Form CCR 1

Illinois Environmental Protection Agency
CCR Surface Impoundment Permit Application
Form CCR 1 – General Provisions

Bureau of Water ID Number:
W1998600002

CCR Permit Number:
2020-EA-65428

Facility Name:
Marion Power Plant

For IEPA Use Only

SECTION 1: FACILITY, OPERATOR, AND OWNER INFORMATION (35 Ill. Adm. Code 845.210(b))

Facility, Operator, and Owner Information

1.1	Facility Name		
	Marion Power Plant		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	2020-EA-65428		
1.3	Facility Contact Information		
	Name (first and last) Wendell Watson	Title Director of Environmental Services	Phone Number 618-964-5078
	Email address wwatson@sipower.org		
1.4	Facility Mailing Address		
	Street or P.O. box 11543 Lake of Egypt Road		
	City or town Marion	State Illinois	Zip Code 62959
1.5	Facility Location		
	Street, route number, or other specific identifier 11543 Lake of Egypt Road		
	County name Williamson	County code (if known)	
	City or town Marion	State Illinois	Zip Code 62959
1.6	Name of Owner/Operator		
	Southern Illinois Power Cooperative		

Facility, Operator, and Owner Info				
	1.7	Owner/Operator Contact Information		
		Name (first and last) Wendell Watson	Title Director of Environmental Services	Phone Number 618-964-5078
		Email address wwatson@sipower.org		
	1.8	Owner/Operator Mailing Address		
		Street or P.O. box 11543 Lake of Egypt Road		
		City or town Marion	State Illinois	Zip Code 62959

SECTION 2: LEGAL DESCRIPTION (35 Ill. Adm. Code 845.210(c))

Legal Description		
	2.1	Legal Description of the facility boundary
		The less-than-one-acre of the former Emery Pond is located within the 40-acre generating station main complex in the SW1/4 of the NE1/4 of Section 26, Township 10S, Range 2E, Williamson County, Illinois.

SECTION 3: PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS (35 Ill. Adm. Code 845.810)

Internet Site					
	3.1	Web Address(es) to publicly accessible internet site(s) (CCR website)			
		https://www.sipower.org/il-845/			
	3.2	Is/are the website(s) titled “Illinois CCR Rule Compliance Data and Information”			
		☑	Yes	☐	No

SECTION 4: IMPOUNDMENT IDENTIFICATION

Impoundment Identification				
	4.1	List all the impoundment identification numbers for your facility and check the corresponding box to indicate that you have attached a written description for each impoundment.		
		W1998600002-10	☑	Attached written description
			☐	Attached written description
			☐	Attached written description
			☐	Attached written description
			☐	Attached written description
			☐	Attached written description

		☐	Attached written description
		☐	Attached written description
		☐	Attached written description
		☐	Attached written description

SECTION 5: CHECKLIST AND CERTIFICATION STATEMENT

Checklist and Certification Statement

5.1 In Column 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing.

Column 1		Column 2	
Section 1: Facility, Operator, and Owner Information	☑	w/attachments	☐
Section 2: Legal Description	☑	w/attachments	☐
Section 3: Publicly Accessible Internet Site Requirement	☑	w/attachments	☐
Section 4: Impoundment Identification	☑	w/attachments	☑

5.2 **Certification Statement**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name) of Owner/Operator	Official Title
Wendell Watson	Director
Signature: Wendell Watson	Date Signed: 10/27/21

Form CCR 2OE	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 2OE – Initial Operating Permit for Existing or Inactive CCR Surface Impoundment Where an Agency-approved Closure Has Been Completed Before July 30, 2021

Bureau of Water ID Number: W1998600002 **CCR Permit Number:** 2020-EA-65428 **Facility Name:** 2020-EA-65428	For IEPA Use Only

SECTION 1: CONSTRUCTION HISTORY (35 Ill. Adm. Code 845.220 and 35 Ill. Adm. Code 845.230)

