: 8121600
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Co+2 = Hfo_sOCo+ + H+
log_k -0.46
delta_h 0 kJ
# Id: 8112000
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Co+2 = Hfo_wOCo+ + H+
log_k -3.01
delta_h 0 kJ
# Id: 8122000
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Zn+2 = Hfo_sOZn+ + H+
```

```
log_k 0.99
delta_h 0 kJ
# Id: 8119500
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Zn+2 = Hfo_wOZn+ + H+
log_k -1.99
delta_h 0 kJ
# Id: 8129500
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Cu+2 = Hfo_sOCu+ + H+
log_k 2.89
delta_h 0 kJ
# Id: 8112310
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Cu+2 = Hfo_wOCu+ + H+
log_k 0.6
delta_h 0 kJ
# Id: 8123100
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Pb+2 = Hfo_sOPb+ + H+
log_k 4.65
delta_h 0 kJ
# Id: 8116000
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Pb+2 = Hfo_wOPb+ + H+
log_k 0.3
delta_h 0 kJ
# Id: 8126000
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Be+2 = Hfo_sOBe+ + H+
log_k 5.7
delta_h 0 kJ
# Id: 8111100
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Be+2 = Hfo_wOBe+ + H+
log_k 3.3
delta_h 0 kJ
# Id: 8121100
# log K source:
# Delta H source:
```

#T and ionic strength:
Hfo_sOH + Hg(OH)2 + H+ = Hfo_sOHg+ + 2H2O
log_k 13.95
delta_h 0 kJ
Id: 8113610
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Hg(OH)2 + H+ = Hfo_wOHg+ + 2H2O
log_k 12.64
delta_h 0 kJ
Id: 8123610
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Sn(OH)2 + H+ = Hfo_sOSn+ + 2H2O
log_k 15.1
delta_h 0 kJ
Id: 8117900
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Sn(OH)2 + H+ = Hfo_wOSn+ + 2H2O
log_k 13
delta_h 0 kJ
Id: 8127900
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Cr(OH)2+ = Hfo_sOCrOH+ + H2O
log_k 11.63
delta_h 0 kJ
Id: 8112110
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO3 = Hfo_sH2AsO3 + H2O
log_k 5.41
delta_h 0 kJ
Id: 8110600
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO3 = Hfo_wH2AsO3 + H2O
log_k 5.41
delta_h 0 kJ
Id: 8120600
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + H3BO3 = Hfo_sH2BO3 + H2O
log_k 0.62
delta_h 0 kJ
Id: 8110900

```
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + H3BO3 = Hfo_wH2BO3 + H2O
log_k 0.62
delta_h 0 kJ
# Id: 8120900
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + PO4-3 + 3H+ = Hfo_sH2PO4 + H2O
log_k 31.29
delta_h 0 kJ
# Id: 8115800
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + PO4-3 + 3H+ = Hfo_wH2PO4 + H2O
log_k 31.29
delta_h 0 kJ
# Id: 8125800
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + PO4-3 + 2H+ = Hfo_sHPO4- + H2O
log_k 25.39
delta_h 0 kJ
# Id: 8115801
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + PO4-3 + 2H+ = Hfo_wHPO4- + H2O
log_k 25.39
delta_h 0 kJ
# Id: 8125801
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + PO4-3 + H+ = Hfo_sPO4-2 + H2O
log_k 17.72
delta_h 0 kJ
# Id: 8115802
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + PO4-3 + H+ = Hfo_wPO4-2 + H2O
log_k 17.72
delta_h 0 kJ
# Id: 8125802
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO4 = Hfo_sH2AsO4 + H2O
log_k 8.61
```

```
delta_h 0 kJ
# Id: 8110610
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO4 = Hfo_wH2AsO4 + H2O
log_k 8.61
delta_h 0 kJ
# Id: 8120610
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO4 = Hfo_sHAsO4- + H2O + H+
log_k 2.81
delta_h 0 kJ
# Id: 8110611
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO4 = Hfo_wHAsO4- + H2O + H+
log_k 2.81
delta_h 0 kJ
# Id: 8120611
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + H3AsO4 = Hfo_sOHAsO4-3 + 3H+
log_k -10.12
delta_h 0 kJ
# Id: 8110613
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + H3AsO4 = Hfo_wOHAsO4-3 + 3H+
log_k -10.12
delta_h 0 kJ
# Id: 8120613
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + VO2+ + 2H2O = Hfo_sOHVO4-3 + 4H+
log_k -16.63
delta_h 0 kJ
# Id: 8119031
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + VO2+ + 2H2O = Hfo_wOHVO4-3 + 4H+
log_k -16.63
delta_h 0 kJ
# Id: 8129031
# log K source:
# Delta H source:
#T and ionic strength:
```

Hfo_sOH + SO4-2 + H+ = Hfo_sSO4- + H2O
log_k 7.78
delta_h 0 kJ
Id: 8117320
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + SO4-2 + H+ = Hfo_wSO4- + H2O
log_k 7.78
delta_h 0 kJ
Id: 8127320
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + SO4-2 = Hfo_sOHSO4-2
log_k 0.79
delta_h 0 kJ
Id: 8117321
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + SO4-2 = Hfo_wOHSO4-2
log_k 0.79
delta_h 0 kJ
Id: 8127321
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + HSeO3- = Hfo_sSeO3- + H2O
log_k 4.29
delta_h 0 kJ
Id: 8117610
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + HSeO3- = Hfo_wSeO3- + H2O
log_k 4.29
delta_h 0 kJ
Id: 8127610
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + HSeO3- = Hfo_sOHSeO3-2 + H+
log_k -3.23
delta_h 0 kJ
Id: 8117611
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + HSeO3- = Hfo_wOHSeO3-2 + H+
log_k -3.23
delta_h 0 kJ
Id: 8127611
log K source:

```
# Delta H source:
#T and ionic strength:
Hfo_sOH + SeO4-2 + H+ = Hfo_sSeO4- + H2O
log_k 7.73
delta_h 0 kJ
# Id: 8117620
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + SeO4-2 + H+ = Hfo_wSeO4- + H2O
log_k 7.73
delta_h 0 kJ
# Id: 8127620
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + SeO4-2 = Hfo_sOHSeO4-2
log_k 0.8
delta_h 0 kJ
# Id: 8117621
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + SeO4-2 = Hfo_wOHSeO4-2
log_k 0.8
delta_h 0 kJ
# Id: 8127621
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + CrO4-2 + H+ = Hfo_sCrO4- + H2O
log_k 10.85
delta_h 0 kJ
# Id: 8112120
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + CrO4-2 + H+ = Hfo_wCrO4- + H2O
log_k 10.85
delta_h 0 kJ
# Id: 8122120
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + CrO4-2 = Hfo_sOHCrO4-2
log_k 3.9
delta_h 0 kJ
# Id: 8112121
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + CrO4-2 = Hfo_wOHCrO4-2
log_k 3.9
delta_h 0 kJ
```

Id: 8122121
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + MoO4-2 + H+ = Hfo_sMoO4- + H2O
log_k 9.5
delta_h 0 kJ
Id: 8114800
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + MoO4-2 + H+ = Hfo_wMoO4- + H2O
log_k 9.5
delta_h 0 kJ
Id: 8124800
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + MoO4-2 = Hfo_sOHMoO4-2
log_k 2.4
delta_h 0 kJ
Id: 8114801
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + MoO4-2 = Hfo_wOHMoO4-2
log_k 2.4
delta_h 0 kJ
Id: 8124801
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Sb(OH)6- + H+ = Hfo_sSbO(OH)4 + 2H2O
log_k 8.4
delta_h 0 kJ
Id: 8117410
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Sb(OH)6- + H+ = Hfo_wSbO(OH)4 + 2H2O
log_k 8.4
delta_h 0 kJ
Id: 8127410
log K source:
Delta H source:
#T and ionic strength:
Hfo_sOH + Sb(OH)6- = Hfo_sOHSbO(OH)4- + H2O
log_k 1.3
delta_h 0 kJ
Id: 8117411
log K source:
Delta H source:
#T and ionic strength:
Hfo_wOH + Sb(OH)6- = Hfo_wOHSbO(OH)4- + H2O

```
log_k 1.3
delta_h 0 kJ
# Id: 8127411
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Cyanide- + H+ = Hfo_sCyanide + H2O
log_k 13
delta_h 0 kJ
# Id: 8111430
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Cyanide- + H+ = Hfo_wCyanide + H2O
log_k 13
delta_h 0 kJ
# Id: 8121430
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_sOH + Cyanide- = Hfo_sOHCyanide-
log_k 5.7
delta_h 0 kJ
# Id: 8111431
# log K source:
# Delta H source:
#T and ionic strength:
Hfo_wOH + Cyanide- = Hfo_wOHCyanide-
log_k 5.7
delta_h 0 kJ
# Id: 8121431
# log K source:
# Delta H source:
#T and ionic strength:
#Additions from GWB Minteq
Hfo_wOH + H4SiO4 = Hfo_wOSi(OH)3 + H2O
log_k 4.28
delta_h 0 kJ
Hfo_wOH + H4SiO4 = Hfo_wOSiO(OH)2- + H+ + H2O
log_k -3.22
delta_h 0 kJ
Hfo_sOH + H4SiO4 = Hfo_sOSi(OH)3 + H2O
log_k 4.28
delta_h 0
Hfo_sOH + H4SiO4 = Hfo_sOSiO(OH)2- + H+ + H2O
log_k -3.22
delta_h 0
Hfo_wOH + CO3-2 + H+ = Hfo_wCO3- + H2O
log_k 12.56
delta_h 0
Hfo_wOH + CO3-2 + 2H+= Hfo_wHCO3 + H2O
log_k 20.62
delta_h 0
Hfo_sOH + CO3-2 + H+ = Hfo_sCO3- + H2O
```

```
log_k 12.56
delta_h 0
Hfo_sOH + CO3-2 + 2H+= Hfo_sHCO3 + H2O
log_k 20.62
delta_h 0

#Karamalidis and Dzombak sorption to gibbsite (hao) as compiled in Cravotta 2021 (https://doi.org/10.1016/j.apgeochem.2020.104845) Table S4 unless otherwise noted
Hao_OH + Cu+2 = Hao_OCu+ + H+
log_k 0.25
Hao_OH + Pb+2 = Hao_OPb+ + H+
log_k 0.37
Hao_OH + Co+2 = Hao_OCo+ + H+
log_k -2.52
Hao_OH + Cd+2 = Hao_OCd+ + H+
log_k -2.73
Hao_OH + Mn+2 = Hao_OMn+ + H+
log_k -5.49
Hao_OH + Fe+2 = Hao_OFe+ + H+
log_k -3.77
Hao_OH + Ca+2 = Hao_OCa+ + H+
log_k -10.49
Hao_OH + Mg+2 = Hao_OMg+ + H+
log_k -5.93
Hao_OH + Ba+2 = Hao_OBa+ + H+
log_k -8.5
Hao_OH + Sr+2 = Hao_OSr+ + H+
log_k -8.26
Hao_OH + Zn+2 = Hao_OZn+ + H+
log_k -0.96
Hao_OH + PO4-3 + 3 H+ = Hao_H2PO4 + H2O
log_k 26.89
Hao_OH + PO4-3 + 2H+ = Hao_HPO4- + H2O
log_k 19.37
Hao_OH + PO4-3 + H+ = Hao_PO4-2 + H2O
log_k 13.57
#Hao_OH + SO4-2 + H+ = Hao_SO4- + H2O
# log_k -0.45
#Hao_OH + SO4-2 = Hao_OHSO4-2
# log_k 1.19
Hao_OH + F- + H+ = Hao_F + H2O
log_k 8.78
Hao_OH + F- = Hao_OHF-
log_k 2.88
Hao_OH + 2 F- + H+ = Hao_F2- + H2O
log_k 11.94
Hao_OH + H4SiO4 = Hao_OH4SiO4- + H+
log_k -4.16

#Modified value from Goldberg and Glaubig (1985)
Hao_OH + H3BO3 = Hao_H2BO3 + H2O
Log_k 4.83
Hao_OH + H3BO3 = Hao_H3BO4- + H+
Log_k -7.40

#Modified value from Kitadai et al. (2018)
```

```
Hao_OH + SO4-2 + H+ = Hao_SO4- + H2O
log_k 2.4
#Modified value from Kitadai et al. (2018)
Hao_OH + SO4-2 = Hao_OHSO4-2
log_k 7.5

END
```

ATTACHMENT C
Details of Geochemical Model Parameterization

Attachment C. Details of Geochemical Model Parameterization

Introduction

This appendix to the Groundwater Polishing Report for the Coffeen Power Plant (CPP) Ash Pond No. 1 (AP1) Unit provides detailed information regarding geochemical model parameterization. The information provided includes sources of thermodynamic data, sources of data used in model parameterization, summarized values, and calculation methods. All solid-phase data is fully documented in the Nature and Extent Report.[1] All aqueous data have been posted to the facility's operating record in accordance with Title 35 of the Illinois Administrative code (35 I.A.C.) § 845.800(d)(15).

Solid Phase Inputs

The solid phase inputs to the model included iron (hydr)oxides and aluminum (hydr)oxides. These phases tend to have relatively rapid precipitation kinetics and form an outer layer on the surfaces of aquifer solids, creating surface area for sorption and attenuation of boron and sulfate. Input concentrations for iron and aluminum (hydr)oxides are ideally derived using sequential extraction procedure (SEP) data. SEP methods employ chemical extractants to dissolve metals from specific solid-associated phases. SEP methods use progressively stronger reagents to solubilize metals from increasingly recalcitrant phases. Although these procedures do not identify the discrete solid phases in a soil/aquifer matrix, they provide a means to evaluate and characterize the metal binding mechanisms and relative stability of metals in each phase, and to estimate the available mass of the respective attenuating phase(s) (i.e., aluminum and iron [hydr]oxide). However, SEP analyses were not completed on Coffeen AP1 samples. The dataset constraints necessitated alternative means of deriving oxide inputs.

Because SEP analyses were not completed on any CPP AP1 samples, model input concentrations for ferrihydrite and gibbsite were derived using site-specific total metals and the proportion of total metals as crystalline metal oxides (applicable to crystalline iron oxides) or amorphous metal oxides (iron and aluminum) compiled from SEP datasets consisting of samples collected from similar geologic systems at various power generating facilities across Illinois. Much of the Coffeen AP1 uppermost aquifer (UA) consists of the Hagarstown Member, so the analogous dataset for the UA is comprised of samples collected from various power generating facilities across Illinois specifically within the Hagarstown Member. The AP1 lower confining unit (LCU) consists of multiple geologic units, one of which is the Mulberry Grove Formation, so the analogous dataset for

[1] The Nature and Extent Report was previously submitted to IEPA on June 2024, and provided with relevant updates as Appendix D of the CAAA to which this report is attached.

the LCU is comprised of samples collected from various power generating facilities across Illinois specifically within the Mulberry Grove Formation. The AP1 deep aquifer (DA) consists of geologic formations which were not sampled at other Illinois power generating facilities; therefore, the DA analogous dataset is comprised of numerous samples collected from multiple geologic units at power generating facilities across Illinois. The geologic similarity (regional geology, similar lithologies and depositional environments, similar mineral assemblages) between the samples comprising these datasets and the CPP AP1 subsurface make these datasets appropriate for estimating the amount and distribution of sorbing solid phases in the absence of a complete site-specific dataset.

SEP data for iron and aluminum is available for 25 solid phase samples across six distinct hydrostratigraphic units (DA analogous dataset), of which three solid phase samples are specifically from the Hagarstown Member (UA analogous dataset) and five solid phase samples are specifically from the Mulberry Grove Formation (LCU analogous dataset).

Total solid-phase iron was measured in seven AP1 UA solids samples at concentrations ranging from 4,900 milligrams per kilogram (mg/kg) to 22,000 mg/kg. Four AP1 UA solid samples were analyzed for mineralogy via X-ray diffraction (XRD) analysis. XRD identified multiple minerals containing iron in their crystal structures, but no iron oxide minerals were detected. The UA in the vicinity of AP1 was therefore determined to not contain crystalline iron oxide material. Total solid-phase iron was measured in four AP1 LCU solid samples at concentrations ranging from 10,000 mg/kg to 21,000 mg/kg. Two AP1 LCU solid samples were analyzed for mineralogy via XRD. XRD identified iron oxide mineral magnetite in one of the two samples at a weight percentage of 0.2 wt. %. The crystalline iron component for the LCU was determined by applying a proportion of 0.1% (the average magnetite component of the two LCU samples) to the average total iron value from the LCU samples. No DA solids samples were analyzed for total iron, but one DA solids sample was analyzed for mineralogy via XRD. This sample did not contain any iron oxide components; therefore, the DA was determined to not contain crystalline iron oxide material.

The amorphous ferrihydrite component for each hydrostratigraphic unit was based on the 25th percentile of amorphous ferrihydrite distribution in each analogous compiled SEP dataset.

The gibbsite component of the models was determined using the average mass of aluminum associated with the oxide fraction from each compiled SEP dataset described above.

In thermodynamic modeling, the amount of sorbing phase present is typically the dominant control on the concentration of constituents sorbed under a given pH. Therefore, different amounts of metal oxides were used to test the sensitivity of the model to the amount of sorbing phase present. The amount of metal oxides used were derived from the 25th percentile, median (*i.e.*, 50th percentile), and 75th percentile of the SEP results for the relevant iron and aluminum phases.

Sorption of inorganic constituents to iron (hydr)oxides in the MINTEQ v4 database[2] is represented by the hydrous ferric oxide (HFO) thermodynamic dataset presented in Dzombak and Morel (1990). Sorption of inorganic constituents to aluminum (hydr)oxides is represented by the hydrous

[2] The default MINTEQ v4 database for PHREEQC does not include sorption data for carbonate and silicate to HFO. Thermodynamic constants for sorption of carbonate and silicate to HFO were added from the MINTEQ database associated with the Geochemist's Workbench software program.

aluminum oxide (HAO) thermodynamic data presented in Karamalidis and Dzombak (2010), Goldberg and Glaubig (1985) (boron), and Kitadai et al. (2018) (sulfate). These sorption data are based on gibbsite, a nearly ubiquitous crystalline aluminum hydroxide mineral (Karamalidis and Dzombak 2010).

The quantities of HFO and HAO in the model are represented by ferrihydrite ($Fe(OH)_3$) and gibbsite ($Al(OH)_3$), respectively. Ferrihydrite is the most similar naturally occurring iron oxide to HFO (Dzombak and Morel, 1990), and sorption data for HAO was determined using gibbsite (Karamalidis and Dzombak 2010). Metal concentrations are presented in milligrams per kilogram of dry weight (mg/kg dw), whereas ferrihydrite and gibbsite inputs to the model represent moles of solid phase associated with one liter (L) of aqueous phase. The concentrations of iron and aluminum were converted to moles of ferrihydrite and gibbsite (respectively) according to the following:

The mass in kilograms (kg) of solid in the model (i.e., per 1 L of water) was calculated by:

$$Solid\ Mass\ In\ Model\ (kg) = \frac{(1-\phi)}{\phi} \times \frac{1000\ cm^3\ water}{L\ water} \times 1\ L\ water\ \times \rho\ \times \frac{1\ kg\ solid}{1000\ g\ solid}$$

Where:

ϕ = porosity (water volume in cubic centimeters [cm^3] / total volume in cm^3)

ρ = density of the solid (grams [g]/cm^3)

Porosity and density represent the median of measurements each hydrostratigraphic unit as reported in the Hydrogeologic Characterization Report (Ramboll 2021).

Moles of ferrihydrite and gibbsite were determined using metal concentrations as described above, the molar mass of iron or aluminum, and the mass of solid phase in the model:

$$Moles\ of\ Metal\ Oxide = \frac{mg\ Fe\ or\ Al}{kg\ solid} \times \frac{g}{1000\ mg} \times \frac{moles\ Fe\ or\ Al}{g\ Fe\ or\ Al} \times kg\ Solid\ Mass\ in\ Model$$

The moles of ferrihydrite and gibbsite are represented by moles of Fe or Al (respectively) in a 1:1 ratio mased on the mineral formula. Ferrihydrite and gibbsite were allowed to precipitate or dissolve in the reaction phase of the model to evaluate the impact of source control on sorbing phase availability.

Calcite and dolomite were included as mineral phases in the model because carbonate mineral formation and dissolution are often major controls on groundwater pH. Calcite and dolomite are common carbonate minerals and were detected at levels of greater than 1 wt.% in XRD analysis of UA and LCU solids and are therefore considered to be present within the aquifer. Neither carbonate mineral was detected in the DA solid sample. The mass fractions reported in the XRD results are used as model inputs for the UA and LCU, and calcite and dolomite were not included as initial model inputs for the DA. Both calcite and dolomite were allowed to precipitate in the reaction phase of all models.

Barite and gypsum are common sulfate minerals that have the potential to form under ambient environmental conditions. Neither mineral was detected in X-ray diffraction results at well locations containing exceedances of GWPSs. Therefore, barite and gypsum did not have initial concentrations in the model but were allowed to precipitate or dissolve in the reaction phase of the model.

Aqueous Inputs

In addition to the constituent of concern boron, the following parameters are included in the model and are anticipated to capture the expected attenuation and mobilization mechanisms for reasons detailed below:

- Temperature, pH and pe: pH and pe (a measure of redox potential) are major controls on chemical attenuation and mobility.
- Chloride, potassium, and sodium: Major ions in groundwater typically required for the model to reach charge balance.
- Carbonate ion, calcium, and magnesium: Major ions in groundwater that may also form common minerals, including carbonates. Carbonate mineral formation and dissolution is often a major control on groundwater pH. Bicarbonate and carbonate ions, a major component of groundwater alkalinity, may also compete with sulfate/boron for sorbing sites.
- Silicon and phosphate: Silicate and phosphate are oxyanions that compete with sulfate/boron for sorbing sites.
- Aluminum, iron, and manganese: As discussed above, iron and aluminum form reactive metal (hydr)oxide minerals which have high capacities for sorbing other ions on their surfaces. Although sorption to manganese oxides was not considered in this model, manganese behaves similarly to iron and is included for completeness.
- Remaining constituents regulated under 35 I.A.C. § 845.600[3]: Although these parameters are not subject to corrective action at Coffeen AP1, they are included in the model for completeness.

Values for pe and carbonate ion concentrations were derived from values previously reported in the analytical data according to the following methods.

pe is a non-dimension scale of redox potential and is calculated from oxidation reduction potential (ORP). First, the field-measured ORP was converted to Eh (i.e., the redox potential normalized to the standard hydrogen electrode). The following equation provided in the Horiba water quality meter instruction manual[4] was used:

$$Eh = ORP + 206 - 0.7*(T - 25)$$

[3] Mercury, thallium, total dissolved solids, and radium were not included in the model. Mercury reactions within the environment are highly complex and would require a separate modeling effort. Thallium forms a non-reactive monovalent cation and is rarely detected in the groundwater and is therefore not expected to contribute to model outcomes. Total dissolved solids are not a chemical parameter, but rather the result of other chemical abundances taken together. Radium is not included in most thermodynamic databases.

[4] https://static.horiba.com/fileadmin/Horiba/Products/Process_and_Environmental/Water_Pollution/Instruction_Manuals/U-50/U-50_Manual.pdf

Where both Eh and ORP are in volts (V) and T is temperature in degrees Celsius. Eh is then converted to pe:

pe = (Eh * F) / (2.303 * R * T)

Where:

F = Faraday constant (96,500 Joules (J) / V-equivalent)

R = Molar gas constant (8.31 J / Kelvin (K)-mole)

T = temperature in Kelvin

Data reported for groundwater at the site include carbonate and bicarbonate alkalinity in units of mg of calcium carbonate per liter (mg $CaCO_3$/L). For use in modeling, it is convenient to convert these values to a single carbonate (CO_3^{2-}) ion concentration. Because carbonate and bicarbonate alkalinity are reported in the same units (i.e., standardized to mg $CaCO_3$) and represent different protonation states of the same inorganic carbon oxyanion, they were summed to represent total alkalinity due to carbonate. This summed alkalinity was converted to concentration of carbonate ion according to the following equation:

$$\frac{mg\ CO_3^{2-}}{L} = \frac{mg\ CaCO_3}{L} \times \frac{mole\ CaCO_3}{100.1\ mg\ CaCO_3} \times \frac{1\ mole\ CO_3^{2-}}{1\ mole\ CaCO_3} \times \frac{60\ mg\ CO_3^{2-}}{mole\ CO_3^{2-}}$$

The full suite of geochemical parameters for this model was measured in Quarter 2 and Quarter 3, 2023. The medians of these results were used in the model to represent average groundwater interacting with the solid phase. For downgradient wells the median for each parameter was calculated for each location individually. For background wells, a single median for each parameter was calculated using data from all three background locations measured in Quarter 2 and Quarter 3, 2023.

The model was run without charge balancing and with charge balancing on chloride. The results during the reaction modeling did not substantially differ with and without charge balancing on chloride. The results presented in the Groundwater Polishing Report therefore represent the model results using charge balancing on chloride.

References

Appelo C.A.J. and Postma D. 2005. Geochemistry, Groundwater, and Pollution. 2nd Edition. A.A. Balkema Publishers, member of Taylor & Francis Group. The Netherlands.

Dzombak D.A. and Morel F.M.M. 1990. Surface Complexation Modeling: Hydrous Ferric Oxide. John Wiley & Sons, New York.

Goldberg S. and Glaubig R.A. 1985. Boron Adsorption on Aluminum and Iron Oxide Minerals. *Soil Science Society of America Journal* **49**(6):1374-1379.

Karamalidis A.K. and Dzombak D.A. 2010. Surface Complexation Modeling: Gibbsite. John Wiley & Sons, New York.

Kitadai N., Nishiuchi K, and Tanaka M. 2018. A comprehensive predictive model for sulfate adsorption on oxide minerals. *Geochimica et Cosmochimica Acta* **238**:150-168.

Ramboll. 2021. Hydrogeologic Site Characterization Report – Ash Pond No.1, Coffeen Power Plant, Coffeen, Illinois. October.

ATTACHMENT D
Complete Geochemical Modeling Outputs

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	pH	pe	charge	pct_err	S(6)	B	Li	As	C(4)	Cl	F
G314D	C - DA	Initial Soln	TRUE	25p	6.96	3.26	8.23e-13	9.22e-10	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.0246	3.32e-05
G307D	C - LCU	Initial Soln	TRUE	25p	7.25	2.66	-7.74e-18	-2.83e-14	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.00218	3.11e-05
G301	C - UA	Initial Soln	TRUE	25p	6.58	0.595	6.43e-12	2.65e-08	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.00230	1.34e-05
G308	C - UA	Initial Soln	TRUE	25p	7.30	4.51	-1.19e-17	-2.86e-14	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.00319	2.91e-05
G312	C - UA	Initial Soln	TRUE	25p	6.29	5.00	-1.05e-17	-2.49e-14	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.00576	8.49e-06
G313	C - UA	Initial Soln	TRUE	25p	6.81	3.67	-1.00e-17	-2.38e-14	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.00686	1.28e-05
G314D	C - DA	Speciation Model	TRUE	25p	6.96	3.26	8.23e-13	9.22e-10	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.0246	3.32e-05
G307D	C - LCU	Speciation Model	TRUE	25p	7.25	2.66	-1.12e-17	-4.09e-14	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.00218	3.11e-05
G301	C - UA	Speciation Model	TRUE	25p	6.58	0.595	6.43e-12	2.65e-08	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.00230	1.34e-05
G308	C - UA	Speciation Model	TRUE	25p	7.30	4.51	7.05e-14	1.70e-10	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.00319	2.91e-05
G312	C - UA	Speciation Model	TRUE	25p	6.29	5.00	-4.87e-20	-1.16e-16	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.00576	8.49e-06
G313	C - UA	Speciation Model	TRUE	25p	6.81	3.67	-9.93e-15	-2.36e-11	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.00686	1.28e-05
G314D	C - DA	First Reaction	TRUE	25p	6.86	1.32	-2.63e-04	-1.03e+00	0.00174	8.48e-06	4.83e-07	3.51e-09	0.00370	0.00749	1.19e-05
G314D	C - DA	Second Reaction	TRUE	25p	6.81	1.46	-5.51e-06	-2.22e-02	0.00152	9.85e-06	4.83e-07	4.17e-09	0.00364	0.00749	1.19e-05
G307D	C - LCU	First Reaction	TRUE	25p	7.30	0.353	4.01e-05	0.152	0.00156	0.000127	4.83e-07	3.48e-08	0.00383	0.00749	1.20e-05
G307D	C - LCU	Second Reaction	TRUE	25p	7.28	0.517	7.79e-07	0.00295	0.00146	0.000115	4.83e-07	3.93e-08	0.00403	0.00749	1.20e-05
G301	C - UA	First Reaction	TRUE	25p	7.23	1.26	-7.26e-05	-2.69e-01	0.00148	0.000273	4.83e-07	2.71e-09	0.00449	0.00749	1.22e-05
G301	C - UA	Second Reaction	TRUE	25p	7.25	1.30	1.76e-06	0.00662	0.00143	0.000226	4.83e-07	3.06e-09	0.00427	0.00749	1.20e-05
G308	C - UA	First Reaction	TRUE	25p	7.29	3.18	-1.34e-04	-5.06e-01	0.00155	0.000123	4.83e-07	9.96e-09	0.00397	0.00749	1.20e-05
G308	C - UA	Second Reaction	TRUE	25p	7.27	3.22	-2.64e-06	-9.98e-03	0.00146	0.000118	4.83e-07	9.15e-09	0.00409	0.00749	1.20e-05
G312	C - UA	First Reaction	TRUE	25p	7.19	2.80	-1.55e-04	-5.59e-01	0.00152	0.000249	4.83e-07	1.77e-09	0.00491	0.00749	1.22e-05
G312	C - UA	Second Reaction	TRUE	25p	7.24	2.75	-9.15e-07	-3.40e-03	0.00143	0.000217	4.83e-07	2.18e-09	0.00442	0.00749	1.20e-05
G313	C - UA	First Reaction	TRUE	25p	7.22	1.77	-1.21e-04	-4.43e-01	0.00149	0.000249	4.83e-07	3.96e-09	0.00462	0.00749	1.21e-05
G313	C - UA	Second Reaction	TRUE	25p	7.25	1.77	5.79e-07	0.00216	0.00143	0.000216	4.83e-07	4.80e-09	0.00432	0.00749	1.20e-05
G314D	C - DA	Initial Soln	TRUE	75p	6.96	3.26	8.23e-13	9.22e-10	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.0246	3.32e-05
G307D	C - LCU	Initial Soln	TRUE	75p	7.25	2.66	-7.74e-18	-2.83e-14	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.00218	3.11e-05
G301	C - UA	Initial Soln	TRUE	75p	6.58	0.595	6.43e-12	2.65e-08	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.00230	1.34e-05
G308	C - UA	Initial Soln	TRUE	75p	7.30	4.51	-1.19e-17	-2.86e-14	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.00319	2.91e-05
G312	C - UA	Initial Soln	TRUE	75p	6.29	5.00	-1.05e-17	-2.49e-14	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.00576	8.49e-06
G313	C - UA	Initial Soln	TRUE	75p	6.81	3.67	-1.00e-17	-2.38e-14	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.00686	1.28e-05
G314D	C - DA	Speciation Model	TRUE	75p	6.96	3.26	8.23e-13	9.22e-10	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.0246	3.32e-05
G307D	C - LCU	Speciation Model	TRUE	75p	7.25	2.66	-1.12e-17	-4.09e-14	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.00218	3.11e-05
G301	C - UA	Speciation Model	TRUE	75p	6.58	0.595	6.43e-12	2.65e-08	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.00230	1.34e-05
G308	C - UA	Speciation Model	TRUE	75p	7.30	4.51	7.05e-14	1.70e-10	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.00319	2.91e-05
G312	C - UA	Speciation Model	TRUE	75p	6.29	5.00	-4.87e-20	-1.16e-16	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.00576	8.49e-06
G313	C - UA	Speciation Model	TRUE	75p	6.81	3.67	-9.93e-15	-2.36e-11	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.00686	1.28e-05
G314D	C - DA	First Reaction	TRUE	75p	6.93	1.11	-9.56e-04	-3.58e+00	0.00224	8.04e-06	4.83e-07	3.22e-09	0.00381	0.00749	1.21e-05
G314D	C - DA	Second Reaction	TRUE	75p	6.90	1.21	-6.65e-05	-2.61e-01	0.00164	7.63e-06	4.83e-07	3.32e-09	0.00366	0.00749	1.17e-05
G307D	C - LCU	First Reaction	TRUE	75p	7.31	0.226	3.98e-05	0.150	0.00163	0.000143	4.83e-07	3.31e-08	0.00372	0.00749	1.21e-05
G307D	C - LCU	Second Reaction	TRUE	75p	7.29	0.324	1.47e-06	0.00561	0.00147	0.000128	4.83e-07	3.66e-08	0.00393	0.00749	1.20e-05
G301	C - UA	First Reaction	TRUE	75p	7.22	1.28	-6.07e-05	-2.22e-01	0.00152	0.000282	4.83e-07	2.55e-09	0.00460	0.00749	1.23e-05
G301	C - UA	Second Reaction	TRUE	75p	7.25	1.29	7.67e-07	0.00287	0.00143	0.000237	4.83e-07	2.64e-09	0.00434	0.00749	1.20e-05
G308	C - UA	First Reaction	TRUE	75p	7.30	3.16	-1.56e-04	-5.93e-01	0.00158	0.000126	4.83e-07	1.04e-08	0.00388	0.00749	1.20e-05
G308	C - UA	Second Reaction	TRUE	75p	7.28	3.21	-4.55e-06	-1.72e-02	0.00147	0.000119	4.83e-07	9.89e-09	0.00405	0.00749	1.20e-05
G312	C - UA	First Reaction	TRUE	75p	7.16	2.87	-1.47e-04	-5.21e-01	0.00157	0.000252	4.83e-07	1.65e-09	0.00523	0.00749	1.23e-05
G312	C - UA	Second Reaction	TRUE	75p	7.22	2.78	-4.12e-06	-1.52e-02	0.00143	0.000225	4.83e-07	1.56e-09	0.00459	0.00749	1.20e-05
G313	C - UA	First Reaction	TRUE	75p	7.20	1.81	-1.27e-04	-4.60e-01	0.00151	0.000253	4.83e-07	3.65e-09	0.00483	0.00749	1.21e-05
G313	C - UA	Second Reaction	TRUE	75p	7.24	1.77	-2.85e-07	-1.06e-03	0.00143	0.000224	4.83e-07	3.78e-09	0.00442	0.00749	1.20e-05
G314D	C - DA	Initial Soln	TRUE	median	6.96	3.26	8.23e-13	9.22e-10	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.0246	3.32e-05
G307D	C - LCU	Initial Soln	TRUE	median	7.25	2.66	-7.74e-18	-2.83e-14	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.00218	3.11e-05
G301	C - UA	Initial Soln	TRUE	median	6.58	0.595	6.43e-12	2.65e-08	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.00230	1.34e-05
G308	C - UA	Initial Soln	TRUE	median	7.30	4.51	-1.19e-17	-2.86e-14	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.00319	2.91e-05
G312	C - UA	Initial Soln	TRUE	median	6.29	5.00	-1.05e-17	-2.49e-14	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.00576	8.49e-06
G313	C - UA	Initial Soln	TRUE	median	6.81	3.67	-1.00e-17	-2.38e-14	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.00686	1.28e-05
G314D	C - DA	Speciation Model	TRUE	median	6.96	3.26	8.23e-13	9.22e-10	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.0246	3.32e-05
G307D	C - LCU	Speciation Model	TRUE	median	7.25	2.66	-1.12e-17	-4.09e-14	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.00218	3.11e-05
G301	C - UA	Speciation Model	TRUE	median	6.58	0.595	6.43e-12	2.65e-08	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.00230	1.34e-05
G308	C - UA	Speciation Model	TRUE	median	7.30	4.51	7.05e-14	1.70e-10	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.00319	2.91e-05
G312	C - UA	Speciation Model	TRUE	median	6.29	5.00	-4.87e-20	-1.16e-16	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.00576	8.49e-06
G313	C - UA	Speciation Model	TRUE	median	6.81	3.67	-9.93e-15	-2.36e-11	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.00686	1.28e-05

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	pH	pe	charge	pct_err	S(6)	B	Li	As	C(4)	Cl	F
G314D	C - DA	First Reaction	TRUE	median	6.91	1.16	-6.47e-04	-2.47e+00	0.00202	7.96e-06	4.83e-07	3.35e-09	0.00375	0.00749	1.20e-05
G314D	C - DA	Second Reaction	TRUE	median	6.86	1.30	-2.95e-05	-1.17e-01	0.00158	7.89e-06	4.83e-07	3.74e-09	0.00365	0.00749	1.17e-05
G307D	C - LCU	First Reaction	TRUE	median	7.31	0.299	5.17e-05	0.196	0.00159	0.000132	4.83e-07	3.36e-08	0.00377	0.00749	1.20e-05
G307D	C - LCU	Second Reaction	TRUE	median	7.29	0.437	1.27e-06	0.00483	0.00147	0.000118	4.83e-07	3.76e-08	0.00398	0.00749	1.20e-05
G301	C - UA	First Reaction	TRUE	median	7.22	1.27	-5.94e-05	-2.18e-01	0.00151	0.000278	4.83e-07	2.57e-09	0.00457	0.00749	1.23e-05
G301	C - UA	Second Reaction	TRUE	median	7.25	1.30	1.25e-06	0.00469	0.00143	0.000232	4.83e-07	2.72e-09	0.00432	0.00749	1.20e-05
G308	C - UA	First Reaction	TRUE	median	7.30	3.16	-1.44e-04	-5.48e-01	0.00157	0.000125	4.83e-07	1.03e-08	0.00390	0.00749	1.20e-05