Construction History

1.1	CCR surface impoundment name.	
	Former Emery Pond	
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).	
	W1998600002-10	
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).	
	SW1/4 of the NE1/4 of Section 26, Township 10S, Range 2E, Williamson County, Illinois	
1.4	State the purpose for which the CCR surface impoundment is being used.	
	Closure by removal was completed for the former Emery Pond on April 5, 2021. The former Emery Pond was primarily used for stormwater management.	
1.5	How long has the CCR surface impoundment been in operation?	
	The former Emery Pond was in operation for approximately 30 years until closure in April 2021.	
1.6	List the types of CCR that have been placed in the CCR surface impoundment.	
	Runoff from the adjacent flue-gas desulfurization loadout area, stormwater runoff from the plant area yard drains and partial coal yard, air heater wash water, fly ash load out area wash water, flue-gas desulfurization decant excess wastewater from a three-stage settling and clarification process. Additional information is provided in Section 2.2 of the attached Application.	
1.7	List the name of the watershed within which the CCR surface impoundment is located.	
	South Fork Saline/ Lake of Egypt	
1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
	94,000	
1.9	Check the corresponding boxes to indicate that you have attached the following:	
	☐	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.

Construction History		☐	A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR surface impoundment.
		☐	A statement of the method of site preparation and construction of each zone of the CCR surface impoundment.
		☑	A statement of the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.
		☑	Drawings satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(1)(F).
		☑	A description of the type, purpose, and location of existing instrumentation.
		☐	Area Capacity Curves for the CCR Impoundment.
		☐	A description of each spillway and diversion design features and capacities and provide the calculations used in their determination.
		☐	The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.
	1.10.1	Is there any record or knowledge of structural instability of the CCR surface impoundment?	
		☐ Yes	☑ No
	1.10.2	If you answered yes to Item 1.10.1, provide detailed explanation of the structural instability.	

SECTION 2: ATTACHMENTS

Attachments	2.1	Check the corresponding boxes to indicate that you have attached the following:	
		☑	Evidence that the permanent markers required by 35 Ill. Adm. Code 845.130 have been installed.
		☐	Documentation demonstrating that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in 35 Ill. Adm. Code 845.430.
		☐	Emergency Action Plan and accompanying certification required by 35 Ill. Adm. Code 845.520(e).
		☐	Written post-closure care plan, if applicable (see 35 Ill. Adm. Code 845.780(d)).
		☑	History of known exceedances of the groundwater protection standards in 35 Ill. Adm. Code 845.600, and any corrective action taken to remediate the groundwater.

SECTION 3: GROUNDWATER MONITORING

	3.1	Check the corresponding boxes to indicate whether you have attached the following groundwater monitoring information:	
		☑	A hydrogeologic site characterization meeting the requirements of 35 Ill. Adm. Code 845.620.

Groundwater		✔	Design and construction plans of a groundwater monitoring system meeting the requirements of 35 Ill. Adm. Code 845.630.
		✔	A groundwater sampling and analysis program that includes section of the statistical procedures to be used for evaluating groundwater monitoring data, required by 35 Ill. Adm. Code 845.640.
		✔	Proposed groundwater monitoring program that includes a minimum of eight independent samples for each background and downgradient well, required by 35 Ill. Adm. Code 845.650(b).

GOLDER
MEMBER OF WSP

APPLICATION

Southern Illinois Power Cooperative Initial Operating Permit Application

Former Emery Pond

Submitted to:

Illinois Environmental Protection Agency

DWPC- Permits MC#15
Attn: Part 845 Coal Combustion Residuals Rule Submittal
1021 North Grand Avenue East
Springfield, IL 62794-9276

Submitted by:

Golder Associates Inc.
670 North Commercial Street, Suite 103, Manchester, NH 03101

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October 2021

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ACRONYMS

ACM	Assessment of Corrective Measures
B-R	Bouwer and Rice
CCR	Coal Combustion Residual
cm/s	centimeters per second
CSM	Conceptual Site Model
FGD	Flue-Gas Desulfurization
ft amsl	feet above mean sea level
ft bgs	feet below ground surface
ft/day	feet per day
GMZ	Groundwater Management Zone
GPD	gallons per day
GPS	Groundwater protection standards
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
KGS	Kansas Geological Survey
mg/L	milligrams per liter
MW	Megawatt
NPDES	National Pollutant Discharge Elimination System
PVC	Polyvinyl Chloride
SIPC	Southern Illinois Power Cooperative
SSD	Statistically Significant Decrease
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
STATSGO	Illinois State Soil Geographic Database

1.0 INTRODUCTION

Southern Illinois Power Cooperative (SIPC) owned and operated a coal combustion residuals surface impoundment, the former Emery Pond, at Marion Power Plant. The former Emery Pond is subject to the 40 Code of Federal Regulations (CFR) Part 257 (until the United States Environmental Protection Agency (USEPA) approves the Illinois CCR program to operate in lieu of Part 257), and the corresponding Illinois Environmental Protection Agency (IEPA) 35 Illinois Administrative Code (IAC) Part 845. By October 30, 2021, newly effective 35 Illinois Administrative Code (IAC) Part 845 requires submittal of an initial operating permit application in accordance with 35 IAC § 845.230 for existing coal combustion residual (CCR) surface impoundments that have not completed Part 845 requirements. SIPC completed an Illinois Environmental Protection Agency (IEPA) approved closure by removal for the former Emery Pond, prior to July 30, 2021, thereby allowing it to close under the more limited initial operating permit application requirements of 35 IAC § 845.230(d)(3). As the closure was by removal, no post-closure care requirements apply (35 IAC 845.780(a)(2)). However, because SIPC has not yet completed the required post-closure groundwater monitoring, SIPC understands it to be IEPA's view that an operating permit is still required. Therefore, in accordance with the applicable provisions of 35 IAC § 845.230(d)(3), on behalf of SIPC, Golder Associates Inc. (Golder), a *Member of WSP*, prepared this "Southern Illinois Power Cooperative Initial Operating Permit Application" (Application) for SIPC's closed former CCR impoundment, former Emery Pond.

1.1 Background Information

Former Emery Pond was located near the northwestern shore of Lake of Egypt on the site of SIPC's Marion Power Plant, 11543 Lake of Egypt Road, Marion, IL (Site, Figure 1). SIPC has owned and operated a coal-fired power plant at the Site since 1963. The Marion Power Plant property includes the Lake of Egypt, which it developed in 1962 to supply cooling water for plant operations. In the fall of 2020, SIPC closed Unit 4, an approximately 180-megawatt (MW) coal-fired unit. The Marion Power Plant still operates a smaller coal-fired unit (approximately 100-MW) and two natural gas units, both of which have limits of 1000 hours of operation per year.

Emery Pond was a less-than-1-acre impoundment situated near the south side of the main stack at the power plant (Figure 2). When operating, the impoundment received CCR and non-CCR materials in waste streams and in runoff that flowed by gravity to the pond (e.g., air heater wash, stormwater runoff, and other miscellaneous boiler and precipitator wastes). In the fall of 2020, SIPC began closure of the impoundment and adjacent flue-gas desulfurization (FGD) Loadout Area by removal of all CCR. A new structure, designated as the Storm Water Basin, was then constructed within the footprint of the former Emery Pond pursuant to an IEPA issued construction permit. The Storm Water Basin collects local drainage and receives no regulated CCR containing wastes. The Storm Water Basin has a composite liner system, and is permitted and operated as a water treatment device under 35 IAC 309, Subpart B. A permanent dewatering system around the base of the basin liner system, installed to provide protection from hydraulic uplift pressures to the liner system, collects groundwater in the vicinity of the new basin. Plant waters, perimeter drain groundwater, and stormwater runoff collected in the Storm Water Basin are discharged via Outfall 002 to Little Saline Creek in accordance with its National Pollutant Discharge Elimination System (NPDES) Permit No. IL0004316.

1.2 Application Organization

Consistent with the provisions of 35 IAC § 845.230(d)(3), the Application has been prepared to address all applicable regulatory requirements of the initial operating permit for the former Emery Pond. Because the former Emery Pond no longer exists, and CCR that was once present in the former pond has already been removed, many Part 845 requirements do not apply. For those that do, the application and supporting materials have been tailored accordingly to this situation. Following this introduction, Section 2.0 summarizes key background information about the former Emery Pond primarily relative to its former operation as a CCR management unit including:

- Construction, historical and current operations, and current conditions;
- Overview of CCR and non-CCR wastes formerly managed therein;
- High-level summary of the historical and current CCR groundwater monitoring programs, including current Federal CCR Rule monitoring phase; and
- Timeline of closure including dates associated with redirection of waste streams, dewatering, excavation, and completion of closure activities as well as earlier submitted, IEPA approved closure and corrective action plans.