G308	C - UA	Second Reaction	TRUE	median	7.28	3.21	-3.86e-06	-1.46e-02	0.00146	0.000119	4.83e-07	9.73e-09	0.00406	0.00749	1.20e-05
G312	C - UA	First Reaction	TRUE	median	7.16	2.86	-1.41e-04	-5.02e-01	0.00155	0.000250	4.83e-07	1.65e-09	0.00515	0.00749	1.23e-05
G312	C - UA	Second Reaction	TRUE	median	7.22	2.77	-2.71e-06	-1.00e-02	0.00143	0.000221	4.83e-07	1.65e-09	0.00455	0.00749	1.20e-05
G313	C - UA	First Reaction	TRUE	median	7.20	1.81	-1.19e-04	-4.34e-01	0.00150	0.000251	4.83e-07	3.68e-09	0.00478	0.00749	1.21e-05
G313	C - UA	Second Reaction	TRUE	median	7.24	1.78	2.98e-07	0.00111	0.00143	0.000220	4.83e-07	3.95e-09	0.00439	0.00749	1.20e-05
G314D	C - DA	Initial Soln	FALSE	25p	6.96	3.26	0.0229	35.0	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.00172	3.32e-05
G307D	C - LCU	Initial Soln	FALSE	25p	7.25	2.66	0.00176	6.88	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.000424	3.11e-05
G301	C - UA	Initial Soln	FALSE	25p	6.58	0.595	0.00194	8.74	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.000353	1.34e-05
G308	C - UA	Initial Soln	FALSE	25p	7.30	4.51	0.00285	7.42	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.000339	2.91e-05
G312	C - UA	Initial Soln	FALSE	25p	6.29	5.00	0.00500	13.6	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.000763	8.49e-06
G313	C - UA	Initial Soln	FALSE	25p	6.81	3.67	0.00623	17.5	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.000636	1.28e-05
G314D	C - DA	Speciation Model	FALSE	25p	6.96	3.26	0.0229	35.0	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.00172	3.32e-05
G307D	C - LCU	Speciation Model	FALSE	25p	7.25	2.66	0.00176	6.88	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.000424	3.11e-05
G301	C - UA	Speciation Model	FALSE	25p	6.58	0.595	0.00194	8.74	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.000353	1.34e-05
G308	C - UA	Speciation Model	FALSE	25p	7.30	4.51	0.00285	7.42	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.000339	2.91e-05
G312	C - UA	Speciation Model	FALSE	25p	6.29	5.00	0.00500	13.6	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.000763	8.49e-06
G313	C - UA	Speciation Model	FALSE	25p	6.81	3.67	0.00623	17.5	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.000636	1.28e-05
G314D	C - DA	First Reaction	FALSE	25p	6.87	1.26	-2.17e-04	-8.48e-01	0.00172	8.41e-06	4.83e-07	3.99e-09	0.00371	0.00749	1.19e-05
G314D	C - DA	Second Reaction	FALSE	25p	6.81	1.42	-4.70e-06	-1.89e-02	0.00152	9.78e-06	4.83e-07	4.76e-09	0.00364	0.00749	1.19e-05
G307D	C - LCU	First Reaction	FALSE	25p	7.30	0.349	3.63e-05	0.138	0.00156	0.000127	4.83e-07	3.53e-08	0.00383	0.00749	1.20e-05
G307D	C - LCU	Second Reaction	FALSE	25p	7.28	0.513	7.48e-07	0.00283	0.00146	0.000115	4.83e-07	3.99e-08	0.00403	0.00749	1.20e-05
G301	C - UA	First Reaction	FALSE	25p	7.23	1.25	-6.70e-05	-2.48e-01	0.00148	0.000273	4.83e-07	2.72e-09	0.00448	0.00749	1.22e-05
G301	C - UA	Second Reaction	FALSE	25p	7.25	1.29	1.85e-06	0.00694	0.00143	0.000226	4.83e-07	3.08e-09	0.00427	0.00749	1.20e-05
G308	C - UA	First Reaction	FALSE	25p	7.29	3.18	-1.27e-04	-4.81e-01	0.00155	0.000123	4.83e-07	1.02e-08	0.00397	0.00749	1.20e-05
G308	C - UA	Second Reaction	FALSE	25p	7.27	3.22	-2.57e-06	-9.72e-03	0.00146	0.000118	4.83e-07	9.36e-09	0.00409	0.00749	1.20e-05
G312	C - UA	First Reaction	FALSE	25p	7.19	2.79	-1.43e-04	-5.17e-01	0.00152	0.000248	4.83e-07	1.81e-09	0.00490	0.00749	1.22e-05
G312	C - UA	Second Reaction	FALSE	25p	7.24	2.74	-7.71e-07	-2.87e-03	0.00143	0.000217	4.83e-07	2.25e-09	0.00442	0.00749	1.20e-05
G313	C - UA	First Reaction	FALSE	25p	7.22	1.76	-1.07e-04	-3.92e-01	0.00149	0.000247	4.83e-07	4.12e-09	0.00462	0.00749	1.21e-05
G313	C - UA	Second Reaction	FALSE	25p	7.25	1.75	7.34e-07	0.00275	0.00143	0.000215	4.83e-07	5.00e-09	0.00432	0.00749	1.20e-05
G314D	C - DA	Initial Soln	FALSE	75p	6.96	3.26	0.0229	35.0	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.00172	3.32e-05
G307D	C - LCU	Initial Soln	FALSE	75p	7.25	2.66	0.00176	6.88	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.000424	3.11e-05
G301	C - UA	Initial Soln	FALSE	75p	6.58	0.595	0.00194	8.74	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.000353	1.34e-05
G308	C - UA	Initial Soln	FALSE	75p	7.30	4.51	0.00285	7.42	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.000339	2.91e-05
G312	C - UA	Initial Soln	FALSE	75p	6.29	5.00	0.00500	13.6	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.000763	8.49e-06
G313	C - UA	Initial Soln	FALSE	75p	6.81	3.67	0.00623	17.5	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.000636	1.28e-05
G314D	C - DA	Speciation Model	FALSE	75p	6.96	3.26	0.0229	35.0	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.00172	3.32e-05
G307D	C - LCU	Speciation Model	FALSE	75p	7.25	2.66	0.00176	6.88	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.000424	3.11e-05
G301	C - UA	Speciation Model	FALSE	75p	6.58	0.595	0.00194	8.74	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.000353	1.34e-05
G308	C - UA	Speciation Model	FALSE	75p	7.30	4.51	0.00285	7.42	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.000339	2.91e-05
G312	C - UA	Speciation Model	FALSE	75p	6.29	5.00	0.00500	13.6	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.000763	8.49e-06
G313	C - UA	Speciation Model	FALSE	75p	6.81	3.67	0.00623	17.5	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.000636	1.28e-05
G314D	C - DA	First Reaction	FALSE	75p	6.95	1.02	-7.85e-04	-2.93e+00	0.00218	8.01e-06	4.83e-07	3.63e-09	0.00383	0.00749	1.21e-05
G314D	C - DA	Second Reaction	FALSE	75p	6.91	1.15	-5.67e-05	-2.22e-01	0.00163	7.57e-06	4.83e-07	3.76e-09	0.00366	0.00749	1.17e-05
G307D	C - LCU	First Reaction	FALSE	75p	7.31	0.222	3.52e-05	0.133	0.00164	0.000142	4.83e-07	3.36e-08	0.00372	0.00749	1.21e-05
G307D	C - LCU	Second Reaction	FALSE	75p	7.29	0.320	1.39e-06	0.00531	0.00147	0.000128	4.83e-07	3.72e-08	0.00393	0.00749	1.20e-05
G301	C - UA	First Reaction	FALSE	75p	7.22	1.27	-5.48e-05	-2.01e-01	0.00152	0.000282	4.83e-07	2.56e-09	0.00460	0.00749	1.23e-05
G301	C - UA	Second Reaction	FALSE	75p	7.25	1.29	8.76e-07	0.00328	0.00143	0.000237	4.83e-07	2.65e-09	0.00434	0.00749	1.20e-05
G308	C - UA	First Reaction	FALSE	75p	7.30	3.15	-1.49e-04	-5.64e-01	0.00157	0.000125	4.83e-07	1.06e-08	0.00387	0.00749	1.20e-05
G308	C - UA	Second Reaction	FALSE	75p	7.28	3.21	-4.45e-06	-1.68e-02	0.00147	0.000119	4.83e-07	1.01e-08	0.00405	0.00749	1.20e-05
G312	C - UA	First Reaction	FALSE	75p	7.16	2.86	-1.35e-04	-4.79e-01	0.00156	0.000251	4.83e-07	1.70e-09	0.00523	0.00749	1.23e-05
G312	C - UA	Second Reaction	FALSE	75p	7.22	2.76	-3.93e-06	-1.45e-02	0.00143	0.000225	4.83e-07	1.61e-09	0.00459	0.00749	1.20e-05
G313	C - UA	First Reaction	FALSE	75p	7.20	1.80	-1.12e-04	-4.05e-01	0.00151	0.000252	4.83e-07	3.80e-09	0.00482	0.00749	1.21e-05
G313	C - UA	Second Reaction	FALSE	75p	7.24	1.76	-6.94e-08	-2.58e-04	0.00143	0.000223	4.83e-07	3.94e-09	0.00442	0.00749	1.20e-05

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	pH	pe	charge	pct_err	S(6)	B	Li	As	C(4)	Cl	F
G314D	C - DA	Initial Soln	FALSE	median	6.96	3.26	0.0229	35.0	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.00172	3.32e-05
G307D	C - LCU	Initial Soln	FALSE	median	7.25	2.66	0.00176	6.88	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.000424	3.11e-05
G301	C - UA	Initial Soln	FALSE	median	6.58	0.595	0.00194	8.74	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.000353	1.34e-05
G308	C - UA	Initial Soln	FALSE	median	7.30	4.51	0.00285	7.42	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.000339	2.91e-05
G312	C - UA	Initial Soln	FALSE	median	6.29	5.00	0.00500	13.6	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.000763	8.49e-06
G313	C - UA	Initial Soln	FALSE	median	6.81	3.67	0.00623	17.5	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.000636	1.28e-05
G314D	C - DA	Speciation Model	FALSE	median	6.96	3.26	0.0229	35.0	0.0114	1.48e-05	1.06e-06	1.10e-08	0.00701	0.00172	3.32e-05
G307D	C - LCU	Speciation Model	FALSE	median	7.25	2.66	0.00176	6.88	0.00625	0.000187	4.11e-07	2.20e-08	0.00213	0.000424	3.11e-05
G301	C - UA	Speciation Model	FALSE	median	6.58	0.595	0.00194	8.74	0.00549	0.000212	5.19e-07	3.64e-09	0.00150	0.000353	1.34e-05
G308	C - UA	Speciation Model	FALSE	median	7.30	4.51	0.00285	7.42	0.0104	0.000247	1.00e-06	9.09e-09	0.00236	0.000339	2.91e-05
G312	C - UA	Speciation Model	FALSE	median	6.29	5.00	0.00500	13.6	0.00894	0.000223	1.94e-06	5.65e-09	0.00508	0.000763	8.49e-06
G313	C - UA	Speciation Model	FALSE	median	6.81	3.67	0.00623	17.5	0.00723	0.000321	2.46e-06	5.65e-09	0.00496	0.000636	1.28e-05
G314D	C - DA	First Reaction	FALSE	median	6.93	1.08	-5.31e-04	-2.02e+00	0.00198	7.92e-06	4.83e-07	3.79e-09	0.00376	0.00749	1.20e-05
G314D	C - DA	Second Reaction	FALSE	median	6.87	1.25	-2.45e-05	-9.70e-02	0.00158	7.82e-06	4.83e-07	4.26e-09	0.00365	0.00749	1.17e-05
G307D	C - LCU	First Reaction	FALSE	median	7.31	0.295	4.67e-05	0.177	0.00159	0.000132	4.83e-07	3.42e-08	0.00377	0.00749	1.20e-05
G307D	C - LCU	Second Reaction	FALSE	median	7.29	0.433	1.21e-06	0.00460	0.00147	0.000118	4.83e-07	3.82e-08	0.00398	0.00749	1.20e-05
G301	C - UA	First Reaction	FALSE	median	7.22	1.27	-5.39e-05	-1.98e-01	0.00151	0.000278	4.83e-07	2.58e-09	0.00457	0.00749	1.23e-05
G301	C - UA	Second Reaction	FALSE	median	7.25	1.29	1.35e-06	0.00506	0.00143	0.000232	4.83e-07	2.73e-09	0.00432	0.00749	1.20e-05
G308	C - UA	First Reaction	FALSE	median	7.30	3.16	-1.37e-04	-5.21e-01	0.00156	0.000124	4.83e-07	1.06e-08	0.00390	0.00749	1.20e-05
G308	C - UA	Second Reaction	FALSE	median	7.28	3.21	-3.77e-06	-1.43e-02	0.00146	0.000118	4.83e-07	9.94e-09	0.00406	0.00749	1.20e-05
G312	C - UA	First Reaction	FALSE	median	7.16	2.84	-1.30e-04	-4.61e-01	0.00155	0.000249	4.83e-07	1.69e-09	0.00514	0.00749	1.23e-05
G312	C - UA	Second Reaction	FALSE	median	7.22	2.76	-2.55e-06	-9.42e-03	0.00143	0.000221	4.83e-07	1.70e-09	0.00454	0.00749	1.20e-05
G313	C - UA	First Reaction	FALSE	median	7.20	1.79	-1.05e-04	-3.82e-01	0.00150	0.000249	4.83e-07	3.83e-09	0.00477	0.00749	1.21e-05
G313	C - UA	Second Reaction	FALSE	median	7.24	1.76	4.83e-07	0.00180	0.00143	0.000220	4.83e-07	4.12e-09	0.00439	0.00749	1.20e-05

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	Ca	Mg	Na	K	Ba	Si	P	Mn	Fe	Al	Sb
G314D	C - DA	Initial Soln	TRUE	25p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Initial Soln	TRUE	25p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Initial Soln	TRUE	25p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Initial Soln	TRUE	25p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Initial Soln	TRUE	25p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Initial Soln	TRUE	25p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	Speciation Model	TRUE	25p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Speciation Model	TRUE	25p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Speciation Model	TRUE	25p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Speciation Model	TRUE	25p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Speciation Model	TRUE	25p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Speciation Model	TRUE	25p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	First Reaction	TRUE	25p	0.00300	0.00232	0.00289	1.46e-05	1.86e-07	9.73e-05	3.65e-08	5.29e-06	1.49e-05	3.07e-08	2.53e-09
G314D	C - DA	Second Reaction	TRUE	25p	0.00300	0.00217	0.00289	1.46e-05	2.10e-07	0.000127	3.97e-08	4.41e-06	1.49e-05	3.02e-08	2.53e-09
G307D	C - LCU	First Reaction	TRUE	25p	0.00292	0.00269	0.00289	1.46e-05	2.13e-07	0.000124	4.33e-07	3.77e-06	6.43e-06	5.21e-08	2.53e-09
G307D	C - LCU	Second Reaction	TRUE	25p	0.00290	0.00268	0.00289	1.46e-05	2.27e-07	0.000139	4.58e-07	3.42e-06	5.05e-06	5.03e-08	2.53e-09
G301	C - UA	First Reaction	TRUE	25p	0.00299	0.00275	0.00289	1.46e-05	2.28e-07	0.000150	1.14e-06	8.53e-06	1.30e-06	4.65e-08	2.53e-09
G301	C - UA	Second Reaction	TRUE	25p	0.00294	0.00271	0.00289	1.46e-05	2.33e-07	0.000162	1.23e-06	4.32e-06	1.00e-06	4.82e-08	2.53e-09
G308	C - UA	First Reaction	TRUE	25p	0.00290	0.00267	0.00289	1.46e-05	2.14e-07	0.000229	1.97e-07	3.40e-06	1.56e-08	5.10e-08	2.53e-09
G308	C - UA	Second Reaction	TRUE	25p	0.00292	0.00269	0.00289	1.46e-05	2.27e-07	0.000221	1.90e-07	3.41e-06	1.59e-08	4.97e-08	2.53e-09
G312	C - UA	First Reaction	TRUE	25p	0.00308	0.00283	0.00289	1.46e-05	2.25e-07	7.35e-05	3.56e-07	6.80e-06	5.65e-08	4.35e-08	2.53e-09
G312	C - UA	Second Reaction	TRUE	25p	0.00297	0.00274	0.00289	1.46e-05	2.34e-07	9.45e-05	4.28e-07	4.03e-06	4.58e-08	4.69e-08	2.53e-09
G313	C - UA	First Reaction	TRUE	25p	0.00301	0.00277	0.00289	1.46e-05	2.27e-07	0.000120	1.58e-07	3.29e-06	4.44e-07	4.55e-08	2.53e-09
G313	C - UA	Second Reaction	TRUE	25p	0.00295	0.00272	0.00289	1.46e-05	2.33e-07	0.000137	1.90e-07	3.23e-06	3.59e-07	4.77e-08	2.53e-09
G314D	C - DA	Initial Soln	TRUE	75p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Initial Soln	TRUE	75p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Initial Soln	TRUE	75p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Initial Soln	TRUE	75p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Initial Soln	TRUE	75p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Initial Soln	TRUE	75p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	Speciation Model	TRUE	75p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Speciation Model	TRUE	75p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Speciation Model	TRUE	75p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Speciation Model	TRUE	75p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Speciation Model	TRUE	75p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Speciation Model	TRUE	75p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	First Reaction	TRUE	75p	0.00300	0.00257	0.00289	1.46e-05	1.48e-07	7.57e-05	3.70e-08	6.38e-06	1.52e-05	3.21e-08	2.53e-09
G314D	C - DA	Second Reaction	TRUE	75p	0.00300	0.00233	0.00289	1.46e-05	1.98e-07	8.84e-05	3.67e-08	5.59e-06	1.45e-05	3.13e-08	2.53e-09
G307D	C - LCU	First Reaction	TRUE	75p	0.00293	0.00270	0.00289	1.46e-05	2.04e-07	0.000118	4.22e-07	4.60e-06	8.04e-06	5.30e-08	2.53e-09
G307D	C - LCU	Second Reaction	TRUE	75p	0.00288	0.00265	0.00289	1.46e-05	2.25e-07	0.000130	4.41e-07	3.64e-06	7.20e-06	5.14e-08	2.53e-09
G301	C - UA	First Reaction	TRUE	75p	0.00304	0.00279	0.00289	1.46e-05	2.23e-07	0.000144	1.09e-06	9.52e-06	1.39e-06	4.55e-08	2.53e-09
G301	C - UA	Second Reaction	TRUE	75p	0.00295	0.00272	0.00289	1.46e-05	2.34e-07	0.000146	1.14e-06	4.65e-06	1.08e-06	4.76e-08	2.53e-09
G308	C - UA	First Reaction	TRUE	75p	0.00289	0.00266	0.00289	1.46e-05	2.10e-07	0.000232	2.02e-07	3.39e-06	1.53e-08	5.20e-08	2.53e-09
G308	C - UA	Second Reaction	TRUE	75p	0.00291	0.00268	0.00289	1.46e-05	2.27e-07	0.000232	1.94e-07	3.42e-06	1.58e-08	5.01e-08	2.53e-09
G312	C - UA	First Reaction	TRUE	75p	0.00317	0.00291	0.00289	1.46e-05	2.22e-07	6.44e-05	3.30e-07	7.49e-06	6.09e-08	4.15e-08	2.53e-09
G312	C - UA	Second Reaction	TRUE	75p	0.00300	0.00277	0.00289	1.46e-05	2.36e-07	6.91e-05	3.46e-07	4.25e-06	4.88e-08	4.56e-08	2.53e-09
G313	C - UA	First Reaction	TRUE	75p	0.00306	0.00282	0.00289	1.46e-05	2.26e-07	0.000113	1.44e-07	3.32e-06	4.73e-07	4.40e-08	2.53e-09
G313	C - UA	Second Reaction	TRUE	75p	0.00297	0.00274	0.00289	1.46e-05	2.34e-07	0.000116	1.58e-07	3.21e-06	3.84e-07	4.69e-08	2.53e-09
G314D	C - DA	Initial Soln	TRUE	median	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Initial Soln	TRUE	median	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Initial Soln	TRUE	median	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Initial Soln	TRUE	median	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Initial Soln	TRUE	median	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Initial Soln	TRUE	median	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	Speciation Model	TRUE	median	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Speciation Model	TRUE	median	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Speciation Model	TRUE	median	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Speciation Model	TRUE	median	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Speciation Model	TRUE	median	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Speciation Model	TRUE	median	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	Ca	Mg	Na	K	Ba	Si	P	Mn	Fe	Al	Sb
G314D	C - DA	First Reaction	TRUE	median	0.00300	0.00247	0.00289	1.46e-05	1.63e-07	8.32e-05	3.74e-08	6.02e-06	1.49e-05	3.17e-08	2.53e-09
G314D	C - DA	Second Reaction	TRUE	median	0.00300	0.00227	0.00289	1.46e-05	2.04e-07	0.000105	3.88e-08	5.22e-06	1.46e-05	3.08e-08	2.53e-09
G307D	C - LCU	First Reaction	TRUE	median	0.00293	0.00269	0.00289	1.46e-05	2.09e-07	0.000120	4.26e-07	3.94e-06	6.99e-06	5.26e-08	2.53e-09
G307D	C - LCU	Second Reaction	TRUE	median	0.00289	0.00266	0.00289	1.46e-05	2.26e-07	0.000134	4.48e-07	3.45e-06	5.79e-06	5.09e-08	2.53e-09
G301	C - UA	First Reaction	TRUE	median	0.00302	0.00278	0.00289	1.46e-05	2.25e-07	0.000144	1.10e-06	9.08e-06	1.35e-06	4.57e-08	2.53e-09
G301	C - UA	Second Reaction	TRUE	median	0.00295	0.00272	0.00289	1.46e-05	2.34e-07	0.000149	1.16e-06	4.49e-06	1.05e-06	4.77e-08	2.53e-09
G308	C - UA	First Reaction	TRUE	median	0.00289	0.00266	0.00289	1.46e-05	2.11e-07	0.000232	2.00e-07	3.39e-06	1.54e-08	5.17e-08	2.53e-09
G308	C - UA	Second Reaction	TRUE	median	0.00291	0.00268	0.00289	1.46e-05	2.27e-07	0.000230	1.93e-07	3.42e-06	1.58e-08	5.00e-08	2.53e-09
G312	C - UA	First Reaction	TRUE	median	0.00314	0.00289	0.00289	1.46e-05	2.23e-07	6.55e-05	3.33e-07	7.20e-06	5.95e-08	4.20e-08	2.53e-09
G312	C - UA	Second Reaction	TRUE	median	0.00300	0.00276	0.00289	1.46e-05	2.35e-07	7.33e-05	3.59e-07	4.14e-06	4.77e-08	4.59e-08	2.53e-09
G313	C - UA	First Reaction	TRUE	median	0.00305	0.00281	0.00289	1.46e-05	2.26e-07	0.000113	1.46e-07	3.31e-06	4.63e-07	4.43e-08	2.53e-09
G313	C - UA	Second Reaction	TRUE	median	0.00297	0.00273	0.00289	1.46e-05	2.34e-07	0.000120	1.63e-07	3.22e-06	3.74e-07	4.71e-08	2.53e-09
G314D	C - DA	Initial Soln	FALSE	25p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Initial Soln	FALSE	25p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Initial Soln	FALSE	25p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Initial Soln	FALSE	25p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Initial Soln	FALSE	25p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Initial Soln	FALSE	25p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	Speciation Model	FALSE	25p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Speciation Model	FALSE	25p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Speciation Model	FALSE	25p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Speciation Model	FALSE	25p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Speciation Model	FALSE	25p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Speciation Model	FALSE	25p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	First Reaction	FALSE	25p	0.00300	0.00234	0.00289	1.46e-05	1.88e-07	9.57e-05	3.75e-08	5.57e-06	1.59e-05	3.08e-08	2.53e-09
G314D	C - DA	Second Reaction	FALSE	25p	0.00300	0.00217	0.00289	1.46e-05	2.10e-07	0.000127	4.05e-08	4.53e-06	1.59e-05	3.02e-08	2.53e-09
G307D	C - LCU	First Reaction	FALSE	25p	0.00292	0.00269	0.00289	1.46e-05	2.13e-07	0.000124	4.35e-07	3.78e-06	6.48e-06	5.21e-08	2.53e-09
G307D	C - LCU	Second Reaction	FALSE	25p	0.00290	0.00268	0.00289	1.46e-05	2.27e-07	0.000139	4.60e-07	3.42e-06	5.10e-06	5.03e-08	2.53e-09
G301	C - UA	First Reaction	FALSE	25p	0.00299	0.00275	0.00289	1.46e-05	2.28e-07	0.000149	1.14e-06	8.64e-06	1.32e-06	4.65e-08	2.53e-09
G301	C - UA	Second Reaction	FALSE	25p	0.00294	0.00271	0.00289	1.46e-05	2.33e-07	0.000162	1.23e-06	4.34e-06	1.02e-06	4.82e-08	2.53e-09
G308	C - UA	First Reaction	FALSE	25p	0.00290	0.00267	0.00289	1.46e-05	2.14e-07	0.000229	1.97e-07	3.42e-06	1.56e-08	5.10e-08	2.53e-09
G308	C - UA	Second Reaction	FALSE	25p	0.00292	0.00269	0.00289	1.46e-05	2.27e-07	0.000221	1.91e-07	3.42e-06	1.59e-08	4.97e-08	2.53e-09
G312	C - UA	First Reaction	FALSE	25p	0.00308	0.00283	0.00289	1.46e-05	2.26e-07	7.34e-05	3.58e-07	6.97e-06	5.81e-08	4.35e-08	2.53e-09
G312	C - UA	Second Reaction	FALSE	25p	0.00297	0.00274	0.00289	1.46e-05	2.34e-07	9.45e-05	4.31e-07	4.07e-06	4.71e-08	4.69e-08	2.53e-09
G313	C - UA	First Reaction	FALSE	25p	0.00301	0.00277	0.00289	1.46e-05	2.28e-07	0.000120	1.59e-07	3.32e-06	4.60e-07	4.55e-08	2.53e-09
G313	C - UA	Second Reaction	FALSE	25p	0.00295	0.00272	0.00289	1.46e-05	2.33e-07	0.000137	1.91e-07	3.24e-06	3.73e-07	4.78e-08	2.53e-09
G314D	C - DA	Initial Soln	FALSE	75p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Initial Soln	FALSE	75p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Initial Soln	FALSE	75p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Initial Soln	FALSE	75p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Initial Soln	FALSE	75p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Initial Soln	FALSE	75p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	Speciation Model	FALSE	75p	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Speciation Model	FALSE	75p	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Speciation Model	FALSE	75p	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Speciation Model	FALSE	75p	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Speciation Model	FALSE	75p	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Speciation Model	FALSE	75p	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	First Reaction	FALSE	75p	0.00300	0.00260	0.00289	1.46e-05	1.53e-07	7.33e-05	3.84e-08	6.86e-06	1.63e-05	3.26e-08	2.53e-09
G314D	C - DA	Second Reaction	FALSE	75p	0.00300	0.00234	0.00289	1.46e-05	1.99e-07	8.65e-05	3.78e-08	5.91e-06	1.54e-05	3.15e-08	2.53e-09
G307D	C - LCU	First Reaction	FALSE	75p	0.00293	0.00270	0.00289	1.46e-05	2.04e-07	0.000118	4.23e-07	4.62e-06	8.10e-06	5.31e-08	2.53e-09
G307D	C - LCU	Second Reaction	FALSE	75p	0.00288	0.00265	0.00289	1.46e-05	2.25e-07	0.000130	4.43e-07	3.65e-06	7.26e-06	5.14e-08	2.53e-09
G301	C - UA	First Reaction	FALSE	75p	0.00304	0.00279	0.00289	1.46e-05	2.24e-07	0.000143	1.09e-06	9.65e-06	1.41e-06	4.55e-08	2.53e-09
G301	C - UA	Second Reaction	FALSE	75p	0.00295	0.00272	0.00289	1.46e-05	2.34e-07	0.000146	1.14e-06	4.68e-06	1.10e-06	4.76e-08	2.53e-09
G308	C - UA	First Reaction	FALSE	75p	0.00289	0.00266	0.00289	1.46e-05	2.10e-07	0.000232	2.02e-07	3.41e-06	1.53e-08	5.20e-08	2.53e-09
G308	C - UA	Second Reaction	FALSE	75p	0.00291	0.00268	0.00289	1.46e-05	2.27e-07	0.000232	1.95e-07	3.43e-06	1.58e-08	5.01e-08	2.53e-09
G312	C - UA	First Reaction	FALSE	75p	0.00317	0.00291	0.00289	1.46e-05	2.22e-07	6.43e-05	3.32e-07	7.69e-06	6.26e-08	4.16e-08	2.53e-09
G312	C - UA	Second Reaction	FALSE	75p	0.00300	0.00277	0.00289	1.46e-05	2.36e-07	6.91e-05	3.48e-07	4.30e-06	5.02e-08	4.56e-08	2.53e-09
G313	C - UA	First Reaction	FALSE	75p	0.00306	0.00282	0.00289	1.46e-05	2.27e-07	0.000112	1.45e-07	3.36e-06	4.90e-07	4.40e-08	2.53e-09
G313	C - UA	Second Reaction	FALSE	75p	0.00297	0.00274	0.00289	1.46e-05	2.34e-07	0.000116	1.59e-07	3.23e-06	3.98e-07	4.69e-08	2.53e-09

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	Ca	Mg	Na	K	Ba	Si	P	Mn	Fe	Al	Sb
G314D	C - DA	Initial Soln	FALSE	median	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Initial Soln	FALSE	median	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Initial Soln	FALSE	median	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Initial Soln	FALSE	median	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Initial Soln	FALSE	median	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Initial Soln	FALSE	median	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	Speciation Model	FALSE	median	0.0131	0.00731	0.0123	8.77e-05	1.87e-07	9.51e-05	1.04e-07	2.20e-05	5.03e-05	1.83e-07	3.77e-09
G307D	C - LCU	Speciation Model	FALSE	median	0.00357	0.00260	0.00422	1.48e-05	1.96e-07	9.21e-05	2.50e-07	9.08e-06	1.07e-05	1.68e-07	4.17e-09
G301	C - UA	Speciation Model	FALSE	median	0.00278	0.00174	0.00507	4.31e-05	1.21e-07	0.000163	1.93e-07	3.95e-05	2.15e-06	2.68e-07	2.94e-09
G308	C - UA	Speciation Model	FALSE	median	0.00495	0.00484	0.00658	1.05e-05	1.58e-07	0.000185	1.77e-07	6.14e-06	1.59e-07	2.31e-07	2.12e-09
G312	C - UA	Speciation Model	FALSE	median	0.00502	0.00569	0.00457	1.64e-05	2.17e-07	0.000192	1.93e-07	7.00e-05	2.71e-07	1.90e-07	1.71e-09
G313	C - UA	Speciation Model	FALSE	median	0.00500	0.00424	0.00660	2.73e-05	1.36e-07	0.000198	1.04e-07	6.89e-06	1.28e-06	3.39e-07	1.71e-09
G314D	C - DA	First Reaction	FALSE	median	0.00300	0.00250	0.00289	1.46e-05	1.67e-07	8.09e-05	3.88e-08	6.44e-06	1.59e-05	3.21e-08	2.53e-09
G314D	C - DA	Second Reaction	FALSE	median	0.00300	0.00227	0.00289	1.46e-05	2.04e-07	0.000104	3.98e-08	5.48e-06	1.55e-05	3.09e-08	2.53e-09
G307D	C - LCU	First Reaction	FALSE	median	0.00292	0.00269	0.00289	1.46e-05	2.09e-07	0.000120	4.28e-07	3.95e-06	7.04e-06	5.27e-08	2.53e-09
G307D	C - LCU	Second Reaction	FALSE	median	0.00289	0.00266	0.00289	1.46e-05	2.26e-07	0.000134	4.50e-07	3.45e-06	5.84e-06	5.09e-08	2.53e-09
G301	C - UA	First Reaction	FALSE	median	0.00302	0.00278	0.00289	1.46e-05	2.25e-07	0.000144	1.10e-06	9.20e-06	1.38e-06	4.57e-08	2.53e-09
G301	C - UA	Second Reaction	FALSE	median	0.00295	0.00272	0.00289	1.46e-05	2.34e-07	0.000149	1.16e-06	4.52e-06	1.06e-06	4.77e-08	2.53e-09
G308	C - UA	First Reaction	FALSE	median	0.00289	0.00266	0.00289	1.46e-05	2.12e-07	0.000232	2.01e-07	3.41e-06	1.54e-08	5.17e-08	2.53e-09
G308	C - UA	Second Reaction	FALSE	median	0.00291	0.00268	0.00289	1.46e-05	2.27e-07	0.000230	1.93e-07	3.42e-06	1.58e-08	5.00e-08	2.53e-09
G312	C - UA	First Reaction	FALSE	median	0.00314	0.00289	0.00289	1.46e-05	2.24e-07	6.54e-05	3.35e-07	7.38e-06	6.11e-08	4.20e-08	2.53e-09
G312	C - UA	Second Reaction	FALSE	median	0.00300	0.00276	0.00289	1.46e-05	2.35e-07	7.33e-05	3.62e-07	4.19e-06	4.90e-08	4.59e-08	2.53e-09
G313	C - UA	First Reaction	FALSE	median	0.00305	0.00281	0.00289	1.46e-05	2.27e-07	0.000113	1.47e-07	3.35e-06	4.79e-07	4.44e-08	2.53e-09
G313	C - UA	Second Reaction	FALSE	median	0.00297	0.00273	0.00289	1.46e-05	2.34e-07	0.000119	1.65e-07	3.23e-06	3.88e-07	4.71e-08	2.53e-09

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
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Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	Be	Cd	Cr	Co	Pb	Mo	Se	Hfo_s	Hfo_w	Hao_	m_Hfo_wOH
G314D	C - DA	Initial Soln	TRUE	25p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	25p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0	0	0	0
G301	C - UA	Initial Soln	TRUE	25p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	0	0	0	0
G308	C - UA	Initial Soln	TRUE	25p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	0	0	0	0
G312	C - UA	Initial Soln	TRUE	25p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	0	0	0	0
G313	C - UA	Initial Soln	TRUE	25p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	25p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	6.00e-05	0.00240	0.00396	0.000136
G307D	C - LCU	Speciation Model	TRUE	25p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0.000285	0.0114	0.000528	0.000968
G301	C - UA	Speciation Model	TRUE	25p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	3.90e-05	0.00156	0.00323	0.000113
G308	C - UA	Speciation Model	TRUE	25p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	3.90e-05	0.00156	0.00323	9.73e-05
G312	C - UA	Speciation Model	TRUE	25p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	3.90e-05	0.00156	0.00323	5.21e-05
G313	C - UA	Speciation Model	TRUE	25p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	3.90e-05	0.00156	0.00323	7.46e-05
G314D	C - DA	First Reaction	TRUE	25p	2.37e-08	5.92e-10	1.29e-08	1.44e-08	3.01e-10	6.65e-09	2.29e-09	6.00e-05	0.00240	0.00396	0.000162
G314D	C - DA	Second Reaction	TRUE	25p	2.73e-08	6.12e-10	1.51e-08	1.47e-08	2.91e-10	4.75e-09	2.65e-09	6.00e-05	0.00240	0.00396	0.000146
G307D	C - LCU	First Reaction	TRUE	25p	2.54e-08	2.19e-09	2.69e-08	1.25e-08	1.49e-09	3.32e-08	6.68e-09	0.000285	0.0114	0.000528	0.000726
G307D	C - LCU	Second Reaction	TRUE	25p	2.72e-08	2.11e-09	2.87e-08	1.19e-08	1.47e-09	1.54e-08	6.83e-09	0.000285	0.0114	0.000528	0.000677
G301	C - UA	First Reaction	TRUE	25p	8.55e-09	1.66e-09	7.50e-09	2.02e-08	4.00e-09	5.30e-09	9.21e-10	3.90e-05	0.00156	0.00323	0.000112
G301	C - UA	Second Reaction	TRUE	25p	8.10e-09	1.36e-09	7.03e-09	1.64e-08	3.27e-09	3.96e-09	1.62e-09	3.90e-05	0.00156	0.00323	0.000112
G308	C - UA	First Reaction	TRUE	25p	2.60e-08	1.38e-09	2.39e-08	3.14e-09	9.71e-10	4.54e-09	4.92e-09	3.90e-05	0.00156	0.00323	7.78e-05
G308	C - UA	Second Reaction	TRUE	25p	2.69e-08	1.39e-09	2.48e-08	3.18e-09	9.77e-10	3.88e-09	4.60e-09	3.90e-05	0.00156	0.00323	7.82e-05
G312	C - UA	First Reaction	TRUE	25p	3.60e-09	5.83e-10	1.13e-09	1.32e-08	6.64e-10	8.57e-09	3.15e-09	3.90e-05	0.00156	0.00323	0.000149
G312	C - UA	Second Reaction	TRUE	25p	3.18e-09	4.93e-10	1.04e-09	1.08e-08	5.52e-10	4.29e-09	3.67e-09	3.90e-05	0.00156	0.00323	0.000150
G313	C - UA	First Reaction	TRUE	25p	8.68e-09	9.75e-10	6.53e-09	5.83e-09	7.99e-10	5.11e-09	3.71e-09	3.90e-05	0.00156	0.00323	0.000122
G313	C - UA	Second Reaction	TRUE	25p	8.00e-09	8.34e-10	6.08e-09	4.92e-09	6.78e-10	3.99e-09	4.18e-09	3.90e-05	0.00156	0.00323	0.000121
G314D	C - DA	Initial Soln	TRUE	75p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	75p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0	0	0	0
G301	C - UA	Initial Soln	TRUE	75p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	0	0	0	0
G308	C - UA	Initial Soln	TRUE	75p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	0	0	0	0
G312	C - UA	Initial Soln	TRUE	75p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	0	0	0	0
G313	C - UA	Initial Soln	TRUE	75p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	75p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0.000145	0.00580	0.0145	0.000328
G307D	C - LCU	Speciation Model	TRUE	75p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0.000485	0.0194	0.00198	0.00165
G301	C - UA	Speciation Model	TRUE	75p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	7.50e-05	0.00300	0.00396	0.000217
G308	C - UA	Speciation Model	TRUE	75p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	7.50e-05	0.00300	0.00396	0.000187
G312	C - UA	Speciation Model	TRUE	75p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	7.50e-05	0.00300	0.00396	0.000100
G313	C - UA	Speciation Model	TRUE	75p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	7.50e-05	0.00300	0.00396	0.000143
G314D	C - DA	First Reaction	TRUE	75p	1.96e-08	5.87e-10	1.04e-08	1.45e-08	3.28e-10	8.94e-09	2.11e-09	0.000145	0.00580	0.0145	0.000437
G314D	C - DA	Second Reaction	TRUE	75p	2.11e-08	5.72e-10	1.13e-08	1.40e-08	3.03e-10	6.25e-09	2.20e-09	0.000145	0.00580	0.0145	0.000418
G307D	C - LCU	First Reaction	TRUE	75p	2.46e-08	2.37e-09	2.62e-08	1.35e-08	1.58e-09	4.26e-08	8.19e-09	0.000485	0.0194	0.00198	0.00128
G307D	C - LCU	Second Reaction	TRUE	75p	2.61e-08	2.27e-09	2.76e-08	1.29e-08	1.55e-09	2.46e-08	7.21e-09	0.000485	0.0194	0.00198	0.00120
G301	C - UA	First Reaction	TRUE	75p	8.85e-09	1.74e-09	7.70e-09	2.14e-08	4.14e-09	6.45e-09	5.81e-10	7.50e-05	0.00300	0.00396	0.000216
G301	C - UA	Second Reaction	TRUE	75p	8.19e-09	1.43e-09	7.07e-09	1.73e-08	3.41e-09	4.15e-09	9.68e-10	7.50e-05	0.00300	0.00396	0.000222
G308	C - UA	First Reaction	TRUE	75p	2.53e-08	1.37e-09	2.33e-08	3.11e-09	9.66e-10	5.13e-09	5.11e-09	7.50e-05	0.00300	0.00396	0.000150
G308	C - UA	Second Reaction	TRUE	75p	2.68e-08	1.39e-09	2.47e-08	3.17e-09	9.77e-10	3.95e-09	4.89e-09	7.50e-05	0.00300	0.00396	0.000147
G312	C - UA	First Reaction	TRUE	75p	3.95e-09	6.19e-10	1.21e-09	1.43e-08	6.87e-10	1.21e-08	2.98e-09	7.50e-05	0.00300	0.00396	0.000278
G312	C - UA	Second Reaction	TRUE	75p	3.32e-09	5.16e-10	1.05e-09	1.15e-08	5.64e-10	5.16e-09	2.95e-09	7.50e-05	0.00300	0.00396	0.000307
G313	C - UA	First Reaction	TRUE	75p	9.24e-09	1.02e-09	6.90e-09	6.17e-09	8.33e-10	6.04e-09	3.52e-09	7.50e-05	0.00300	0.00396	0.000233
G313	C - UA	Second Reaction	TRUE	75p	8.19e-09	8.73e-10	6.16e-09	5.19e-09	7.07e-10	4.21e-09	3.63e-09	7.50e-05	0.00300	0.00396	0.000244
G314D	C - DA	Initial Soln	TRUE	median	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	median	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0	0	0	0
G301	C - UA	Initial Soln	TRUE	median	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	0	0	0	0
G308	C - UA	Initial Soln	TRUE	median	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	0	0	0	0
G312	C - UA	Initial Soln	TRUE	median	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	0	0	0	0
G313	C - UA	Initial Soln	TRUE	median	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	median	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	9.00e-05	0.00360	0.00957	0.000203
G307D	C - LCU	Speciation Model	TRUE	median	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0.000385	0.0154	0.000792	0.00131
G301	C - UA	Speciation Model	TRUE	median	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	6.50e-05	0.00260	0.00363	0.000188
G308	C - UA	Speciation Model	TRUE	median	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	6.50e-05	0.00260	0.00363	0.000162
G312	C - UA	Speciation Model	TRUE	median	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	6.50e-05	0.00260	0.00363	8.69e-05
G313	C - UA	Speciation Model	TRUE	median	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	6.50e-05	0.00260	0.00363	0.000124

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Location	Location Description	Model	Charge Balance	Solids Summary	Be	Cd	Cr	Co	Pb	Mo	Se	Hfo_s	Hfo_w	Hao_	m_Hfo_wOH
G314D	C - DA	First Reaction	TRUE	median	2.04e-08	5.81e-10	1.09e-08	1.43e-08	3.17e-10	7.72e-09	2.19e-09	9.00e-05	0.00360	0.00957	0.000264
G314D	C - DA	Second Reaction	TRUE	median	2.31e-08	5.79e-10	1.25e-08	1.41e-08	2.95e-10	5.31e-09	2.42e-09	9.00e-05	0.00360	0.00957	0.000242
G307D	C - LCU	First Reaction	TRUE	median	2.49e-08	2.24e-09	2.64e-08	1.27e-08	1.50e-09	3.85e-08	6.94e-09	0.000385	0.0154	0.000792	0.00100
G307D	C - LCU	Second Reaction	TRUE	median	2.66e-08	2.14e-09	2.81e-08	1.21e-08	1.48e-09	2.02e-08	6.75e-09	0.000385	0.0154	0.000792	0.000937