Section 3.0 provides the history of construction specified in 35 IAC § 845.220(a)(1). Section 4.0 provides information related to groundwater monitoring including the hydrogeologic site characterization required by 35 IAC § 845.620 and identification of nearby receptors, as follows:

- Regional and site geologic conditions;
- Description of geologic layers to 100 feet below land surface;
- Description of site hydrogeology including stratigraphic cross-sections;
- Description of the upper most aquifer;
- Potentiometric surface maps characterizing the direction of groundwater flow accounting for seasonal variations;
- Identification of potential receptors and potential groundwater migration pathways;
- Identification of nearby surface water bodies and drinking water intakes, nearby pumping wells, and nearby nature preserves; and
- Illinois groundwater classification.

Section 5.0 provides groundwater monitoring results and related information including:

- Description of existing groundwater monitoring network designed and installed in accordance with 40 CFR § 257.91 and 35 IAC § 845.630;
- Well construction diagrams;
- Federal CCR Rule monitoring program status;
- Tabulated groundwater monitoring data for each monitoring well;
- Description of relevant groundwater standards and historical exceedances;
- The completed corrective measure assessment in accordance with 40 CFR § 257.96; and

- Progress reports on remedy selection and design and the final remedy selection as required by 40 CFR § 257.97(a).

Section 6.0 is a compilation of, or description of inapplicability of, any additional documentation for the initial operating permit including:

- Permanent marker installation in accordance with 40 CFR § 257.73(a)(1) and 35 IAC § 845.130;
- Slope protection in accordance with 35 IAC § 845.430;
- Emergency action plan in accordance with 40 CFR § 257.73(a)(3) and 35 IAC § 845.520;
- Design and construction plans for a groundwater monitoring program in accordance with 40 CFR § 257.91 and 35 IAC § 845.630;
- Groundwater sampling and analysis program including statistical procedures in accordance with 40 CFR § 257.93 and 35 IAC § 845.640;
- Proposed groundwater monitoring program in accordance with 40 CFR § 257.98(a)(1) and 35 IAC § 845.650(b); and
- Written post-closure plan in accordance with 35 IAC § 845.780(d).

2.0 DESCRIPTION OF THE CCR UNIT

This section of the permit application provides unit-specific details about the former Emery Pond including a background discussion of its construction and operation; a summary of the source, type, and volumes of waste streams historically managed in Emery Pond prior to and during its operation as a CCR Rule regulated unit; an overview of the CCR Rule-required groundwater monitoring well network and monitoring phases/status; and a discussion of key activities related to closure-by-removal.

2.1 Construction and Operation

The former Emery Pond was constructed in the late 1980s for storage of stormwater drainage from the Marion Power Plant. The impoundment was incised on the north, west, and south sides, with a wide berm separating it from nearby Lake of Egypt to the east. The berm, which remains in place following the closure of the former Emery Pond, is approximately 140 feet in width at the crest, with a height of approximately 10 feet. The impoundment was unlined and had a maximum volume of 6.6 acre-feet. The original impoundment footprint was reduced around 2009 when a FGD gypsum belt dewatering loadout facility was built on the western end of the existing pond. The approximate historical limits of the former Emery Pond are shown on Figure 2. As operating conditions dictated, an electric pump was used to pump aqueous contents to the plant's south fly ash pond and occasional dredging removed accumulated sediment carried into the pond via various plant effluent and rainfall runoff streams. Prior to 2015, dredged soils were placed in the on-Site landfill; however, no dredging/on-Site disposal was completed since October 16, 2015.

2.2 Overview of Waste Streams Managed

The former Emery Pond was primarily designed and operated to manage stormwater on Site, although incidental amounts of CCR waste were discharged into the impoundment until the shutdown of Unit 4 in 2020. Until cessation of CCR discharge, the impoundment received precipitator, air heater, boiler and scrubber material intermittently from washes during plant outages. Specifically, the following CCR and non-CCR waste streams were intermittently managed in the former Emery Pond:

- Runoff from the FGD load out area.
- Stormwater runoff from the plant area yard drains and partial coal yard.
- Air heater wash resulting in about 120,000 gallons of wash water containing small amounts of salts and de minimis amounts of ash materials. The air heater washes occurred approximately twice a year.
- Fly ash load out area wash water.
- FGD decant excess wastewater from a three-stage settling and clarification process in which most water was reused in the FGD system. Water that was not reused flowed to the former Emery Pond.

Following the shutdown of Unit 4, all process water discharges to the former Emery Pond ceased. The storm water basin newly constructed in the location of the former Emery Pond receives only waste streams that are not regulated under the CCR Rule, primarily storm water runoff.

2.3 CCR Rule Groundwater Monitoring

In 2017, following the installation of a groundwater monitoring system, groundwater monitoring at the Site was completed to evaluate background water quality consistent with 40 CFR § 257.90. In March 2018, the first round of Detection Monitoring was completed pursuant to the requirements of 40 CFR § 257.94. The results of Detection Monitoring required the transition to Assessment Monitoring. The first Assessment Monitoring sampling event was completed in August 2018. The results of Assessment Monitoring initiated an Assessment of Corrective Measures which was originally completed in March 2019 and revised in March 2021. The selected remedy, closure by removal, was completed in April 2021. The former Emery Pond is currently in Corrective Action Monitoring.

The former Emery Pond has five groundwater monitoring wells including one upgradient well (EBG) and four downgradient monitoring wells (EP-1, EP-2, EP-3, and EP-4). In October 2021, three additional wells were installed to evaluate groundwater at the limits of the groundwater management zone (EP-5, EP-6, and EP-7). The monitoring well network is shown on Figure 2 and the monitoring well logs are included in Appendix A.

2.4 Cessation of Operation and Closure

The former Emery Pond ceased receipt of CCR materials in the fall of 2020. Notice of intent to close the unit was posted to the public website in December 2020. Closure construction activities began in late 2020. The former Emery Pond, and the adjacent FGD storage area, were dewatered and excavated. The removal and decontamination of Emery Pond was completed April 5, 2021 and the final inspection was completed May 28, 2021. The Closure Plan completed by Hanson Professional Services, Inc. (Hanson) in March 2019, and revised in April 2021 (Hanson, 2021b), is attached in Appendix B. The Decontamination Certification and Closure Completion Certification is provided in Appendix C.

3.0 HISTORY OF CONSTRUCTION

This section includes the history of construction as specified in 35 IAC § 845.220(a)(1). The former Emery Pond is owned by Southern Illinois Power Cooperative, 11543 Lake of Egypt Road, Marion, Illinois 62959. The IEPA identification number is W1998600002-10. Although designed primary for stormwater management, it intermittently received CCR and non-CCR waste streams including precipitator, air heater, boiler and scrubber material and some ash from boiler wash downs and wash downs of other equipment in the event of outages. The former Emery Pond was in the South Fork Saline/Lake of Egypt watershed which drains approximately 94,000 acres within southern Illinois (IEPA, 2008).

The former Emery Pond was less-than-1-acre in size with a maximum depth of 10 feet and a maximum volume of approximately 6.6 acre-feet. Detailed dimensional plan view and cross-section drawings completed prior to closure are included in Appendix B (Closure Plan; Hanson, 2021b). Emery Pond was constructed in the 1980s, however, the exact date is unknown and neither design nor as-built drawings exist. The impoundment, which was unlined and incised on three sides, was constructed directly on bedrock which consists of sandstone with imbedded limestone and shale. The bottom elevation of the impoundment varied between 510 to 502 feet above mean sea level (ft amsl). Additional details related to construction are unknown. Because Emery Pond has been closed by removal, there are no existing instrumentation; area-capacity curves; spillway or diversion design features; or specifications for surveillance, maintenance, and repair. There is no record or SIPC institutional knowledge of any structural instability associated with the former Emery Pond.