G301	C - UA	First Reaction	TRUE	median	8.76e-09	1.71e-09	7.63e-09	2.10e-08	4.07e-09	6.15e-09	6.40e-10	6.50e-05	0.00260	0.00363	0.000188
G301	C - UA	Second Reaction	TRUE	median	8.15e-09	1.40e-09	7.04e-09	1.69e-08	3.34e-09	4.09e-09	1.09e-09	6.50e-05	0.00260	0.00363	0.000191
G308	C - UA	First Reaction	TRUE	median	2.55e-08	1.38e-09	2.35e-08	3.12e-09	9.67e-10	4.97e-09	5.08e-09	6.50e-05	0.00260	0.00363	0.000130
G308	C - UA	Second Reaction	TRUE	median	2.68e-08	1.39e-09	2.47e-08	3.17e-09	9.77e-10	3.92e-09	4.82e-09	6.50e-05	0.00260	0.00363	0.000128
G312	C - UA	First Reaction	TRUE	median	3.86e-09	6.07e-10	1.19e-09	1.39e-08	6.76e-10	1.12e-08	2.99e-09	6.50e-05	0.00260	0.00363	0.000244
G312	C - UA	Second Reaction	TRUE	median	3.28e-09	5.07e-10	1.04e-09	1.13e-08	5.55e-10	4.89e-09	3.07e-09	6.50e-05	0.00260	0.00363	0.000264
G313	C - UA	First Reaction	TRUE	median	9.09e-09	1.01e-09	6.79e-09	6.06e-09	8.20e-10	5.79e-09	3.54e-09	6.50e-05	0.00260	0.00363	0.000203
G313	C - UA	Second Reaction	TRUE	median	8.13e-09	8.58e-10	6.13e-09	5.09e-09	6.95e-10	4.14e-09	3.73e-09	6.50e-05	0.00260	0.00363	0.000210
G314D	C - DA	Initial Soln	FALSE	25p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	25p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0	0	0	0
G301	C - UA	Initial Soln	FALSE	25p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	0	0	0	0
G308	C - UA	Initial Soln	FALSE	25p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	0	0	0	0
G312	C - UA	Initial Soln	FALSE	25p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	0	0	0	0
G313	C - UA	Initial Soln	FALSE	25p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	25p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	6.00e-05	0.00240	0.00396	0.000135
G307D	C - LCU	Speciation Model	FALSE	25p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0.000285	0.0114	0.000528	0.000967
G301	C - UA	Speciation Model	FALSE	25p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	3.90e-05	0.00156	0.00323	0.000112
G308	C - UA	Speciation Model	FALSE	25p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	3.90e-05	0.00156	0.00323	9.72e-05
G312	C - UA	Speciation Model	FALSE	25p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	3.90e-05	0.00156	0.00323	5.20e-05
G313	C - UA	Speciation Model	FALSE	25p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	3.90e-05	0.00156	0.00323	7.44e-05
G314D	C - DA	First Reaction	FALSE	25p	2.28e-08	1.05e-09	1.29e-08	1.57e-08	3.22e-10	6.99e-09	2.39e-09	6.00e-05	0.00240	0.00396	0.000164
G314D	C - DA	Second Reaction	FALSE	25p	2.67e-08	1.08e-09	1.55e-08	1.61e-08	3.09e-10	4.83e-09	2.76e-09	6.00e-05	0.00240	0.00396	0.000147
G307D	C - LCU	First Reaction	FALSE	25p	2.53e-08	2.35e-09	2.69e-08	1.26e-08	1.49e-09	3.35e-08	6.74e-09	0.000285	0.0114	0.000528	0.000727
G307D	C - LCU	Second Reaction	FALSE	25p	2.72e-08	2.26e-09	2.88e-08	1.21e-08	1.48e-09	1.55e-08	6.87e-09	0.000285	0.0114	0.000528	0.000677
G301	C - UA	First Reaction	FALSE	25p	8.55e-09	1.82e-09	7.59e-09	2.07e-08	4.10e-09	5.32e-09	9.22e-10	3.90e-05	0.00156	0.00323	0.000112
G301	C - UA	Second Reaction	FALSE	25p	8.11e-09	1.49e-09	7.11e-09	1.68e-08	3.36e-09	3.96e-09	1.62e-09	3.90e-05	0.00156	0.00323	0.000112
G308	C - UA	First Reaction	FALSE	25p	2.59e-08	1.52e-09	2.40e-08	3.18e-09	9.79e-10	4.55e-09	4.96e-09	3.90e-05	0.00156	0.00323	7.79e-05
G308	C - UA	Second Reaction	FALSE	25p	2.69e-08	1.53e-09	2.49e-08	3.23e-09	9.86e-10	3.88e-09	4.62e-09	3.90e-05	0.00156	0.00323	7.83e-05
G312	C - UA	First Reaction	FALSE	25p	3.60e-09	7.00e-10	1.16e-09	1.38e-08	6.96e-10	8.70e-09	3.18e-09	3.90e-05	0.00156	0.00323	0.000149
G312	C - UA	Second Reaction	FALSE	25p	3.18e-09	5.90e-10	1.06e-09	1.13e-08	5.79e-10	4.30e-09	3.70e-09	3.90e-05	0.00156	0.00323	0.000150
G313	C - UA	First Reaction	FALSE	25p	8.65e-09	1.23e-09	6.61e-09	6.10e-09	8.30e-10	5.16e-09	3.76e-09	3.90e-05	0.00156	0.00323	0.000122
G313	C - UA	Second Reaction	FALSE	25p	7.98e-09	1.05e-09	6.16e-09	5.16e-09	7.06e-10	4.00e-09	4.23e-09	3.90e-05	0.00156	0.00323	0.000121
G314D	C - DA	Initial Soln	FALSE	75p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	75p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0	0	0	0
G301	C - UA	Initial Soln	FALSE	75p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	0	0	0	0
G308	C - UA	Initial Soln	FALSE	75p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	0	0	0	0
G312	C - UA	Initial Soln	FALSE	75p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	0	0	0	0
G313	C - UA	Initial Soln	FALSE	75p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	75p	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0.000145	0.00580	0.0145	0.000325
G307D	C - LCU	Speciation Model	FALSE	75p	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0.000485	0.0194	0.00198	0.00165
G301	C - UA	Speciation Model	FALSE	75p	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	7.50e-05	0.00300	0.00396	0.000216
G308	C - UA	Speciation Model	FALSE	75p	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	7.50e-05	0.00300	0.00396	0.000187
G312	C - UA	Speciation Model	FALSE	75p	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	7.50e-05	0.00300	0.00396	0.000100
G313	C - UA	Speciation Model	FALSE	75p	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	7.50e-05	0.00300	0.00396	0.000143
G314D	C - DA	First Reaction	FALSE	75p	1.85e-08	1.05e-09	1.02e-08	1.59e-08	3.58e-10	9.61e-09	2.20e-09	0.000145	0.00580	0.0145	0.000448
G314D	C - DA	Second Reaction	FALSE	75p	2.02e-08	1.02e-09	1.13e-08	1.52e-08	3.24e-10	6.49e-09	2.29e-09	0.000145	0.00580	0.0145	0.000426
G307D	C - LCU	First Reaction	FALSE	75p	2.45e-08	2.54e-09	2.62e-08	1.36e-08	1.59e-09	4.30e-08	8.35e-09	0.000485	0.0194	0.00198	0.00128
G307D	C - LCU	Second Reaction	FALSE	75p	2.60e-08	2.44e-09	2.77e-08	1.30e-08	1.56e-09	2.48e-08	7.29e-09	0.000485	0.0194	0.00198	0.00120
G301	C - UA	First Reaction	FALSE	75p	8.85e-09	1.91e-09	7.78e-09	2.19e-08	4.25e-09	6.49e-09	5.82e-10	7.50e-05	0.00300	0.00396	0.000216
G301	C - UA	Second Reaction	FALSE	75p	8.19e-09	1.56e-09	7.15e-09	1.77e-08	3.50e-09	4.15e-09	9.68e-10	7.50e-05	0.00300	0.00396	0.000222
G308	C - UA	First Reaction	FALSE	75p	2.53e-08	1.51e-09	2.33e-08	3.15e-09	9.73e-10	5.15e-09	5.15e-09	7.50e-05	0.00300	0.00396	0.000150
G308	C - UA	Second Reaction	FALSE	75p	2.68e-08	1.53e-09	2.47e-08	3.21e-09	9.85e-10	3.95e-09	4.93e-09	7.50e-05	0.00300	0.00396	0.000148
G312	C - UA	First Reaction	FALSE	75p	3.95e-09	7.44e-10	1.23e-09	1.49e-08	7.20e-10	1.24e-08	3.01e-09	7.50e-05	0.00300	0.00396	0.000278
G312	C - UA	Second Reaction	FALSE	75p	3.31e-09	6.18e-10	1.07e-09	1.20e-08	5.91e-10	5.19e-09	2.99e-09	7.50e-05	0.00300	0.00396	0.000307
G313	C - UA	First Reaction	FALSE	75p	9.21e-09	1.29e-09	6.98e-09	6.46e-09	8.65e-10	6.13e-09	3.57e-09	7.50e-05	0.00300	0.00396	0.000233
G313	C - UA	Second Reaction	FALSE	75p	8.17e-09	1.10e-09	6.24e-09	5.43e-09	7.35e-10	4.22e-09	3.67e-09	7.50e-05	0.00300	0.00396	0.000245

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Location	Location Description	Model	Charge Balance	Solids Summary	Be	Cd	Cr	Co	Pb	Mo	Se	Hfo_s	Hfo_w	Hao_	m_Hfo_wOH
G314D	C - DA	Initial Soln	FALSE	median	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	median	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0	0	0	0
G301	C - UA	Initial Soln	FALSE	median	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	0	0	0	0
G308	C - UA	Initial Soln	FALSE	median	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	0	0	0	0
G312	C - UA	Initial Soln	FALSE	median	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	0	0	0	0
G313	C - UA	Initial Soln	FALSE	median	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	median	2.48e-08	2.10e-09	1.69e-08	4.51e-08	9.92e-10	3.71e-08	4.25e-09	9.00e-05	0.00360	0.00957	0.000202
G307D	C - LCU	Speciation Model	FALSE	median	2.19e-08	2.09e-09	2.31e-08	1.38e-08	9.90e-10	5.01e-08	4.25e-09	0.000385	0.0154	0.000792	0.00131
G301	C - UA	Speciation Model	FALSE	median	2.47e-08	2.09e-09	2.31e-08	2.80e-08	1.84e-09	3.50e-09	4.25e-09	6.50e-05	0.00260	0.00363	0.000187
G308	C - UA	Speciation Model	FALSE	median	2.20e-08	2.09e-09	2.22e-08	5.44e-09	9.91e-10	1.57e-08	4.25e-09	6.50e-05	0.00260	0.00363	0.000162
G312	C - UA	Speciation Model	FALSE	median	3.31e-08	2.09e-09	1.69e-08	5.10e-08	9.91e-10	1.76e-08	4.25e-09	6.50e-05	0.00260	0.00363	8.67e-05
G313	C - UA	Speciation Model	FALSE	median	2.47e-08	2.09e-09	2.12e-08	1.33e-08	9.91e-10	1.25e-08	4.25e-09	6.50e-05	0.00260	0.00363	0.000124
G314D	C - DA	First Reaction	FALSE	median	1.93e-08	1.04e-09	1.07e-08	1.56e-08	3.43e-10	8.21e-09	2.28e-09	9.00e-05	0.00360	0.00957	0.000269
G314D	C - DA	Second Reaction	FALSE	median	2.22e-08	1.03e-09	1.26e-08	1.53e-08	3.14e-10	5.44e-09	2.53e-09	9.00e-05	0.00360	0.00957	0.000246
G307D	C - LCU	First Reaction	FALSE	median	2.49e-08	2.40e-09	2.65e-08	1.29e-08	1.51e-09	3.88e-08	7.03e-09	0.000385	0.0154	0.000792	0.00100
G307D	C - LCU	Second Reaction	FALSE	median	2.65e-08	2.30e-09	2.81e-08	1.23e-08	1.49e-09	2.04e-08	6.79e-09	0.000385	0.0154	0.000792	0.000937
G301	C - UA	First Reaction	FALSE	median	8.76e-09	1.87e-09	7.71e-09	2.14e-08	4.17e-09	6.18e-09	6.40e-10	6.50e-05	0.00260	0.00363	0.000188
G301	C - UA	Second Reaction	FALSE	median	8.16e-09	1.53e-09	7.11e-09	1.73e-08	3.43e-09	4.09e-09	1.09e-09	6.50e-05	0.00260	0.00363	0.000191
G308	C - UA	First Reaction	FALSE	median	2.55e-08	1.51e-09	2.35e-08	3.16e-09	9.75e-10	4.99e-09	5.11e-09	6.50e-05	0.00260	0.00363	0.000130
G308	C - UA	Second Reaction	FALSE	median	2.68e-08	1.53e-09	2.48e-08	3.21e-09	9.85e-10	3.92e-09	4.86e-09	6.50e-05	0.00260	0.00363	0.000128
G312	C - UA	First Reaction	FALSE	median	3.85e-09	7.29e-10	1.21e-09	1.45e-08	7.08e-10	1.14e-08	3.02e-09	6.50e-05	0.00260	0.00363	0.000244
G312	C - UA	Second Reaction	FALSE	median	3.27e-09	6.07e-10	1.06e-09	1.17e-08	5.82e-10	4.92e-09	3.11e-09	6.50e-05	0.00260	0.00363	0.000264
G313	C - UA	First Reaction	FALSE	median	9.06e-09	1.27e-09	6.88e-09	6.34e-09	8.52e-10	5.87e-09	3.59e-09	6.50e-05	0.00260	0.00363	0.000203
G313	C - UA	Second Reaction	FALSE	median	8.11e-09	1.08e-09	6.21e-09	5.33e-09	7.23e-10	4.15e-09	3.78e-09	6.50e-05	0.00260	0.00363	0.000210

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Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_wOH2+	m_Hfo_wOHSO4-2	m_Hfo_wSO4-	m_Hfo_wOSi(OH)3	m_Hfo_wOSiO(OH)2-	m_Hfo_wHCO3	m_Hfo_wCO3-	m_Hfo_wPO4-2	m_Hfo_wHPO4-	m_Hfo_wH2PO4	m_Hfo_sCO3-
G314D	C - DA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	25p	0.000108	1.86e-05	7.39e-06	0.000250	0.000194	0.00103	0.000219	2.27e-06	4.33e-06	1.40e-07	4.96e-08
G307D	C - LCU	Speciation Model	TRUE	25p	0.000453	8.96e-05	2.10e-05	0.00171	0.00225	0.00154	0.000558	6.30e-05	7.08e-05	1.35e-06	4.38e-08
G301	C - UA	Speciation Model	TRUE	25p	0.000139	2.98e-05	1.84e-05	0.000351	0.000175	0.000405	5.57e-05	8.84e-06	2.62e-05	1.32e-06	1.20e-08
G308	C - UA	Speciation Model	TRUE	25p	5.02e-05	8.32e-06	2.15e-06	0.000345	0.000413	0.000139	4.58e-05	2.39e-06	2.95e-06	6.20e-08	4.33e-09
G312	C - UA	Speciation Model	TRUE	25p	0.000120	1.95e-05	2.25e-05	0.000192	5.15e-05	0.000900	6.64e-05	2.37e-06	1.31e-05	1.22e-06	4.88e-08
G313	C - UA	Speciation Model	TRUE	25p	7.92e-05	9.94e-06	5.29e-06	0.000283	0.000164	0.000604	9.67e-05	1.71e-06	4.37e-06	1.89e-07	2.08e-08
G314D	C - DA	First Reaction	TRUE	25p	0.000122	9.97e-06	3.77e-06	0.000302	0.000247	0.000922	0.000208	2.48e-06	4.49e-06	1.38e-07	5.01e-08
G314D	C - DA	Second Reaction	TRUE	25p	0.000120	8.37e-06	3.44e-06	0.000357	0.000268	0.000893	0.000185	2.46e-06	4.85e-06	1.62e-07	4.47e-08
G307D	C - LCU	First Reaction	TRUE	25p	0.000335	1.35e-05	3.13e-06	0.00173	0.00231	0.00178	0.000657	6.35e-05	7.03e-05	1.32e-06	5.16e-08
G307D	C - LCU	Second Reaction	TRUE	25p	0.000328	1.18e-05	2.87e-06	0.00180	0.00229	0.00183	0.000642	6.18e-05	7.18e-05	1.42e-06	5.08e-08
G301	C - UA	First Reaction	TRUE	25p	8.58e-05	9.86e-07	3.78e-07	0.000321	0.000259	0.000373	8.28e-05	1.23e-05	2.26e-05	7.04e-07	1.29e-08
G301	C - UA	Second Reaction	TRUE	25p	8.59e-05	8.46e-07	3.27e-07	0.000345	0.000276	0.000337	7.43e-05	1.20e-05	2.21e-05	6.94e-07	1.16e-08
G308	C - UA	First Reaction	TRUE	25p	4.16e-05	1.14e-06	3.05e-07	0.000340	0.000392	0.000203	6.46e-05	2.43e-06	3.11e-06	6.79e-08	6.27e-09
G308	C - UA	Second Reaction	TRUE	25p	4.16e-05	1.17e-06	3.11e-07	0.000331	0.000383	0.000218	6.95e-05	2.53e-06	3.22e-06	6.99e-08	6.75e-09
G312	C - UA	First Reaction	TRUE	25p	0.000117	1.53e-06	6.03e-07	0.000209	0.000164	0.000590	0.000127	5.66e-06	1.07e-05	3.44e-07	6.63e-08
G312	C - UA	Second Reaction	TRUE	25p	0.000120	1.15e-06	4.60e-07	0.000271	0.000210	0.000487	0.000104	5.62e-06	1.07e-05	3.47e-07	5.11e-08
G313	C - UA	First Reaction	TRUE	25p	8.43e-05	1.41e-06	4.89e-07	0.000280	0.000250	0.000430	0.000106	2.41e-06	3.99e-06	1.12e-07	2.03e-08
G313	C - UA	Second Reaction	TRUE	25p	8.51e-05	1.13e-06	3.98e-07	0.000317	0.000278	0.000374	9.02e-05	2.46e-06	4.15e-06	1.19e-07	1.69e-08
G314D	C - DA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	75p	0.000260	4.48e-05	1.79e-05	0.000603	0.000468	0.00248	0.000530	5.49e-06	1.05e-05	3.39e-07	1.20e-07
G307D	C - LCU	Speciation Model	TRUE	75p	0.000772	0.000152	3.58e-05	0.00290	0.00382	0.00262	0.000949	0.000107	0.000120	2.30e-06	7.46e-08
G301	C - UA	Speciation Model	TRUE	75p	0.000268	5.72e-05	3.55e-05	0.000675	0.000337	0.000779	0.000107	1.70e-05	5.04e-05	2.54e-06	2.30e-08
G308	C - UA	Speciation Model	TRUE	75p	9.66e-05	1.60e-05	4.14e-06	0.000664	0.000794	0.000267	8.80e-05	4.59e-06	5.68e-06	1.19e-07	8.34e-09
G312	C - UA	Speciation Model	TRUE	75p	0.000231	3.75e-05	4.32e-05	0.000369	9.90e-05	0.00173	0.000128	4.55e-06	2.51e-05	2.35e-06	9.38e-08
G313	C - UA	Speciation Model	TRUE	75p	0.000152	1.91e-05	1.02e-05	0.000544	0.000316	0.00116	0.000186	3.30e-06	8.40e-06	3.63e-07	4.00e-08
G314D	C - DA	First Reaction	TRUE	75p	0.000302	2.91e-05	1.01e-05	0.000633	0.000565	0.00224	0.000550	6.16e-06	1.02e-05	2.87e-07	1.32e-07
G314D	C - DA	Second Reaction	TRUE	75p	0.000301	2.20e-05	7.95e-06	0.000707	0.000606	0.00219	0.000517	6.13e-06	1.06e-05	3.10e-07	1.24e-07
G307D	C - LCU	First Reaction	TRUE	75p	0.000576	2.50e-05	5.63e-06	0.00287	0.00394	0.00299	0.00113	0.000109	0.000118	2.17e-06	8.81e-08
G307D	C - LCU	Second Reaction	TRUE	75p	0.000565	2.11e-05	4.97e-06	0.00298	0.00391	0.00308	0.00111	0.000107	0.000121	2.31e-06	8.77e-08
G301	C - UA	First Reaction	TRUE	75p	0.000165	2.08e-06	7.95e-07	0.000592	0.000479	0.000756	0.000168	2.40e-05	4.39e-05	1.37e-06	2.65e-08
G301	C - UA	Second Reaction	TRUE	75p	0.000166	1.83e-06	6.90e-07	0.000619	0.000509	0.000692	0.000157	2.40e-05	4.32e-05	1.32e-06	2.46e-08
G308	C - UA	First Reaction	TRUE	75p	8.01e-05	2.11e-06	5.66e-07	0.000664	0.000764	0.000374	0.000118	4.58e-06	5.88e-06	1.28e-07	1.15e-08
G308	C - UA	Second Reaction	TRUE	75p	7.95e-05	2.10e-06	5.68e-07	0.000653	0.000746	0.000402	0.000127	4.65e-06	6.01e-06	1.32e-07	1.23e-08
G312	C - UA	First Reaction	TRUE	75p	0.000221	3.31e-06	1.32e-06	0.000342	0.000265	0.00125	0.000267	1.08e-05	2.06e-05	6.69e-07	1.45e-07
G312	C - UA	Second Reaction	TRUE	75p	0.000229	2.91e-06	1.09e-06	0.000405	0.000336	0.00107	0.000244	1.13e-05	2.02e-05	6.14e-07	1.25e-07
G313	C - UA	First Reaction	TRUE	75p	0.000160	3.02e-06	1.04e-06	0.000501	0.000449	0.000893	0.000220	4.57e-06	7.54e-06	2.11e-07	4.28e-08
G313	C - UA	Second Reaction	TRUE	75p	0.000164	2.64e-06	8.87e-07	0.000540	0.000497	0.000792	0.000200	4.74e-06	7.62e-06	2.08e-07	3.81e-08
G314D	C - DA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	median	0.000162	2.78e-05	1.11e-05	0.000374	0.000291	0.00154	0.000329	3.41e-06	6.49e-06	2.10e-07	7.45e-08
G307D	C - LCU	Speciation Model	TRUE	median	0.000613	0.000121	2.84e-05	0.00230	0.00303	0.00208	0.000754	8.51e-05	9.56e-05	1.82e-06	5.92e-08
G301	C - UA	Speciation Model	TRUE	median	0.000232	4.96e-05	3.07e-05	0.000585	0.000292	0.000675	9.28e-05	1.47e-05	4.37e-05	2.20e-06	2.00e-08
G308	C - UA	Speciation Model	TRUE	median	8.37e-05	1.39e-05	3.59e-06	0.000575	0.000688	0.000232	7.63e-05	3.98e-06	4.92e-06	1.03e-07	7.22e-09
G312	C - UA	Speciation Model	TRUE	median	0.000200	3.25e-05	3.75e-05	0.000320	8.58e-05	0.00150	0.000111	3.94e-06	2.18e-05	2.04e-06	8.13e-08
G313	C - UA	Speciation Model	TRUE	median	0.000132	1.66e-05	8.82e-06	0.000471	0.000274	0.00101	0.000161	2.86e-06	7.28e-06	3.15e-07	3.46e-08

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_wOH2+	m_Hfo_wOHSO4-2	m_Hfo_wSO4-	m_Hfo_wOSi(OH)3	m_Hfo_wOSiO(OH)2-	m_Hfo_wHCO3	m_Hfo_wCO3-	m_Hfo_wPO4-2	m_Hfo_wHPO4-	m_Hfo_wH2PO4	m_Hfo_sCO3-
G314D	C - DA	First Reaction	TRUE	median	0.000187	1.63e-05	5.80e-06	0.000420	0.000365	0.00137	0.000329	3.81e-06	6.48e-06	1.87e-07	7.88e-08
G314D	C - DA	Second Reaction	TRUE	median	0.000185	1.28e-05	4.87e-06	0.000488	0.000395	0.00134	0.000299	3.76e-06	6.87e-06	2.13e-07	7.18e-08
G307D	C - LCU	First Reaction	TRUE	median	0.000455	1.90e-05	4.34e-06	0.00230	0.00312	0.00239	0.000893	8.64e-05	9.43e-05	1.75e-06	7.00e-08
G307D	C - LCU	Second Reaction	TRUE	median	0.000446	1.64e-05	3.92e-06	0.00239	0.00310	0.00246	0.000878	8.43e-05	9.63e-05	1.87e-06	6.93e-08
G301	C - UA	First Reaction	TRUE	median	0.000143	1.77e-06	6.76e-07	0.000517	0.000418	0.000648	0.000144	2.08e-05	3.80e-05	1.18e-06	2.27e-08
G301	C - UA	Second Reaction	TRUE	median	0.000144	1.55e-06	5.86e-07	0.000544	0.000445	0.000591	0.000133	2.07e-05	3.74e-05	1.15e-06	2.10e-08
G308	C - UA	First Reaction	TRUE	median	6.94e-05	1.84e-06	4.93e-07	0.000574	0.000660	0.000327	0.000104	3.98e-06	5.11e-06	1.12e-07	1.01e-08
G308	C - UA	Second Reaction	TRUE	median	6.90e-05	1.85e-06	4.98e-07	0.000563	0.000645	0.000352	0.000111	4.06e-06	5.24e-06	1.15e-07	1.08e-08
G312	C - UA	First Reaction	TRUE	median	0.000193	2.82e-06	1.12e-06	0.000305	0.000238	0.00106	0.000228	9.41e-06	1.79e-05	5.75e-07	1.23e-07
G312	C - UA	Second Reaction	TRUE	median	0.000199	2.40e-06	9.06e-07	0.000370	0.000303	0.000902	0.000204	9.75e-06	1.76e-05	5.39e-07	1.04e-07
G313	C - UA	First Reaction	TRUE	median	0.000139	2.57e-06	8.83e-07	0.000440	0.000395	0.000762	0.000188	3.98e-06	6.55e-06	1.83e-07	3.65e-08
G313	C - UA	Second Reaction	TRUE	median	0.000142	2.20e-06	7.47e-07	0.000480	0.000438	0.000672	0.000169	4.11e-06	6.66e-06	1.84e-07	3.21e-08
G314D	C - DA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	25p	0.000106	1.92e-05	7.58e-06	0.000247	0.000194	0.00103	0.000222	2.31e-06	4.36e-06	1.39e-07	4.90e-08
G307D	C - LCU	Speciation Model	FALSE	25p	0.000453	9.01e-05	2.11e-05	0.00170	0.00224	0.00154	0.000558	6.31e-05	7.09e-05	1.35e-06	4.38e-08
G301	C - UA	Speciation Model	FALSE	25p	0.000139	3.01e-05	1.86e-05	0.000350	0.000175	0.000405	5.58e-05	8.88e-06	2.63e-05	1.32e-06	1.19e-08
G308	C - UA	Speciation Model	FALSE	25p	5.01e-05	8.39e-06	2.17e-06	0.000345	0.000413	0.000139	4.59e-05	2.40e-06	2.96e-06	6.21e-08	4.33e-09
G312	C - UA	Speciation Model	FALSE	25p	0.000119	1.99e-05	2.28e-05	0.000192	5.16e-05	0.000900	6.68e-05	2.40e-06	1.32e-05	1.23e-06	4.87e-08
G313	C - UA	Speciation Model	FALSE	25p	7.86e-05	1.02e-05	5.38e-06	0.000282	0.000164	0.000605	9.72e-05	1.73e-06	4.40e-06	1.89e-07	2.07e-08
G314D	C - DA	First Reaction	FALSE	25p	0.000124	9.61e-06	3.62e-06	0.000301	0.000247	0.000920	0.000208	2.51e-06	4.52e-06	1.38e-07	4.89e-08
G314D	C - DA	Second Reaction	FALSE	25p	0.000121	8.23e-06	3.39e-06	0.000357	0.000267	0.000893	0.000184	2.48e-06	4.89e-06	1.64e-07	4.35e-08
G307D	C - LCU	First Reaction	FALSE	25p	0.000336	1.35e-05	3.12e-06	0.00172	0.00230	0.00178	0.000656	6.35e-05	7.04e-05	1.33e-06	5.14e-08
G307D	C - LCU	Second Reaction	FALSE	25p	0.000328	1.18e-05	2.87e-06	0.00180	0.00229	0.00183	0.000641	6.19e-05	7.20e-05	1.42e-06	5.06e-08
G301	C - UA	First Reaction	FALSE	25p	8.58e-05	9.85e-07	3.78e-07	0.000321	0.000259	0.000373	8.28e-05	1.24e-05	2.27e-05	7.07e-07	1.27e-08
G301	C - UA	Second Reaction	FALSE	25p	8.59e-05	8.46e-07	3.27e-07	0.000345	0.000276	0.000337	7.43e-05	1.20e-05	2.22e-05	6.97e-07	1.15e-08
G308	C - UA	First Reaction	FALSE	25p	4.17e-05	1.13e-06	3.04e-07	0.000340	0.000392	0.000203	6.45e-05	2.43e-06	3.12e-06	6.81e-08	6.24e-09
G308	C - UA	Second Reaction	FALSE	25p	4.17e-05	1.16e-06	3.11e-07	0.000331	0.000383	0.000218	6.94e-05	2.53e-06	3.24e-06	7.02e-08	6.73e-09
G312	C - UA	First Reaction	FALSE	25p	0.000117	1.52e-06	6.02e-07	0.000209	0.000164	0.000589	0.000127	5.70e-06	1.08e-05	3.46e-07	6.56e-08
G312	C - UA	Second Reaction	FALSE	25p	0.000120	1.15e-06	4.60e-07	0.000271	0.000210	0.000486	0.000104	5.65e-06	1.08e-05	3.50e-07	5.05e-08
G313	C - UA	First Reaction	FALSE	25p	8.44e-05	1.41e-06	4.88e-07	0.000280	0.000250	0.000430	0.000106	2.43e-06	4.02e-06	1.13e-07	2.01e-08
G313	C - UA	Second Reaction	FALSE	25p	8.53e-05	1.13e-06	3.98e-07	0.000317	0.000278	0.000374	9.02e-05	2.48e-06	4.18e-06	1.20e-07	1.68e-08
G314D	C - DA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	75p	0.000256	4.64e-05	1.83e-05	0.000597	0.000468	0.00248	0.000536	5.58e-06	1.05e-05	3.37e-07	1.19e-07
G307D	C - LCU	Speciation Model	FALSE	75p	0.000771	0.000153	3.60e-05	0.00290	0.00382	0.00262	0.000950	0.000107	0.000121	2.30e-06	7.45e-08
G301	C - UA	Speciation Model	FALSE	75p	0.000267	5.78e-05	3.58e-05	0.000674	0.000337	0.000779	0.000107	1.71e-05	5.06e-05	2.54e-06	2.30e-08
G308	C - UA	Speciation Model	FALSE	75p	9.63e-05	1.61e-05	4.17e-06	0.000663	0.000794	0.000268	8.83e-05	4.61e-06	5.69e-06	1.20e-07	8.33e-09
G312	C - UA	Speciation Model	FALSE	75p	0.000229	3.82e-05	4.38e-05	0.000368	9.92e-05	0.00173	0.000128	4.61e-06	2.53e-05	2.36e-06	9.37e-08
G313	C - UA	Speciation Model	FALSE	75p	0.000151	1.95e-05	1.04e-05	0.000542	0.000316	0.00116	0.000187	3.34e-06	8.46e-06	3.64e-07	3.99e-08
G314D	C - DA	First Reaction	FALSE	75p	0.000305	2.72e-05	9.29e-06	0.000627	0.000568	0.00222	0.000554	6.28e-06	1.03e-05	2.84e-07	1.29e-07
G314D	C - DA	Second Reaction	FALSE	75p	0.000305	2.14e-05	7.67e-06	0.000704	0.000607	0.00218	0.000518	6.21e-06	1.07e-05	3.11e-07	1.21e-07
G307D	C - LCU	First Reaction	FALSE	75p	0.000577	2.49e-05	5.63e-06	0.00287	0.00393	0.00299	0.00113	0.000110	0.000118	2.18e-06	8.78e-08
G307D	C - LCU	Second Reaction	FALSE	75p	0.000566	2.10e-05	4.96e-06	0.00297	0.00390	0.00308	0.00111	0.000107	0.000121	2.31e-06	8.74e-08
G301	C - UA	First Reaction	FALSE	75p	0.000165	2.08e-06	7.95e-07	0.000592	0.000478	0.000756	0.000168	2.41e-05	4.41e-05	1.37e-06	2.62e-08
G301	C - UA	Second Reaction	FALSE	75p	0.000166	1.83e-06	6.90e-07	0.000619	0.000509	0.000692	0.000157	2.41e-05	4.34e-05	1.32e-06	2.44e-08
G308	C - UA	First Reaction	FALSE	75p	8.02e-05	2.11e-06	5.66e-07	0.000663	0.000764	0.000373	0.000118	4.59e-06	5.90e-06	1.29e-07	1.14e-08
G308	C - UA	Second Reaction	FALSE	75p	7.96e-05	2.10e-06	5.67e-07	0.000653	0.000746	0.000403	0.000127	4.66e-06	6.04e-06	1.33e-07	1.23e-08
G312	C - UA	First Reaction	FALSE	75p	0.000221	3.31e-06	1.32e-06	0.000342	0.000265	0.00125	0.000267	1.09e-05	2.08e-05	6.74e-07	1.43e-07
G312	C - UA	Second Reaction	FALSE	75p	0.000229	2.91e-06	1.08e-06	0.000405	0.000335	0.00107	0.000244	1.14e-05	2.04e-05	6.18e-07	1.24e-07
G313	C - UA	First Reaction	FALSE	75p	0.000160	3.01e-06	1.04e-06	0.000500	0.000448	0.000894	0.000221	4.60e-06	7.60e-06	2.13e-07	4.24e-08
G313	C - UA	Second Reaction	FALSE	75p	0.000164	2.64e-06	8.87e-07	0.000540	0.000496	0.000792	0.000200	4.77e-06	7.68e-06	2.10e-07	3.78e-08

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Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_wOH2+	m_Hfo_wOHSO4-2	m_Hfo_wSO4-	m_Hfo_wOSi(OH)3	m_Hfo_wOSiO(OH)2-	m_Hfo_wHCO3	m_Hfo_wCO3-	m_Hfo_wPO4-2	m_Hfo_wHPO4-	m_Hfo_wH2PO4	m_Hfo_sCO3-
G314D	C - DA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	median	0.000159	2.88e-05	1.14e-05	0.000371	0.000291	0.00154	0.000333	3.47e-06	6.53e-06	2.09e-07	7.36e-08
G307D	C - LCU	Speciation Model	FALSE	median	0.000612	0.000122	2.86e-05	0.00230	0.00303	0.00208	0.000754	8.53e-05	9.57e-05	1.83e-06	5.91e-08
G301	C - UA	Speciation Model	FALSE	median	0.000231	5.01e-05	3.10e-05	0.000584	0.000292	0.000675	9.29e-05	1.48e-05	4.38e-05	2.20e-06	1.99e-08
G308	C - UA	Speciation Model	FALSE	median	8.35e-05	1.40e-05	3.61e-06	0.000575	0.000688	0.000232	7.65e-05	3.99e-06	4.94e-06	1.04e-07	7.22e-09
G312	C - UA	Speciation Model	FALSE	median	0.000198	3.31e-05	3.80e-05	0.000319	8.60e-05	0.00150	0.000111	3.99e-06	2.19e-05	2.04e-06	8.12e-08
G313	C - UA	Speciation Model	FALSE	median	0.000131	1.69e-05	8.97e-06	0.000469	0.000274	0.00101	0.000162	2.89e-06	7.33e-06	3.16e-07	3.46e-08
G314D	C - DA	First Reaction	FALSE	median	0.000189	1.54e-05	5.42e-06	0.000417	0.000366	0.00136	0.000330	3.87e-06	6.52e-06	1.86e-07	7.71e-08
G314D	C - DA	Second Reaction	FALSE	median	0.000187	1.24e-05	4.75e-06	0.000487	0.000395	0.00134	0.000298	3.79e-06	6.93e-06	2.15e-07	7.00e-08
G307D	C - LCU	First Reaction	FALSE	median	0.000456	1.90e-05	4.34e-06	0.00230	0.00311	0.00239	0.000892	8.65e-05	9.45e-05	1.75e-06	6.97e-08
G307D	C - LCU	Second Reaction	FALSE	median	0.000447	1.64e-05	3.91e-06	0.00239	0.00309	0.00246	0.000877	8.44e-05	9.65e-05	1.87e-06	6.91e-08
G301	C - UA	First Reaction	FALSE	median	0.000143	1.77e-06	6.75e-07	0.000517	0.000418	0.000648	0.000144	2.09e-05	3.81e-05	1.18e-06	2.25e-08
G301	C - UA	Second Reaction	FALSE	median	0.000144	1.55e-06	5.87e-07	0.000544	0.000445	0.000591	0.000133	2.07e-05	3.75e-05	1.15e-06	2.08e-08
G308	C - UA	First Reaction	FALSE	median	6.95e-05	1.83e-06	4.92e-07	0.000573	0.000660	0.000327	0.000104	3.99e-06	5.13e-06	1.12e-07	1.00e-08
G308	C - UA	Second Reaction	FALSE	median	6.91e-05	1.84e-06	4.98e-07	0.000563	0.000644	0.000352	0.000111	4.07e-06	5.26e-06	1.15e-07	1.08e-08
G312	C - UA	First Reaction	FALSE	median	0.000193	2.81e-06	1.11e-06	0.000305	0.000238	0.00106	0.000228	9.48e-06	1.80e-05	5.79e-07	1.22e-07
G312	C - UA	Second Reaction	FALSE	median	0.000199	2.40e-06	9.06e-07	0.000370	0.000303	0.000902	0.000204	9.82e-06	1.77e-05	5.43e-07	1.03e-07
G313	C - UA	First Reaction	FALSE	median	0.000139	2.56e-06	8.81e-07	0.000439	0.000394	0.000762	0.000189	4.01e-06	6.60e-06	1.85e-07	3.61e-08
G313	C - UA	Second Reaction	FALSE	median	0.000142	2.20e-06	7.47e-07	0.000480	0.000437	0.000673	0.000169	4.13e-06	6.71e-06	1.85e-07	3.17e-08

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Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_sHCO3	m_Hfo_sHPO4-	m_Hfo_sH2BO3	m_Hfo_sH2PO4	m_Hfo_sOSi(OH)3	m_Hfo_sOSiO(OH)2-	m_Hfo_sOHSO4-2	m_Hfo_sSO4-	m_Hao_SO4-	m_Hao_OHSO4-2	m_Hao_H2BO3
G314D	C - DA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	25p	2.32e-07	9.80e-10	1.92e-12	3.17e-11	5.65e-08	4.39e-08	4.20e-09	1.67e-09	1.69e-13	0.00131	0.000300
G307D	C - LCU	Speciation Model	TRUE	25p	1.21e-07	5.56e-09	5.89e-11	1.06e-10	1.34e-07	1.76e-07	7.04e-09	1.65e-09	5.88e-15	8.84e-05	0.000285
G301	C - UA	Speciation Model	TRUE	25p	8.71e-08	5.64e-09	2.15e-11	2.84e-10	7.55e-08	3.77e-08	6.40e-09	3.97e-09	1.34e-13	0.000306	0.00245
G308	C - UA	Speciation Model	TRUE	25p	1.32e-08	2.79e-10	9.45e-12	5.87e-12	3.27e-08	3.91e-08	7.87e-10	2.04e-10	3.42e-14	0.000562	0.00179
G312	C - UA	Speciation Model	TRUE	25p	6.61e-07	9.59e-09	3.58e-11	8.99e-10	1.41e-07	3.78e-08	1.43e-08	1.65e-08	3.02e-13	0.000326	0.00251
G313	C - UA	Speciation Model	TRUE	25p	1.30e-07	9.39e-10	2.15e-11	4.06e-11	6.08e-08	3.53e-08	2.14e-09	1.14e-09	6.94e-14	0.000329	0.00249
G314D	C - DA	First Reaction	TRUE	25p	2.22e-07	1.08e-09	1.38e-12	3.32e-11	7.28e-08	5.95e-08	2.40e-09	9.08e-10	1.48e-13	0.00104	0.000403
G314D	C - DA	Second Reaction	TRUE	25p	2.16e-07	1.17e-09	1.45e-12	3.91e-11	8.61e-08	6.47e-08	2.02e-09	8.31e-10	1.57e-13	0.000992	0.000504
G307D	C - LCU	First Reaction	TRUE	25p	1.40e-07	5.52e-09	3.00e-11	1.04e-10	1.36e-07	1.81e-07	1.06e-09	2.46e-10	3.03e-15	8.62e-05	0.000269
G307D	C - LCU	Second Reaction	TRUE	25p	1.45e-07	5.68e-09	2.55e-11	1.12e-10	1.43e-07	1.82e-07	9.35e-10	2.27e-10	3.22e-15	8.65e-05	0.000266
G301	C - UA	First Reaction	TRUE	25p	5.79e-08	3.51e-09	1.97e-11	1.09e-10	4.99e-08	4.02e-08	1.53e-10	5.87e-11	1.36e-14	0.000337	0.00229
G301	C - UA	Second Reaction	TRUE	25p	5.27e-08	3.46e-09	1.63e-11	1.09e-10	5.39e-08	4.32e-08	1.32e-10	5.11e-11	1.42e-14	0.000369	0.00217
G308	C - UA	First Reaction	TRUE	25p	1.97e-08	3.02e-10	3.85e-12	6.59e-12	3.30e-08	3.80e-08	1.10e-10	2.96e-11	1.92e-14	0.000482	0.00177
G308	C - UA	Second Reaction	TRUE	25p	2.12e-08	3.13e-10	3.72e-12	6.80e-12	3.21e-08	3.72e-08	1.13e-10	3.02e-11	1.96e-14	0.000482	0.00177
G312	C - UA	First Reaction	TRUE	25p	3.08e-07	5.59e-09	8.01e-11	1.79e-10	1.09e-07	8.54e-08	7.96e-10	3.15e-10	1.54e-14	0.000308	0.00237
G312	C - UA	Second Reaction	TRUE	25p	2.39e-07	5.27e-09	6.64e-11	1.71e-10	1.33e-07	1.03e-07	5.67e-10	2.26e-10	1.47e-14	0.000337	0.00227
G313	C - UA	First Reaction	TRUE	25p	8.24e-08	7.65e-10	2.41e-11	2.15e-11	5.36e-08	4.79e-08	2.71e-10	9.36e-11	1.44e-14	0.000315	0.00235
G313	C - UA	Second Reaction	TRUE	25p	7.02e-08	7.80e-10	2.03e-11	2.24e-11	5.96e-08	5.23e-08	2.12e-10	7.48e-11	1.45e-14	0.000344	0.00225
G314D	C - DA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	75p	5.61e-07	2.37e-09	4.63e-12	7.67e-11	1.37e-07	1.06e-07	1.02e-08	4.05e-09	6.21e-13	0.00481	0.00110
G307D	C - LCU	Speciation Model	TRUE	75p	2.06e-07	9.46e-09	1.00e-10	1.80e-10	2.28e-07	3.00e-07	1.20e-08	2.81e-09	2.21e-14	0.000331	0.00107
G301	C - UA	Speciation Model	TRUE	75p	1.68e-07	1.08e-08	4.13e-11	5.46e-10	1.45e-07	7.24e-08	1.23e-08	7.63e-09	1.64e-13	0.000375	0.00300
G308	C - UA	Speciation Model	TRUE	75p	2.53e-08	5.37e-10	1.82e-11	1.13e-11	6.29e-08	7.51e-08	1.51e-09	3.92e-10	4.19e-14	0.000688	0.00219
G312	C - UA	Speciation Model	TRUE	75p	1.27e-06	1.84e-08	6.89e-11	1.73e-09	2.71e-07	7.27e-08	2.75e-08	3.17e-08	3.69e-13	0.000399	0.00308
G313	C - UA	Speciation Model	TRUE	75p	2.50e-07	1.81e-09	4.14e-11	7.82e-11	1.17e-07	6.79e-08	4.11e-09	2.19e-09	8.49e-14	0.000402	0.00305
G314D	C - DA	First Reaction	TRUE	75p	5.35e-07	2.44e-09	3.51e-12	6.88e-11	1.52e-07	1.35e-07	6.97e-09	2.41e-09	4.93e-13	0.00406	0.00120
G314D	C - DA	Second Reaction	TRUE	75p	5.26e-07	2.54e-09	3.19e-12	7.45e-11	1.70e-07	1.45e-07	5.28e-09	1.91e-09	4.79e-13	0.00389	0.00131
G307D	C - LCU	First Reaction	TRUE	75p	2.34e-07	9.23e-09	5.90e-11	1.69e-10	2.24e-07	3.07e-07	1.95e-09	4.40e-10	1.08e-14	0.000317	0.00104
G307D	C - LCU	Second Reaction	TRUE	75p	2.43e-07	9.49e-09	5.01e-11	1.81e-10	2.34e-07	3.07e-07	1.66e-09	3.91e-10	1.12e-14	0.000319	0.00102
G301	C - UA	First Reaction	TRUE	75p	1.19e-07	6.91e-09	3.97e-11	2.15e-10	9.32e-08	7.53e-08	3.27e-10	1.25e-10	1.70e-14	0.000406	0.00283
G301	C - UA	Second Reaction	TRUE	75p	1.09e-07	6.79e-09	3.42e-11	2.08e-10	9.74e-08	8.01e-08	2.88e-10	1.08e-10	1.72e-14	0.000440	0.00270
G308	C - UA	First Reaction	TRUE	75p	3.62e-08	5.70e-10	7.53e-12	1.24e-11	6.43e-08	7.41e-08	2.05e-10	5.49e-11	2.29e-14	0.000592	0.00217
G308	C - UA	Second Reaction	TRUE	75p	3.92e-08	5.85e-10	7.07e-12	1.29e-11	6.35e-08	7.26e-08	2.04e-10	5.52e-11	2.37e-14	0.000590	0.00217
G312	C - UA	First Reaction	TRUE	75p	6.80e-07	1.12e-08	1.58e-10	3.64e-10	1.86e-07	1.44e-07	1.80e-09	7.18e-10	2.03e-14	0.000370	0.00294
G312	C - UA	Second Reaction	TRUE	75p	5.48e-07	1.04e-08	1.47e-10	3.15e-10	2.08e-07	1.72e-07	1.49e-09	5.56e-10	1.83e-14	0.000400	0.00282
G313	C - UA	First Reaction	TRUE	75p	1.73e-07	1.46e-09	4.74e-11	4.11e-11	9.73e-08	8.72e-08	5.86e-10	2.02e-10	1.84e-14	0.000378	0.00291
G313	C - UA	Second Reaction	TRUE	75p	1.51e-07	1.45e-09	4.32e-11	3.97e-11	1.03e-07	9.45e-08	5.02e-10	1.69e-10	1.77e-14	0.000409	0.00279
G314D	C - DA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	median	3.48e-07	1.47e-09	2.88e-12	4.76e-11	8.48e-08	6.58e-08	6.30e-09	2.51e-09	4.09e-13	0.00317	0.000725
G307D	C - LCU	Speciation Model	TRUE	median	1.63e-07	7.51e-09	7.96e-11	1.43e-10	1.81e-07	2.38e-07	9.51e-09	2.23e-09	8.83e-15	0.000133	0.000427
G301	C - UA	Speciation Model	TRUE	median	1.45e-07	9.40e-09	3.58e-11	4.73e-10	1.26e-07	6.28e-08	1.07e-08	6.61e-09	1.50e-13	0.000343	0.00275
G308	C - UA	Speciation Model	TRUE	median	2.19e-08	4.66e-10	1.58e-11	9.79e-12	5.45e-08	6.51e-08	1.31e-09	3.39e-10	3.84e-14	0.000631	0.00200
G312	C - UA	Speciation Model	TRUE	median	1.10e-06	1.60e-08	5.97e-11	1.50e-09	2.35e-07	6.30e-08	2.38e-08	2.75e-08	3.39e-13	0.000366	0.00282
G313	C - UA	Speciation Model	TRUE	median	2.17e-07	1.57e-09	3.59e-11	6.77e-11	1.01e-07	5.88e-08	3.56e-09	1.90e-09	7.79e-14	0.000369	0.00279

Attachment D. PHREEQC modeling output
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Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_sHCO3	m_Hfo_sHPO4-	m_Hfo_sH2BO3	m_Hfo_sH2PO4	m_Hfo_sOSi(OH)3	m_Hfo_sOSiO(OH)2-	m_Hfo_sOHSO4-2	m_Hfo_sSO4-	m_Hao_SO4-	m_Hao_OHSO4-2	m_Hao_H2BO3
G314D	C - DA	First Reaction	TRUE	median	3.29e-07	1.55e-09	2.10e-12	4.49e-11	1.01e-07	8.74e-08	3.91e-09	1.39e-09	3.27e-13	0.00263	0.000828
G314D	C - DA	Second Reaction	TRUE	median	3.22e-07	1.65e-09	1.92e-12	5.13e-11	1.17e-07	9.49e-08	3.07e-09	1.17e-09	3.38e-13	0.00252	0.000932
G307D	C - LCU	First Reaction	TRUE	median	1.87e-07	7.39e-09	4.29e-11	1.37e-10	1.80e-07	2.45e-07	1.49e-09	3.40e-10	4.45e-15	0.000129	0.000407
G307D	C - LCU	Second Reaction	TRUE	median	1.94e-07	7.60e-09	3.62e-11	1.47e-10	1.89e-07	2.45e-07	1.30e-09	3.09e-10	4.70e-15	0.000130	0.000400
G301	C - UA	First Reaction	TRUE	median	1.02e-07	5.97e-09	3.40e-11	1.85e-10	8.13e-08	6.57e-08	2.78e-10	1.06e-10	1.56e-14	0.000375	0.00258
G301	C - UA	Second Reaction	TRUE	median	9.30e-08	5.88e-09	2.89e-11	1.81e-10	8.57e-08	7.01e-08	2.44e-10	9.23e-11	1.59e-14	0.000408	0.00246
G308	C - UA	First Reaction	TRUE	median	3.17e-08	4.96e-10	6.48e-12	1.08e-11	5.56e-08	6.40e-08	1.78e-10	4.78e-11	2.11e-14	0.000542	0.00199
G308	C - UA	Second Reaction	TRUE	median	3.43e-08	5.10e-10	6.13e-12	1.12e-11	5.47e-08	6.27e-08	1.80e-10	4.84e-11	2.18e-14	0.000541	0.00198
G312	C - UA	First Reaction	TRUE	median	5.72e-07	9.62e-09	1.36e-10	3.10e-10	1.64e-07	1.28e-07	1.52e-09	6.02e-10	1.83e-14	0.000342	0.00268
G312	C - UA	Second Reaction	TRUE	median	4.59e-07	8.95e-09	1.23e-10	2.74e-10	1.88e-07	1.54e-07	1.22e-09	4.61e-10	1.68e-14	0.000371	0.00257
G313	C - UA	First Reaction	TRUE	median	1.48e-07	1.27e-09	4.08e-11	3.55e-11	8.51e-08	7.64e-08	4.97e-10	1.71e-10	1.67e-14	0.000349	0.00265
G313	C - UA	Second Reaction	TRUE	median	1.28e-07	1.27e-09	3.64e-11	3.49e-11	9.12e-08	8.31e-08	4.18e-10	1.42e-10	1.63e-14	0.000379	0.00255
G314D	C - DA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	25p	2.27e-07	9.63e-10	1.85e-12	3.08e-11	5.46e-08	4.28e-08	4.25e-09	1.67e-09	1.67e-13	0.00130	0.000287
G307D	C - LCU	Speciation Model	FALSE	25p	1.21e-07	5.55e-09	5.87e-11	1.06e-10	1.33e-07	1.76e-07	7.06e-09	1.66e-09	5.89e-15	8.84e-05	0.000284
G301	C - UA	Speciation Model	FALSE	25p	8.68e-08	5.63e-09	2.13e-11	2.83e-10	7.51e-08	3.75e-08	6.44e-09	3.98e-09	1.34e-13	0.000305	0.00245
G308	C - UA	Speciation Model	FALSE	25p	1.31e-08	2.80e-10	9.41e-12	5.87e-12	3.25e-08	3.90e-08	7.92e-10	2.05e-10	3.42e-14	0.000561	0.00178
G312	C - UA	Speciation Model	FALSE	25p	6.57e-07	9.60e-09	3.55e-11	8.95e-10	1.40e-07	3.77e-08	1.45e-08	1.66e-08	3.01e-13	0.000322	0.00251
G313	C - UA	Speciation Model	FALSE	25p	1.29e-07	9.38e-10	2.13e-11	4.04e-11	6.01e-08	3.50e-08	2.17e-09	1.15e-09	6.94e-14	0.000325	0.00248
G314D	C - DA	First Reaction	FALSE	25p	2.16e-07	1.06e-09	1.36e-12	3.26e-11	7.08e-08	5.81e-08	2.26e-09	8.51e-10	1.42e-13	0.00105	0.000390
G314D	C - DA	Second Reaction	FALSE	25p	2.11e-07	1.15e-09	1.42e-12	3.87e-11	8.42e-08	6.31e-08	1.94e-09	8.01e-10	1.55e-13	0.000999	0.000492
G307D	C - LCU	First Reaction	FALSE	25p	1.40e-07	5.52e-09	2.99e-11	1.04e-10	1.35e-07	1.80e-07	1.06e-09	2.45e-10	3.03e-15	8.64e-05	0.000269
G307D	C - LCU	Second Reaction	FALSE	25p	1.44e-07	5.68e-09	2.54e-11	1.12e-10	1.42e-07	1.81e-07	9.30e-10	2.26e-10	3.23e-15	8.66e-05	0.000265
G301	C - UA	First Reaction	FALSE	25p	5.74e-08	3.49e-09	1.95e-11	1.09e-10	4.93e-08	3.98e-08	1.52e-10	5.81e-11	1.36e-14	0.000338	0.00229
G301	C - UA	Second Reaction	FALSE	25p	5.23e-08	3.45e-09	1.62e-11	1.08e-10	5.34e-08	4.28e-08	1.31e-10	5.07e-11	1.43e-14	0.000370	0.00217
G308	C - UA	First Reaction	FALSE	25p	1.97e-08	3.02e-10	3.82e-12	6.60e-12	3.29e-08	3.79e-08	1.10e-10	2.94e-11	1.92e-14	0.000484	0.00177
G308	C - UA	Second Reaction	FALSE	25p	2.11e-08	3.14e-10	3.70e-12	6.81e-12	3.20e-08	3.71e-08	1.13e-10	3.01e-11	1.97e-14	0.000483	0.00176
G312	C - UA	First Reaction	FALSE	25p	3.04e-07	5.57e-09	7.92e-11	1.79e-10	1.08e-07	8.45e-08	7.87e-10	3.11e-10	1.54e-14	0.000309	0.00237
G312	C - UA	Second Reaction	FALSE	25p	2.37e-07	5.25e-09	6.57e-11	1.70e-10	1.32e-07	1.02e-07	5.61e-10	2.24e-10	1.48e-14	0.000338	0.00227
G313	C - UA	First Reaction	FALSE	25p	8.15e-08	7.62e-10	2.38e-11	2.14e-11	5.30e-08	4.74e-08	2.67e-10	9.24e-11	1.44e-14	0.000316	0.00235
G313	C - UA	Second Reaction	FALSE	25p	6.95e-08	7.78e-10	2.00e-11	2.23e-11	5.90e-08	5.17e-08	2.10e-10	7.40e-11	1.45e-14	0.000345	0.00224
G314D	C - DA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	75p	5.49e-07	2.33e-09	4.48e-12	7.45e-11	1.32e-07	1.04e-07	1.03e-08	4.05e-09	6.12e-13	0.00477	0.00105
G307D	C - LCU	Speciation Model	FALSE	75p	2.05e-07	9.45e-09	9.99e-11	1.80e-10	2.27e-07	2.99e-07	1.20e-08	2.82e-09	2.21e-14	0.000331	0.00107
G301	C - UA	Speciation Model	FALSE	75p	1.67e-07	1.08e-08	4.10e-11	5.45e-10	1.44e-07	7.21e-08	1.24e-08	7.66e-09	1.64e-13	0.000373	0.00300
G308	C - UA	Speciation Model	FALSE	75p	2.53e-08	5.37e-10	1.81e-11	1.13e-11	6.26e-08	7.49e-08	1.52e-09	3.93e-10	4.19e-14	0.000687	0.00218
G312	C - UA	Speciation Model	FALSE	75p	1.26e-06	1.85e-08	6.83e-11	1.72e-09	2.69e-07	7.24e-08	2.79e-08	3.20e-08	3.69e-13	0.000395	0.00307
G313	C - UA	Speciation Model	FALSE	75p	2.48e-07	1.80e-09	4.09e-11	7.77e-11	1.16e-07	6.74e-08	4.17e-09	2.21e-09	8.50e-14	0.000398	0.00304
G314D	C - DA	First Reaction	FALSE	75p	5.18e-07	2.39e-09	3.48e-12	6.63e-11	1.46e-07	1.32e-07	6.34e-09	2.17e-09	4.58e-13	0.00409	0.00116
G314D	C - DA	Second Reaction	FALSE	75p	5.11e-07	2.49e-09	3.14e-12	7.27e-11	1.65e-07	1.42e-07	5.00e-09	1.79e-09	4.60e-13	0.00393	0.00126
G307D	C - LCU	First Reaction	FALSE	75p	2.33e-07	9.23e-09	5.87e-11	1.69e-10	2.24e-07	3.06e-07	1.94e-09	4.38e-10	1.08e-14	0.000318	0.00103
G307D	C - LCU	Second Reaction	FALSE	75p	2.42e-07	9.48e-09	4.99e-11	1.82e-10	2.33e-07	3.06e-07	1.65e-09	3.89e-10	1.12e-14	0.000320	0.00102
G301	C - UA	First Reaction	FALSE	75p	1.18e-07	6.87e-09	3.94e-11	2.14e-10	9.23e-08	7.46e-08	3.24e-10	1.24e-10	1.70e-14	0.000408	0.00283
G301	C - UA	Second Reaction	FALSE	75p	1.08e-07	6.76e-09	3.39e-11	2.07e-10	9.65e-08	7.93e-08	2.86e-10	1.08e-10	1.72e-14	0.000442	0.00270
G308	C - UA	First Reaction	FALSE	75p	3.61e-08	5.70e-10	7.47e-12	1.24e-11	6.41e-08	7.38e-08	2.04e-10	5.46e-11	2.30e-14	0.000593	0.00217
G308	C - UA	Second Reaction	FALSE	75p	3.91e-08	5.86e-10	7.02e-12	1.29e-11	6.33e-08	7.24e-08	2.03e-10	5.50e-11	2.38e-14	0.000591	0.00216
G312	C - UA	First Reaction	FALSE	75p	6.72e-07	1.12e-08	1.56e-10	3.62e-10	1.84e-07	1.42e-07	1.78e-09	7.09e-10	2.03e-14	0.000371	0.00293
G312	C - UA	Second Reaction	FALSE	75p	5.43e-07	1.03e-08	1.45e-10	3.14e-10	2.06e-07	1.70e-07	1.47e-09	5.51e-10	1.83e-14	0.000401	0.00282
G313	C - UA	First Reaction	FALSE	75p	1.72e-07	1.46e-09	4.68e-11	4.09e-11	9.62e-08	8.62e-08	5.79e-10	2.00e-10	1.84e-14	0.000380	0.00290
G313	C - UA	Second Reaction	FALSE	75p	1.49e-07	1.45e-09	4.26e-11	3.96e-11	1.02e-07	9.35e-08	4.97e-10	1.67e-10	1.78e-14	0.000411	0.00279

Attachment D. PHREEQC modeling output
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Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	m_Hfo_sHCO3	m_Hfo_sHPO4-	m_Hfo_sH2BO3	m_Hfo_sH2PO4	m_Hfo_sOSi(OH)3	m_Hfo_sOSiO(OH)2-	m_Hfo_sOHSO4-2	m_Hfo_sSO4-	m_Hao_SO4-	m_Hao_OHSO4-2	m_Hao_H2BO3
G314D	C - DA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	median	3.40e-07	1.44e-09	2.78e-12	4.63e-11	8.19e-08	6.43e-08	6.37e-09	2.51e-09	4.03e-13	0.00315	0.000695
G307D	C - LCU	Speciation Model	FALSE	median	1.63e-07	7.50e-09	7.93e-11	1.43e-10	1.80e-07	2.37e-07	9.54e-09	2.24e-09	8.84e-15	0.000133	0.000426
G301	C - UA	Speciation Model	FALSE	median	1.45e-07	9.39e-09	3.56e-11	4.72e-10	1.25e-07	6.25e-08	1.07e-08	6.64e-09	1.51e-13	0.000342	0.00275
G308	C - UA	Speciation Model	FALSE	median	2.19e-08	4.66e-10	1.57e-11	9.78e-12	5.42e-08	6.49e-08	1.32e-09	3.41e-10	3.84e-14	0.000630	0.00200
G312	C - UA	Speciation Model	FALSE	median	1.09e-06	1.60e-08	5.92e-11	1.49e-09	2.33e-07	6.28e-08	2.42e-08	2.77e-08	3.38e-13	0.000362	0.00282
G313	C - UA	Speciation Model	FALSE	median	2.15e-07	1.56e-09	3.55e-11	6.73e-11	1.00e-07	5.84e-08	3.61e-09	1.91e-09	7.80e-14	0.000365	0.00279
G314D	C - DA	First Reaction	FALSE	median	3.19e-07	1.52e-09	2.08e-12	4.35e-11	9.74e-08	8.56e-08	3.60e-09	1.27e-09	3.08e-13	0.00265	0.000798
G314D	C - DA	Second Reaction	FALSE	median	3.14e-07	1.63e-09	1.88e-12	5.04e-11	1.14e-07	9.27e-08	2.92e-09	1.11e-09	3.29e-13	0.00254	0.000902
G307D	C - LCU	First Reaction	FALSE	median	1.87e-07	7.39e-09	4.27e-11	1.37e-10	1.80e-07	2.44e-07	1.49e-09	3.39e-10	4.46e-15	0.000129	0.000406
G307D	C - LCU	Second Reaction	FALSE	median	1.94e-07	7.60e-09	3.61e-11	1.48e-10	1.88e-07	2.44e-07	1.29e-09	3.08e-10	4.70e-15	0.000130	0.000399
G301	C - UA	First Reaction	FALSE	median	1.01e-07	5.93e-09	3.36e-11	1.84e-10	8.04e-08	6.51e-08	2.75e-10	1.05e-10	1.56e-14	0.000376	0.00258
G301	C - UA	Second Reaction	FALSE	median	9.22e-08	5.85e-09	2.86e-11	1.80e-10	8.49e-08	6.94e-08	2.42e-10	9.15e-11	1.59e-14	0.000409	0.00246
G308	C - UA	First Reaction	FALSE	median	3.16e-08	4.96e-10	6.44e-12	1.08e-11	5.54e-08	6.38e-08	1.77e-10	4.76e-11	2.12e-14	0.000544	0.00199
G308	C - UA	Second Reaction	FALSE	median	3.42e-08	5.10e-10	6.09e-12	1.12e-11	5.46e-08	6.25e-08	1.79e-10	4.83e-11	2.19e-14	0.000542	0.00198
G312	C - UA	First Reaction	FALSE	median	5.66e-07	9.59e-09	1.35e-10	3.09e-10	1.63e-07	1.27e-07	1.50e-09	5.94e-10	1.83e-14	0.000343	0.00268
G312	C - UA	Second Reaction	FALSE	median	4.54e-07	8.92e-09	1.22e-10	2.73e-10	1.86e-07	1.53e-07	1.21e-09	4.56e-10	1.68e-14	0.000372	0.00257
G313	C - UA	First Reaction	FALSE	median	1.46e-07	1.27e-09	4.03e-11	3.54e-11	8.42e-08	7.56e-08	4.91e-10	1.69e-10	1.67e-14	0.000351	0.00265
G313	C - UA	Second Reaction	FALSE	median	1.26e-07	1.26e-09	3.60e-11	3.48e-11	9.02e-08	8.22e-08	4.14e-10	1.40e-10	1.64e-14	0.000381	0.00254

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	m_Hao_H3BO4-	Ferrihydrite	d_Ferrihydrite	Gibbsite	d_Gibbsite	Barite	d_Barite	Calcite	d_Calcite	Dolomite (ordered)	d_Dolomite (ordered)
G314D	C - DA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	25p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	25p	1.09e-11	0.0120	0	0.120	0	0	0	0	0	0	0
G307D	C - LCU	Speciation Model	TRUE	25p	2.00e-11	0.0570	0	0.0160	0	0	0	1.00	0	2.00	0
G301	C - UA	Speciation Model	TRUE	25p	2.62e-11	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G308	C - UA	Speciation Model	TRUE	25p	1.37e-10	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G312	C - UA	Speciation Model	TRUE	25p	1.27e-11	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G313	C - UA	Speciation Model	TRUE	25p	5.52e-11	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G314D	C - DA	First Reaction	TRUE	25p	1.33e-11	0.0120	1.38e-07	0.120	3.45e-07	3.26e-07	3.26e-07	0	0	0	0
G314D	C - DA	Second Reaction	TRUE	25p	1.49e-11	0.0120	1.33e-07	0.120	3.45e-07	6.29e-07	3.02e-07	0	0	0	0
G307D	C - LCU	First Reaction	TRUE	25p	3.58e-11	0.0570	4.25e-07	0.0160	3.23e-07	3.00e-07	3.00e-07	1.00	0.000745	2.00	-6.67e-04
G307D	C - LCU	Second Reaction	TRUE	25p	3.33e-11	0.0570	3.23e-08	0.0160	3.25e-07	5.86e-07	2.86e-07	1.00	0.000667	2.00	-5.73e-04
G301	C - UA	First Reaction	TRUE	25p	2.66e-10	0.00780	-1.33e-08	0.0980	3.29e-07	2.84e-07	2.84e-07	0.901	0.000907	3.00	-9.01e-04
G301	C - UA	Second Reaction	TRUE	25p	2.64e-10	0.00780	1.42e-07	0.0980	3.27e-07	5.64e-07	2.79e-07	0.902	0.000756	3.00	-6.99e-04
G308	C - UA	First Reaction	TRUE	25p	2.09e-10	0.00780	1.43e-07	0.0980	3.24e-07	2.99e-07	2.99e-07	0.901	0.000653	3.00	-5.60e-04
G308	C - UA	Second Reaction	TRUE	25p	2.03e-10	0.00780	1.43e-07	0.0980	3.26e-07	5.84e-07	2.85e-07	0.901	0.000685	3.00	-6.06e-04
G312	C - UA	First Reaction	TRUE	25p	2.22e-10	0.00780	1.41e-07	0.0980	3.32e-07	2.86e-07	2.86e-07	0.901	0.000899	3.00	-9.86e-04
G312	C - UA	Second Reaction	TRUE	25p	2.43e-10	0.00780	1.42e-07	0.0980	3.29e-07	5.64e-07	2.78e-07	0.902	0.000758	3.00	-7.35e-04
G313	C - UA	First Reaction	TRUE	25p	2.40e-10	0.00780	1.42e-07	0.0980	3.30e-07	2.85e-07	2.85e-07	0.901	0.000836	3.00	-8.54e-04
G313	C - UA	Second Reaction	TRUE	25p	2.49e-10	0.00780	1.42e-07	0.0980	3.28e-07	5.64e-07	2.79e-07	0.902	0.000751	3.00	-7.06e-04
G314D	C - DA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	75p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	75p	3.99e-11	0.0290	0	0.440	0	0	0	0	0	0	0
G307D	C - LCU	Speciation Model	TRUE	75p	7.51e-11	0.0970	0	0.0600	0	0	0	1.00	0	2.00	0
G301	C - UA	Speciation Model	TRUE	75p	3.21e-11	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G308	C - UA	Speciation Model	TRUE	75p	1.68e-10	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G312	C - UA	Speciation Model	TRUE	75p	1.56e-11	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G313	C - UA	Speciation Model	TRUE	75p	6.75e-11	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G314D	C - DA	First Reaction	TRUE	75p	4.63e-11	0.0290	1.48e-07	0.440	3.43e-07	3.64e-07	3.64e-07	0	0	0	0
G314D	C - DA	Second Reaction	TRUE	75p	4.97e-11	0.0290	1.34e-07	0.440	3.44e-07	6.78e-07	3.14e-07	0	0	0	0
G307D	C - LCU	First Reaction	TRUE	75p	1.43e-10	0.0970	9.07e-07	0.0600	3.22e-07	3.09e-07	3.09e-07	1.00	0.000813	2.00	-7.53e-04
G307D	C - LCU	Second Reaction	TRUE	75p	1.36e-10	0.0970	-8.51e-09	0.0600	3.24e-07	5.96e-07	2.87e-07	1.00	0.000657	2.00	-5.39e-04
G301	C - UA	First Reaction	TRUE	75p	3.16e-10	0.0150	-1.57e-07	0.120	3.30e-07	2.89e-07	2.89e-07	0.901	0.000962	3.00	-1.01e-03
G301	C - UA	Second Reaction	TRUE	75p	3.23e-10	0.0150	1.42e-07	0.120	3.28e-07	5.67e-07	2.78e-07	0.902	0.000767	3.00	-7.24e-04
G308	C - UA	First Reaction	TRUE	75p	2.62e-10	0.0150	1.43e-07	0.120	3.24e-07	3.03e-07	3.03e-07	0.901	0.000640	3.00	-5.34e-04
G308	C - UA	Second Reaction	TRUE	75p	2.52e-10	0.0150	1.43e-07	0.120	3.25e-07	5.89e-07	2.86e-07	0.901	0.000680	3.00	-5.93e-04
G312	C - UA	First Reaction	TRUE	75p	2.50e-10	0.0150	1.41e-07	0.120	3.34e-07	2.89e-07	2.89e-07	0.901	0.000942	3.00	-1.13e-03
G312	C - UA	Second Reaction	TRUE	75p	2.89e-10	0.0150	1.42e-07	0.120	3.30e-07	5.65e-07	2.76e-07	0.902	0.000777	3.00	-7.89e-04
G313	C - UA	First Reaction	TRUE	75p	2.80e-10	0.0150	1.42e-07	0.120	3.32e-07	2.86e-07	2.86e-07	0.901	0.000865	3.00	-9.37e-04
G313	C - UA	Second Reaction	TRUE	75p	3.02e-10	0.0150	1.42e-07	0.120	3.29e-07	5.64e-07	2.78e-07	0.902	0.000765	3.00	-7.41e-04
G314D	C - DA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	TRUE	median	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	TRUE	median	2.63e-11	0.0180	0	0.290	0	0	0	0	0	0	0
G307D	C - LCU	Speciation Model	TRUE	median	3.00e-11	0.0770	0	0.0240	0	0	0	1.00	0	2.00	0
G301	C - UA	Speciation Model	TRUE	median	2.94e-11	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G308	C - UA	Speciation Model	TRUE	median	1.54e-10	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G312	C - UA	Speciation Model	TRUE	median	1.43e-11	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G313	C - UA	Speciation Model	TRUE	median	6.19e-11	0.0130	0	0.110	0	0	0	0.900	0	3.00	0

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	m_Hao_H3BO4-	Ferrihydrite	d_Ferrihydrite	Gibbsite	d_Gibbsite	Barite	d_Barite	Calcite	d_Calcite	Dolomite (ordered)	d_Dolomite (ordered)
G314D	C - DA	First Reaction	TRUE	median	3.11e-11	0.0180	1.43e-07	0.290	3.44e-07	3.50e-07	3.50e-07	0	0	0	0
G314D	C - DA	Second Reaction	TRUE	median	3.24e-11	0.0180	1.34e-07	0.290	3.45e-07	6.58e-07	3.09e-07	0	0	0	0
G307D	C - LCU	First Reaction	TRUE	median	5.51e-11	0.0770	5.97e-07	0.0240	3.23e-07	3.04e-07	3.04e-07	1.00	0.000775	2.00	-7.05e-04
G307D	C - LCU	Second Reaction	TRUE	median	5.16e-11	0.0770	-3.72e-09	0.0240	3.25e-07	5.90e-07	2.87e-07	1.00	0.000660	2.00	-5.53e-04
G301	C - UA	First Reaction	TRUE	median	2.91e-10	0.0130	-1.17e-07	0.110	3.30e-07	2.87e-07	2.87e-07	0.901	0.000943	3.00	-9.75e-04
G301	C - UA	Second Reaction	TRUE	median	2.95e-10	0.0130	1.42e-07	0.110	3.28e-07	5.66e-07	2.79e-07	0.902	0.000763	3.00	-7.16e-04
G308	C - UA	First Reaction	TRUE	median	2.39e-10	0.0130	1.43e-07	0.110	3.24e-07	3.01e-07	3.01e-07	0.901	0.000644	3.00	-5.41e-04
G308	C - UA	Second Reaction	TRUE	median	2.30e-10	0.0130	1.43e-07	0.110	3.26e-07	5.87e-07	2.86e-07	0.901	0.000682	3.00	-5.97e-04
G312	C - UA	First Reaction	TRUE	median	2.34e-10	0.0130	1.41e-07	0.110	3.33e-07	2.88e-07	2.88e-07	0.901	0.000926	3.00	-1.08e-03
G312	C - UA	Second Reaction	TRUE	median	2.66e-10	0.0130	1.42e-07	0.110	3.30e-07	5.65e-07	2.77e-07	0.902	0.000770	3.00	-7.73e-04
G313	C - UA	First Reaction	TRUE	median	2.59e-10	0.0130	1.42e-07	0.110	3.31e-07	2.86e-07	2.86e-07	0.901	0.000855	3.00	-9.13e-04
G313	C - UA	Second Reaction	TRUE	median	2.77e-10	0.0130	1.42e-07	0.110	3.28e-07	5.64e-07	2.78e-07	0.902	0.000760	3.00	-7.30e-04
G314D	C - DA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	25p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	25p	1.05e-11	0.0120	0	0.120	0	0	0	0	0	0	0
G307D	C - LCU	Speciation Model	FALSE	25p	1.99e-11	0.0570	0	0.0160	0	0	0	1.00	0	2.00	0
G301	C - UA	Speciation Model	FALSE	25p	2.60e-11	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G308	C - UA	Speciation Model	FALSE	25p	1.37e-10	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G312	C - UA	Speciation Model	FALSE	25p	1.25e-11	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G313	C - UA	Speciation Model	FALSE	25p	5.44e-11	0.00780	0	0.0980	0	0	0	0.900	0	3.00	0
G314D	C - DA	First Reaction	FALSE	25p	1.35e-11	0.0120	1.39e-07	0.120	3.45e-07	3.24e-07	3.24e-07	0	0	0	0
G314D	C - DA	Second Reaction	FALSE	25p	1.48e-11	0.0120	1.32e-07	0.120	3.45e-07	6.26e-07	3.02e-07	0	0	0	0
G307D	C - LCU	First Reaction	FALSE	25p	3.58e-11	0.0570	4.34e-07	0.0160	3.23e-07	3.00e-07	3.00e-07	1.00	0.000744	2.00	-6.65e-04
G307D	C - LCU	Second Reaction	FALSE	25p	3.33e-11	0.0570	2.88e-08	0.0160	3.25e-07	5.86e-07	2.86e-07	1.00	0.000667	2.00	-5.73e-04
G301	C - UA	First Reaction	FALSE	25p	2.66e-10	0.00780	-1.34e-08	0.0980	3.29e-07	2.84e-07	2.84e-07	0.901	0.000904	3.00	-8.99e-04
G301	C - UA	Second Reaction	FALSE	25p	2.64e-10	0.00780	1.42e-07	0.0980	3.27e-07	5.63e-07	2.79e-07	0.902	0.000756	3.00	-6.98e-04
G308	C - UA	First Reaction	FALSE	25p	2.08e-10	0.00780	1.43e-07	0.0980	3.24e-07	2.98e-07	2.98e-07	0.901	0.000650	3.00	-5.57e-04
G308	C - UA	Second Reaction	FALSE	25p	2.02e-10	0.00780	1.43e-07	0.0980	3.26e-07	5.84e-07	2.85e-07	0.901	0.000685	3.00	-6.06e-04
G312	C - UA	First Reaction	FALSE	25p	2.22e-10	0.00780	1.41e-07	0.0980	3.32e-07	2.86e-07	2.86e-07	0.901	0.000895	3.00	-9.81e-04
G312	C - UA	Second Reaction	FALSE	25p	2.43e-10	0.00780	1.42e-07	0.0980	3.29e-07	5.64e-07	2.78e-07	0.902	0.000757	3.00	-7.34e-04
G313	C - UA	First Reaction	FALSE	25p	2.40e-10	0.00780	1.42e-07	0.0980	3.30e-07	2.84e-07	2.84e-07	0.901	0.000829	3.00	-8.48e-04
G313	C - UA	Second Reaction	FALSE	25p	2.49e-10	0.00780	1.42e-07	0.0980	3.28e-07	5.64e-07	2.79e-07	0.902	0.000751	3.00	-7.05e-04
G314D	C - DA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	75p	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	75p	3.84e-11	0.0290	0	0.440	0	0	0	0	0	0	0
G307D	C - LCU	Speciation Model	FALSE	75p	7.47e-11	0.0970	0	0.0600	0	0	0	1.00	0	2.00	0
G301	C - UA	Speciation Model	FALSE	75p	3.19e-11	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G308	C - UA	Speciation Model	FALSE	75p	1.67e-10	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G312	C - UA	Speciation Model	FALSE	75p	1.54e-11	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G313	C - UA	Speciation Model	FALSE	75p	6.66e-11	0.0150	0	0.120	0	0	0	0.900	0	3.00	0
G314D	C - DA	First Reaction	FALSE	75p	4.83e-11	0.0290	1.54e-07	0.440	3.43e-07	3.59e-07	3.59e-07	0	0	0	0
G314D	C - DA	Second Reaction	FALSE	75p	5.03e-11	0.0290	1.33e-07	0.440	3.44e-07	6.73e-07	3.14e-07	0	0	0	0
G307D	C - LCU	First Reaction	FALSE	75p	1.43e-10	0.0970	9.32e-07	0.0600	3.22e-07	3.09e-07	3.09e-07	1.00	0.000812	2.00	-7.50e-04
G307D	C - LCU	Second Reaction	FALSE	75p	1.36e-10	0.0970	-1.26e-08	0.0600	3.24e-07	5.96e-07	2.87e-07	1.00	0.000657	2.00	-5.38e-04
G301	C - UA	First Reaction	FALSE	75p	3.17e-10	0.0150	-1.57e-07	0.120	3.30e-07	2.88e-07	2.88e-07	0.901	0.000960	3.00	-1.01e-03
G301	C - UA	Second Reaction	FALSE	75p	3.24e-10	0.0150	1.42e-07	0.120	3.28e-07	5.67e-07	2.78e-07	0.902	0.000767	3.00	-7.24e-04
G308	C - UA	First Reaction	FALSE	75p	2.62e-10	0.0150	1.43e-07	0.120	3.24e-07	3.02e-07	3.02e-07	0.901	0.000636	3.00	-5.30e-04
G308	C - UA	Second Reaction	FALSE	75p	2.51e-10	0.0150	1.43e-07	0.120	3.25e-07	5.88e-07	2.86e-07	0.901	0.000679	3.00	-5.92e-04
G312	C - UA	First Reaction	FALSE	75p	2.51e-10	0.0150	1.41e-07	0.120	3.34e-07	2.88e-07	2.88e-07	0.901	0.000937	3.00	-1.12e-03
G312	C - UA	Second Reaction	FALSE	75p	2.89e-10	0.0150	1.42e-07	0.120	3.30e-07	5.65e-07	2.76e-07	0.902	0.000777	3.00	-7.88e-04
G313	C - UA	First Reaction	FALSE	75p	2.80e-10	0.0150	1.42e-07	0.120	3.31e-07	2.85e-07	2.85e-07	0.901	0.000857	3.00	-9.29e-04
G313	C - UA	Second Reaction	FALSE	75p	3.01e-10	0.0150	1.42e-07	0.120	3.29e-07	5.64e-07	2.78e-07	0.902	0.000764	3.00	-7.40e-04

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	m_Hao_H3BO4-	Ferrihydrite	d_Ferrihydrite	Gibbsite	d_Gibbsite	Barite	d_Barite	Calcite	d_Calcite	Dolomite (ordered)	d_Dolomite (ordered)
G314D	C - DA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G307D	C - LCU	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G301	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G308	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G312	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G313	C - UA	Initial Soln	FALSE	median	0	0	0	0	0	0	0	0	0	0	0
G314D	C - DA	Speciation Model	FALSE	median	2.53e-11	0.0180	0	0.290	0	0	0	0	0	0	0
G307D	C - LCU	Speciation Model	FALSE	median	2.99e-11	0.0770	0	0.0240	0	0	0	1.00	0	2.00	0
G301	C - UA	Speciation Model	FALSE	median	2.92e-11	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G308	C - UA	Speciation Model	FALSE	median	1.53e-10	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G312	C - UA	Speciation Model	FALSE	median	1.41e-11	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G313	C - UA	Speciation Model	FALSE	median	6.10e-11	0.0130	0	0.110	0	0	0	0.900	0	3.00	0
G314D	C - DA	First Reaction	FALSE	median	3.21e-11	0.0180	1.46e-07	0.290	3.43e-07	3.46e-07	3.46e-07	0	0	0	0
G314D	C - DA	Second Reaction	FALSE	median	3.25e-11	0.0180	1.33e-07	0.290	3.45e-07	6.54e-07	3.08e-07	0	0	0	0
G307D	C - LCU	First Reaction	FALSE	median	5.50e-11	0.0770	6.12e-07	0.0240	3.23e-07	3.04e-07	3.04e-07	1.00	0.000773	2.00	-7.02e-04
G307D	C - LCU	Second Reaction	FALSE	median	5.15e-11	0.0770	-8.07e-09	0.0240	3.25e-07	5.91e-07	2.87e-07	1.00	0.000660	2.00	-5.53e-04
G301	C - UA	First Reaction	FALSE	median	2.92e-10	0.0130	-1.17e-07	0.110	3.30e-07	2.87e-07	2.87e-07	0.901	0.000940	3.00	-9.73e-04
G301	C - UA	Second Reaction	FALSE	median	2.95e-10	0.0130	1.42e-07	0.110	3.28e-07	5.66e-07	2.79e-07	0.902	0.000763	3.00	-7.16e-04
G308	C - UA	First Reaction	FALSE	median	2.39e-10	0.0130	1.43e-07	0.110	3.24e-07	3.01e-07	3.01e-07	0.901	0.000640	3.00	-5.37e-04
G308	C - UA	Second Reaction	FALSE	median	2.29e-10	0.0130	1.43e-07	0.110	3.26e-07	5.87e-07	2.86e-07	0.901	0.000681	3.00	-5.96e-04
G312	C - UA	First Reaction	FALSE	median	2.34e-10	0.0130	1.41e-07	0.110	3.33e-07	2.87e-07	2.87e-07	0.901	0.000921	3.00	-1.08e-03
G312	C - UA	Second Reaction	FALSE	median	2.66e-10	0.0130	1.42e-07	0.110	3.30e-07	5.64e-07	2.77e-07	0.902	0.000770	3.00	-7.73e-04
G313	C - UA	First Reaction	FALSE	median	2.60e-10	0.0130	1.42e-07	0.110	3.31e-07	2.85e-07	2.85e-07	0.901	0.000847	3.00	-9.06e-04
G313	C - UA	Second Reaction	FALSE	median	2.76e-10	0.0130	1.42e-07	0.110	3.28e-07	5.63e-07	2.78e-07	0.902	0.000759	3.00	-7.30e-04

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	Gypsum	d_Gypsum	si_Ferrihydrite	si_Gibbsite	si_Barite	si_Calcite	si_Dolomite (ordered)	si_Gypsum
G314D	C - DA	Initial Soln	TRUE	25p	0	0	2.28	0.681	0.495	0.237	0.231	-2.71e-01
G307D	C - LCU	Initial Soln	TRUE	25p	0	0	2.34	0.492	0.518	-3.03e-01	-6.69e-01	-7.88e-01
G301	C - UA	Initial Soln	TRUE	25p	0	0	-2.48e+00	0.865	0.336	-1.37e+00	-2.89e+00	-8.94e-01
G308	C - UA	Initial Soln	TRUE	25p	0	0	1.37	0.660	0.582	-1.83e-01	-3.41e-01	-5.56e-01
G312	C - UA	Initial Soln	TRUE	25p	0	0	-5.53e-02	0.481	0.632	-1.09e+00	-2.09e+00	-6.10e-01
G313	C - UA	Initial Soln	TRUE	25p	0	0	0.982	1.04	0.337	-3.58e-01	-7.31e-01	-6.73e-01
G314D	C - DA	Speciation Model	TRUE	25p	0	0	2.28	0.681	0.495	0.237	0.231	-2.71e-01
G307D	C - LCU	Speciation Model	TRUE	25p	0	0	2.34	0.492	0.518	-3.03e-01	-6.69e-01	-7.88e-01
G301	C - UA	Speciation Model	TRUE	25p	0	0	-2.48e+00	0.865	0.336	-1.37e+00	-2.89e+00	-8.94e-01
G308	C - UA	Speciation Model	TRUE	25p	0	0	1.37	0.660	0.582	-1.83e-01	-3.41e-01	-5.56e-01
G312	C - UA	Speciation Model	TRUE	25p	0	0	-5.53e-02	0.481	0.632	-1.09e+00	-2.09e+00	-6.10e-01
G313	C - UA	Speciation Model	TRUE	25p	0	0	0.982	1.04	0.337	-3.58e-01	-7.31e-01	-6.73e-01
G314D	C - DA	First Reaction	TRUE	25p	0	0	0	0	0	-5.13e-01	-1.10e+00	-1.31e+00
G314D	C - DA	Second Reaction	TRUE	25p	0	0	0	0	0	-5.74e-01	-1.25e+00	-1.35e+00
G307D	C - LCU	First Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.37e+00
G307D	C - LCU	Second Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.40e+00
G301	C - UA	First Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.39e+00
G301	C - UA	Second Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.41e+00
G308	C - UA	First Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.38e+00
G308	C - UA	Second Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.40e+00
G312	C - UA	First Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.37e+00
G312	C - UA	Second Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.40e+00
G313	C - UA	First Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.39e+00
G313	C - UA	Second Reaction	TRUE	25p	0	0	0	0	0	0	0	-1.41e+00
G314D	C - DA	Initial Soln	TRUE	75p	0	0	2.28	0.681	0.495	0.237	0.231	-2.71e-01
G307D	C - LCU	Initial Soln	TRUE	75p	0	0	2.34	0.492	0.518	-3.03e-01	-6.69e-01	-7.88e-01
G301	C - UA	Initial Soln	TRUE	75p	0	0	-2.48e+00	0.865	0.336	-1.37e+00	-2.89e+00	-8.94e-01
G308	C - UA	Initial Soln	TRUE	75p	0	0	1.37	0.660	0.582	-1.83e-01	-3.41e-01	-5.56e-01
G312	C - UA	Initial Soln	TRUE	75p	0	0	-5.53e-02	0.481	0.632	-1.09e+00	-2.09e+00	-6.10e-01
G313	C - UA	Initial Soln	TRUE	75p	0	0	0.982	1.04	0.337	-3.58e-01	-7.31e-01	-6.73e-01
G314D	C - DA	Speciation Model	TRUE	75p	0	0	2.28	0.681	0.495	0.237	0.231	-2.71e-01
G307D	C - LCU	Speciation Model	TRUE	75p	0	0	2.34	0.492	0.518	-3.03e-01	-6.69e-01	-7.88e-01
G301	C - UA	Speciation Model	TRUE	75p	0	0	-2.48e+00	0.865	0.336	-1.37e+00	-2.89e+00	-8.94e-01
G308	C - UA	Speciation Model	TRUE	75p	0	0	1.37	0.660	0.582	-1.83e-01	-3.41e-01	-5.56e-01
G312	C - UA	Speciation Model	TRUE	75p	0	0	-5.53e-02	0.481	0.632	-1.09e+00	-2.09e+00	-6.10e-01
G313	C - UA	Speciation Model	TRUE	75p	0	0	0.982	1.04	0.337	-3.58e-01	-7.31e-01	-6.73e-01
G314D	C - DA	First Reaction	TRUE	75p	0	0	0	0	0	-4.29e-01	-8.88e-01	-1.22e+00
G314D	C - DA	Second Reaction	TRUE	75p	0	0	0	0	0	-4.67e-01	-1.01e+00	-1.33e+00
G307D	C - LCU	First Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.35e+00
G307D	C - LCU	Second Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.40e+00
G301	C - UA	First Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.38e+00
G301	C - UA	Second Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.41e+00
G308	C - UA	First Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.37e+00
G308	C - UA	Second Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.40e+00
G312	C - UA	First Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.35e+00
G312	C - UA	Second Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.40e+00
G313	C - UA	First Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.38e+00
G313	C - UA	Second Reaction	TRUE	75p	0	0	0	0	0	0	0	-1.40e+00
G314D	C - DA	Initial Soln	TRUE	median	0	0	2.28	0.681	0.495	0.237	0.231	-2.71e-01
G307D	C - LCU	Initial Soln	TRUE	median	0	0	2.34	0.492	0.518	-3.03e-01	-6.69e-01	-7.88e-01
G301	C - UA	Initial Soln	TRUE	median	0	0	-2.48e+00	0.865	0.336	-1.37e+00	-2.89e+00	-8.94e-01
G308	C - UA	Initial Soln	TRUE	median	0	0	1.37	0.660	0.582	-1.83e-01	-3.41e-01	-5.56e-01
G312	C - UA	Initial Soln	TRUE	median	0	0	-5.53e-02	0.481	0.632	-1.09e+00	-2.09e+00	-6.10e-01
G313	C - UA	Initial Soln	TRUE	median	0	0	0.982	1.04	0.337	-3.58e-01	-7.31e-01	-6.73e-01
G314D	C - DA	Speciation Model	TRUE	median	0	0	2.28	0.681	0.495	0.237	0.231	-2.71e-01
G307D	C - LCU	Speciation Model	TRUE	median	0	0	2.34	0.492	0.518	-3.03e-01	-6.69e-01	-7.88e-01
G301	C - UA	Speciation Model	TRUE	median	0	0	-2.48e+00	0.865	0.336	-1.37e+00	-2.89e+00	-8.94e-01
G308	C - UA	Speciation Model	TRUE	median	0	0	1.37	0.660	0.582	-1.83e-01	-3.41e-01	-5.56e-01
G312	C - UA	Speciation Model	TRUE	median	0	0	-5.53e-02	0.481	0.632	-1.09e+00	-2.09e+00	-6.10e-01
G313	C - UA	Speciation Model	TRUE	median	0	0	0.982	1.04	0.337	-3.58e-01	-7.31e-01	-6.73e-01

Attachment D. PHREEQC modeling output
Groundwater Polishing Report
Ash Pond No. 1
Coffeen Power Plant
Coffeen, IL

Location	Location Description	Model	Charge Balance	Solids Summary	Gypsum	d_Gypsum	si_Ferrihydrite	si_Gibbsite	si_Barite	si_Calcite	si_Dolomite (ordered)	si_Gypsum
G314D	C - DA	First Reaction	TRUE	median	0	0	0	0	0	-4.49e-01	-9.45e-01	-1.25e+00
G314D	C - DA	Second Reaction	TRUE	median	0	0	0	0	0	-5.05e-01	-1.10e+00	-1.34e+00
G307D	C - LCU	First Reaction	TRUE	median	0	0	0	0	0	0	0	-1.36e+00
G307D	C - LCU	Second Reaction	TRUE	median	0	0	0	0	0	0	0	-1.40e+00
G301	C - UA	First Reaction	TRUE	median	0	0	0	0	0	0	0	-1.38e+00
G301	C - UA	Second Reaction	TRUE	median	0	0	0	0	0	0	0	-1.41e+00
G308	C - UA	First Reaction	TRUE	median	0	0	0	0	0	0	0	-1.37e+00
G308	C - UA	Second Reaction	TRUE	median	0	0	0	0	0	0	0	-1.40e+00
G312	C - UA	First Reaction	TRUE	median	0	0	0	0	0	0	0	-1.36e+00
G312	C - UA	Second Reaction	TRUE	median	0	0	0	0	0	0	0	-1.40e+00
G313	C - UA	First Reaction	TRUE	median	0	0	0	0	0	0	0	-1.38e+00
G313	C - UA	Second Reaction	TRUE	median	0	0	0	0	0	0	0	-1.40e+00
G314D	C - DA	Initial Soln	FALSE	25p	0	0	2.32	0.685	0.529	0.258	0.274	-2.44e-01
G307D	C - LCU	Initial Soln	FALSE	25p	0	0	2.35	0.493	0.525	-3.00e-01	-6.62e-01	-7.82e-01
G301	C - UA	Initial Soln	FALSE	25p	0	0	-2.48e+00	0.866	0.345	-1.36e+00	-2.88e+00	-8.87e-01
G308	C - UA	Initial Soln	FALSE	25p	0	0	1.37	0.661	0.590	-1.80e-01	-3.33e-01	-5.50e-01
G312	C - UA	Initial Soln	FALSE	25p	0	0	-4.64e-02	0.483	0.645	-1.09e+00	-2.07e+00	-6.00e-01
G313	C - UA	Initial Soln	FALSE	25p	0	0	0.994	1.05	0.355	-3.49e-01	-7.12e-01	-6.59e-01
G314D	C - DA	Speciation Model	FALSE	25p	0	0	2.32	0.685	0.529	0.258	0.274	-2.44e-01
G307D	C - LCU	Speciation Model	FALSE	25p	0	0	2.35	0.493	0.525	-3.00e-01	-6.62e-01	-7.82e-01
G301	C - UA	Speciation Model	FALSE	25p	0	0	-2.48e+00	0.866	0.345	-1.36e+00	-2.88e+00	-8.87e-01
G308	C - UA	Speciation Model	FALSE	25p	0	0	1.37	0.661	0.590	-1.80e-01	-3.33e-01	-5.50e-01
G312	C - UA	Speciation Model	FALSE	25p	0	0	-4.64e-02	0.483	0.645	-1.09e+00	-2.07e+00	-6.00e-01
G313	C - UA	Speciation Model	FALSE	25p	0	0	0.994	1.05	0.355	-3.49e-01	-7.12e-01	-6.59e-01
G314D	C - DA	First Reaction	FALSE	25p	0	0	0	0	0	-5.00e-01	-1.07e+00	-1.31e+00
G314D	C - DA	Second Reaction	FALSE	25p	0	0	0	0	0	-5.70e-01	-1.24e+00	-1.35e+00
G307D	C - LCU	First Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.37e+00
G307D	C - LCU	Second Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.40e+00
G301	C - UA	First Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.39e+00
G301	C - UA	Second Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.41e+00
G308	C - UA	First Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.38e+00
G308	C - UA	Second Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.40e+00
G312	C - UA	First Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.37e+00
G312	C - UA	Second Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.40e+00
G313	C - UA	First Reaction	FALSE	25p	0	0	0	0	0	0	0	-1.39e+00
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G314D	C - DA	Initial Soln	FALSE	75p	0	0	2.32	0.685	0.529	0.258	0.274	-2.44e-01
G307D	C - LCU	Initial Soln	FALSE	75p	0	0	2.35	0.493	0.525	-3.00e-01	-6.62e-01	-7.82e-01
G301	C - UA	Initial Soln	FALSE	75p	0	0	-2.48e+00	0.866	0.345	-1.36e+00	-2.88e+00	-8.87e-01
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G314D	C - DA	Speciation Model	FALSE	75p	0	0	2.32	0.685	0.529	0.258	0.274	-2.44e-01
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G308	C - UA	Speciation Model	FALSE	75p	0	0	1.37	0.661	0.590	-1.80e-01	-3.33e-01	-5.50e-01
G312	C - UA	Speciation Model	FALSE	75p	0	0	-4.64e-02	0.483	0.645	-1.09e+00	-2.07e+00	-6.00e-01
G313	C - UA	Speciation Model	FALSE	75p	0	0	0.994	1.05	0.355	-3.49e-01	-7.12e-01	-6.59e-01
G314D	C - DA	First Reaction	FALSE	75p	0	0	0	0	0	-4.03e-01	-8.30e-01	-1.23e+00
G314D	C - DA	Second Reaction	FALSE	75p	0	0	0	0	0	-4.53e-01	-9.77e-01	-1.33e+00
G307D	C - LCU	First Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.35e+00
G307D	C - LCU	Second Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.40e+00
G301	C - UA	First Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.38e+00
G301	C - UA	Second Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.41e+00
G308	C - UA	First Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.37e+00
G308	C - UA	Second Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.40e+00
G312	C - UA	First Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.36e+00
G312	C - UA	Second Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.40e+00
G313	C - UA	First Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.38e+00
G313	C - UA	Second Reaction	FALSE	75p	0	0	0	0	0	0	0	-1.40e+00

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G314D	C - DA	Initial Soln	FALSE	median	0	0	2.32	0.685	0.529	0.258	0.274	-2.44e-01
G307D	C - LCU	Initial Soln	FALSE	median	0	0	2.35	0.493	0.525	-3.00e-01	-6.62e-01	-7.82e-01
G301	C - UA	Initial Soln	FALSE	median	0	0	-2.48e+00	0.866	0.345	-1.36e+00	-2.88e+00	-8.87e-01
G308	C - UA	Initial Soln	FALSE	median	0	0	1.37	0.661	0.590	-1.80e-01	-3.33e-01	-5.50e-01
G312	C - UA	Initial Soln	FALSE	median	0	0	-4.64e-02	0.483	0.645	-1.09e+00	-2.07e+00	-6.00e-01
G313	C - UA	Initial Soln	FALSE	median	0	0	0.994	1.05	0.355	-3.49e-01	-7.12e-01	-6.59e-01
G314D	C - DA	Speciation Model	FALSE	median	0	0	2.32	0.685	0.529	0.258	0.274	-2.44e-01
G307D	C - LCU	Speciation Model	FALSE	median	0	0	2.35	0.493	0.525	-3.00e-01	-6.62e-01	-7.82e-01
G301	C - UA	Speciation Model	FALSE	median	0	0	-2.48e+00	0.866	0.345	-1.36e+00	-2.88e+00	-8.87e-01
G308	C - UA	Speciation Model	FALSE	median	0	0	1.37	0.661	0.590	-1.80e-01	-3.33e-01	-5.50e-01
G312	C - UA	Speciation Model	FALSE	median	0	0	-4.64e-02	0.483	0.645	-1.09e+00	-2.07e+00	-6.00e-01
G313	C - UA	Speciation Model	FALSE	median	0	0	0.994	1.05	0.355	-3.49e-01	-7.12e-01	-6.59e-01
G314D	C - DA	First Reaction	FALSE	median	0	0	0	0	0	-4.27e-01	-8.98e-01	-1.26e+00
G314D	C - DA	Second Reaction	FALSE	median	0	0	0	0	0	-4.95e-01	-1.07e+00	-1.34e+00
G307D	C - LCU	First Reaction	FALSE	median	0	0	0	0	0	0	0	-1.36e+00
G307D	C - LCU	Second Reaction	FALSE	median	0	0	0	0	0	0	0	-1.40e+00
G301	C - UA	First Reaction	FALSE	median	0	0	0	0	0	0	0	-1.38e+00
G301	C - UA	Second Reaction	FALSE	median	0	0	0	0	0	0	0	-1.41e+00
G308	C - UA	First Reaction	FALSE	median	0	0	0	0	0	0	0	-1.37e+00
G308	C - UA	Second Reaction	FALSE	median	0	0	0	0	0	0	0	-1.40e+00
G312	C - UA	First Reaction	FALSE	median	0	0	0	0	0	0	0	-1.36e+00
G312	C - UA	Second Reaction	FALSE	median	0	0	0	0	0	0	0	-1.40e+00
G313	C - UA	First Reaction	FALSE	median	0	0	0	0	0	0	0	-1.38e+00
G313	C - UA	Second Reaction	FALSE	median	0	0	0	0	0	0	0	-1.40e+00

NOTES:
All model results are in units of moles with the exceptions of:
pH and pe (standard units)
charge (equivalents)
Results beginning with 'd_' (change from prior model step)
Results beginning with 'si_' (saturation index)

APPENDIX B
CORRECTIVE ACTION GROUNDWATER MONITORING PLAN

Intended for
Illinois Power Generating Company
134 CIPS Lane
Coffeen, IL 62017

Date
June 10, 2025

Project No.