4.0 HYDROGEOLOGIC SITE CHARACTERIZATION

This section includes the hydrogeologic site characterization meeting the requirements of 35 IAC § 845.620. Golder compiled the hydrogeologic site characterization based on existing boring logs, groundwater monitoring reports, and publicly available information.

4.1 Regional Geology

The Marion Power Plant is located on the southern margin of the Illinois Basin in the Shawnee Hills section of the Interior Low Plateaus physiographic region. The Illinois Basin is a depositional and structural basin comprised of Cambrian to Permian age sedimentary rocks. The southern portion of the basin is heavily faulted with northeast-striking, high-angle reverse and normal faults and bears evidence of several tectonic episodes. Many of these faults contain commercial vein deposits of fluorite. This region contains gently rolling topography with a strip of rugged Mississippian and Pennsylvanian (Caseyville/Tradewater Formation) bedrock hills between Pleistocene glacial deposits in lowlands to the north and the Mississippi Embayment to the south. Mississippian rocks are composed of the Clore and Degonia Formations overlain by the Kinkaid Limestone (Nelson et al, 1991).

The stratigraphic sequence in the vicinity of the Site, from ground surface to depth, is as follows:

- The Caseyville/Tradewater Formation is 190 to 500 ft thick and consists of lenticular, vertically and horizontally intergraded beds of sandstone, siltstone, and shale underlying a relatively thin (i.e., $\leq$ 20 ft thick) layer of unconsolidated materials. There are also thin beds of coal and limestone interbedded with clastic sediments. The upper portion of the formation is laterally continuous, and it grades down into lenticular beds at the base.
- The Kinkaid Formation is 120 to 160 ft thick and consists of limestone, shale, claystone, and sandstone, which are separated from overlying Pennsylvanian rocks of the Caseyville Formation by a laterally extensive unconformity. The thickness of the Kinkaid varies because of erosion of the overlying Caseyville.
- The Degonia Formation is 20 to 64 ft thick and consists of thinly bedded, very fine-grained sandstone, siltstone, shale, and irregular chert beds. It is a clastic interval between limestones of the Clore and Kinkaid Formations that is generally composed of a thin shale bed at the base overlain by sandstone that grades upward to siltstone and shale. The Degonia-Kinkaid contact is sharp and conformable.

- The Clore Formation is 110 to 155 ft thick and consists of sandstone, shale, and limestone. The Clore contains three members, from deep to shallow, the Cora, Tygett, and Ford Station Members. The Cora is 35 to 70 ft thick and consists of partly calcareous shale and fine-grained, argillaceous limestone. The Tygett is 15 to 50 ft thick and is composed of fine-grained sandstone to the west that transitions eastwardly to shale and siltstone. The Ford Station contains 23 to 50 ft of interbedded shale and limestone beds less than 2 ft thick. The Clore sporadically outcrops at the surface.

4.2 Site Geology

The Site is underlain by glacially-derived deposits of the Illinoisan Stage overlying the Pennsylvanian Age Bedrock (Hanson, 2021d). Golder's interpretation of the Site geology is based on soil borings (Appendix A) and bedrock geology maps and includes:

- Fill Materials: Where present, the fill materials generally consist of light gray to yellowish brown gravel with some silt and clay, and trace amounts of sand and asphalt from the ground surface to as deep as 14 feet below ground surface (ft bgs).
- Silt (upper discontinuous silt layer): Yellowish brown silt with little clay and trace very fine-grained sand from the ground surface to as deep as 8 ft bgs.
- Clay: Yellowish brown to black clay with some silt, little sand, and trace gravel from ground surface to approximately 20 ft bgs.
- Silt (lower discontinuous silt layer): Black to yellowish brown silt with little clay and trace very fine-grained sand from approximately 14 ft bgs to 20 ft bgs.
- Bedrock: Yellowish brown, weathered, sandstone and shale. As described in Section 4.1, the upper bedrock layer is at least 190 feet thick. The depth to bedrock is approximately 20 ft bgs.

A representative cross-section of the geology in the vicinity of the former Emery Pond is shown in a cross-section in Figure 3. Additional cross-sections are included in the "Hydrogeologic Investigation Report" provided in Appendix D.