1940110241-001

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN

COFFEEN POWER PLANT, ASH POND NO. 1, IEPA ID NO W1350150004-01

RAMBOLL Bright ideas. Sustainable change.

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN COFFEEN POWER PLANT, ASH POND NO. 1, IEPA ID NO W1350150004-01

Project name	**Coffeen Power Plant Ash Pond No. 1**
Project no.	**1940110241-001**
Recipient	**Illinois Power Generating Company**
Document type	**Corrective Action Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**June 10, 2025**
Prepared by	**Kristen L. Theesfeld**
Checked by	**J. Austin Bond, PE**
Approved by	**Brian G. Hennings, PG**
Description	**Corrective Action Groundwater Monitoring Plan**

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Table 2-3 Sampling and Analysis Summary
Table 3-1 Adaptive Site Management Metrics and Trigger Criteria

FIGURES (ATTACHED)

Figure 1-1 Corrective Action Monitoring Outline
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Figure 3-1 Corrective Action Monitoring Timeline
Figure 3-2 Adaptive Site Management Decision-Making Flow Chart

APPENDICES

Appendix A Boring Logs and Well Construction Forms
Appendix B 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
AP1	Ash Pond No. 1
AP2	Ash Pond No. 2
ASD	Alternative Source Demonstration
CAAA	Corrective Action Alternatives Analysis
CCR	coal combustion residuals
COC	constituent of concern
CPP	Coffeen Power Plant
CSM	conceptual site model
DA	deep aquifer
DCU	deep confining unit
E001	Event 1
GMF GSP	Gypsum Management Facility Gypsum Stack Pond
GMF RP	Gypsum Management Facility Recycle Pond
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
HCR	Hydrogeologic Site Characterization Report
ID	identification
IEPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
IPGC	Illinois Power Generating Company
LCU	lower confining unit
LF	Landfill
NID	National Inventory of Dams
No.	Number
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
StAP	Statistical Analysis Plan
TDS	total dissolved solids
UA	uppermost aquifer
UCU	upper confining unit
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

1.1 Overview

In accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments, Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Corrective Action Groundwater Monitoring Plan (GMP) on behalf of Coffeen Power Plant (CPP), operated by Illinois Power Generating Company (IPGC). This GMP will apply specifically to the coal combustion residuals (CCR) Unit referred to as Ash Pond Number (No.) 1 (AP1), CCR identification (ID) No. 101, Illinois Environmental Protection Agency (IEPA) ID No. W1350150004-01, and National Inventory of Dams (NID) No. IL50722. AP1 is a 23-acre, unlined SI used to manage CCR (bottom ash) and non-CCR waste streams at the CPP. Its total storage capacity is approximately 300 acre-feet. The bottom ash is periodically removed from AP1 for beneficial uses by a third-party contractor. Sluicing of waste to API ceased prior to November 4, 2019. This Corrective Action GMP includes content requirements specific to 35 I.A.C. § 845.630 (*Groundwater Monitoring System*), 35 I.A.C. § 845.640 (*Groundwater Sampling and Analysis*), 35 I.A.C. § 845.650 (Groundwater Monitoring Program), and 35 I.A.C. § 845.680 (*Implementation of the Corrective Action Plan*) for AP1 at the CPP.

A checklist in **Table 1-1** provides references to sections, tables, and figures within this document that meet the specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, 35 I.A.C. § 845.650, and 35 I.A.C. § 845.680.

This Corrective Action GMP is included as Appendix B to the Corrective Action Plan for CPP AP1. The Corrective Action Plan proposes source control with groundwater polishing, as the remedy for AP1. As described in the Corrective Action Plan, the proposed remedy meets the performance standards of 35 I.A.C. § 845.670(d) and addresses all current and potential future releases from AP1. Likewise, this Corrective Action GMP establishes how data will be collected, documented, and evaluated to assess remedy effectiveness for all currently documented and potential future releases from AP1[1] per the process outlined in **Figure 1-1**.

Adaptive site management strategies are an integral part of corrective action groundwater monitoring. The adaptive site management approach consistent with National Research Council, Interstate Technology & Regulatory Council and United States Environmental Protection Agency (USEPA) methodologies will allow timely incorporation of new site information throughout corrective action to ensure the achievement of the groundwater protection standard (GWPS). The adaptive site management approach expedites progress toward meeting the GWPS while acknowledging uncertainties, such as the persistence of current groundwater flow directions and potential related changes in geochemical conditions. The structured decision-making process proposed in this Corrective Action GMP includes specific metrics used to evaluate remedy progress, criteria which would trigger adaptive management evaluation, and options for those management actions.

1.2 Site Location and Background

The CPP is located in Montgomery County, in central Illinois, within Section 11 Township 7 North and Range 7 East. The CPP is approximately two miles south of the city of Coffeen and about

[1] The presence of exceedances at the waste boundary will continue to be evaluated under the Operating permit GMP previously submitted to IEPA [3].

eight miles southeast of the city of Hillsboro, Illinois (**Figure 1-2**). The CPP operated as a coal-fired power plant with five CCR units present, including AP1, Ash Pond No. 2 (AP2), the Gypsum Management Facility Gypsum Stack Pond (GMF GSP), the Gypsum Management Facility Recycle Pond (GMF RP), and Landfill (LF). Operations began in 1964 and CCR was disposed of in AP1. AP2 was also utilized in the early 1970's and AP1 was reconstructed in 1978. Both of these units were used until the mid-1980's, beginning in 2010 CCR material was placed in the LF and GMF Units. AP1 is located between the two lobes of Coffeen Lake (identified as "Coffeen Lake" and "Unnamed Tributary" on **Figure 1-2**) to the west, east, and south and AP2 to the north (**Figure 1-3**). Beyond the lake and other CCR units is agricultural land.

AP1 is a 23-acre, unlined SI used to manage CCR (bottom ash) and non-CCR waste streams at the CPP. Its total storage capacity is approximately 300 acre-feet. AP1 (also known as the Bottom Ash/Recycle Pond) is a reclaimed ash pond that was constructed utilizing the existing earthen berms with reinforcement, as provided by Water Pollution Control Permit 1978-EA-389 issued by the Agency on May 26, 1978. Several years ago, air heater wash and boiler chemical cleaning wastes were directed to AP1, but this practice was discontinued. The bottom ash is periodically removed from AP1 for beneficial uses by a third-party contractor. Sluicing of waste to AP1 ceased prior to November 4, 2019.

1.3 Conceptual Site Model

Significant site investigation has been completed at the CPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, AP1 has been well characterized as detailed in the Hydrogeologic Site Characterization Report (HCR) [1] included in the Operating Permit Application[2] and in the Nature and Extent Report [2].[3] A conceptual site model (CSM) has been developed and is discussed below.

In addition to the CCR, five hydrostratigraphic units have been identified at AP1 based on stratigraphic relationships, geologic composition, and common hydrogeologic properties. The units, listed from surface downward, are summarized as follows:

- **Upper Confining Unit (UCU):** Consists of the Loess Unit and the upper clayey portion of the Hagarstown Member which has generally lower vertical permeability and generally greater than 60 percent fine. The UCU was encountered across most of the CPP, with the exception of the eastern edges of the SIs near the Unnamed Tributary where the unit was eroded following deposition or locations where it has been excavated for construction.
- **Uppermost Aquifer (UA):** Consists primarily of sand and sandy silts and clays at the base of the Hagarstown Member and, in some locations, the uppermost weathered sandy clay portion of the Vandalia Member. The UA is absent in several locations due to weathering and in others due to excavation during construction of the CCR Unit. The hydraulic characteristics of the Hagarstown Member indicate the UA has a moderate hydraulic conductivity.
- **Lower Confining Unit (LCU):** Is composed of the sandy clay till of the Vandalia Member, the silt of the Mulberry Grove Formation, and the compacted clay till of the Smithboro Member. The LCU underlies the UA and was encountered in all boring locations on the CPP.

[2] The HCR was previously included as Attachment H of the Coffeen AP1 Operating Permit Application, submitted to IEPA on October 25, 2021.
[3] The Nature and Extent Report was previously submitted to IEPA [2] and is provided as Appendix D of the Corrective Action Alternatives Analysis (CAAA). The CAAA serves as Appendix A to the Corrective Action Plan to which this report is attached.

Results from laboratory tests completed for vertical hydraulic conductivity indicate the Vandalia Member has a very low vertical hydraulic conductivity.

- **Deep Aquifer (DA):** Consists primarily of sandy silt and sands of the Yarmouth Soil, which are thin (less than 5 feet) and discontinuous across the CPP.
- **Deep Confining Unit (DCU):** Underlies the DA and is composed of the Banner Formation, of which the thick Lierle Clay is the first encountered unit. No boring penetrated the full thickness of the DCU.

Overall groundwater flow within the UA is divided towards the two lobes of Coffeen Lake. The groundwater divide runs approximately through the center of the CPP, with groundwater east of the divide flowing east to southeast towards the Unnamed Tributary or the eastern lobe of Coffeen Lake and groundwater west of the divide flowing west to southwest towards the western lobe of Coffeen Lake. Groundwater flows primarily east to northeast across AP1 toward the former discharge structure and Unnamed Tributary. Although elevations vary seasonally, the groundwater flow direction in the UA is consistent and likely controlled by the proximity and hydraulic connection to Coffeen Lake. Groundwater elevations and contours for the October 2024 groundwater monitoring event are presented in **Figure 1-4**.

1.4 Groundwater Quality

Groundwater monitoring in accordance with the proposed Operating GMP and sampling methodologies provided in the operating permit application for groundwater compliance at AP1 began in the second quarter of 2023 [3]. The proposed compliance monitoring wells yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)).

The Event 1 (E001) quarterly groundwater monitoring event was completed on June 8, 2023. In accordance with 35 I.A.C. § 845.610(b)(3)(C) and the statistical analysis plan submitted with the operating permit application (Appendix A of the GMP), constituent concentrations observed at compliance wells were evaluated for compliance with the GWPSs summarized in 35 I.A.C. § 845.600 to determine exceedances[4] of the GWPS. The following GWPS exceedances at compliance groundwater monitoring wells were identified [4]:

- Boron at well G313
- Sulfate at wells G301, G303, G305, G307, G307D, G308, G310, G312, G313, G314, G314D, and G316
- Total dissolved solids (TDS) at wells G303, G305, G308, G312, G313, G314, G314D, G315, and G316

An Alternative Source Demonstration (ASD) was not completed for the GWPS exceedances listed above. Subsequent compliance sampling events (following E001) were evaluated for exceedances of the GWPS as described in 35 I.A.C. § 845.600 [5, 6, 7, 8, 9, 10]. Exceedances identified

[4] Throughout this document, "exceedance" or "exceedances" is intended to refer only to potential exceedances of proposed applicable background statistics or GWPSs as described in the proposed groundwater monitoring program which was submitted to the IEPA on October 25, 2021 as part of IPGC's operating permit application for the CPP AP1. That operating permit application, including the proposed groundwater monitoring program, remains under review by the IEPA and, therefore, IPGC has not identified any actual exceedances.

during the subsequent events were consistent with those listed above. In addition to the exceedances listed above, the following exceedances were identified:

- TDS at well G310

In accordance with 35 I.A.C. § 845.660, a Corrective Measures Assessment was developed to address current and potential future GWPS exceedances originating from AP1 and was submitted to IEPA on June 12, 2024 [11]. The selected remedy will meet the performance standards of 35 I.A.C. § 845.670(d) and once implemented and completed, the selected remedy presented in the Corrective Action Plan will attain the GWPSs.

1.5 Nature and Extent Investigation

Solid phase data were collected and evaluated from the following 10 locations during monitoring well installation at AP1 to further assess the nature, degree, and extent of potential groundwater impacts downgradient of AP1 in accordance with 35 I.A.C. § 845.650.

- XPW01 and XPW02 for CCR source material characterization
- UA monitoring wells G306, G307D, G311, G311D, G313, and G316
- UCU monitoring wells G307D, G311D, and G314D
- LCU monitoring wells G314, G307D, G311D, and G314D
- DA at monitoring well G314.

Soil lithology was logged continuously at the above locations, and soil samples were collected from each boring for laboratory analysis from within the screened interval of each well and from the soil just above the screened interval. Soil samples were analyzed for total metals, sulfur content, bulk mineralogy by x-ray diffraction, bulk elemental composition by x-ray fluorescence, total organic carbon and loss on ignition, and cation exchange capacity.

Additionally, six surface water samples were collected later in 2021 to characterize the water quality in Coffeen Lake and supplement previous samples collected in 2016 [12]. Surface water samples were analyzed for 35 I.A.C. § 845.600 parameters (total and dissolved), ferrous and ferric iron, major ions, and monitored natural attenuation parameters. An evaluation of the data is provided in the Nature and Extent Report.[5]

[5] The Nature and Extent Report was previously submitted to IEPA [2] and is provided as Appendix D of the CAAA. The CAAA serves as Appendix A to the Corrective Action Plan to which this report is attached.

2. CORRECTIVE ACTION GROUNDWATER MONITORING PLAN

This Corrective Action GMP is being provided to propose a groundwater monitoring program specific to AP1 that will comply with 35 I.A.C. § 845.680. The Corrective Action GMP will monitor and evaluate groundwater quality specifically to document the effectiveness of the corrective action remedy. The groundwater monitoring program will include sampling and analysis procedures that are consistent and that provide an accurate representation of groundwater quality.

2.1 Corrective Action Groundwater Monitoring Program and Parameters

2.1.1 35 I.A.C. § 845 Corrective Action Groundwater Monitoring

The proposed 35 I.A.C. § 845 corrective action monitoring well network will consist of fourteen wells to document the effectiveness of the corrective action remedy and ultimately demonstrate compliance with GWPSs (**Figure 2-1**). The wells included in the corrective action monitoring well network include select compliance monitoring wells from the Operating GMP network (*e.g.*, those with previously reported exceedances of the GWPS) (**Section 1.4**)

As appropriate to meet the corrective action monitoring objectives and evaluate the effectiveness of the corrective action remedy (as described in **Section 3**), the corrective action monitoring program involves assigning each well to a monitoring category or purpose (**Table 2-1**). These monitoring categories include:

- **Inside Plume**: monitoring wells installed at the CCR boundary with GWPS exceedances.
- **Plume Definition**: wells located along the lateral or vertical boundary of the plume.

A summary of the well locations and associated purpose as it relates to the above category is presented in **Table 2-1** and **Figure 2-1**. Monitoring well depths and construction details are listed in **Table 2-2**, and boring logs and monitoring well construction forms are provided in **Appendix A**. Groundwater samples will be collected and analyzed for the laboratory and field parameters in **Table 2-3**. Laboratory parameters include major ions for evaluating groundwater chemistry and constituents of concern (COCs) (*i.e.*, reported exceedances in accordance with the Operating GMP) the Corrective Action is intended to address. Sampling to evaluate corrective action effectiveness will begin the quarter after the corrective action remedy is implemented and commissioned.

2.2 Sampling Schedule

All wells in the 35 I.A.C. § 845 corrective action GMP network, as presented in **Table 2-1**, will be sampled quarterly to provide a complete picture of corrective action effectiveness. Groundwater elevations will be determined at the time of sample collection from each well. Sampling will end in accordance with 35 I.A.C. § 845.680(c), when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years" (details in **Section 3.3**).

Consistent with 35 I.A.C. § 845.650(b)(4), quarterly sampling may be reduced to a semiannual frequency with IEPA approval after completion of five years of monitoring. A request for reduced sampling frequency will include a demonstration that corrective action monitoring effectiveness will not be compromised; sufficient data has been collected to evaluate ongoing remedy

effectiveness; and existing data show trends consistent with anticipated remedy performance (details in **Section 3.1**).

2.3 Groundwater Sample Collection

Groundwater sampling procedures have been developed and the collection of groundwater samples is being implemented to meet the requirements of 35 I.A.C. § 845.640. In addition to groundwater well samples, quality assurance samples will be collected as described in **Section 2.5** (**Table 2-3**). Groundwater samples will be collected and analyzed in accordance with the Multi-Site Sampling and Analysis Plan [13][6].

2.4 Laboratory Analysis

Laboratory analysis will be performed consistent with the requirements of 35 I.A.C. § 845.640(j) by a state-certified laboratory using methods approved by IEPA and USEPA. Laboratory methods may be modified based on laboratory equipment availability or procedures, but the Reporting Limit (RL) for all parameters analyzed, regardless of method, will be lower than the applicable groundwater quality standard [14]. Concentrations lower than the RL will be reported as less than the RL.

2.5 Quality Assurance Program

Consistent with the requirements of 35 I.A.C. § 845.640(a)(5), the sampling and analysis program includes procedures and techniques for quality assurance/quality control (QA/QC). Additional quality assurance samples to be collected will include the following[6]:

- Field duplicates will be collected at a frequency of one per group of ten or fewer investigative water samples.
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.
- The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:
  - Regular generation of instrument calibration curves to assure instrument reliability
  - Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
  - Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
  - Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
  - Analysis of method blanks to assure that the system is free of contamination

Water quality meters used to measure pH and turbidity will be calibrated according to manufacturer's specifications. At a minimum, it is recommended that calibration of pH occur daily prior to sampling and checked for accuracy at the end of each day. Unusual or suspect pH measurements during sampling events will be flagged, evaluated, and additional calibration may

[6] The Multi-Site Sampling and Analysis Plan and Multi-Site Quality Assurance Project plan are living documents which are subject to routine evaluation and updates in accordance with USEPA recommended best practices [21, 22].

be performed throughout the sampling events. Turbidity meters will be checked daily, prior to and following sampling. Unusual measurements or erratic meter performance will be flagged and evaluated for overall effects on the data prior to reporting.

2.6 Groundwater Monitoring Well Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed according to the Multi-Site Sampling and Analysis Plan [13] as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring wells will be inspected during each groundwater sampling event; inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas, in which case caps will not be vented
- Routine measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks to assure that wells are clear of internal obstructions, and flow freely

If wells are damaged or become otherwise inoperable, they will be replaced by wells screened at the same elevation and as close to the original well as possible (ideally within 10 feet) and notification will be provided to IEPA. If a replacement well cannot be installed within approximately 10 feet of the original well location, notification will be sent to IEPA and a monitoring well will be installed as close as possible to the original monitoring well and given a new well identification number. Any well replacement activities will also be documented in the Annual Groundwater Monitoring and Corrective Action Report.

2.7 Statistical Analysis

A Multi-Site Statistical Analysis Plan (StAP) (**Appendix B**) has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

2.8 Data Reporting

Groundwater monitoring and analysis completed in accordance with 35 I.A.C. § 845 under an approved monitoring program will be reported to IEPA annually by January 31 as required by I.A.C. § 845.550, for data collected the preceding year. The Annual Groundwater Monitoring and Corrective Action Report will include the status of the groundwater monitoring and Corrective Action Plan for AP1 in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

2.9 Compliance with Applicable Groundwater Protection Standards

As provided in 35 I.A.C. § 845.680(c)(2), corrective action is considered complete when compliance with the GWPS has been achieved by demonstrating that concentration of constituents listed in 35 I.A.C. § 845.600 have not exceeded the GWPSs for a period of three

consecutive years, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g).

Attainment of GWPSs and conclusion of corrective action monitoring is discussed below in **Section 3.3**.

If a new exceedance is determined during monitoring under the Operating GMP, the Corrective Action groundwater monitoring program will be evaluated for monitoring of additional locations and/or constituents using the adaptive site management methods presented herein.

3. EFFECTIVENESS OF THE CORRECTIVE ACTION REMEDY

The methods for evaluating the effectiveness of the corrective action remedy described in this section are based on the following guidance documents:

- "Methods for Evaluating the Attainment of Cleanup Standards Volume 2: Ground Water," USEPA, Office of Policy, Planning, and Evaluation, 1992. [15]
- "Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind," USEPA, Office of Solid Waste and Emergency Response, 2014. [16]
- "Adaptive Site Management – A Framework for Implementing Adaptive Management at Contaminated Sediment Superfund Sites," USEPA, Office of Superfund Remediation and Technology Innovation, 2022. [17]
- "Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model," USEPA, Office of Solid Waste and Emergency Response, 2011. [18]

Evaluation of corrective action remedy effectiveness will occur in three phases (**Figure 3-1**): remedy progress evaluation, stability evaluation, and attainment evaluation [15].

1. Remedy progress evaluation occurs after implementation of corrective actions to assess if the remedy is functioning as anticipated.
2. The stability evaluation, which assesses if a new post-treatment steady state in the groundwater has been reached.
3. Attainment evaluation occurs after a new steady state has been achieved and assesses if COC concentrations are below the GWPS.

COCs are parameters with exceedances of the GWPS to be addressed by the Corrective Action Plan. Corrective action monitoring at COF AP1 includes the following COC parameters:

- Boron, sulfate, and TDS

The effectiveness of the remedy at each phase is evaluated using performance metrics designed to assess the goals of that phase. Performance metrics answer questions designed to evaluate multiple aspects of remedy effectiveness with the ultimate goal of holistically guiding management decisions [16]. These metrics may be evaluated using qualitative (subject to expert judgement) or quantitative (numerical outcomes) methods.

This section details the goals and performance metrics of each phase of remedy evaluation. Within each phase, the well groups described in **Section 2.1** have distinct applicable metrics and/or potential management actions consistent with the role of that well group within the corrective action monitoring framework. The remedy evaluation metrics documented here are specific to wells within the Corrective Action monitoring program.

3.1 Remedy Progress Evaluation

The goal of remedy process evaluation is to determine if a groundwater remedy is on track to achieve cleanup standards within the proposed time frame and to inform adaptive management decisions if performance metrics are not achieved. Evaluation of remedy progress includes evaluating the response of COCs in individual monitoring wells and in the plume as a whole. Remedy progress is evaluated using performance metrics as described below. **Table 3-1** details

the questions used to assess remedy progress and metrics which would trigger additional evaluation of adaptive site management options. **Figure 3-2** presents an outline of the decision-making process regarding adaptive management actions (the first step of which is assessing remedy progress per **Table 3-1**).

Documentation of remedy progress metrics will be provided in the Annual Groundwater Monitoring and Corrective Action Report (**Section 2.8**) beginning after the second year of data collection: a minimum of eight data points is required to complete meaningful statistical analysis required for evaluation of the remedy progress metrics, which will be available after two years of quarterly sampling. Per USEPA guidance [16], a thorough review of corrective action progress and remedy effectiveness will be conducted every five years. A Five-Year Annual Groundwater Monitoring and Corrective Action Report will evaluate the comprehensive data set and, if triggered by the results of the remedy progress evaluation metrics (**Table 3-1**), evaluate whether adaptive management actions are needed (**Figure 3-2**). The five-year time frame allows adaptive management decisions to be based on robust data sufficient to complete meaningful statistical analysis while remaining responsive to changing site conditions [16]. The remedy progress evaluation metrics and triggers for additional evaluation are described below.

3.1.1 Comparison to Groundwater Protection Standard

The Inside Plume wells in this monitoring plan were defined based on exceedances of the GWPS. The question posed to evaluate whether exceedances of the GWPS occur, and associated method of evaluation is (**Table 3-1**):

- Are COC concentrations greater than the GWPS? – Compare data points or summary statistics to site-specific GWPS values.

COC concentrations below the GWPS in Inside Plume wells may indicate that remedial actions are approaching completion and that moving to the next phase of remedy effectiveness evaluation may be warranted (see **Section 3.2**). Persistence of COC concentrations above the GWPS in Plume Definition wells may indicate that the plume is no longer properly delineated. Therefore, the trigger criterion for further evaluation is a central tendency measure of the last eight data points exceeding the GWPS.

3.1.2 Agreement with Groundwater Model

A groundwater flow and transport model[7] was used to compare the anticipated time to reach the GWPS for the different corrective actions considered at AP1.

The question posed to evaluate agreement of corrective action remedy progress with the groundwater model results is provided in **Table 3-1** and summarized below:

- Are concentrations of COCs at individual wells consistent with modeling expectations? – Evaluate if the observed results track with the predicted results in general direction and magnitude using expert professional judgement.

Only Inside Plume and Plume Definition wells included in the flow and transport model are evaluated according to this metric. Trigger criteria for additional adaptive site management evaluation include monitoring results failing to follow the general magnitude and direction of

[7] The Groundwater Modeling Technical Memorandum is included as an attachment to the CAAA presented as part of the Corrective Action Plan.

groundwater model results at one or more locations. It is acceptable to conclude that no further adaptive site management evaluation is triggered if future observations do not precisely match modeled results on an individual well basis if the direction of remedy progress is adequate.

3.1.3 Trend Analysis

Evaluation of COC trends in wells both within and outside of the plume is a major component of remedy progress evaluations [15, 16]. Decreasing COC concentrations within the groundwater plume provides critical support for remedy effectiveness evaluations. Changing concentrations in wells defining the plume may indicate unanticipated plume migration or a need for better plume definition. Both short-term and long-term trends are important to evaluate remedy performance [15]. All trend analyses are performed in accordance with the Multi-Site StAP (**Appendix B**) and the USEPA Unified Guidance for groundwater statistics [19].

The questions posed to evaluate if COC concentrations are decreasing in Inside Plume wells and the associated methods for evaluation are provided in **Table 3-1** and summarized as follows:

- Are the average plume COC concentrations decreasing? – Evaluate trend based on quarterly average of COC concentrations of Inside Plume wells, both for the last eight sampling events and since corrective action was initiated.

The questions posed to evaluate if COC concentrations are changing in Inside Plume wells and Plume Definition wells and the associated methods for evaluation are provided in **Table 3-1** and summarized below:

- Are concentrations of COCs at individual wells changing? – Evaluate trend of COC concentrations, both for the last eight sampling events and since corrective action was initiated.

The goal of the corrective action is to reduce COC concentrations in the groundwater. Therefore, trigger criteria have been established for the two types of corrective action monitoring wells as follows:

- Inside Plume well triggers for adaptive site management evaluation are based on no decreasing trend in COC concentrations (short-term or long-term).
- Plume Definition well triggers are based on increasing COC concentrations, which may indicate improper delineation of the plume. Therefore, the trigger criterion for adaptive site management evaluation at Plume Definition wells is increasing short- or long-term trend.

3.1.4 Adaptive Management Actions

The goal of adaptive management actions is to understand why performance metrics are not met and, if the remedy is found to be unsuccessful in meeting remediation goals, drive supplemental corrective actions or, in extreme cases, re-evaluation of remedy selection. This section describes in greater detail the steps in the flow chart presented in **Figure 3-2** (adapted from Figure 2 in [16]).

As the remedy progress evaluation metrics are evaluated annually, failure to meet the metrics (as described in **Table 3-1**) leads to further action. If the data available at the time of the Five-Year Review are anticipated to be inadequate for determining the need for adaptive site management actions, additional data may be collected before the Five-Year Review including collecting samples from additional wells or measuring additional parameters.

If the remedy progress is not found to be adequate during the Five-Year Review, the most critical question is whether or not the remedy is likely to achieve the GWPS in a reasonable time frame. This may be evaluated using methods such as regression analysis or analysis of groundwater flow. If the remedy progress is not judged to be adequate but the remedy is likely to achieve the GWPS in a reasonable time frame, the CSM or the groundwater model may require updating to reflect evolving field conditions[8]. Additional data collected may also suggest ways to optimize the monitoring network or performance metrics [16].

If the remedy does not appear likely to achieve the GWPS in a reasonable time frame, it may be due to changing hydrogeochemical dynamics within the plume or an additional source of COCs not accounted for in the CSM. If available data suggests either occurrence, the Five-Year Review will describe additional activities planned to investigate if the existing remedy is still a viable option for attaining the GWPS. If the remedy is still viable, an update to the CSM and groundwater model is likely required [16, 18] and will be conducted after additional investigation is completed.

If the remedy does not appear likely to achieve the GWPS in a reasonable time frame, there is no alternative source of COCs not accounted for in the CSM, and the plume is appropriately delineated; or if the investigation into the hydrogeochemical changes or alternative source of COCs determines that the remedial action is no longer solely viable as a corrective action, an evaluation of additional remedial actions will be initiated.

If the remedy progress evaluation metrics indicate that concentrations across the monitoring network are below the GWPS, the remedy progress phase may be considered complete, and the monitoring program may move to the Stability Evaluation phase (see **Section 3.2**).

3.2 Stability Evaluation

Evaluation of groundwater stability reflects the idea that implementation of a remedy will, by necessity, cause changes to the physical and chemical environment of the groundwater. Before assessing if compliance with the GWPS has been attained (**Section 3.3**), any transient effects of treatment on the groundwater (e.g., rebounding concentrations) should be allowed to dissipate [15]. Stability is evaluated to assess if a new stable equilibrium has been reached after final closure has been implemented. Stability is achieved when groundwater elevations are stable (accounting for seasonal variability), average COC concentrations are stable across all wells, and COC concentrations are stable at each well.

Trends in groundwater elevation and COC concentrations at each plume well will be evaluated using the most recent eight data points (*i.e.*, two years of data when sampling quarterly) according to methods presented in the Multi-Site StAP (**Appendix B**). This metric is met for a plume well when there is no statistically significant trend in groundwater elevation or COC concentrations.

Plume COC concentrations will be evaluated for trend using the most recent eight data points, with the average concentration across plume wells per sampling event considered as one data

[8] As stated in Section 1.4.1 of the Corrective Action Plan, "Estimated times to reach GWPS will be periodically reviewed and updated based on observed corrective action performance via an adaptive site management strategy."

point, according to methods presented in the Multi-Site StAP (**Appendix B**). This metric is met when there is no statistically significant trend in average COC concentrations.

3.3 Attainment Evaluation and Conclusion of Corrective Action Monitoring

The ultimate goal of groundwater corrective action is to attain compliance with the GWPS for each COC in Inside Plume wells. After stability has been achieved per the metrics discussed in **Section 3.2**, attainment evaluation will begin. Per 35 I.A.C. § 845.680(c), corrective action is considered complete when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years". Attainment of the GWPS will be evaluated in accordance with the Multi-Site StAP (**Appendix B**). Corrective action monitoring is considered complete for the site when COCs in the corrective action monitoring well network do not exceed the GWPS for three years.

4. REFERENCES

[1] Ramboll Americas Engineering Solutions, Inc., "Hydrogeologic Site Characterization Report, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," October 25, 2021.

[2] Ramboll Americas Engineering Solutions, Inc., Nature and Extent Report, Coffeen Power Plant, Ash Pond No. 1, IEPA ID No. W1350150004-01, June 12, 2024.

[3] Ramboll Americas Engineering Solutions, Inc., "Groundwater Monitoring Plan, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," October 25, 2021.

[4] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances, Quarter 2, 2023: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," October 16, 2023.

[5] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances Quarter 3, 2023: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," January 20, 2024.

[6] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances Quarter 4, 2023: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois.," March 10, 2024.

[7] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances Quarter 1, 2024: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," June 7, 2024.

[8] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances Quarter 2, 2024: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," August 16, 2024.

[9] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances Quarter 3, 2024: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," November 12, 2024.

[10] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845.610(B)(3)(D) Groundwater Monitoring Data and Detected Exceedances Quarter 4, 2024: Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois," February 17, 2025.

[11] Ramboll Americas Engineering Solutions, Inc., "35 I.A.C. § 845 Corrective Measures Assessment, Ash Pond No. 1, Coffeen Power Plant, Coffeen, Illinois, IEPA ID: W1350150004-01," June 12, 2024.

[12] Gradient Corporation, "Human Health and Ecological Risk Assessment. Ash Pond 1, Coffeen Power Plant, Coffeen, Illinois," July 28, 2022.

[13] Ramboll Americas Engineering Solutions, Inc., "Multi-Site Sampling and Analysis Plan," December 28, 2022. [Online]. Available: https://www.luminant.com/documents/ccr/il-ccr/Coffeen/2023/Multi-Site%20Sampling%20Analysis%20Plan-Coffeen-W1350150004%E2%80%9001,02,03,04.pdf.

[14] Ramboll Americas Engineering Solutions, Inc., "Multi-Site Quality Assurance Project Plan," December 28, 2022. [Online]. Available: https://www.luminant.com/documents/ccr/il-ccr/Coffeen/2023/Multi-site%20Quality%20Assurance%20Project%20Plan-Coffeen-W1350150004%E2%80%9001,02,03,04.pdf.

[15] United States Environmental Protection Agency, "Methods for Evaluating the Attainment of Cleanup Standards Volume 2: Ground Water," Office of Policy, Planning, and Evaluation, 1992.

[16] United States Environmental Protection Agency, "Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind," Office of Solid Waste and Emergency Response, 2014.

[17] United States Environmental Protection Agency, "Adaptive Site Management - A Framework for Implementing Adaptive Management at Contaminated Sediment Superfund Sites," Office of Superfund Remediation and Technology Innovation, 2022.

[18] United States Environmental Protection Agency, "Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model," Office of Solid Waste and Emergency Response, 2011.

[19] United States Environmental Protection Agency, "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance," Office of Resource Conservation and Recovery, 2009.

[20] United States Environmental Protection Agency, "Quality Assurance Project Plan Standard," 2023. [Online]. Available: https://www.epa.gov/system/files/documents/2024-04/quality_assurance_project_plan_standard.pdf.

[21] United States Environmental Protection Agency, "EPA QA Field Activities Procedure," 2020. [Online]. Available: https://www.epa.gov/system/files/documents/2022-09/epa_qa_field_activities_procedure.pdf.

TABLES

Table 1-1. 35 I.A.C. § 845 Requirements Checklist

Corrective Action Groundwater Monitoring Plan
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

35 I.A.C. § 845 Reference	35 I.A.C. § 845 Components	Location of Information in Corrective Action GMP
845.630	**Groundwater Monitoring Systems**	
845.630(a)(2)	Potential contaminant pathways must be monitored.	NA
845.630(a) 845.630(b) 845.630(c)	At least two upgradient wells and four downgradient wells (min. 1 and 3, but requires additional documentation)	Section 2.1 Figure 1-4
845.630(a) 845.630(b) 845.630(c)	Downgradient Well Density	Figure 1-4
845.630(a)(2)	Downgradient wells at waste boundary	Figure 1-4
845.640	**Groundwater Sampling and Analysis Requirements**	
845.640(a)	Consistent sampling and analysis procedures	Section 2 Tables 2-3 and 2-4
845.640(b)	Methods are appropriate	Section 2 Tables 2-3 and 2-4
845.640(c)	Groundwater elevations must be measured in each well prior to purging, each time groundwater is sampled.	Section 2.2
845.640 (d)(e)(f)(g)(h)	Establishment of background and application of statistical methods	Section 2.7 Appendix B
845.640(i)	Analyze total recoverable metals	Table 2-3
845.640(j)	Analyze groundwater samples using a certified laboratory	Section 2.4

Table 1-1. 35 I.A.C. § 845 Requirements Checklist
Corrective Action Groundwater Monitoring Plan
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

35 I.A.C. § 845 Reference	35 I.A.C. § 845 Components	Location of Information in Corrective Action GMP
845.650	**Groundwater Monitoring Program**	
845.650(a)	Must include monitoring for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity	Section 2.1 Table 2-3
845.650(b)(c)	Groundwater Monitoring Frequency	Section 2.2
845.650(d)(e)	Exceedances of the groundwater protection standard	Sections 2.9 and 3.1.1
845.650(b)(2) and (3)	Staff gauge/ piezometer to monitor head in impoundment	Figure 1-4 (XPW01 and XPW02)
NA	Staff gauge/ piezometer to monitor head of neighboring surface water body	Figure 1-4 (SG02 and SG03)
845.680	**Implementation of the Corrective Action Plan**	
845.680(a)(1)(a)	Establish and implement a corrective action groundwater monitoring program that meets requirements of 845.650	Sections 2.1 and 3 Tables 2-1 and 3-1 Figure 2-1
845.680(a)(1)(b)	Document the effectiveness of the corrective action remedy	Section 3
845.680(a)(1)(c)	Demonstrate compliance with the groundwater protection standard under Subsection [845.680] (c)	Sections 2.9 and 3

Table 1-1. 35 I.A.C. § 845 Requirements Checklist

Corrective Action Groundwater Monitoring Plan

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

35 I.A.C. § 845 Reference	35 I.A.C. § 845 Components	Location of Information in Corrective Action GMP
845.680(c)(1)	Demonstrate compliance with the groundwater protection standards established by 845.600 has been achieved at all points within the plume of contamination that lies beyond the waste boundary	Section 3.3
845.680(c)(2)	Demonstrate that concentrations of constituents listed in 845.600 have not exceeded the groundwater protection standards for a period of three consecutive years using statistical procedures and performance standards in 845.640(f) and (g)	Sections 3.3 and 3.4

[O: CJC 10/23/2024; C: LDC 11/7/2024][U: KLT 2/10/25, C: CJC 04/02/2025]

Notes:

GMP = Groundwater Monitoring Plan

NA = Not Applicable

Table 2-1. Summary of Monitoring Well Locations and Purpose

Corrective Action Groundwater Monitoring Plan

Coffeen Power Plant

Ash Pond No. 1

Coffeen, IL

Well ID	Monitored Unit	Corrective Action Monitoring Well System	
		Inside Plume	Plume Definition
G301	UA	X	
G303	UA	X	
G305	UA	X	
G307	UA	X	
G307D	LCU	X	
G308	UA	X	
G310	UA	X	
G311D	LCU		X
G312	UA	X	
G313	UA	X	
G314	LCU	X	
G314D	DA	X	
G315	UA	X	
G316	LCU	X	

[O: KLT 2/10/2024, C: CJC 04/02/2025]

Notes:

UA = uppermost aquifer

LCU = Lower Confining Unit

DA = deep aquifer

Table 2-2. Monitoring Well Locations and Construction Details

Corrective Action Groundwater Monitoring Plan
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Location	HSU	Date Constructed	Top of PVC Elevation (ft NAVD88)	Measuring Point Elevation (ft NAVD88)	Measuring Point Description	Ground Elevation (ft NAVD88)	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Screen Top Elevation (ft NAVD88)	Screen Bottom Elevation (ft NAVD88)	Well Depth (ft bgs)	Bottom of Boring Elevation (ft NAVD88)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
G301	UA	9/4/2015	622.7	622.8	Top of Casing	620.8	11.3	16.0	609.5	604.8	18.3	602.5	4.7	2	39.059510	-89.395421
G303	UA	8/26/2010	621.8	621.9	Top of Casing	619.2	10.0	20.0	609.2	599.2	23.1	596.1	10	2	39.057144	-89.391726
G305	UA	5/3/2016	625.7	625.8	Top of Casing	623.1	13.4	18.3	609.7	604.9	21.2	601.9	4.8	2	39.056558	-89.396804
G307	UA	7/27/2016	624.6	624.6	Top of Casing	622.4	13.0	17.8	609.4	604.6	20.4	602.0	4.8	2	39.057214	-89.395550
G307D	LCU	1/19/2021	624.9	625.1	Top of Casing	622.4	49.0	58.8	573.4	563.7	62.3	560.1	9.8	2	39.057211	-89.395526
G308	UA	1/18/2021	624.5	624.7	Top of Casing	621.5	10.1	14.9	611.4	606.6	18.5	603.1	5	2	39.057379	-89.397141
G310	UA	2/9/2021	622.8	623.0	Top of Casing	619.8	10.2	15.0	609.5	604.7	18.6	601.1	4.8	2	39.059532	-89.396912
G311D	LCU	1/12/2021	621.2	621.2	Top of Casing	618.4	50.2	60.1	568.2	558.3	63.4	555.0	9.9	2	39.059513	-89.394312
G312	UA	1/15/2021	619.8	620.0	Top of Casing	616.6	9.8	14.6	606.8	602.0	18.3	598.3	4.8	2	39.059558	-89.391988
G313	UA	2/5/2021	614.2	614.4	Top of Casing	611.4	6.3	11.1	605.1	600.3	14.5	596.9	4.8	2	39.058773	-89.391131
G314	LCU	2/5/2021	613.8	614.0	Top of Casing	611.1	14.6	19.6	596.5	591.5	23.0	588.1	5	2	39.057820	-89.390970
G314D	DA	2/4/2021	613.5	613.7	Top of Casing	610.8	39.3	49.1	571.4	561.6	52.4	558.4	10	2	39.057852	-89.390963
G315	UA	1/14/2021	623.5	623.6	Top of Casing	620.8	9.7	14.5	611.1	606.4	17.6	603.2	4.8	2	39.057165	-89.393673
G316	LCU	2/26/2021	602.8	602.8	Top of Casing	599.5	10.0	14.8	589.4	584.6	18.5	581.0	5	2	39.057847	-89.389703

[O: CJC 10/23/2024; C: AOC 10/30/2024][U: KLT 2/3/25, C: CJC 04/02/2025]

Notes:

All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
bgs = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
LCU = lower confining unit
NAVD88 = North American Vertical Datum of 1988
PVC = polyvinyl chloride
UA = uppermost aquifer

Table 2-3. Sampling and Analysis Summary
Corrective Action Groundwater Monitoring Plan
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

Parameter	Analytical Method [1]	Number of Samples	Field Duplicates [2]	Field Blanks [3]	Equipment Blanks [3]	MS/MSD [4]	Total	Container Type	Minimum Volume [5]	Preservation (Cool to 6 °C for all samples)	Sample Hold Time from Collection Date
Corrective Action Parameter(s) [6]											
Boron	6020 [7]	14	2	0	0	1	17	plastic	600 mL	HNO_3 to pH<2	6 months
Sulfate	9036 or EPA 300	14	2	0	0	1	17	plastic	50 mL	Cool to 6 °C	28 days
Total Dissolved Solids	SM 2540 C	14	2	0	0	1	17	plastic	200 mL	Cool to 6 °C	7 days
Inorganic Parameters											
Alkalinity, bicarbonate	SM 2320 B	14	2	0	0	1	17	plastic	500 mL	Cool to 6 °C	14 days
Alkalinity, carbonate	SM 2320 B	14	2	0	0	1	17	plastic	500 mL	Cool to 6 °C	14 days
Calcium	6020 [7]	14	2	0	0	1	17	plastic	600 mL	HNO_3 to pH<2	6 months
Chloride	9251 or EPA 300	14	2	0	0	1	17	plastic	100 mL	Cool to 6 °C	28 days
Fluoride	9214 or EPA 300	14	2	0	0	1	17	plastic	300 mL	Cool to 6 °C	28 days
Magnesium	6020 [7]	14	2	0	0	1	17	plastic	600 mL	HNO_3 to pH<2	6 months
Sodium	6020 [7]	14	2	0	0	1	17	plastic	600 mL	HNO_3 to pH<2	6 months
Potassium	6020 [7]	14	2	0	0	1	17	plastic	600 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	14	NA	NA	NA	NA	14	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	14	NA	NA	NA	NA	14	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	14	NA	NA	NA	NA	14	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	14	NA	NA	NA	NA	14	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	14	NA	NA	NA	NA	14	flow-through cell	NA	none	immediately
Turbidity [9]	SM 2130 B	14	NA	NA	NA	NA	14	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: CJC 10/23/2024, C: AOC 10/30/2024][U: KLT 2/10/25, C: CJC 04/02/2025]

Notes:
[1] Analytical method numbers are from SW-846 unless otherwise indicated. Analytical methods may be updated with more recent versions as appropriate.
[2] Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples. Field duplicates will not be collected for radium analysis.
[3] Field blanks will be collected at the discretion of the project manager; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
[4] Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.
[5] Sample volume is estimated and will be determined by the laboratory.
[6] Determined by reported exceedances under the Operating Groundwater Monitoring Plan
[7] Metals may be analyzed via USEPA methods 6010 or 6020 depending on laboratory instrument availability.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under 35 I.A.C. § 845; collection of parameter may be discontinued without notification.