4.3 Structural Characteristics

There are principal structures in the area of the Cottage Grove Fault System, located north of the Site, and the Little Cache Fault Zone located southeast of the Site. The Cottage Grove Fault System presents right-lateral, strike-slip faulting and the Little Cache Fault Zone consists of high-angle normal vaults that follows the valley of Little Cache Creek in Johnson County (Nelson, 1995).

4.4 Soil characteristics

The predominate soil type in the vicinity of the Marion Power Plant are soils characterized as fine-grained and made up of silts and clays. According to the State Soil Geographic (STATSGO) database, soils on site are characterized as B/C hydraulic soil groups or soils with moderate runoff potential with K-Factors between 0.17 and 0.43 (IEPA, 2008).

4.5 Regional and Site Hydrogeology

The former Emery Pond was located within the South Fork Saline/Lake of Egypt watershed (IEPA, 2008). Regional groundwater flow is toward the Lake of Egypt which discharges into the South Fork Saline River.

Drinking water wells in the vicinity of the Marion Power Plant are 95-260 feet deep and screened in the shallow bedrock. These wells are capable of being pumped at 5-20 gallons per minute (gpm) to support domestic water use (ISGS, 2021a). A further discussion of identified drinking water wells in the vicinity of the former Emery Pond is provided in Section 4.6.

4.5.1 Description of the Uppermost Water Bearing Zone

The uppermost water bearing zone is a shallow, hydraulically “perched” zone comprised of fill and residuum (silts and clays) from the weathering of bedrock and is not considered a usable water source. No confining layer was identified. The unit has only 3-5 feet of saturated thickness. Because the former Emery Pond was constructed directly on top of the bedrock, following a conceptual site model (CSM) approach to understand where potential releases, if any, were most likely to occur and would be most likely to be detected, groundwater monitoring wells are screened at the unlithified/bedrock unit interface. This zone has a low hydraulic conductivity (<1E-04 centimeters per second [cm/s], see Section 4.5.2) and only a few feet of saturated thickness (5-10 ft; Hanson, 2019b).

Groundwater in the vicinity of the former Emery Pond generally flows east/northeast toward the Lake of Egypt. The average groundwater elevation varies between approximately 502 to 518 ft amsl with an average depth to groundwater of less than 8 ft. Figure 4 is an example of a wet season potentiometric surface map showing the groundwater elevations and groundwater contours from January 2020. Figure 5 is an example of a dry season potentiometric surface map showing the groundwater elevations and groundwater contours from June 2020. Generally, the change in groundwater elevation from the dry to wet seasons is less than 2 ft. Seasonally the groundwater flow direction varies slightly from east/northeast in the wet season to more easterly in the dry season (see Figure 4 and Figure 5). Groundwater elevation data is reported in the Annual Groundwater and Corrective Action Reports for the former Emery Pond (AECOM, 2018; Hanson, 2019a; Hanson, 2020; Hanson, 2021a).

4.5.2 Hydraulic Conductivity Testing

Hanson performed hydraulic conductivity testing in five monitoring wells at the Site (Hanson, 2019b). To obtain slug test data, Hanson used the Kansas Geological Survey (KGS) Model to calculate the hydraulic conductivity values. The KGS Model uses curve matching over the entire dataset and not just the second portion of the data curve as done with the Bouwer and Rice (B-R) Method. The slug test results, measurement data, and calculations are provided in Hanson’s report, “Hydrogeologic Investigation Report”, which is provided in Appendix D. Hanson also prepared a pump test model to further assess the characteristics of the aquifer (Hanson, 2019c). The model identified that the shallow groundwater in the unlithified unit cannot sustain a pumping rate of 150 gallons per day (GPD), a requirement of Class I groundwater (35 IAC § 620.210(a)(4)(A)). However, the shallow bedrock (below approximately 450 ft amsl) is capable of sustaining a 150 GPD pumping rate. Hanson’s report describing the pump test model, “Hydrogeologic Investigation Addendum,” is attached in Appendix E. A summary of the calculated hydraulic conductivities and averages are provided in the embedded table below. Hydraulic conductivity values range from 9.1×10^{-7} cm/s to 1.4×10^{-3} cm/s. The calculated hydraulic conductivity values appear to be consistent with anticipated values for fine glacial till deposits.