[9] If turbidity exceeds 10 NTU, a duplicate sample filtered through a 0.45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
< = less than
°C = degrees Celsius
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

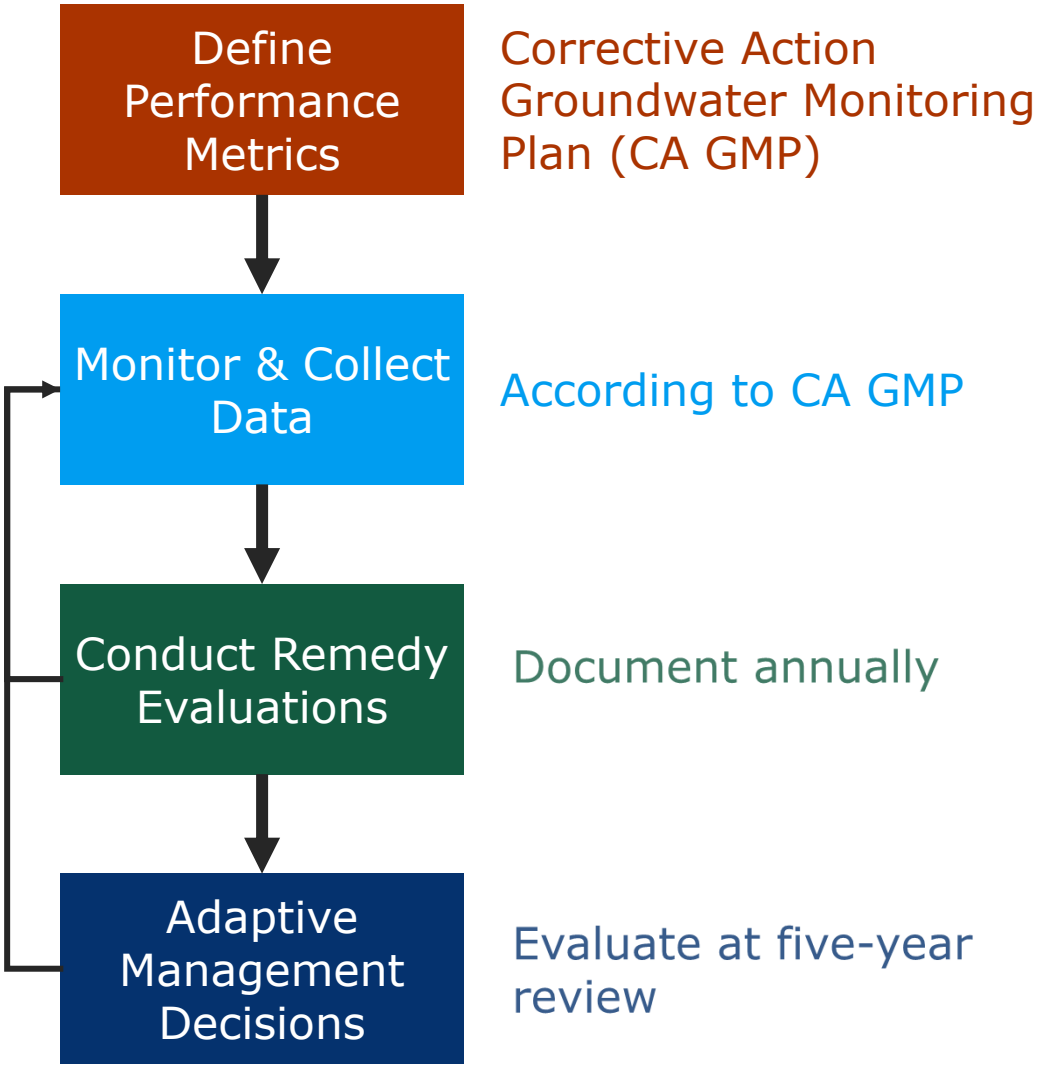
Table 3-1. Adaptive Site Management Metrics and Trigger Criteria
Corrective Action Groundwater Monitoring Plan
Coffeen Power Plant
Ash Pond No. 1
Coffeen, IL

QUESTION	**Are COC concentrations greater than the GWPS?**		**Are concentrations of COCs at individual wells consistent with modeling expectations?** [1]		**Are the average COC concentrations decreasing?**	**Are concentrations of COCs at individual wells changing?**	**Adaptive Site Management Outcome**
EVALUATION [2]	Compare data points or summary statistics to site-specific GWPS		Do the observed results track with the predicted results in general direction and magnitude? (Professional judgement)		Evaluate trend on quarterly average of well concentrations, both for last 8 data points and since corrective action initiated or closure completed	Evaluate trend of COCs at each well, both for last 8 data points and since corrective action initiated	
Inside Plume	Central tendency concentration of last eight data points above the GWPS	**AND**	Results inconsistent with model	**AND MORE THAN ONE OF**	Neither trend decreasing	Neither trend decreasing	**Additional Evaluation Triggered (See Figure 3-2)**
Lateral/Vertical Plume Definition	Central tendency concentration of last eight data points above the GWPS		Results inconsistent with model		--	Either trend increasing	

[O: CJC 10/23/2024; C: AOC 10/30/2024]

Notes:
1. Only applies to wells included in the flow and transport model
2. To be documented in Annual Monitoring and Corrective Action Reports
-- = No relevant trigger criteria
COC = constituent of concern
GWPS = groundwater protection standard

FIGURES



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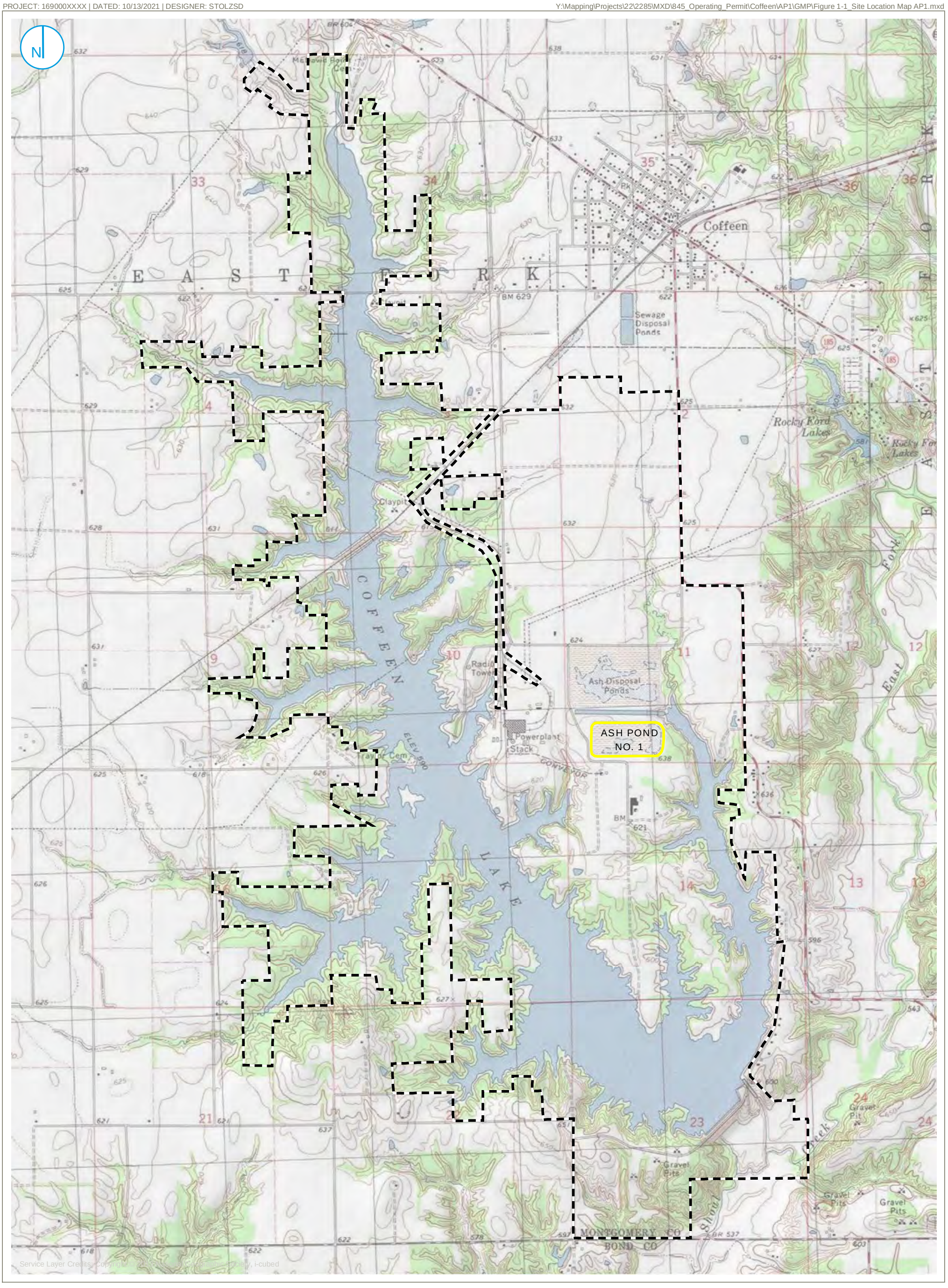
CORRECTIVE ACTION MONITORING OUTLINE

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Figure 1-1



REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-2

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

0 325 650 Feet

SITE MAP

FIGURE 1-3

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL

- COMPLIANCE MONITORING WELL
- BACKGROUND MONITORING WELL
- MONITORING WELL
- PORE WATER WELL
- LEACHATE WELL
- STAFF GAGE, RIVER
- STAFF GAGE, CCR UNIT
- GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- REGULATED UNIT (SUBJECT UNIT)
- SITE FEATURE
- LIMITS OF FINAL COVER
- PROPERTY BOUNDARY

0 325 650 Feet

NOTES:
1. ELEVATIONS IN PARENTHESES WERE NOT USED FOR CONTOURING.
2. ELEVATION CONTOURS SHOWN IN FEET, NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

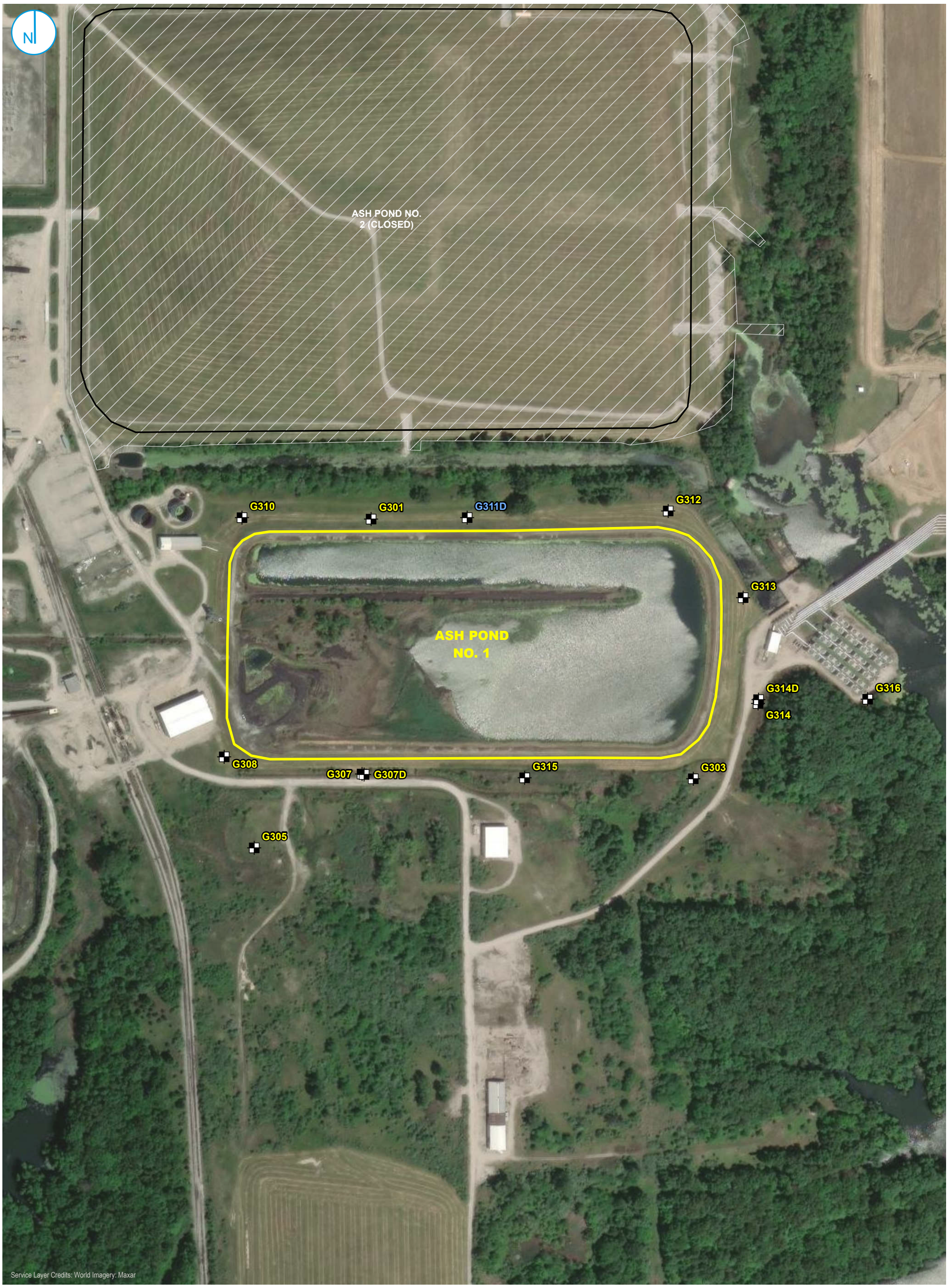
POTENTIOMETRIC SURFACE MAP OCTOBER 28 AND 29, 2024

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 1-4

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



MONITORING WELL
REGULATED UNIT (SUBJECT UNIT)
SITE FEATURE
LIMITS OF FINAL COVER
PROPERTY BOUNDARY

XXX INSIDE PLUME MONITORING WELL
XXX PLUME DEFINITION MONITORING WELL

0 150 300 Feet

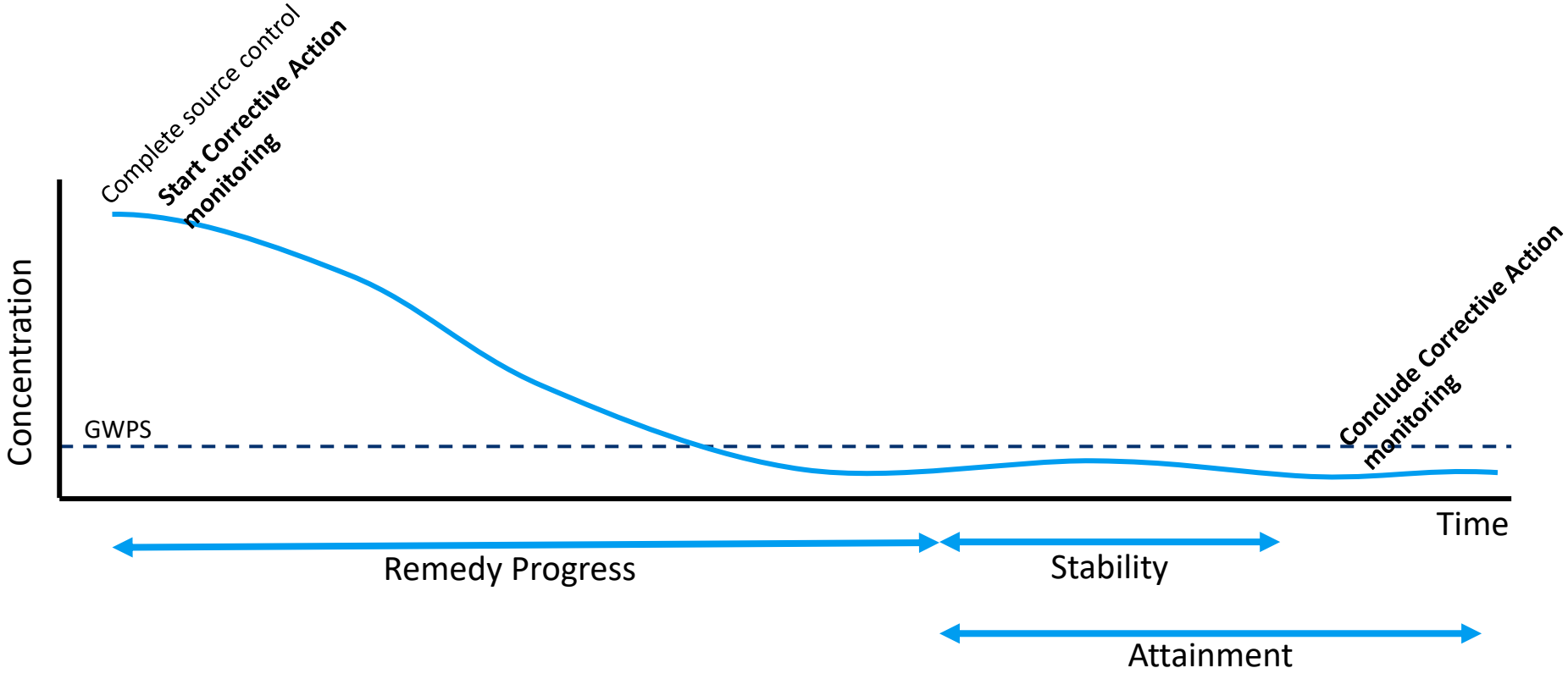
PROPOSED 35 I.A.C. § 845 CORRECTIVE ACTION MONITORING WELL LOCATION MAP

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
ASH POND NO. 1
COFFEEN POWER PLANT
COFFEEN, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



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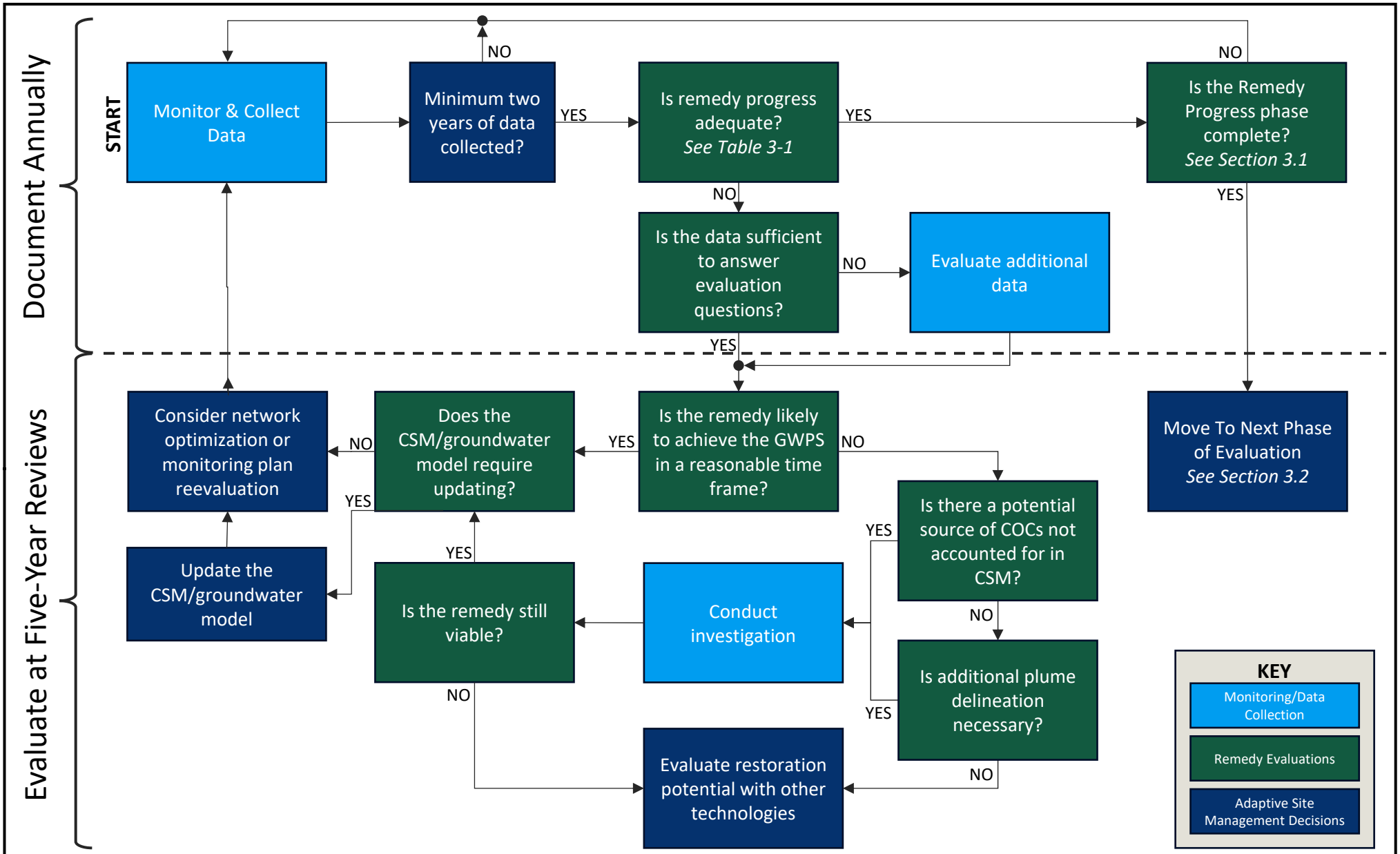
CORRECTIVE ACTION MONITORING TIMELINE

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Figure 3-1



Adapted from Figure 2 in USEPA (2014) *"Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind,"* Office of Solid Waste and Emergency Response. 9200.2-144. May. https://semspub.epa.gov/work/HQ/100000021.pdf

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ADAPTIVE SITE MANAGEMENT DECISION-MAKING FLOW CHART

CORRECTIVE ACTION GROUNDWATER MONITORING PLAN
COFFEEN POWER PLANT
ASH POND NO. 1
COFFEEN, ILLINOIS

Figure 3-2

APPENDICES

APPENDIX A
BORING LOGS AND WELL CONSTRUCTION FORMS

BORING LOGS

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Coffeen Energy Center
Location: Coffeen, Illinois
Project: 15E0030
DATES: Start: 9/4/2015
Finish: 9/4/2015
WEATHER: Sunny, hi 70's

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: D-50 Turbo Tracked MST 800ATV
Drilling Method: Hollow Stem Auger (3¼"overdrill / 4¼")
FIELD STAFF: Driller: D. Crump
Helper: D. Groves
Eng/Geo: K. Theesfeld

BOREHOLE ID: G301
Well ID: G301
Surface Elev: 620.27 ft. MSL
Completion: 16.21 ft. BGS
Station: 2,515,582.97N
872,234.82E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 12.00 - During Drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	19/24 *79%*	SS	*4-4 3-5* N=7	18		*1.80*
2A	22/24 *92%*	SS	*2-4 4-6* N=8	26		*2.40*
3A	21/24 *88%*	SS	*2-2 3-4* N=5	22		*1.30*
4A	24/24 *100%*	SS	*6-4 6-6* N=10	19		*1.10*
5A	21/24 *88%*	SS	*1-2 3-4* N=5	21		
6A	24/24 *100%*	SS	*3-2 3-3* N=5	19		*0.80*
7A	24/24 *100%*	SS	*2-4 6-21* N=10	13		*1.60*
8A	21/24 *88%*	SS	*20-27 50* N=77	7		*4.50*
	0/3 *0%*	BD				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Brown (10YR4/3), moist, stiff, SILT with few clay, trace organics.	620
2	Brown (10YR5/3) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with few clay, trace organics.	618
4	Brown (10YR5/3) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with few clay, trace very fine- to medium-grained sand.	616
6	Brown (10YR5/3) with 15% yellowish brown (10YR5/6) mottles, moist, stiff, CLAY with some silt and trace very fine- to medium-grained sand.	614
8	Brown (10YR5/3) with 10% yellowish brown (10YR5/6) mottles, moist, medium to stiff, CLAY with some silt and little very fine- to coarse-grained sand and small gravel.	612
10	Brown (10YR5/3) with 5% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with some clay and little very fine- to coarse-grained sand and small gravel.	610
12	Brown (10YR5/3) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, SILT with some clay and little very fine- to coarse-grained sand and small gravel.	608
14	Yellowish brown (10YR5/6) with 10% grayish brown (10YR5/2) and 5% yellowish brown (10YR5/4) mottles, wet, stiff, SILT with few clay and little fine- to coarse-grained sand and small gravel.	606
16	Grayish brown (10YR5/2) with 5% brown (10YR5/3) mottles, dry, hard, SILT with few clay, very fine- to coarse-grained sand and small gravel.	

End of boring = 16.21 feet

NOTE(S): G301 installed in borehole.

Surface Elevation: 619.10

Datum msl

Completion Date: 8/26/10

Northing: 871382.45

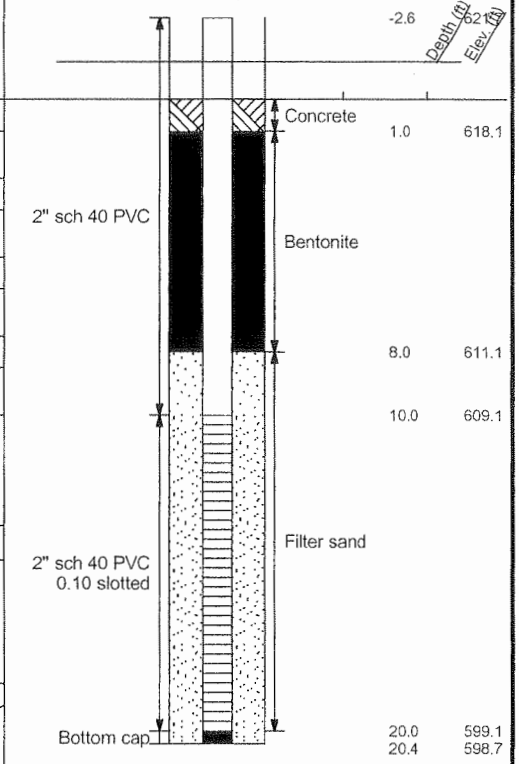
Easting: 2516641.06

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

GRAPHIC LOG

WELL DIAGRAM

Stickup
Diameter: 6 inches



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

GROUNDWATER DATA

ENCOUNTERED AT 9 FEET ∇

DRILLING DATA

___ AUGER 4 1/4" HOLLOW STEM

WASHBORING FROM ___ FEET

MVU DRILLER SWG LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

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

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren-Coffeen Ash Pond Evaluation

Renamed G303

LOG OF BORING: APW-3

Project No. J017150.01

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

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Coffeen Power Station
Location: Coffeen, Illinois
Project: 15E0030
DATES: Start: 5/3/2016
Finish: 5/3/2016
WEATHER: Cloudy, breezy, warm, lo 60s

CONTRACTOR: Ramsey Geotechnical Engineering LLC
Rig mfg/model: D-50 Turbo Tracked MST 800ATV
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: D. Crump
Eng/Geo: S. Keim

HANSON

BOREHOLE ID: G305
Well ID: G305
Surface Elev: 622.54 ft. MSL
Completion: 18.45 ft. BGS
Station: 2,515,199.36N
871,156.33E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork
Section 14, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 3.00 - During Drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	14/24 58%	SS	2-2 5-7 N=7	12		
2A	17/24 71%	SS	6-7 7-6 N=14	19		
3A	18/24 75%	SS	3-3 6-4 N=9	28		
4A	16/24 67%	SS	6-6 7-8 N=13	24		
5A	23/24 96%	SS	1-3 5-6 N=8	21		
6A	21/24 88%	SS	3-4 6-6 N=10	21		
7A	24/24 100%	SS	8-8 9-9 N=17	18		
8A	19/24 79%	SS	3-3 4-4 N=7	18		
9A	22/24 92%	SS	1-3 7-14 N=10	19		
9B	0/5 0%	BD		15		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	FILL - Grayish brown (10YR5/2), moist, soft, silty CLAY with few small to coarse sand and few small to large gravel.	622
	FILL - Black (10YR2/1), moist, loose, silty, fine- to coarse-grained SAND with little coal fragments.	
2	Gray (10YR6/1) and light yellowish brown (10YR6/4), moist, very stiff, SILT with little clay.	620
4	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, very stiff, silty CLAY with trace very fine-grained sand.	618
6	Gray (10YR5/1) with 30% dark yellowish brown (10YR4/6) mottles, moist, stiff, silty CLAY with trace very fine- to coarse-grained sand.	616
8	Dark gray (10YR4/1) with 25% dark yellowish brown (10YR4/6) mottles, moist, very stiff, silty CLAY with few fine- to coarse-grained sand and trace small gravel.	614
10	Gray (10YR5/1) with 35% dark yellowish brown (10YR4/6) mottles, moist, very stiff, silty CLAY with few fine- to coarse-grained sand and trace small gravel.	612
12	Yellowish brown (10YR5/8) with 15% gray (10YR5/1) mottles, moist, very stiff, silty CLAY with few fine- to coarse-grained sand and trace small gravel.	610
14	Gray (10YR5/1) with 15% yellowish brown (10YR5/6) mottles, moist, stiff, silty CLAY with little fine- to coarse-grained sand and trace small gravel.	608
	Gray (10YR5/1) with 15% yellowish brown (10YR5/6) mottles, moist, stiff, silty CLAY with some fine- to coarse-grained sand and trace small gravel.	
16	Brown (10YR5/3), wet, loose, very silty, very fine- to coarse-grained SAND with trace small gravel.	606
18	Brown (10YR5/3) with 40% yellowish brown (10YR5/8) mottles, moist, very stiff, SILT with little clay and trace fine- to coarse-grained sand.	

End of boring = 18.45 feet

NOTE(S): G305 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Power Station Ash Pond 1
Location: Coffeen, Illinois
Project: 16E0108
DATES: Start: 07/26/2016
Finish: 07/27/2016
WEATHER: Overcast, warm & humid (mid-80s)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME 55LC Track Drill
Drilling Method: 4¼" Hollow Stem Auger w/Continuous Split Spoon
FIELD STAFF: Driller: J. Gates
Helper: C. Clines
Eng/Geo: R. Hasenyager

BOREHOLE ID: G307
Well ID: G307
Surface Elev: 622.08 ft. MSL
Completion: 18.22 ft. BGS
Station: 871,398.55N
2,515,553.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen
Township: East Fork
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▼ = 14.00 - during drilling
▼ = -1.76 - 7/27/2016 @ 07:30
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	18/24 75%	SS	1-3 3-2 N=6	22		
2A	22/24 92%	SS	2-1 3-3 N=4	28		
3A	24/24 100%	SS	1-2 3-4 N=5	26		
4A	24/24 100%	SS	1-3 3-3 N=6	18		
5A	24/24 100%	SS	3-3 4-5 N=7	19		
6A	24/24 100%	SS	3-3 4-5 N=7	20		
7A	24/24 100%	SS	woh-2 5-13 N=7	20		
7B				11		
8A	24/24 100%	SS	12-9 6-9 N=15	20		
9A	18/18 100%	SS	8-30 50 N=80	8		
	0/9 0%	BD				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Brown (10YR5/3), moist, stiff, SILT with few clay, trace sand, gravel and roots.	
2	Gray (10YR5/1), moist, soft, CLAY, with some silt, trace sand, gravel and roots.	620
4	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand, gravel and roots.	618
6		616
8	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium CLAY,with some silt, few very fine- to medium-grained sand, and trace gravel.	614
10		612
12	Gray (10YR5/1), moist, medium, CLAY with little silt and very fine to very coarse sand, trace gravel.	610
	Gray (10YR5/1) with 25% yellowish brown (10YR5/8) mottles, moist, soft, CLAY with some silt, trace sand and gravel.	
14	Gray (10YR6/1), wet, medium dense, very fine- to very coarse-grained SAND with few silt and trace clay.	608
	Yellow brown (10YR5/6), wet. medium dense, very fine- to very coarse-grained SAND, with little silt and trace gravel.	
16	Yellowish brown (10YR5/8), moist, hard, SILT with some clay, little very fine- to very coarse-grained sand and trace gravel.	606
	Gray (10YR5/1), moist, hard, SILT with some clay, little very fine- to very coarse-grained sand and trace gravel.	
18		604

End of boring = 18.2 feet

NOTE(S):

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/9/2021
Finish: 2/9/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G307D
Well ID: G307D
Surface Elev: 622.51 ft. MSL
Completion: 60.00 ft. BGS
Station: 871,397.20N
2,515,560.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 12.80 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	18/24 75%	SS	3-2 1-2 N=3			
2A	16/24 67%	SS	2-3 5-6 N=8			
3A	24/24 100%	SS	2-3 4-5 N=7			
4A	24/24 100%	SS	3-4 6-7 N=10			
5A	24/24 100%	SH				
6A	24/24 100%	SS	1-2 4-4 N=6			
7A	20/24 83%	SS	4-7 3-8 N=10			
7B						
8A	21/24 88%	SS	0-6 10-13 N=16			
9A	11/11 100%	SS	29-50/5"			
10A	7/9 78%	SS	45-50/3"			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0–4	Greenish gray (GLEY15/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace roots and very fine-grained sand.	622 – 620
4–6	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	620 – 618
6–10	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) and 10% very dark grayish brown (10YR3/2) mottles, moist, stiff, lean CLAY, with some silt, few very fine-grained sand.	618 – 616
8–10	Gray (10YR5/1) with 40% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, trace small gravel.	616 – 614
10–12	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	614 – 612
12	Gray (10YR5/1), wet, medium stiff, SILT, with some very fine- to fine-grained sand, little clay, trace small gravel.	612
12–14	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	612 – 610
14–16	Yellowish brown (10YR5/6), wet, loose, very fine- to medium-grained SAND, with some silt, few small to medium gravel.	610 – 608
16	Yellowish brown (10YR4/6), moist, hard, SILT, with some very fine- to medium-grained sand, few clay and small gravel.	608
16–18	Yellowish brown (10YR5/6), wet, loose, very fine- to medium-grained SAND, with some silt, few small to medium gravel.	608 – 606
18–20	Dark gray (10YR4/1) with 10% yellowish brown (10YR5/6) mottles, moist, hard, SILT, with some very fine- to fine-grained sand, few clay and small gravel, trace medium gravel.	606 – 604

Borehole Detail

Remarks

NOTE(S): G307D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/9/2021
Finish: 2/9/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G307D
Well ID: G307D
Surface Elev: 622.51 ft. MSL
Completion: 60.00 ft. BGS
Station: 871,397.20N
2,515,560.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 12.80 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A	8/8 100%	SS	35-50/2"						602	Little sand below 20 ft.
12A	8/9 89%	SS	30-50/3"				22		600	
13A	17/17 100%	SS	23-39 50/5"				24		598	
14A	9/9 100%	SS	38-50/3"				26		596	
15A	23/23 100%	SS	31-44 34-50/5" N=78				28	Dark gray (10YR4/1) with 10% yellowish brown (10YR5/6) mottles, moist, hard, SILT, with some very fine- to fine-grained sand, few clay and small gravel, trace medium gravel. *[Continued from previous page]*	594	1" dark gray (10YR4/1), fine- to medium-grained sand, with some silt, little small gravel.
16A	15/15 100%	SS	3-44 50/3"				30		592	
17A	10/10 100%	SS	34-50/4"				32		590	
18A	11/11 100%	SS	31-50/5"				34		588	
19A	17/17 100%	SS	28-44 50/5"				36		586	
20A	24/24 100%	SS	14-19 13-24 N=32				38	Dark gray (10YR4/1), moist, hard, lean CLAY, with some silt, little to few very fine- to fine-grained sand, few small gravel.	584	
							40			

NOTE(S): G307D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/9/2021
Finish: 2/9/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G307D
Well ID: G307D
Surface Elev: 622.51 ft. MSL
Completion: 60.00 ft. BGS
Station: 871,397.20N
2,515,560.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 12.80 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
21A	24/24 100%	SS	7-8 12-15 N=20						582	Trace medium gravel below 40 ft.
22A	20/24 83%	SH					42		580	
23A	24/24 100%	SS	6-8 10-12 N=18				44		578	
24A	24/24 100%	SS	5-6 10-12 N=16				46	Dark gray (10YR4/1), moist, hard, lean CLAY, with some silt, little to few very fine- to fine-grained sand, few small gravel. *[Continued from previous page]*	576	
25A	24/24 100%	SS	3-6 11-11 N=17				48		574	Trace wood fragments below 48.5 ft.
26A	24/24 100%	SS	3-7 9-10 N=16				50		572	
27A	16/24 67%	SS	4-7 11-9 N=18				52		570	Gravel plugged shoe in Run 27. Large lignite fragment at 52.4 ft.
28A	24/24 100%	SS	3-6 10-9 N=16				54	Greenish gray (GLEY15/1) with 15% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace small gravel.	568	
29A	24/24 100%	SS	4-6 8-12 N=14				56	Yellowish brown (10YR5/6) with 30% greenish gray (GLEY15/1) and 5% very dark grayish brown (10YR3/2) mottles, moist, stiff, lean CLAY, with some silt, trace small gravel.	566	
30A	24/24 100%	SS	2-5 8-10 N=13				58	Yellowish brown (10YR5/6) with 20% greenish gray (GLEY15/1) and 5% very dark grayish brown (10YR3/2) mottles, moist, stiff, lean CLAY, with some silt, trace small gravel.	564	Large wood fragment
							60			

NOTE(S): G307D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/9/2021
Finish: 2/9/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: **Driller:** Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G307D
Well ID: G307D
Surface Elev: 622.51 ft. MSL
Completion: 60.00 ft. BGS
Station: 871,397.20N
2,515,560.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = 12.80 - During Drilling
▽ =
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								End of boring = 60.0 feet			at 59.8 ft.

NOTE(S): G307D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/13/2021
Finish: 1/13/2021
WEATHER: Clear, cold (30s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler

FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G308
Well ID: G308
Surface Elev: 621.59 ft. MSL
Completion: 15.80 ft. BGS
Station: 871,454.70N
2,515,101.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 13.00 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	16/24 67%	SS	2-2 2-3 N=4					Grayish brown (10YR5/2), moist, stiff, lean CLAY, with some silt, trace roots.	620	
							2			
2A	19/24 79%	SS	0-2 3-5 N=5					Brown (10YR5/3) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace roots.	618	
							4			
3A	17/24 71%	SS	2-4 5-6 N=9					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.	616	
							6			
4A	23/24 96%	SS	1-4 5-6 N=9						614	
							8			
5A	22/24 92%	SS	2-4 6-7 N=10					Gray (10YR5/1) with 30% yellowish brown (10YR5/6) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small to medium gravel.	612	
							10			
6A	21/24 88%	SS	2-3 4-5 N=7					Gray (10YR5/1) with 40% yellowish brown (10YR5/6) mottles, moist, stiff to very stiff, lean CLAY, with some silt, little to trace very fine-grained sand, trace small to medium gravel.	610	
7A							12			
	24/24 100%	SS	2-3 4-6 N=7					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, wet, stiff, lean CLAY, with some very fine- to fine-grained sand, little silt, trace small gravel.	608	
							14			
8A	19/22 86%	SS	4-12 33-50/4" N=45					Light yellowish brown (10YR6/4) wet, hard, SILT, with some very fine-grained sand, few clay and small to medium gravel.	606	

End of boring = 15.8 feet

NOTE(S): G308 installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/15/2021
Finish: 1/15/2021
WEATHER: Clear, light snow, cold (30s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G310
Well ID: G310
Surface Elev: 619.89 ft. MSL
Completion: 15.90 ft. BGS
Station: 872,239.40N
2,515,159.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 14.20 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A, 1B	21/24 88%	SS	2-7 4-6 N=11					Dark gray (10YR4/1), moist, very stiff, lean CLAY, with some silt, trace roots.		
								Gray (10YR6/1) with 15% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT, few clay, trace roots.		
							2		618	
2A	18/24 75%	SS	2-4 4-6 N=8					Gray (10YR6/1) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt.		
							4		616	
3A	23/24 96%	SS	2-3 4-5 N=7					Gray (10YR6/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt.		
							6		614	
4A	24/24 100%	SS	2-3 5-6 N=8					Dark gray (10YR4/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few very fine- to fine-grained sand and small gravel.		
							8		612	
5A	24/24 100%	SS	2-3 4-5 N=7							
							10	Gray (10YR6/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few small gravel, trace very fine- to fine-grained sand.	610	
6A	24/24 100%	SS	2-3 4-4 N=7							
							12		608	
7A	24/24 100%	SS	0-1 2-2 N=3					Gray (10YR5/1), moist, medium stiff, SILT, with some clay, little very fine- to fine-grained sand, few small gravel.		
							14		606	
8A	17/23 74%	SS	8-16 26-50/5" N=42					Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, wet, hard, SILT, with some very fine-grained sand, few small gravel, trace clay.		
								Yellowish brown (10YR5/6), wet, SAND, some silt, few gravel.		
								Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, wet, hard, SILT, with some very fine-grained sand, few small gravel, trace clay.	604	
								Yellowish brown (10YR5/6), wet, SAND, some silt, few gravel seam from 15.3 to 15.5 ft.		
								Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, wet, hard, SILT, with some very fine-grained sand, few small gravel, trace clay.		

End of boring = 15.9 feet

NOTE(S): G310 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	13/24 54%	SS	0-4 4-4 N=8					Yellowish brown (10YR5/6), moist, stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	618	
							2			
2A	24/24 100%	SS	3-4 5-6 N=9					Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, stiff, lean CLAY, with some silt, trace very fine- to fine-grained sand, and small gravel.	616	
							4			
3A	24/24 100%	SS	2-4 5-7 N=9					Very dark grayish brown (10YR3/2) with 10% gray (10YR5/1) mottles, moist, stiff, lean CLAY, with some silt, trace very fine- to fine-grained sand, and small gravel.	614	
4A	24/24 100%	SH					6		612	
							8	Gray (10YR5/1) with 15% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, few small gravel.	610	
5A	18/24 75%	SS	1-2 4-5 N=6							
							10		608	
6A	24/24 100%	SS	1-3 3-4 N=6					Gray (10YR5/1) with 10% yellowish brown (10YR5/6) mottles, moist to wet, medium stiff, lean CLAY, with some very fine- to fine-grained sand, little silt, few small gravel.		
							12	Yellowish brown (10YR5/6), moist to wet, medium stiff, lean CLAY, with some very fine- to fine-grained sand, little silt, few small gravel.	606	
7A	24/24 100%	SS	2-6 12-13 N=18					Gray (10YR5/1), moist to wet, medium stiff, SILT, with some very fine- to fine-grained sand, few clay, trace small gravel.		1" wet, SAND at 13.5 ft.
							14		604	
8A	24/24 100%	SS	2-6 12-13 N=18							
							16	Yellowish brown (10YR5/6), moist, hard, SILT, with some clay, some to little sand, few small gravel.	602	
9A	24/24 100%	SS	6-15 18-22 N=33							Vertical fracture with very fine- to fine-grained sand from 16.9 to 18 ft.
							18		600	
10A	24/24 100%	SS	6-13 16-22 N=29					Dark grayish brown (10YR4/2) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.		
							20			

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
11A	24/24 *100%*	SS	*5-15* *20-26* N=35						598	
							22		596	No oxidation below 22 ft.
12A	12/24 *50%*	SS	*2-3* *14-17* N=17							
							24		594	Trace medium gravel below 24 ft.
13A	24/24 *100%*	SS	*6-11* *14-20* N=25							
14A	24/24 *100%*	SS	*4-8* *11-16* N=19				26		592	
							28		590	
15A	24/24 *100%*	SH						Dark gray (10YR4/1) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.		
							30		588	
16A	24/24 *100%*	SS	*0-3* *5-8* N=8							
							32		586	
17A	24/24 *100%*	SS	*2-4* *6-8* N=10							
							34		584	Gravel plugged shoe in Run 18.
18A	24/24 *100%*	SS	*2-5* *7-7* N=12							Trace large gravel from 35 to 36 ft.
							36		582	Trace lignite and wood fragments below 36 ft.
19A	13/24 *54%*	SS	*2-7* *8-11* N=15							
							38		580	
20A	24/24 *100%*	SS	*2-6* *10-8* N=16				40			

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
21A	16/24 67%	SS	3-3 6-8 N=9					Dark gray (10YR4/1) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel. *[Continued from previous page]*	578	
22A							42	Greenish gray (GLEY15/1) with 20% dark reddish brown (10YR3/2) mottles, moist, medium stiff, lean CLAY, with some silt.	576	
22B	24/24 100%	SS	3-4 7-8 N=11				44		574	
23A	24/24 100%	SS	1-3 5-7 N=8				46		572	
24A	20/24 83%	SS	3-4 10-8 N=14				48	Dark grayish brown (10YR4/1) with frequent yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small to large gravel.	570	
25A	24/24 100%	SS	3-5 8-13 N=13				50		568	
26A	24/24 100%	SS	2-5 10-12 N=15				52		566	
27A	24/24 100%	SS	2-6 10-14 N=16				54	Dark gray (10YR4/1) with 20% greenish gray (GLEY15/1) and 5% yellowish brown (10YR5/6) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.	564	Trace small gravel below 54.3 ft.
28A	24/24 100%	SS	4-7 7-11 N=14				56	Greenish gray (GLEY16/1) with 40% yellowish brown (10YR5/6) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.	562	
29A	24/24 100%	SS	2-5 9-11 N=14				58		560	0.5" small to medium GRAVEL.
30A	24/24 100%	SS	3-7 10-13 N=17				60	Yellowish brown (10YR5/6) with 30% greenish gray (GLEY16/1) mottles, moist, very stiff, lean CLAY, with some silt, trace very fine-grained sand and small gravel.		

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/5/2021
Finish: 2/5/2021
WEATHER: Clear, cold (20s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 3.25" HSA w/SS sampler

FIELD STAFF: **Driller:** Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G311D
Well ID: G311D
Surface Elev: 618.39 ft. MSL
Completion: 60.00 ft. BGS
Station: 872,238.70N
2,515,881.80E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 11.20 - During Drilling
=
=

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								End of boring = 60.0 feet			

NOTE(S): G311D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/4/2021
Finish: 2/4/2021
WEATHER: Rain, cold (30s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler

FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G312
Well ID: G312
Surface Elev: 616.92 ft. MSL
Completion: 15.25 ft. BGS
Station: 872,260.90N
2,516,557.40E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 12.70 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	14/24 *58%*	SS	*0-2* *3-2* N=5					Brown (10YR5/3) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, trace small gravel.	616	
2A	17/24 *71%*	SS	*2-1* *2-2* N=3				2	Yellowish brown (10YR5/6), moist, stiff to very stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, trace small gravel.	614	
3A	18/24 *75%*	SS	*1-3* *5-6* N=8				4	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) mottles, moist, stiff to very stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, trace small gravel.	612	
4A	17/24 *71%*	SS	*2-3* *3-4* N=6				6	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, moist, very stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	610	
5A	20/24 *83%*	SS	*2-4* *5-7* N=9				8	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, very stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	608	
6A	20/24 *83%*	SS	*1-3* *4-4* N=7				10	Gray (10YR5/1), moist, soft SILT, some clay, trace roots.	606	
7A 7B	24/24 *100%*	SS	*0-3* *2-5* N=5				12	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, very stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	604	
8A 8B	15/15 *100%*	SS	*4-17* *50/3"*				14	Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, very stiff, lean CLAY, with some silt and very fine- to fine-grained sand.	602	
								Gray (10YR6/1) with 15% yellowish brown (10YR5/6), moist, very stiff, lean CLAY, with some silt and very fine- to fine-grained sand.		
								Gray (10YR5/1), wet, loose, SILT, with some very fine- to fine-grained sand, few clay, trace small gravel.		
								Yellowish brown (10YR5/6) with 5% very dark grayish brown (10YR3/2), wet, loose, SILT, with some very fine- to fine-grained sand, few clay and small gravel.		
								Yellowish brown (10YR5/6) with 5% very dark grayish brown (10YR3/2) mottles, moist, hard, SILT, with some very fine- to fine-grained sand, few clay and small gravel.		

End of boring = 15.25 feet

NOTE(S): G312 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/14/2021
Finish: 1/14/2021
WEATHER: Overcast, cool (40s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler

FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G313
Well ID: G313
Surface Elev: 611.51 ft. MSL
Completion: 12.00 ft. BGS
Station: 871,976.80N
2,516,803.70E

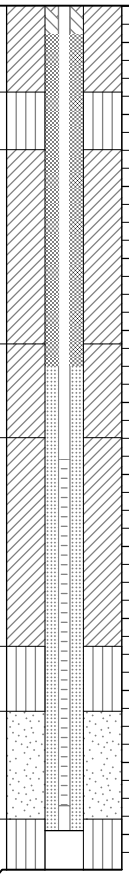
TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = 9.80 - During Drilling
▽ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A, 1B	17/24 *71%*	SS	*0-2* *3-3* N=5			
2A	13/24 *54%*	SS	*0-2* *2-3* N=4			
3A	19/24 *79%*	SS	*2-3* *5-5* N=8			
4A	22/24 *92%*	SS	*2-3* *4-5* N=7			
5A	22/24 *92%*	SS	*2-5* *9-12* N=14			
6A, 6B	21/24 *88%*	SS	*9-12* *21-22* N=33			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Dark yellowish brown (10YR4/4), wet, stiff, lean CLAY, with some silt, few roots, trace small gravel.	
	Gray (10YR6/1) with 15% yellowish brown (10YR5/6) mottles, moist, very stiff, SILT, with little clay, few roots.	610
2	Dark gray (10YR4/1) with 5% black (10YR2/1) mottles, moist, stiff, lean CLAY, with some silt.	608
4	Dark gray (10YR4/1) with 20% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.	606
6	Very dark gray (10YR3/1), moist, stiff, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	604
8	Yellowish brown (10YR5/6) with 10% very dark gray (10YR3/1) mottles, moist, stiff SILT, with some very fine- to fine-grained sand and clay, few small gravel.	602
▽ 10	Yellowish brown (10YR5/4), wet, medium dense, very fine- to medium-grained SAND, with some silt, few small gravel.	
12	Dark grayish brown (10YR4/2) with 10% yellowish brown (10YR5/6) mottles, moist, hard, SILT, with some very fine- to fine-grained sand, few clay and small gravel, trace medium gravel.	600

Borehole Detail



Remarks

End of boring = 12.0 feet

NOTE(S): G313 installed in borehole.

FIELD BORING LOG

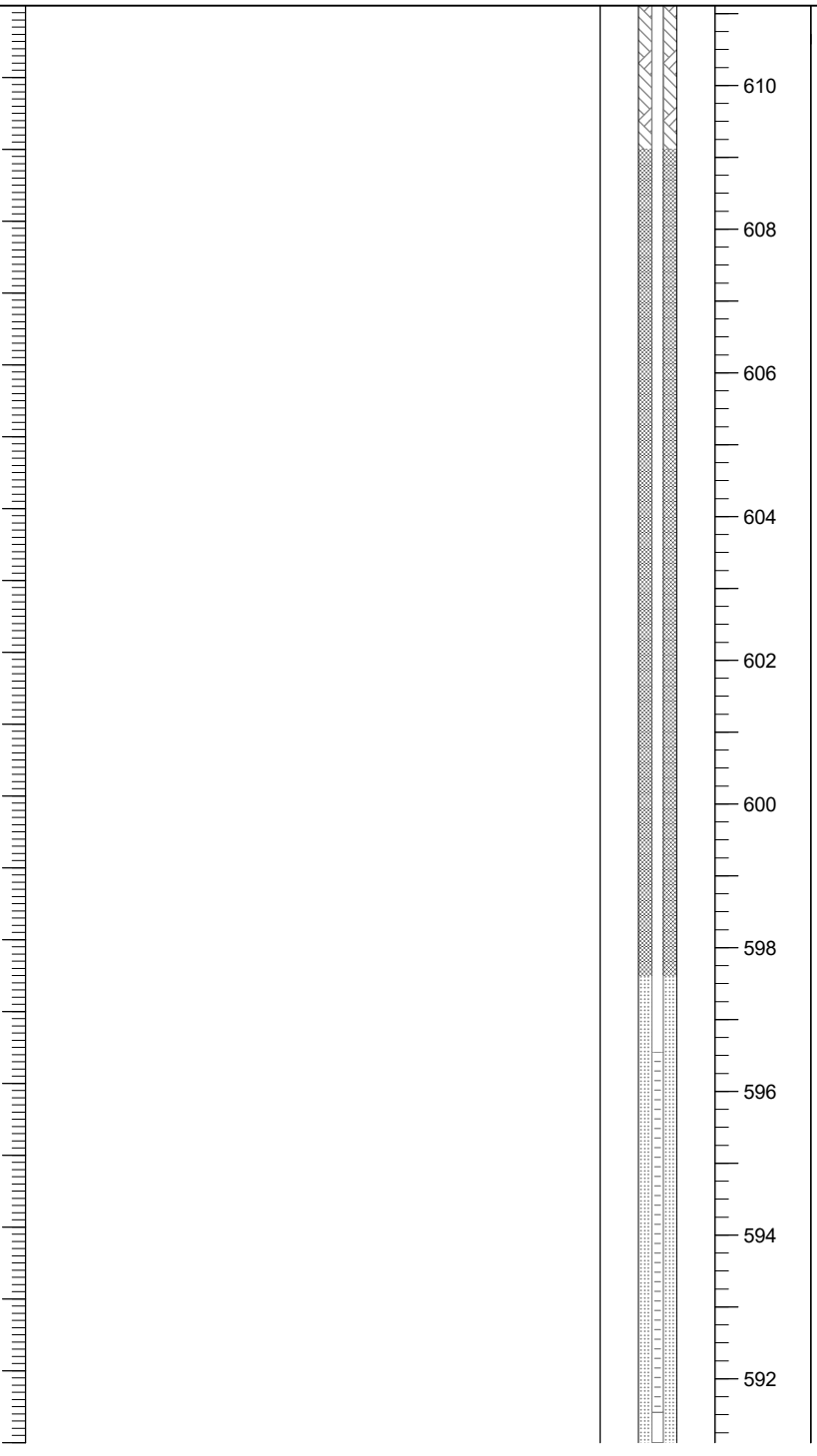
HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/26/2021
Finish: 2/26/2021
WEATHER: Clear, mild (40s)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model:
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Steve
Helper: Jeff
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314
Well ID: G314
Surface Elev: 611.11 ft. MSL
Completion: 20.05 ft. BGS
Station: 871,630.20N
2,516,852.10E

SAMPLE			TESTING							
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks



NOTE(S): G314 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/26/2021
Finish: 2/26/2021
WEATHER: Clear, mild (40s)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model:
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: **Driller:** Steve
Helper: Jeff
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314
Well ID: G314
Surface Elev: 611.11 ft. MSL
Completion: 20.05 ft. BGS
Station: 871,630.20N
2,516,852.10E

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks

NOTE(S): G314 installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	4/24 *17%*	SS	*13-7 4-5* N=11					Moist, dense, small to large GRAVEL. [FILL]	610	
	1/24 *4%*	SS	*3-4 5-5* N=9				2	Gray (10YR6/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	608	
3A	24/24 *100%*	SS	*1-3 4-5* N=7				4		606	
4A	24/24 *100%*	SS	*2-5 15-17* N=20				6	Yellowish brown (10YR5/6) with occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	604	
5A	24/24 *100%*	SS	*4-10 12-16* N=22				8		602	
6A	24/24 *100%*	SS	*4-5 14-18* N=19				10	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	600	1" wet, SAND, with some silt at 11.6 ft.
7A	24/24 *100%*	SS	*3-11 14-18* N=25				12		598	
8A	24/24 *100%*	SS	*3-9 13-18* N=22				14		596	
9A	24/24 *100%*	SS	*1-7 9-13* N=16				16	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) and 10% dark yellowish brown (10YR4/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	594	
							18	Dark grayish brown (10YR4/2) with 15% yellowish brown (10YR5/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	592	
							20			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
10A	24/24 100%	SS	1-5 10-13 N=15							1" wet, SAND, with some silt at 20 ft.
									590	
							22	Dark grayish brown (10YR4/2) with 15% yellowish brown (10YR5/6) and 5% dark yellowish brown (10YR4/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel. *[Continued from previous page]*		Frequent oxidation below 21.7 ft.
11A	24/24 100%	SS	1-6 9-12 N=15						588	
							24			
12A	24/24 100%	SS	4-7 10-13 N=17						586	
							26			
13A	24/24 100%	SS	3-7 10-13 N=17						584	
							28			1 ft vertical fracture with yellowish red (5YR4/6) oxidation at 28.3 ft.
14A	24/24 100%	SS	4-6 10-10 N=16					Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	582	
							30			
15A	24/24 100%	SS	3-9 10-12 N=19						580	
							32			
16A	24/24 100%	SS	2-3 7-8 N=10						578	
							34			Trace roots below 34 ft.
17A	24/24 100%	SS	2-4 7-9 N=11					Gray (GLEY15/), moist, stiff, lean CLAY, with some silt.	576	
							36			
18A	21/24 88%	SH					38	Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel and roots.	574	
									572	
			2-5				40			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
19A	24/24 100%	SS	7-12 N=12						570	
20A	24/24 100%	SS	4-8 10-14 N=18				42	Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel and roots. *[Continued from previous page]*	568	Trace medium gravel below 41.3 ft.
21A	24/24 100%	SS	3-9 13-16 N=22				44		566	
22A 22B	24/24 100%	SS	12-31 14-11 N=45				46	Gray (10YR5/1), wet, dense, SAND, with some silt, few small gravel.	564	
23A	24/24 100%	SS	3-4 6-9 N=10				48	Gray (GLEY15/) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	562	1" SILT, with some sand at 48.2 ft.
24A	24/24 100%	SS	5-11 14-17 N=25				50		560	
25A	24/24 100%	SS	4-6 11-15 N=17				52	Yellowish brown (10YR5/6) with 20% gray (GLEY15/) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	558	
26A	20/24 83%	SS	4-5 18-30 N=23				54		556	
27A	20/24 83%	SS	9-22 33-33 N=55				56	Yellowish brown (10YR5/6), moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	554	
							58	Yellowish brown (10YR5/6) with 20% gray (GLEY15/) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.		
28A	24/24 100%	SS	7-19 29-43				60	Yellowish brown (10YR5/6) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	552	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
			N=48								
29A	20/24 83%	SS	13-20 30-38 N=50				62			550	
30A	24/24 100%	SS	8-15 30-34 N=45				64	Yellowish brown (10YR5/6) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel. *[Continued from previous page]*		548	
31A	24/24 100%	SS	5-17 28-29 N=45				66			546	
32A	24/24 100%	SS	7-18 29-43 N=47				68	Yellowish brown (10YR5/6) with 10% gray (GLEY15/), 5% dark yellowish brown (10YR4/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.		544	
33A	24/24 100%	SS	5-14 32-26 N=46				70	Dark grayish brown (10YR4/2) with 5% gray (GLEY15/), 5% yellowish brown (10YR5/6), and 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, little sand and gravel.		542	
34A	24/24 100%	SS	8-17 26-38 N=43				72	Yellowish brown (10YR5/6) with 5% gray (GLEY15/), 5% dark grayish brown (10YR4/2), and 5% light gray (10YR7/1) mottles.		540	
35A	24/24 100%	SS	5-12 24-24 N=36				74	Dark grayish brown (10YR4/2) with 5% gray (GLEY15/), 5% yellowish brown (10YR5/6), and 5% light gray (10YR7/1) mottles.		538	
36A	24/24 100%	SS	14-24 20-33 N=44				76	Dark grayish brown (10YR5/2) with 20% reddish brown (5YR4/4) and 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.		536	
37A	24/24 100%	SS	6-14 17-31 N=31				78	Dark gray (10YR4/1) with 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.		534	
							80			532	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
38A	24/24 100%	SS	7-17 21-29 N=38				82	Dark gray (10YR4/1) with 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel. *[Continued from previous page]*	530	Trace roots at 82 ft.
39A	24/24 100%	SS	8-24 26-27 N=50				84	Very dark gray (10YR3/1), moist, hard, lean CLAY, with some silt.	528	
40A	24/24 100%	SS	5-9 10-13 N=19				86	Dark gray (10YR4/1) with 5% black (10YR2/1) mottles, moist, hard, lean CLAY, with some silt.	526	
41A	24/24 100%	SS	6-10 25-33 N=35				88	Dark greenish gray (GLEY14/1) with 5% yellowish brown (10YR5/6) mottles, moist, hard, lean CLAY, with some silt.	524	Few very fine- to fine-grained sand below 88 ft.
42A	11/11 100%	SS	3-50/5"				90	Light reddish brown (2.5YR6/3) with 10% gray (GLEY15/), dry, hard, SILT, with few clay and very fine-grained sand.	522	
43A	5/5 100%	SS	50/5"				92		520	
44A	5/5 100%	SS	50/5"				94		518	
45A	8/8 100%	SS	49-50/2"				96		516	
46A	11/11 100%	SS	25-50/5"				98	Light reddish brown (2.5YR6/3) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, dry, hard, SILT, with few clay and very fine-grained sand.	514	
							100		512	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: **Driller:** Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
47A	3/3 *100%*	☒ SS	*50/3"*					**End of boring = 100.3 feet**			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	4/24 *17%*	SS	*13-7 4-5* N=11					Moist, dense, small to large GRAVEL. [FILL]	610	
	1/24 *4%*	SS	*3-4 5-5* N=9				2	Gray (10YR6/1) with 30% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few very fine- to fine-grained sand, trace small gravel.	608	
3A	24/24 *100%*	SS	*1-3 4-5* N=7				4		606	
4A	24/24 *100%*	SS	*2-5 15-17* N=20				6	Yellowish brown (10YR5/6) with occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	604	
5A	24/24 *100%*	SS	*4-10 12-16* N=22				8		602	
6A	24/24 *100%*	SS	*4-5 14-18* N=19				10	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	600	1" wet, SAND, with some silt at 11.6 ft.
7A	24/24 *100%*	SS	*3-11 14-18* N=25				12		598	
8A	24/24 *100%*	SS	*3-9 13-18* N=22				14		596	
9A	24/24 *100%*	SS	*1-7 9-13* N=16				16	Yellowish brown (10YR5/6) with 10% very dark grayish brown (10YR3/2) and 10% dark yellowish brown (10YR4/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	594	
							18	Dark grayish brown (10YR4/2) with 15% yellowish brown (10YR5/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	592	
							20			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
10A	24/24 100%	SS	1-5 10-13 N=15							1" wet, SAND, with some silt at 20 ft.
									590	
							22	Dark grayish brown (10YR4/2) with 15% yellowish brown (10YR5/6) and 5% dark yellowish brown (10YR4/6) mottles and occasional yellowish red (5YR4/6) oxidation along fractures, moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel. *[Continued from previous page]*		Frequent oxidation below 21.7 ft.
11A	24/24 100%	SS	1-6 9-12 N=15						588	
							24			
12A	24/24 100%	SS	4-7 10-13 N=17						586	
							26			
13A	24/24 100%	SS	3-7 10-13 N=17						584	
							28			1 ft vertical fracture with yellowish red (5YR4/6) oxidation at 28.3 ft.
14A	24/24 100%	SS	4-6 10-10 N=16					Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel.	582	
							30			
15A	24/24 100%	SS	3-9 10-12 N=19						580	
							32			
16A	24/24 100%	SS	2-3 7-8 N=10						578	
							34			Trace roots below 34 ft.
17A	24/24 100%	SS	2-4 7-9 N=11					Gray (GLEY15/), moist, stiff, lean CLAY, with some silt.	576	
							36			
18A	21/24 88%	SH					38	Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel and roots.	574	
									572	
			2-5				40			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
19A	24/24 100%	SS	7-12 N=12						570	
20A	24/24 100%	SS	4-8 10-14 N=18				42	Dark grayish brown (10YR4/2), moist, hard, lean CLAY, with some silt and very fine- to fine-grained sand, trace small gravel and roots. *[Continued from previous page]*	568	Trace medium gravel below 41.3 ft.
21A	24/24 100%	SS	3-9 13-16 N=22				44		566	
22A 22B	24/24 100%	SS	12-31 14-11 N=45				46	Gray (10YR5/1), wet, dense, SAND, with some silt, few small gravel.	564	
23A	24/24 100%	SS	3-4 6-9 N=10				48	Gray (GLEY15/) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	562	1" SILT, with some sand at 48.2 ft.
24A	24/24 100%	SS	5-11 14-17 N=25				50		560	
25A	24/24 100%	SS	4-6 11-15 N=17				52	Yellowish brown (10YR5/6) with 20% gray (GLEY15/) mottles, moist, stiff, lean CLAY, with some silt, trace very fine-grained sand.	558	
26A	20/24 83%	SS	4-5 18-30 N=23				54		556	
27A	20/24 83%	SS	9-22 33-33 N=55				56	Yellowish brown (10YR5/6), moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	554	
							58	Yellowish brown (10YR5/6) with 20% gray (GLEY15/) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.		
28A	24/24 100%	SS	7-19 29-43				60	Yellowish brown (10YR5/6) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.	552	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
			N=48								
29A	20/24 83%	SS	13-20 30-38 N=50				62			550	
30A	24/24 100%	SS	8-15 30-34 N=45				64	Yellowish brown (10YR5/6) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel. *[Continued from previous page]*		548	
31A	24/24 100%	SS	5-17 28-29 N=45				66			546	
32A	24/24 100%	SS	7-18 29-43 N=47				68	Yellowish brown (10YR5/6) with 10% gray (GLEY15/), 5% dark yellowish brown (10YR4/6) and 5% very dark grayish brown (10YR3/2) mottles, moist, hard, lean CLAY, with some silt, little very fine- to fine-grained sand and small gravel.		544	
33A	24/24 100%	SS	5-14 32-26 N=46				70	Dark grayish brown (10YR4/2) with 5% gray (GLEY15/), 5% yellowish brown (10YR5/6), and 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, little sand and gravel.		542	
34A	24/24 100%	SS	8-17 26-38 N=43				72	Yellowish brown (10YR5/6) with 5% gray (GLEY15/), 5% dark grayish brown (10YR4/2), and 5% light gray (10YR7/1) mottles.		540	
35A	24/24 100%	SS	5-12 24-24 N=36				74	Dark grayish brown (10YR4/2) with 5% gray (GLEY15/), 5% yellowish brown (10YR5/6), and 5% light gray (10YR7/1) mottles.		538	
36A	24/24 100%	SS	14-24 20-33 N=44				76	Dark grayish brown (10YR5/2) with 20% reddish brown (5YR4/4) and 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.		536	
37A	24/24 100%	SS	6-14 17-31 N=31				78	Dark gray (10YR4/1) with 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel.		534	
							80			532	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= During Drilling
=
=

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
38A	24/24 100%	SS	7-17 21-29 N=38				82	Dark gray (10YR4/1) with 5% light gray (10YR7/1) mottles, moist, hard, lean CLAY, with some silt, trace very fine- to fine-grained sand and small gravel. *[Continued from previous page]*	530	Trace roots at 82 ft.
39A	24/24 100%	SS	8-24 26-27 N=50				84	Very dark gray (10YR3/1), moist, hard, lean CLAY, with some silt.	528	
40A	24/24 100%	SS	5-9 10-13 N=19				86	Dark gray (10YR4/1) with 5% black (10YR2/1) mottles, moist, hard, lean CLAY, with some silt.	526	
41A	24/24 100%	SS	6-10 25-33 N=35				88	Dark greenish gray (GLEY14/1) with 5% yellowish brown (10YR5/6) mottles, moist, hard, lean CLAY, with some silt.	524	Few very fine- to fine-grained sand below 88 ft.
42A	11/11 100%	SS	3-50/5"				90	Light reddish brown (2.5YR6/3) with 10% gray (GLEY15/), dry, hard, SILT, with few clay and very fine-grained sand.	522	
43A	5/5 100%	SS	50/5"				92		520	
44A	5/5 100%	SS	50/5"				94		518	
45A	8/8 100%	SS	49-50/2"				96		516	
46A	11/11 100%	SS	25-50/5"				98	Light reddish brown (2.5YR6/3) with 10% gray (GLEY15/) and 5% dark yellowish brown (10YR4/6) mottles, dry, hard, SILT, with few clay and very fine-grained sand.	514	
							100		512	

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: **Start:** 2/10/2021
Finish: 2/12/2021
WEATHER: Overcast, very cold (10s)

CONTRACTOR: Roberts
Rig mfg/model: CME-75 Track Rig
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: **Driller:** Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G314D
Well ID: G314D
Surface Elev: 610.87 ft. MSL
Completion: 100.30 ft. BGS
Station: 871,642.00N
2,516,853.90E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
▽ = During Drilling
▼ =
▼ =

SAMPLE			TESTING						
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
47A	3/3 *100%*	☒ SS	*50/3"*					**End of boring = 100.3 feet**			

NOTE(S): G314D installed in borehole.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/13/2021
Finish: 1/13/2021
WEATHER: Overcast, cool (40s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G315
Well ID: G315
Surface Elev: 620.94 ft. MSL
Completion: 15.90 ft. BGS
Station: 871,385.00N
2,516,086.60E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 13.00 - During Drilling
=
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A	15/24 *63%*	SS	*0-2 3-2* N=5			
2A	9/24 *38%*	SS	*1-1 2-2* N=3			
3A	22/24 *92%*	SS	*2-3 3-5* N=6			
4A	24/24 *100%*	SS	*1-2 2-4* N=4			
5A	23/24 *96%*	SS	*2-2 3-4* N=5			
6A	19/24 *79%*	SS	*0-2 4-5* N=6			
7A	24/24 *100%*	SS	*1-2 3-3* N=5			
8A	21/23 *91%*	SS	*8-16 32-50/5"* N=48			

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	Light gray (10YR7/1) with 20% brown (10YR4/3) mottles, moist, stiff, lean CLAY, with some silt, few roots.	620	
2	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, lean CLAY, with some silt.	618	
4		616	
6	Gray (10YR5/1) with 20% yellowish brown (10YR5/6) mottles, lean CLAY, with some silt, few to trace small gravel.	614	
8		612	
10	Gray (10YR5/1) with 30% yellowish brown (10YR5/6) mottles, lean CLAY, with some silt, few to trace small gravel.	610	Gray (10YR6/1), SILT seam.
12	Gray (10YR5/1) with 30% yellowish brown (10YR6/1) mottles, lean CLAY, with some silt, few to trace small gravel.	608	
14	Gray (10YR6/1) with 40% yellowish brown (10YR5/6) mottles, wet, medium stiff, lean CLAY, with some very fine- to fine-grained sand, little silt, few small to medium gravel.	606	Gravel plugged shoe in Run 8.
	Yellowish brown (10YR5/6), wet, very stiff, SILT, with some very fine- to fine-grained sand, little small to medium gravel, few clay.		

End of boring = 15.9 feet

NOTE(S): G315 installed in borehole.

FIELD BORING LOG

CLIENT: Illinois Power Generating Co.
Site: Coffeen Part 845 Groundwater
Location: Coffeen, Illinois
Project: 20E0111A
DATES: Start: 1/14/2021
Finish: 1/14/2021
WEATHER: Overcast, cold (30s)

CONTRACTOR: Roberts
Rig mfg/model: GeoProbe 8040DT
Drilling Method: 4.25" HSA w/SS sampler
FIELD STAFF: Driller: Matt
Helper: Corey
Eng/Geo: C. Colin Winter

BOREHOLE ID: G316
Well ID: G316
Surface Elev: 599.64 ft. MSL
Completion: 15.75 ft. BGS
Station: 871,643.10N
2,517,211.60E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Coffeen, IL
Township: East Fork Township
Section 11, **Tier** 7N; **Range** 3W

WATER LEVEL INFORMATION:
= 8.60 - During Drilling
= 13.80 - During Drilling
=

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A	15/24 *63%*	SS	*10-9 5-4* N=14			
2A	10/24 *42%*	SS	*1-3 4-6* N=7			
3A	14/24 *58%*	SS	*2-2 3-3* N=5			
4A	10/24 *42%*	SS	*0-1 1-2* N=2			
5A						
5B	22/24 *92%*	SS	*1-1 1-2* N=2			
6A	20/24 *83%*	SS	*1-2 4-7* N=6			
7A	22/24 *92%*	SS	*0-2 3-3* N=5			
8A	21/17 *124%*	SS	*2-2 26-50/3"* N=28			
8B						

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
	Brown (10YR5/3), moist, medium dense, small to large GRAVEL, with some clay and fine to coarse grained sand. [FILL]	
2	Gray (10YR5/1), moist, hard, lean CLAY, with some silt, few small gravel and very fine- to fine-grained sand.	598
4	Gray (10YR5/1) with 10% yellowish brown (10YR5/6) mottles, moist, stiff, lean CLAY, with some silt, few small gravel and very fine- to fine-grained sand.	596
6	Gray (10YR5/1) with 30% black (10YR2/1) mottles, moist, stiff, lean CLAY, with some silt, few very fine-grained sand, organics and wood fragments.	594
8	Very dark gray (10YR3/1), wet, medium stiff to stiff, SILT, with some clay and very fine- to fine-grained sand.	592
10	Brown (10YR4/3), moist, very stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, few small gravel.	590
12	Dark gray (10YR4/1) with 20% yellowish brown (10YR5/6) mottles, moist, medium stiff to stiff, lean CLAY, with some silt, little very fine- to fine-grained sand, few small gravel.	588
14	Brown (10YR4/3), wet, loose, very fine- to fine-grained SAND, with some silt, trace clay.	586
	Yellowish brown (10YR5/6), moist, hard, SILT, with some very fine- to fine-grained sand, trace small gravel.	584

End of boring = 15.75 feet

NOTE(S): G316 installed in borehole.

WELL CONSTRUCTION FORMS

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G301

Site Name: Natural Resource Technology, Inc. Coffeen Energy Center Borehole #: G301

State Plane Coordinate: X 872,234.8 Y 2,515,583.0 (or) Latitude: _____ Longitude: _____

Surveyed By: Gary C. Rogers IL Registration #: 035-002957

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: D. Crump

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Kristen L. Theesfeld Date Started: 9/4/2015 Date Finished: 9/4/2015

Report Form Completed By: Suzanna L. Keim Date: 10/6/2015

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite Chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: Gravity

Setting Time: 25 minutes

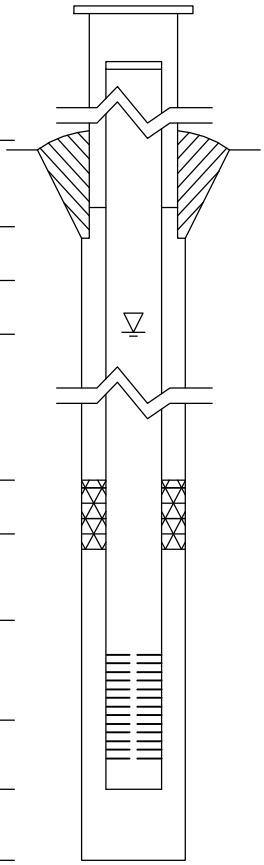
Type of Sand Pack: Quartz Sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
622.98	-2.71	Top of Protective Casing
622.65	-2.38	Top of Riser Pipe
620.27	0.00	Ground Surface
618.20	2.07	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
612.75	7.52	Top of Sand Pack
608.96	11.31	Top of Screen
604.31	15.96	Bottom of Screen
604.06	16.21	Bottom of Well
604.06	16.21	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.56
Bottom of Screen to End Cap	(feet)	0.38
Screen Length (1st slot to last slot)	(feet)	4.65
Total Length of Casing	(feet)	18.59
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Surface Elevation: 619.10

Datum msl

Completion Date: 8/26/10

Northing: 871382.45

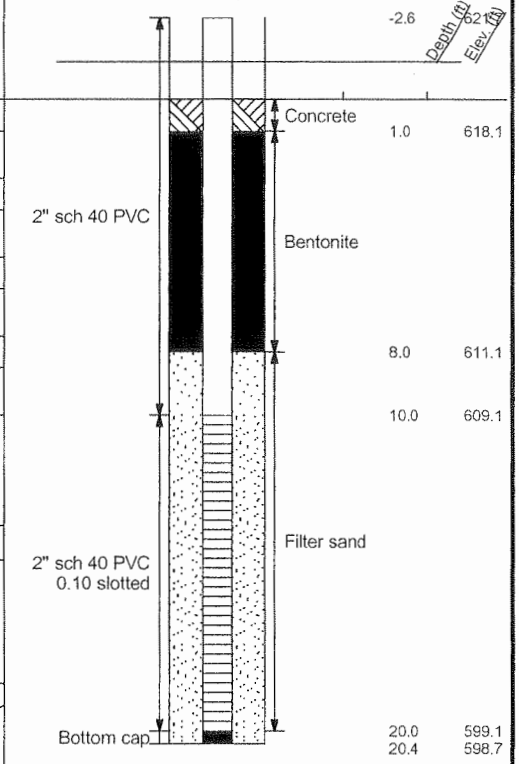
Easting: 2516641.06

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

GRAPHIC LOG

WELL DIAGRAM

Stickup
Diameter: 6 inches



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

GROUNDWATER DATA

ENCOUNTERED AT 9 FEET ∇

DRILLING DATA

___ AUGER 4 1/4" HOLLOW STEM

WASHBORING FROM ___ FEET

MVU DRILLER SWG LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

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

GEOTECHNOLOGY INC
FROM THE GROUND UP

Ameren-Coffeen Ash Pond Evaluation

Renamed G303

LOG OF BORING: APW-3

Project No. J017150.01

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

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G305

Site Name: Coffeen Power Station Borehole #: G305

State Plane Coordinate: X 871,156.3 Y 2,515,199.4 (or) Latitude: _____ Longitude: _____

Surveyed By: Gary C. Rogers IL Registration #: 035-002957

Drilling Contractor: Ramsey Geotechnical Engineering LLC Driller: B. Williamson

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna L. Keim Date Started: 5/3/2016 Date Finished: 5/3/2016

Report Form Completed By: Suzanna L. Keim Date: 5/19/2016

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite Chips

Installation Method: Gravity

Setting Time: >12 hours

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

Installation Method: n/a

Setting Time: n/a

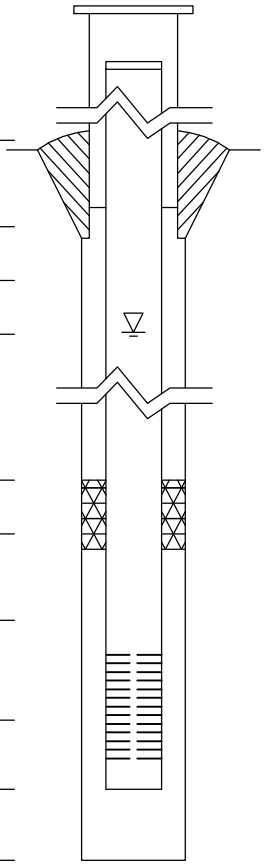
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: n/a (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
625.88	-3.34	Top of Protective Casing
625.55	-3.01	Top of Riser Pipe
622.54	0.00	Ground Surface
621.54	1.00	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
611.04	11.50	Top of Sand Pack
609.10	13.44	Top of Screen
604.27	18.27	Bottom of Screen
604.09	18.45	Bottom of Well
604.09	18.45	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	16.45
Bottom of Screen to End Cap	(feet)	0.18
Screen Length (1st slot to last slot)	(feet)	4.83
Total Length of Casing	(feet)	21.46
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G307

Site Name: Coffeen Power Station Ash Pond 1 Borehole #: G307

State Plane Coordinate: X 2,515,553.3 Y 871,398.6 (or) Latitude: _____ Longitude: _____

Surveyed By: _____ IL Registration #: _____

Drilling Contractor: Bulldog Drilling, Inc. Driller: J. Gates

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

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 7/26/2016 Date Finished: 7/27/2016

Report Form Completed By: Rhonald W. Hasenyager Date: 7/28/2016

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite Chips

Installation Method: Gravity

Setting Time: 18 hrs.

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

Installation Method: _____

Setting Time: _____

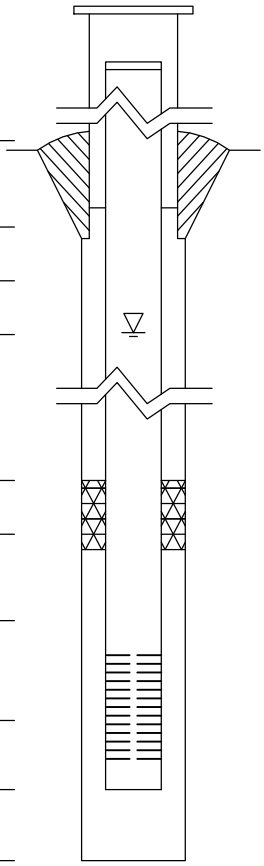
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: none (if applicable)

Installation Method: n/a



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
624.72	-2.64	Top of Protective Casing
624.47	-2.39	Top of Riser Pipe
622.08	0.00	Ground Surface
620.08	2.00	Top of Annular Sealant
623.84	-1.76	Static Water Level (After Completion) 7/27/2016
n/a	n/a	Top of Seal
610.10	11.98	Top of Sand Pack
609.12	12.96	Top of Screen
604.28	17.80	Bottom of Screen
603.86	18.22	Bottom of Well
603.86	18.22	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	15.37
Bottom of Screen to End Cap	(feet)	0.40
Screen Length (1st slot to last slot)	(feet)	4.84
Total Length of Casing	(feet)	20.61
Screen Slot Size **	(inches)	0.010

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G307D

Site Name: Coffeen Part 845 Groundwater Borehole #: G307D

State Plane Coordinate: X 2,515,560.3 Y 871,397.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 2/9/2021 Date Finished: 2/9/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

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

Installation Method: Gravity

Setting Time: 30 minutes

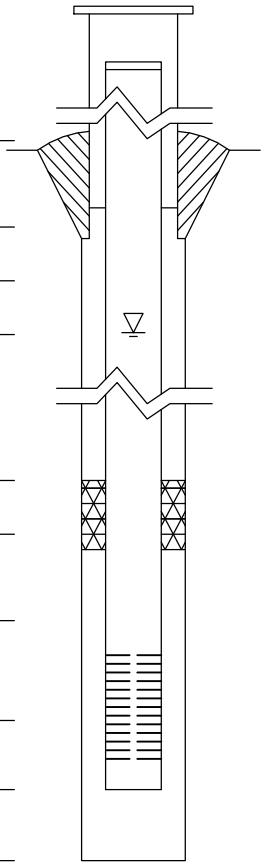
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
625.29	-2.78	Top of Protective Casing
624.88	-2.37	Top of Riser Pipe
622.51	0.00	Ground Surface
621.51	1.00	Top of Annular Sealant
		Static Water Level (After Completion)
575.51	47.00	Top of Seal
574.51	48.00	Top of Sand Pack
573.53	48.98	Top of Screen
563.76	58.75	Bottom of Screen
562.91	59.60	Bottom of Well
562.51	60.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	51.85
Bottom of Screen to End Cap	(feet)	0.35
Screen Length (1st slot to last slot)	(feet)	9.77
Total Length of Casing	(feet)	61.97
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G308

Site Name: Coffeen Part 845 Groundwater Borehole #: G308

State Plane Coordinate: X 2,515,101.4 Y 871,454.7 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 1/13/2021 Date Finished: 1/13/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: _____

Setting Time: _____

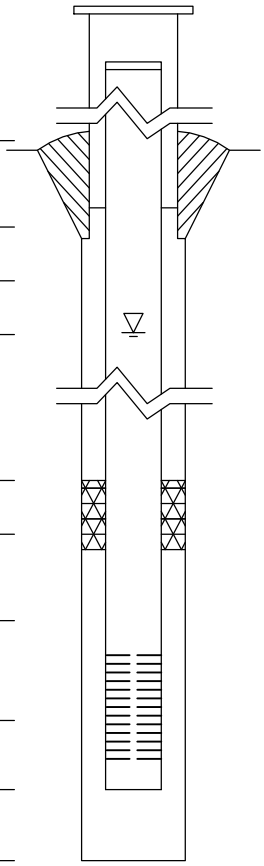
Type of Sand Pack: Quartz Sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
624.96	-3.37	Top of Protective Casing
624.59	-3.00	Top of Riser Pipe
621.59	0.00	Ground Surface
621.39	0.20	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
612.59	9.00	Top of Sand Pack
611.49	10.10	Top of Screen
606.70	14.89	Bottom of Screen
606.35	15.24	Bottom of Well
605.79	15.80	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.10
Bottom of Screen to End Cap	(feet)	0.35
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	18.24
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G310

Site Name: Coffeen Part 845 Groundwater Borehole #: G310

State Plane Coordinate: X 2,515,159.4 Y 872,239.4 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 1/15/2021 Date Finished: 1/15/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: _____

Setting Time: _____

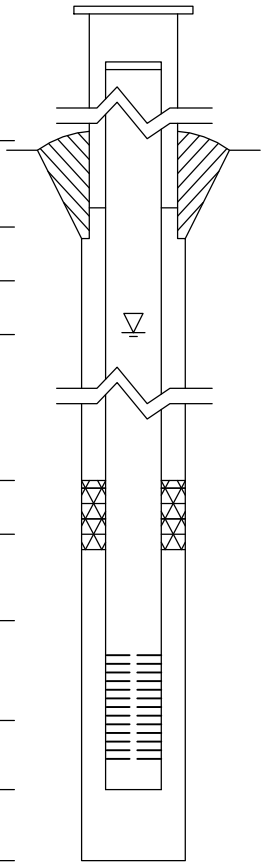
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
623.32	-3.43	Top of Protective Casing
622.87	-2.98	Top of Riser Pipe
619.89	0.00	Ground Surface
619.39	0.50	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
610.69	9.20	Top of Sand Pack
609.65	10.24	Top of Screen
604.86	15.03	Bottom of Screen
604.51	15.38	Bottom of Well
603.99	15.90	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.22
Bottom of Screen to End Cap	(feet)	0.35
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	18.36
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G311D

Site Name: Coffeen Part 845 Groundwater Borehole #: G311D

State Plane Coordinate: X 2,515,881.8 Y 872,238.7 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 2/5/2021 Date Finished: 2/5/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: 1 hour

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

Installation Method: Gravity

Setting Time: 30 minutes

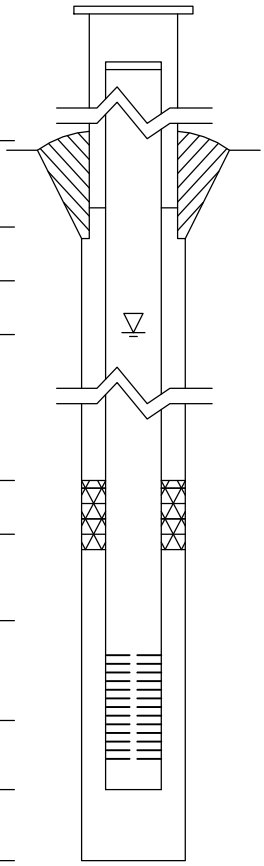
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Tremie

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
621.75	-3.36	Top of Protective Casing
621.24	-2.85	Top of Riser Pipe
618.39	0.00	Ground Surface
617.09	1.30	Top of Annular Sealant
		Static Water Level (After Completion)
572.39	46.00	Top of Seal
569.39	49.00	Top of Sand Pack
568.23	50.16	Top of Screen
558.29	60.10	Bottom of Screen
557.81	60.58	Bottom of Well
557.81	60.58	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	6.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	53.01
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	9.94
Total Length of Casing	(feet)	63.43
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G312

Site Name: Coffeen Part 845 Groundwater Borehole #: G312

State Plane Coordinate: X 2,516,557.4 Y 872,260.9 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 2/4/2021 Date Finished: 2/4/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: _____

Setting Time: _____

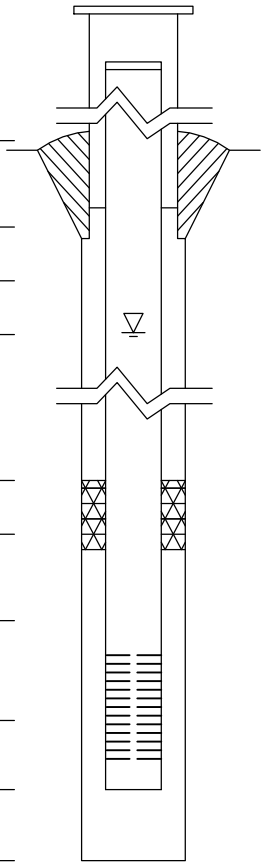
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
620.11	-3.19	Top of Protective Casing
619.78	-2.86	Top of Riser Pipe
616.92	0.00	Ground Surface
615.92	1.00	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
608.92	8.00	Top of Sand Pack
607.13	9.79	Top of Screen
602.34	14.58	Bottom of Screen
601.99	14.93	Bottom of Well
601.67	15.25	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.65
Bottom of Screen to End Cap	(feet)	0.35
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	17.79
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G313

Site Name: Coffeen Part 845 Groundwater Borehole #: G313

State Plane Coordinate: X 2,516,803.7 Y 871,976.8 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 1/14/2021 Date Finished: 1/14/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: _____

Setting Time: _____

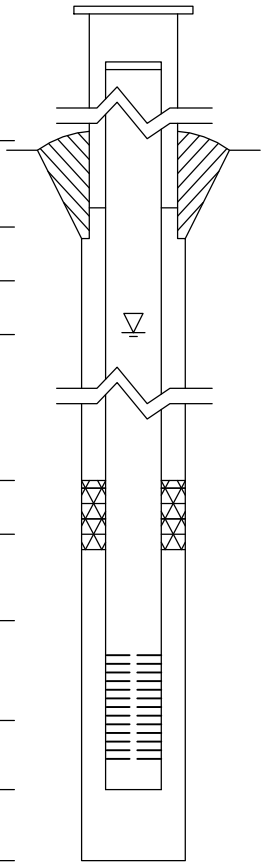
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
614.62	-3.11	Top of Protective Casing
614.30	-2.79	Top of Riser Pipe
611.51	0.00	Ground Surface
611.11	0.40	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
606.51	5.00	Top of Sand Pack
605.21	6.30	Top of Screen
600.40	11.11	Bottom of Screen
600.05	11.46	Bottom of Well
599.51	12.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	9.09
Bottom of Screen to End Cap	(feet)	0.35
Screen Length (1st slot to last slot)	(feet)	4.81
Total Length of Casing	(feet)	14.25
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G314

Site Name: Coffeen Part 845 Groundwater Borehole #: G314

State Plane Coordinate: X 2,516,852.1 Y 871,630.2 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Holcomb Foundation Engineering Co. Driller: Steve

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 2/26/2021 Date Finished: 2/26/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 1 hour

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

Installation Method: _____

Setting Time: _____

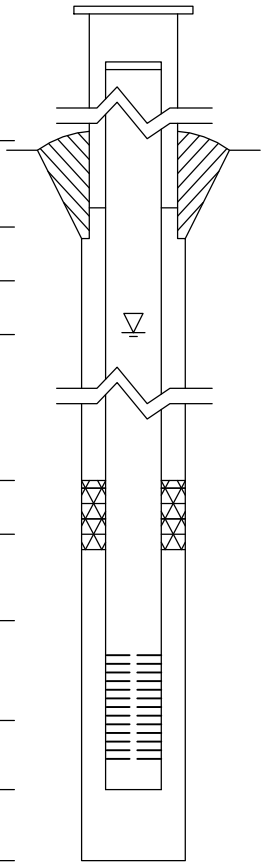
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
614.28	-3.17	Top of Protective Casing
613.88	-2.77	Top of Riser Pipe
611.11	0.00	Ground Surface
609.11	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
597.61	13.50	Top of Sand Pack
596.55	14.56	Top of Screen
591.53	19.58	Bottom of Screen
591.09	20.02	Bottom of Well
591.06	20.05	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	17.30
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	5.02
Total Length of Casing	(feet)	22.79
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G314D

Site Name: Coffeen Part 845 Groundwater Borehole #: G314D

State Plane Coordinate: X 2,516,853.9 Y 871,642.0 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 2/10/2021 Date Finished: 2/12/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

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

Installation Method: Gravity

Setting Time: 30 minutes

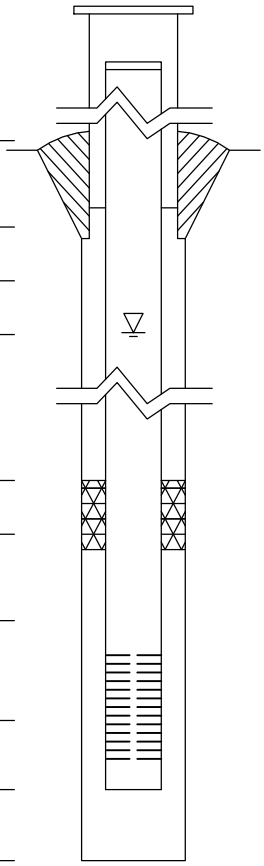
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
614.10	-3.23	Top of Protective Casing
613.70	-2.83	Top of Riser Pipe
610.87	0.00	Ground Surface
608.87	2.00	Top of Annular Sealant
		Static Water Level (After Completion)
574.07	36.80	Top of Seal
572.97	37.90	Top of Sand Pack
571.53	39.34	Top of Screen
561.76	49.11	Bottom of Screen
561.40	49.47	Bottom of Well
510.57	100.30	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	42.17
Bottom of Screen to End Cap	(feet)	0.36
Screen Length (1st slot to last slot)	(feet)	9.77
Total Length of Casing	(feet)	52.30
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G315

Site Name: Coffeen Part 845 Groundwater Borehole #: G315

State Plane Coordinate: X 2,516,086.6 Y 871,385.0 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 1/13/2021 Date Finished: 1/13/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: _____

Setting Time: _____

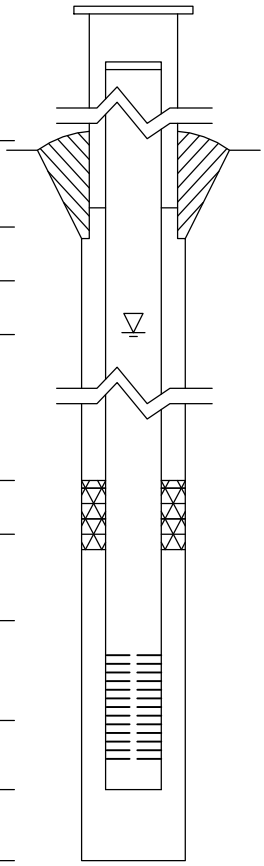
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
623.89	-2.95	Top of Protective Casing
623.52	-2.58	Top of Riser Pipe
620.94	0.00	Ground Surface
620.54	0.40	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
612.64	8.30	Top of Sand Pack
611.25	9.69	Top of Screen
606.46	14.48	Bottom of Screen
606.09	14.85	Bottom of Well
605.04	15.90	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.27
Bottom of Screen to End Cap	(feet)	0.37
Screen Length (1st slot to last slot)	(feet)	4.79
Total Length of Casing	(feet)	17.43
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Montgomery Well #: G316

Site Name: Coffeen Part 845 Groundwater Borehole #: G316

State Plane Coordinate: X 2,517,211.6 Y 871,643.1 (or) Latitude: _____ Longitude: _____

Surveyed By: Kyle J. Nolan IL Registration #: 035-003919

Drilling Contractor: Roberts Env. Drilling Inc. Driller: Matt

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): None

Logged By: Colin Winter Date Started: 1/14/2021 Date Finished: 1/14/2021

Report Form Completed By: Colin Winter Date: 5/3/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: >24 hours

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

Installation Method: _____

Setting Time: _____

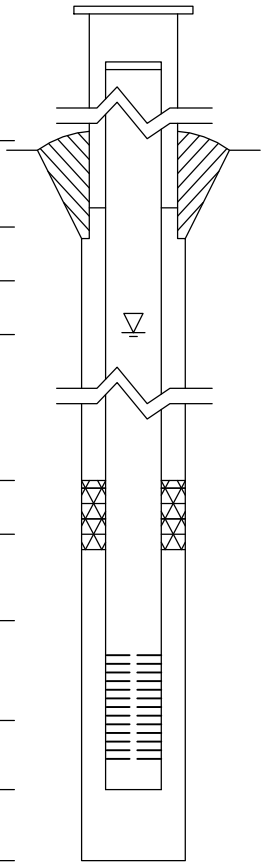
Type of Sand Pack: Quartz sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: N/A (if applicable)

Installation Method: _____



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
603.06	-3.42	Top of Protective Casing
602.59	-2.95	Top of Riser Pipe
599.64	0.00	Ground Surface
598.84	0.80	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
590.64	9.00	Top of Sand Pack
589.62	10.02	Top of Screen
584.82	14.82	Bottom of Screen
584.48	15.16	Bottom of Well
583.89	15.75	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	12.97
Bottom of Screen to End Cap	(feet)	0.34
Screen Length (1st slot to last slot)	(feet)	4.80
Total Length of Casing	(feet)	18.11
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

APPENDIX B
35 I.A.C. 845 Multi-Site Statistical Analysis Plan

Date
April 1, 2025

Project No.
1940110241

35 I.A.C § 845 MULTI-SITE STATISTICAL ANALYSIS PLAN

RAMBOLL Bright ideas. Sustainable change.

35 I.A.C § 845 MULTI-SITE STATISTICAL ANALYSIS PLAN

Project no.	**1940110241**
Recipient	**Vistra Corp**
Document type	**Statistical Analysis Plan**
Revision	**FINAL**
Date	**April 1, 2025**
Prepared by	**Rachel Banoff and Alison O'Connor**
Checked by	**Eric J. Tlachac, PE**
Approved by	**Brian G. Hennings, PG**

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Senior Managing Engineer

Brian G. Hennings, PG
Senior Managing Hydrogeologist

LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan. The procedures described in the plan will be used to establish background conditions and implement compliance and corrective action monitoring as necessary and required by 35 I.A.C. § 845.640, § 845.650, and § 845.680. The 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in the United States Environmental Protection Agency (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* USEPA 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring. In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality is the tolerance interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Groundwater Protection Standards (GWPS) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The GWPS will be compared to the appropriate confidence interval for the observed concentrations for each constituent in each compliance well. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Description of the statistical methods chosen for analysis of groundwater monitoring data and application of these methods for determining exceedances of the GWPS identified in 35 I.A.C. § 845.600(a) is provided in this 35 I.A.C. § 845 Multi-Site Statistical Analysis Plan.

35 I.A.C. § 845.640 Statistical Analysis (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the statistical methods summarized above and described in this document (35 I.A.C. § 845 Multi-Site Statistical Analysis Plan) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: April 1, 2025

35 I.A.C. § 845.640 Statistical Analysis (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the statistical methods described in this document (35 I.A.C. § 845 Multi-Site Statistical Analysis Plan) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: April 1, 2025

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (35 I.A.C. § 845 Multi-Site Statistical Analysis Plan), are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.

Rachel A. Banoff, EIT
Project Statistician
Date: April 1, 2025

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	April 1, 2025	• Original Document

DOCUMENT APPLICABILITY BY FACILITY OWNER

Table A. Document Applicability by Facility Owner

Facility & Owner	Unit ID	Unit Name
Baldwin Power Plant Dynegy Midwest Generation, LLC	601	Bottom Ash Pond
	605	Fly Ash Pond System
Coffeen Power Plant Illinois Power Generating Company	101	Ash Pond No. 1
	102	Ash Pond No. 2
	103	GMF Gypsum Stack Pond
	104	GMF Recycle Pond
Duck Creek Power Plant Illinois Power Resources Generating, LLC	201/202	Ash Pond No. 1 Ash Pond No. 2
	203	GMF Pond
	205	Bottom Ash Basin
Edwards Power Plant Illinois Power Resources Generating, LLC	301	Ash Pond
Hennepin Power Plant Dynegy Midwest Generation, LLC	802	Ash Pond No. 2
	803	East Ash Pond
	804	Old West Ash Pond
	802/805	Ash Pond No. 2 Ash Pond No. 4
Joppa Power Plant Electric Energy, Inc.	401	East Ash Pond
	403	West Ash Pond
Kincaid Power Plant Kincaid Generation, LLC	141	Ash Pond
Newton Power Plant Illinois Power Generating Company	501	Primary Ash Pond
Vermilion Power Plant Dynegy Midwest Generation, LLC	910	North Ash Pond
	911/912	Old East Ash Pond New East Ash Pond

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Figure 1 Flow chart illustrating the statistical methods used for calculating background under Compliance Monitoring

Figure 2 Flow chart illustrating the statistical methods used for calculating confidence intervals in Compliance Monitoring

ACRONYMS AND ABBREVIATIONS

%	percent
35 I.A.C.	Title 35 of the Illinois Administrative Code
CCR	coal combustion residuals
CI	confidence interval
DQR	Double Quantification Rule
GMP	Groundwater Monitoring Plan
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MDL	method detection limit
PQL	practical quantitation limit
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
SAP	Sampling and Analysis Plan
SI	surface impoundment
UCL	upper confidence limit
Unified Guidance	Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance (USEPA, 2009)
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

In April 2021, the Illinois Environmental Protection Agency (IEPA) issued a final rule for the regulation and management of coal combustion residuals (CCR) in surface impoundments (SIs) under the Standards for the Disposal of CCR in Surface Impoundments: Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845. Facilities regulated under 35 I.A.C. § 845 are required to develop and sample a groundwater monitoring well system to evaluate whether impounded CCR materials are impacting groundwater quality. The groundwater quality evaluation must include certification from a qualified professional engineer that the selected statistical method is appropriate for evaluating groundwater monitoring data for the CCR surface impoundment. The procedures described in the evaluation will be used to establish background conditions and implement Compliance and Corrective Action Monitoring as necessary and required by 35 I.A.C. § 845.640, § 845.650, § 845.680, and § 845.780. This Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (Unified Guidance) (USEPA, 2009).[1]

1.1 Statistical Analysis Objectives

This Multi-Site Statistical Analysis Plan provides a framework for conducting the statistical analyses of groundwater data collected during operation, post-closure care, and corrective action monitoring (if required). This Multi-Site Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis conducted in accordance with the Multi-Site Sampling and Analysis Plan (SAP; Ramboll, 2022) or data quality evaluation conducted in accordance with the Multi-Site Quality Assurance Project Plan (QAPP; Ramboll, 2022).[2]

1.2 Statistical Analysis Plan Approach

The analyses described in this document are intended to support monitoring programs described in detail in the CCR unit-specific Operating Permit Groundwater Monitoring Plans (GMPs), Closure Construction Permit GMPs, and Corrective Action GMPs. When necessary and contingent upon equivalent statistical power, an alternative test consistent with the performance standards in 35 I.A.C. § 845.640(g), not included in this Statistical Analysis Plan, may be chosen due to site-specific data requirements.

35 I.A.C. § 845 outlines three phases of groundwater monitoring:

- Baseline Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650 and 35 I.A.C. § 845.780(b)
- Corrective Action Monitoring in accordance with 35 I.A.C. § 845.680(a)

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the first phase, background groundwater quality will be established, utilizing upgradient and background wells. Compliance Monitoring, which

[1] Despite being currently archived on USEPA's website, the Unified Guidance remains a valid reference for developing a statistical analysis plan (personal communication with Alison O'Connor, February 11, 2025).

[2] The Multi-Site Sampling and Analysis Plan and Multi-Site Quality Assurance Project plan are living documents which are subject to routine evaluation and updates in accordance with USEPA recommended best practices (USEPA 2020; USEPA 2023).

encompasses data collection and statistical evaluation conducted during unit operation and the post-closure care period, will then evaluate whether exceedances occur for 20 required constituents (per 35 I.A.C. § 845.600(a)(1)) relative to the groundwater protection standard (GWPS) established by 35 I.A.C. § 845.600. Corrective Action Monitoring evaluates remedy progress and completion and will be initiated upon implementation of the Corrective Action GMP.

2. GROUNDWATER DATA EVALUATION AND STATISTICAL ASSUMPTIONS

The following subsections outline the statistical tests and procedures utilized to evaluate data collected for consistency with statistical assumptions and evaluate data distribution. These methods may be used in any phase of groundwater monitoring.

2.1 Sample Independence

Independence of sample results is a major assumption for most statistical analyses. To ensure physical independence of groundwater sampling results, the minimum time between sampling events must be longer than the time required for groundwater to move through the monitoring well. Therefore, the minimum time interval between sampling events is a function of the groundwater velocity and well bore volume (diameter of the well and surrounding filter pack). The sampling schedules for Baseline Monitoring, Compliance Monitoring, and Corrective Action Monitoring are specified in 35 I.A.C. § 845 and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

Groundwater sample analysis results below the reporting limit (RL), also referred to as the practical quantitation limit (PQL), will not be used in statistical calculations due to the inherent uncertainty in results that are estimated between the method detection limit (MDL) and RL/PQL, and error assumptions inherent to the statistical calculations. Results below the RL/PQL will be considered non-detect data. For statistical characterization evaluations (*e.g.*, distribution testing, and trend analysis), non-detects were replaced with the half of the RL for the analysis. For statistical test procedures that involve the calculation of a mean and standard deviation (as described in **Section 3**):

- If the frequency of non-detect data are less than or equal to 15 percent (%), half of the RL will be substituted for these data.
- If the non-detect frequency is greater than 15% and less than or equal to 50% and the data are normally or log-normally distributed (**Section 2.3**), the Kaplan-Meier method will be used to estimate the mean and standard deviation adjusted for the presence of left-censored values.
- If the non-detect frequency is greater than 50% or data are not normally or log-normally distributed (**Section 2.3**), a non-parametric test or calculation will be used.

2.3 Testing for Normality

In accordance with 35 I.A.C. § 845.640(g)(1), "the statistical method used to evaluate groundwater monitoring data must be appropriate for the distribution of constituents". The Unified Guidance document recommends the Shapiro-Wilk normality test for sample sizes of 50 or less, and the Shapiro-Francia normality test for sample sizes greater than 50. Log-transformation of datasets to achieve normal distributions is preferred to using non-parametric methods. However, if data normality cannot be achieved through log transformation, a non-parametric method is used.

2.4 Outlier Evaluation and Management

Groundwater analytical data may be screened for the existence of outliers using methods described by the Unified Guidance. Outliers are extreme data points that may represent an anomaly or erroneous data point. To test for outliers, one or more of the following outlier tests will be utilized:

- Dixon's test, for well-constituent pairs with less than 25 samples, assumes normally distributed data.
- Rosner's test, for well-constituent pairs with more than 20 samples, assumes normally distributed data.
- Grubb's test for well-constituent pairs with seven or more samples, assumes normally distributed data.

In addition, time series, box-whisker plots, and probability plots will be used to provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

When necessary, a confirmatory sample will be collected to allow the facility to distinguish between an outlier and a true release from the facility (35 I.A.C. § 845.650(d)). If re-sampling is necessary, this sample will be collected within 60 days following outlier identification. Rigorous data validation and review is preferred to formal outlier testing and exclusion to ensure that all data used in statistical evaluations is representative of field conditions. Quality control/quality assurance data are collected and data verification is completed in accordance with the QAPP. Project staff familiar with the site and historical data will review the data generated each quarter and facilitate additional validation as needed. Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. Exclusion of potential outliers without an identified source of error may be considered only for data that could cause extremely elevated background concentrations.

2.5 Trend Analysis

Statistical analyses confirming the lack of trend are a fundamental step to confirm the assumption that groundwater quality values (*i.e.,* constituent means) are stationary or constant over time. These analyses allow for evaluation of variation in the background and compliance data for each constituent over time. A statistically significant increasing trend in the background data could indicate an existing release from the CCR unit or alternative source, requiring further investigation. In addition, statistically significant trending background data can result in increased standard deviation and, therefore, greater prediction or tolerance limits. Consequently, the increased prediction or tolerance limit will have less statistical power or ability to identify a release from a CCR unit.

A linear regression, coupled with a t-test for slope significance at a 95% confidence level (or 0.05 significance level), may be used on datasets for each constituent with few non-detects and a normally distributed variance of the mean to evaluate time trends. The Theil-Sen trend line, coupled with the Mann-Kendall test for slope significance at a 95% confidence level (or 0.05 significance level), may be used for datasets with frequent non-detects or non-normal variance. Similarly, trend analyses could also be used on compliance data to evaluate a possible release from the CCR unit.

2.6 Spatial Variation

Spatial trends and/or variation between background wells could indicate an existing release from a CCR unit. If the spatial variability is not due to an existing release, intrawell comparisons in compliance wells may be used to account for spatial variability and monitor for a future release. However, the CCR units being monitored have been placed into service prior to the start of groundwater monitoring and it is unknown whether a previous release has occurred. Accordingly, intrawell comparisons in compliance wells cannot be used to determine the occurrence of a future release, and interwell comparisons between compliance wells and background wells will be used.

2.7 Temporal Variation

Time series plots can be used to identify temporal dependence. Potentially significant temporal components of variability can be identified by graphing single constituent data from multiple wells together on a time series plot. With temporal dependence, the time series plot has a pattern of parallel traces, in which the individual wells will tend to rise and fall together across the sequence of sampling dates. Time series plots can be helpful by plotting multiple constituents over time for the same well, or averaging values for each constituent across wells on each sampling event and then plotting the averages over time. In either case, the plots can signify whether the general concentration pattern over time is simultaneously observed for different constituents. If so, it may indicate that a group of constituents is highly correlated in groundwater or that the same artifacts of sampling and/or lab analysis impacted the results of several monitoring parameters.

2.8 Updating Background

Updating the background dataset periodically by adding recent results to an existing background dataset can improve the statistical power and accuracy of the statistical analysis, especially for non-parametric prediction intervals. The Unified Guidance recommends updating statistical limits (background) when at least four to eight new measurements (every 2 to 4 years under a semiannual monitoring program or 1 to 2 years under a quarterly monitoring program) are available for comparison to historical data. Methods discussed in **Section 2.4** and professional judgement will be used to evaluate whether any individual data points appear to drive an anomalously high background level. A t-test for equal means (if normal data distribution) or a Mann-Whitney or Wilcoxon test for equal medians (if non-normal data distribution) will be conducted to verify that the two groups of background sample populations are statistically different prior to updating any background datasets. A 0.05 significance level will be utilized when evaluating the two populations, with the null hypothesis that the two populations have equal means or medians. In addition, time series graphs or other trend evaluation statistics (such as a Mann-Kendall test) will be conducted on the new background dataset to verify the absence of a release or changing groundwater quality. If the tests indicate that there are no statistical differences between the two background populations, the new data will be combined with the existing dataset. If the two populations are found to be different, the data will be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a release (*i.e.,* if the new data are significantly higher, or lower for pH), then the previous background dataset may continue to be used. Furthermore, verified outliers will not be added to an existing background dataset. Spatial variability among background wells will also be assessed when background datasets are updated to determine whether pooling data is appropriate.

3. COMPLIANCE MONITORING PROGRAM

Compliance Monitoring encompasses data collection and statistical evaluation conducted during unit operation (35 I.A.C. § 845.640 and 845.650) and the post-closure care period (35 I.A.C. § 845.780). Compliance Monitoring is designed to evaluate whether concentrations of constituents listed in 35 I.A.C. § 845.600(a)(1) in compliance wells exceed GWPS or background in a statistically significant manner.

3.1 Monitoring Program Outline

3.1.1 Establish Background and GWPS

A site-specific GWPS will be established for constituents listed in 35 I.A.C. § 845.600(a)(1) for each CCR unit. The GWPS will be the concentration specified in 35 I.A.C. § 845.600(a)(1), unless the background concentration is greater. For this exception, background concentrations will be used to define the GWPS. Background concentrations will be calculated using a parametric or non-parametric upper tolerance limit (UTL), depending on the data distribution, consistent with 35 I.A.C. § 845.640(f)(1)(C). The procedure for calculating a UTL is outlined in **Figure 1** and described in **Section 3.2**. If only one background result is detected, that value will be used as the UTL.

3.1.2 Evaluate Background and GWPS Exceedances

Per 35 I.A.C. § 845.610(b)(3), groundwater monitoring data from compliance monitoring wells will be evaluated for statistically significant exceedances over background and the site-specific GWPS. In accordance with recommendation in the Unified Guidance for compliance monitoring, exceedances are evaluated by comparing a confidence interval (CI) to a fixed standard. The null hypothesis of this comparison is that compliance well groundwater concentrations do not exceed the standard unless the statistical test indicates otherwise.

GWPS exceedances will be determined by comparing the lower confidence limit (LCL) of the compliance well concentrations to the GWPS, except for pH where the LCL will be compared to the upper end of the GWPS range, and the upper confidence limit (UCL) compared to the low end of the GWPS range. A GWPS exceedance is determined if the LCL is greater than the GWPS, and, for pH, either the LCL is greater than the upper end of the GWPS range or the UCL is less than the low end of the GWPS range. The method of calculating the CI (outlined in **Figure 2** and described in **Section 3.3**) will be determined by sample size, trends in the data, and data normality. The significance level (alpha) for this calculation will be fixed at 0.01 (99% confidence) as recommended by Unified Guidance. If there are too few data points to calculate an LCL (a minimum of four data points is typically required), the most recent data point will be compared to the GWPS.

In the event that statistical analyses identify an exceedance of the GWPS for one or more parameters, the exceedance parameters and wells of concern may be immediately re-sampled. Compliance Monitoring statistics will be updated using the verification resample. If the Compliance Monitoring statistics using the compliance verification resample data result in an exceedance of the GWPS, the exceedance is confirmed.

Comparison of groundwater monitoring data to background is required by 35 I.A.C. § 845.610(3)(B), but these background "exceedances" do not carry any compliance implications.

Background exceedances will be determined by comparing the LCL of the compliance well concentrations to the background UTL, with the exception of pH where the UCL of the compliance well concentrations will also be compared to the background lower tolerance limit (LTL). A background exceedance is determined if the LCL is greater than the background UTL, or, for pH, either the LCL is greater than the UTL or the UCL is less than the LTL. If there are too few data points to calculate an LCL (a minimum of four data points is required), the most recent data point will be compared to the background UTL (and LTL for pH).

Additionally, an exceedance of either background or GWPS will be identified if the constituent monitored was not detected in all previous samples at a compliance well and the two most recent samples have both detections and exceed the GPWS (or are less than the low end of the GWPS range for pH) or background UTL (or are less than the LTL for pH).

3.2 Upper Tolerance Limit

The method for calculating a UTL depends primarily on the proportion of non-detects and the data distribution (**Figure 1**). A parametric UTL will be used to calculate the GWPS when the background data are normally distributed and have a non-detect frequency of 50% or less. The Unified Guidance recommends 95% confidence level and 95% coverage (95/95 tolerance interval). When the non-detect frequency is 15% or less, half the RL will be substituted for non-detects (simple substitution), and the normal mean and standard deviation will be calculated. The Kaplan-Meier method will be used when the detection frequency is between 15% and 50%. The Kaplan-Meier method assesses the linearity of a censored probability plot to determine whether the background sample can be approximately normalized. If so, then the Kaplan-Meier method will be used to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. The Kaplan-Meier estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.

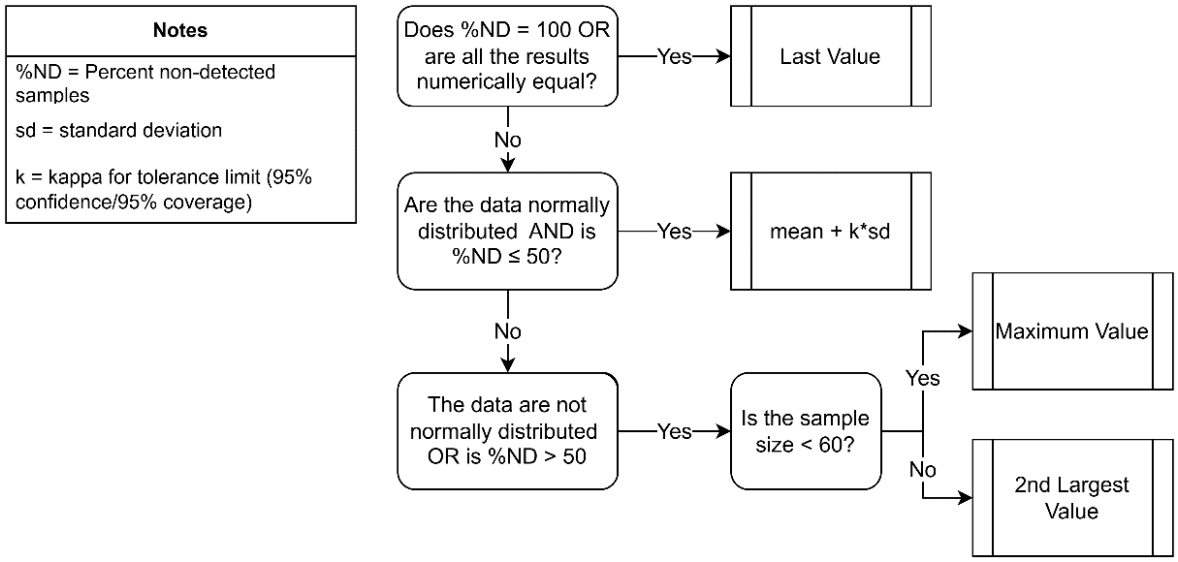

Figure 1. Flow chart illustrating the statistical methods used for calculating background under Compliance Monitoring.

The parametric UTL on a future mean will be calculated from the background dataset as follows:

$$UTL = \overline{x} + \kappa\,(n, \gamma, \alpha - 1) \cdot s$$

$\overline{x}$ = background sample mean

s = background sample standard deviation

$\kappa\,(n, \gamma, \alpha - 1)$ = one-sided normal tolerance factor based on the chosen coverage (γ) and confidence level (α -1) and the size of the background dataset (n). Values may be calculated per Millard (2013) or looked up in Table 17-3 in Appendix D of the Unified Guidance.

If the UTL is constructed on the logarithms of original observations to achieve normality, where $\overline{y}$ and s_y are the log-mean and log-standard deviation, the limit will be exponentiated for back-transformation to the concentration scale as follows:

$$TL = \exp\left[\overline{y} + \kappa\,(n, \gamma, \alpha - 1) \cdot s_y\right]$$

$\overline{y}$ = background sample log-mean

s_y = background sample log-standard deviation

If the background data set is non-parametric or has a non-detect frequency greater than 50%, a non-parametric UTL is used. The maximum concentration is used as the non-parametric UTL for sample sizes less than 60 and the second largest concentration is used as the non-parametric UTL for sample sizes greater than or equal to 60. As described in the Unified Guidance, the advantages include the resulting UTL reflecting actual concentration magnitudes, and the UTL more likely representing a detected concentration (unless all the data were non-detect).

3.3 Confidence Intervals

The method for calculating a CI depends on whether or not there is a trend in the data, the proportion of non-detects, and the data distribution (**Figure 2**). The following sections describe the procedure for calculating the CI in each case.

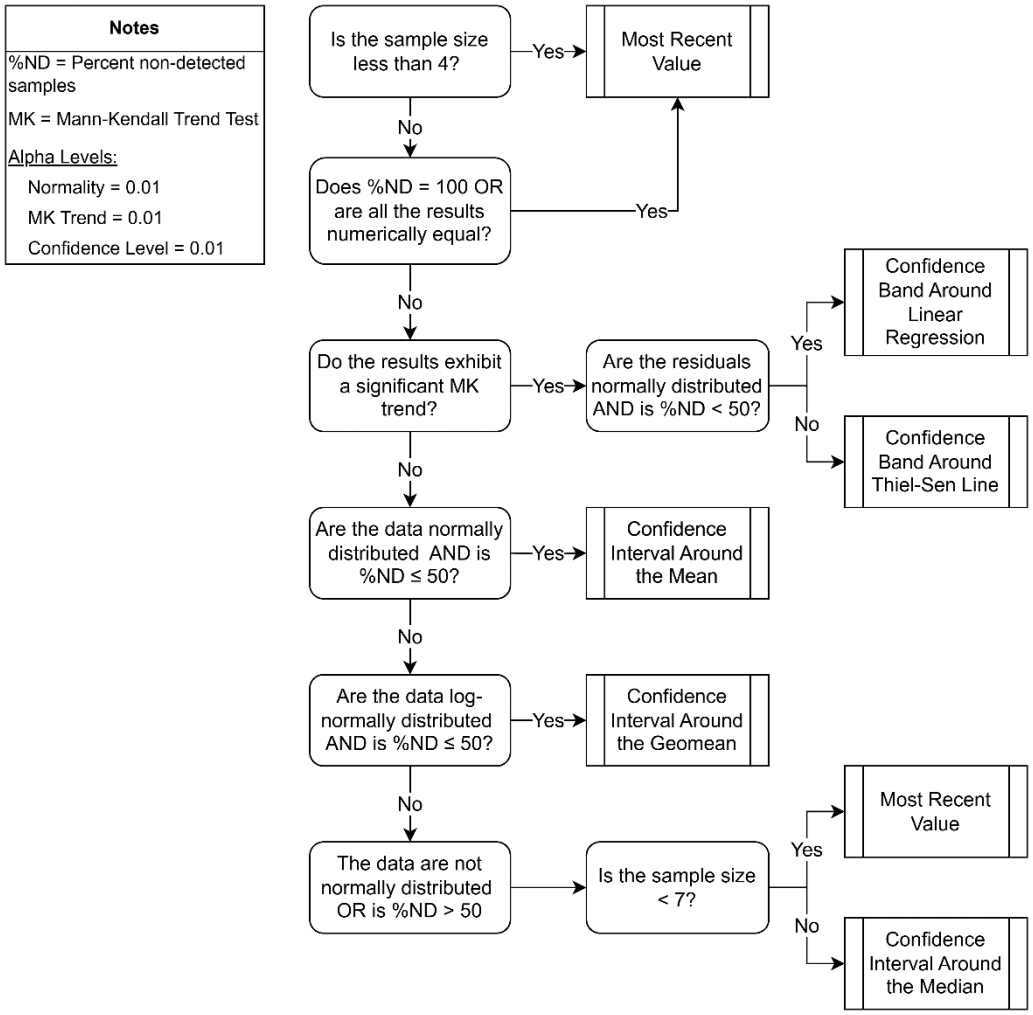

Figure 2. Flow chart illustrating the statistical methods used for calculating confidence intervals in Compliance Monitoring.

3.3.1 Confidence Intervals Around Trending Data

If compliance data exhibit a statistically significant trend based on results from a Mann-Kendall trend test and consists of a sufficient sample size (see below), CIs accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider CI will inevitably be calculated for a given confidence level and sample size (*n*). A wider CI will result in less statistical power, or ability to demonstrate an exceedance or return to compliance. When a linear trend line has been estimated, a series of CIs is estimated at each point along the trend. This creates a simultaneous confidence band that follows the trend line. As the underlying population mean increases or decreases, the confidence band also increases to reflect this change at that point in time.

Linear regression will be used when the compliance data set consists of at least eight samples, the frequency of non-detects is below 50%, and residuals around the trend line are normally distributed. The linear regression of concentration against sampling date (time) will be computed as follows:

$$\hat{b} = \sum_{i=1}^{n} (t_i - \bar{t}) \cdot x_i / (n-1) \cdot s_t^2$$

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\bar{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

$$\hat{x} = \bar{x} + \hat{b} \cdot (\mathrm{t} - \bar{t})$$

$\bar{x}$ = mean concentration level

$\hat{x}$ = estimated mean concentration at time t

The regression residuals will also be computed at each sampling event to ensure uniformity and lack of significant skewness. Regression residuals will be computed at each sampling event as follows:

$$r_i = x_i - \hat{x}_i$$

The estimated variance around the regression line, or mean squared error, will be computed as follows:

$$s_e^2 = \frac{1}{n-2} \sum_{i=1}^{n} r_i^2$$

The CI around a linear regression trend line given confidence level (1-α) and a point in time (t_0), will be computed as follows:

$$LCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-1} \cdot \left[\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$$UCL_{1-\alpha} = \hat{x}_0 - \sqrt{2 s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-2} \cdot \left[\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t_0

$F_{1-2\alpha,2,\mathrm{n}-2}$ = upper (1-2α)th percentage point from an F-distribution with 2 and (n-2) degrees of freedom

If the compliance data set consists of at least seven samples but has a non-detect frequency greater than 50% or the residuals are not normally distributed, the Thiel-Sen trend line will be used as a non-parametric alternative to linear regression for calculation of the CI. The Thiel-Sen trend line estimates the median concentration over time by combining the median pairwise slope with the median concentration value and the median sample date. To compute the Thiel-Sen line,

the data will first be ordered by sampling event x_1, x_2, x_n. All possible distinct pairs of measurements (x_i, x_j) for $j > i$ will be considered and the simple pairwise slope estimate will be computed for each pair as follows:

$$m_{ij} = (x_j - x_i)/(j - i)$$

With a sample size of n, there will be a total of $N = n(n\text{-}1)/2$ pairwise estimates m_{ij}. If a given observation is a non-detect, half the RL will be substituted. The N pairwise slope estimates (m_{ij}) will be ordered from least to greatest (renamed $m_{(1)}$, $m_{(2)}$,..$m_{(N)}$). The Thiel-Sen estimate of slope (Q) will be calculated as the median value of the list depending on whether N is even or odd as follows:

$$Q = \begin{cases} m_{([N+1]/2)} \; if \; N \; is \; odd \\ (m_{(N/2)} + m_{([N+2]/2)})/2 \; if \; N \; is \; even \end{cases}$$

The sample concentration magnitude will be ordered from least to greatest, $x_{(1)}$, $x_{(2)}$, to $x_{(n)}$ and the median concentration will be calculated as follows:

$$\tilde{x} = \begin{cases} x_{([n+1]/2)} \; if \; n \; is \; odd \\ (x_{(n/2)} + x_{([n+2]/2)})/2 \; if \; n \; is \; even \end{cases}$$

The median sampling date ($\tilde{t}$) with ordered times ($t_{(1)}$, $t_{(2)}$, to $t_{(n)}$) will also be determined in this way. The Thiel-Sen trend line will then be computed for an estimate at any time (t) of the expected median concentration (x) as follows:

$$x = \tilde{x} + Q \cdot (\mathrm{t} - \tilde{t}) = (\tilde{x} - Q \cdot \tilde{t}) + Q \cdot \mathrm{t}$$

To construct a confidence band around the Thiel-Sen line, sample pairs (t_i, x_i) will be formed with a sample date (t_i) and the concentration measurement from that date (x_i). Bootstrap samples (B) will be formed by repeatedly sampling n pairs at random with replacement from the original sample pairs. This will be repeated 500 times. For each bootstrap sample, a Thiel-Sen trend line will be constructed using the equation above. A series of equally spaced t_j values will be identified along the range of sampling dates represented in the original sample, j=1 to m. The Thiel-Sen trend line associated with each bootstrap replicate will be used to compute an estimated concentration ($\hat{x}_j^B$). A CI will be constructed for the lower αth percentile $\hat{x}_j^{[\alpha]}$from the distribution of estimated concentrations at each time point (t_j). For a UCL, compute the upper (1-α)th percentile, $\hat{x}_j^{[1-\alpha]}$ at each t_j; for an LCL, compute the lower αth percentile, $\hat{x}_j^{[\alpha]}$ at each t_j.

3.3.2 Parametric Confidence Intervals around a Mean

If compliance data do not show a trend and are normal or log-normal, one-sided parametric CIs around a sample mean will be constructed for each constituent and well pair. The LCL will be calculated as:

$$LCL_{1-\alpha} = \overline{x} - t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

The UCL will be calculated as:

$$UCL_{1-\alpha} = \overline{x} + t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

$\overline{x}$ = compliance sample mean

s = compliance sample standard deviation

n = compliance sample size

$t_{1-\alpha,n-1}$ = obtained from a Student's t-table with (n–1) degrees of freedom at the chosen alpha level (0.01) (Table 16-1 in Appendix D of the Unified Guidance)

If compliance data are distributed lognormally, the LCL will be computed around the lognormal geometric mean as:

$$LCL_{1-\alpha} = \exp\left(\overline{y} - t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

The UCL will be computed around the lognormal geometric mean as:

$$UCL_{1-\alpha} = \exp\left(\overline{y} + t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

$\overline{y}$ = compliance sample log-mean

s_y = compliance sample log-standard deviation

3.3.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data do not show a trend and contain greater than 50% non-detects or are non-normally distributed. The mathematical algorithm used to construct non-parametric CIs is based on the probability p that any randomly-selected measurement in a sample of n concentration measurements will be less than an unknown p x 100th percentile of interest (where P is between 0 and 1). Then the probability that the measurement will exceed the p x 100th percentile is (1–p). The number of sample values falling below the p x 100th percentile out of a set of n should follow a binomial distribution with parameters n and success probability p, where 'success' is defined as the event that a sample measurement is below the p x 100th percentile. The probability that the interval formed by a given pair of order statistics will contain the percentile of interest will then be determined by a cumulative binomial distribution *Bin(x;n,p)*, representing the probability of x or fewer successes occurring in n trials with success probability p. P will be set to 0.50 for an interval around the median. In accordance with the Unified Guidance, a confidence interval around the median will only be calculated if at least seven data points are available.

The sample size n will be ordered from least to greatest. Given p = 0.50, candidate interval endpoints will be chosen by ordered data values with ranks rounded upward to the next higher integers. The ranks of the endpoint will be denoted L^* and U* and are calculated using the following equations (Conover, 1999, p. 144):

$$L^* = np - Z_{1-\alpha}\sqrt{np(1-p)}$$

$$U^* = np + Z_{1-\alpha}\sqrt{np(1-p)}$$

4. CORRECTIVE ACTION MONITORING PROGRAM

Corrective Action Monitoring is performed after a corrective action remedy has been selected and implemented. 35 I.A.C. § 845.680(a)(1) specifies that the corrective action groundwater monitoring program must meet the requirements listed in 35 I.A.C. § 845.650 (*i.e.*, Compliance Monitoring), document the effectiveness of the selected remedy, and demonstrate compliance with the GWPS. Post-Closure Care monitoring as described in **Section 3** will operate concurrently with Corrective Action Monitoring, fulfilling the requirements of 35 I.A.C. § 845.650. This document describes the statistical methods used to document the progress of the selected remedy and demonstrate compliance with the GWPS.

Evaluation of corrective action remedy effectiveness will occur in three phases: remedy progress evaluation, stability evaluation, and attainment evaluation (USEPA, 1992).

1. Remedy progress evaluation occurs after implementation of corrective actions to assess if the remedy is functioning as anticipated.
2. The stability evaluation, which occurs after treatment has been concluded and a re-equilibration period has elapsed, assesses if a new post-treatment steady state in the groundwater has been reached.
3. Attainment evaluation occurs after a new steady state has been achieved and assesses if COC concentrations are below the GWPS.

In accordance with the Unified Guidance, these evaluations only apply to constituents which have previous exceedances of the GWPS. Constituents without previous GWPS exceedances continue to be evaluated according to Compliance Monitoring (per **Section 3**). The Corrective Action GMP for each unit describes the detailed approach to remedy effectiveness evaluation and reporting. Statistical evaluations used in each of these three phases are described below.

4.1 Remedy Progress Evaluation

The goal of remedy progress evaluation is to determine if a groundwater remedy is on track to achieve cleanup standards within the proposed time frame and to inform adaptive management decisions if performance metrics are not achieved. Evaluations of remedy effectiveness include:

- Comparison of the central tendency (*i.e.*, mean or median) of data from corrective action monitoring wells to the GWPS
- Trend analysis of average concentrations in individual wells and in a plume

Unlike Compliance Monitoring, remedy progress evaluation does not result in the determination of exceedances. Instead, the results from these analyses are used to evaluate performance metrics described in the site-specific Corrective Action GMP.

4.1.1 Central Tendency

The two most common central tendency measures of a data set are the sample mean and sample median. The sample mean best represents the central tendency of normally-distributed data; therefore, the mean will be used to represent the tendency if the data are approximately normally distributed and the frequency of non-detects is below 50%. The sample mean is given by the arithmetic average of each value in the sample:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$\bar{x}$ = sample mean

n = sample count

x_i = i^{th} observation of x

The sample median is the 50th percentile of values in a sample and represents the midpoint of the ordered list of values. Because it is based on rank-order, the sample median is insensitive to data distribution; therefore, the median will be used if the data are not normally distributed or the frequency of non-detects is 50% or greater. The sample median is determined by arranging all values in order and selecting the middle value (or, if an even number of values exists, the mean of the two middle values).

4.1.2 Trend of Average Concentration in Individual Wells and in a Plume

Insight into remedy progress can be gained by evaluating changes in concentration at both the individual well and plume levels.

Trends at the individual well level are evaluated according to **Section 2.5**. To evaluate trends at the plume level, the trend on quarterly average concentrations is evaluated (per **Section 4.1.1**). Quarterly average concentrations in the plume are generated by calculating the mean or median as appropriate based on distribution (**Section 4.1.1**) of concentrations collected during a single sample event. Trend is then evaluated as described in **Section 2.5**. The magnitude of the trend (*i.e.*, slope) may be evaluated according to methods in **Section 3.3.1**.

4.2 Stability Evaluation

In order to evaluate ultimate effectiveness of the remedy, it is critical to evaluate if a new stable equilibrium has been reached after the implementation of corrective action (e.g., completion of source control or conclusion of groundwater extraction). Stability evaluation will be completed using trend analysis as described in **Section 2.5**.

4.3 Attainment Evaluation

Per 35 I.A.C. § 845.680(c), corrective action is considered complete when compliance with the GWPS has been demonstrated "at all points within the plume of contamination that lies beyond the waste boundary […] for a period of three consecutive years". Accordingly, attainment of the GWPS will be evaluated for well-constituent pairs previously determined to exceed the GWPS. This evaluation will include data collected after groundwater conditions have stabilized (**Section 4.2**).

The Unified Guidance recommends comparing a CI to the fixed GWPS to evaluate attainment of corrective action. The null hypothesis of this test is the reverse of that in Compliance Monitoring: corrective action well groundwater concentrations are assumed to exceed the GWPS unless the statistical test indicates otherwise. The CI will be calculated according to methods presented in **Section 3.3**. For pH, the only parameter with an upper and lower background and GWPS, the GWPS will be attained (*i.e.*, the null hypothesis rejected) when the CI falls within the range of the GWPS (*i.e.*, if the LCL of the CI is above the lower limit and the UCL is below the upper limit). For all other parameters, the GWPS will be attained when the UCL is below the GWPS. Once this

statistical evaluation indicates that GWPS has been met for three years (*i.e.*, that the null hypothesis is rejected), corrective action will be concluded.

5. REFERENCES

Conover, W. J., 1999. Practical Nonparametric Statistics (3rd ed.). John Wiley & Sons, Inc.

Illinois Administrative Code, Title 35, Subtitle G, Chapter I, Subchapter J, Part 845: Standards for The Disposal Of Coal Combustion Residuals In Surface Impoundments, effective April 21, 2021.

Millard S. P., 2013. EnvStats: An R Package for Environmental Statistics. Springer. ISBN 978-1-4614-8455-4

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2022. *Multi-Site Sampling and Analysis Plan*. https://www.luminant.com/documents/ccr/il-ccr/Newton/2023/Multi-Site%20Sampling%20Analysis%20Plan-Newton-W0798070001%E2%80%9001.pdf. December 28.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2022. *Multi-Site Quality Assurance Project Plan.* https://www.luminant.com/documents/ccr/il-ccr/Newton/2023/Multi-site%20Quality%20Assurance%20Project%20Plan-Newton-W0798070001%E2%80%9001.pdf. December 28.

United States Environmental Protection Agency (USEPA), 1992. Methods for Evaluating the Attainment of Cleanup Standards Volume 2: Groundwater. EPA 230-R-92-014. Office of Policy, Planning, and Evaluation. July.

United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. EPA 530-R-09-007. March.

United States Environmental Protection Agency (USEPA), 2020. EPA QA Field Activities Procedure. IT/IM Directive Procedure. https://www.epa.gov/system/files/documents/2022-09/epa_qa_field_activities_procedure.pdf. June 9.

United States Environmental Protection Agency (USEPA), 2023. Quality Assurance Project Plan Standard. IT/IM Directive Procedure. https://www.epa.gov/system/files/documents/2024-04/quality_assurance_project_plan_standard.pdf. August 21.