Table 1: Slug Test Results

Well ID	Method	Falling Head ($cm^3/cm^2/s$)	Rising Head ($cm^3/cm^2/s$)	Average ($cm^3/cm^2/s$)
EBG	B-R	3.00×10^{-6}	9.10×10^{-7}	1.96×10^{-6}
EBR	Packer			1.72×10^{-5}
EP-1	B-R	2.80×10^{-5}	3.45×10^{-5}	3.13×10^{-5}
EP-1a	KGS	7.60×10^{-5}	7.50×10^{-6}	7.55×10^{-6}
EP-2	B-R	6.00×10^{-6}	8.40×10^{-6}	7.20×10^{-6}
EP-3	B-R	3.10×10^{-5}	2.50×10^{-5}	2.80×10^{-5}
EP-4	B-R	3.30×10^{-5}	3.25×10^{-5}	3.28×10^{-5}
EP-4	KGS	1.10×10^{-4}	9.10×10^{-6}	5.96×10^{-5}
EP-4a	KGS	1.40×10^{-3}	9.40×10^{-4}	1.17×10^{-3}

Depth of EBR Packer Test at 26.2 ft. is equivalent to the depth of the screen (in the sandstone) at EP-1.

EP-1a and EP-4a are test wells installed to confirm lithology and complete hydraulic conductivity testing.

4.5.3 Horizontal Component of Flow

Golder calculated the horizontal hydraulic gradient (i) for the unconfined aquifer in the vicinity of the former Emery Pond at 0.029 foot per foot as shown below using average groundwater elevation data for EP-1 and EP-2 from March 2017 through January 2020. The calculated horizontal hydraulic gradient ranges from 0.012 to 0.040 foot per foot. Horizontal gradients become steeper near Lake of Egypt (Hanson, 2018, 2019b, 2020, 2021c).

$$i = \left({}^{h_L}/_{L_H} \right)$$

Where: h_L = head loss (elevation difference – foot)

L_H = length (horizontal distance – foot)

Using an assumed effective porosity value of 40% (AECOM, 2018), the average hydraulic conductivity from slug tests of 2.6×10^{-4} cm/s or 7.5×10^{-1} feet per day (ft/day), and the calculated horizontal gradient, the average rate of horizontal groundwater flow (V_{gw}) in the overburden was calculated using the algorithm below.

$$V_{gw} = K\, i \left({}^{1}/_{n_e} \right)$$

Where:
V_{gw} = Groundwater velocity
K = Hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity

V_{gw} = [(7.5E-01 ft/day) x (2.9E-02)] / 0.40
V_{gw} = 5.4E-02 ft/day, or 20 ft/year

As calculated above, the estimated horizontal rate of flow in the shallow aquifer is expected to be an average of 20 feet per year.

4.5.4 Vertical Components of Flow

Hanson collected thin-wall (Shelby) tube samples from borings near EP-1 (from 6.5-7 ft bgs) and EP-4 (from 7.5-8 ft bgs). The results of the laboratory testing following ASTM D5084 indicate an average vertical hydraulic conductivity of 6.91 x 10^{-8} cm/s and 5.52 x 10^{-8} cm/s for EP-1 and EP-4 locations, respectively (Hanson, 2019b). The low vertical hydraulic conductivity indicates limited vertical recharge or precipitation through the overburden materials. The vertical hydraulic conductivity is significantly lower than the horizontal hydraulic conductivity (approximately 3-orders of magnitude lower) indicating groundwater flow is primarily horizontal, and there is not a significant vertical component of flow (i.e., into the bedrock near the former Emery Pond).

4.6 Identification of Nearby Receptors

The following sections identify and describe nearby receptors, potential migration pathways, and the Illinois groundwater classification.

4.6.1 Identification of Nearby Water Uses and Other Potential Receptors

The Lake of Egypt is located approximately 250 feet downgradient of the former Emery Pond. The Lake of Egypt is primarily used for cooling water for the Marion Power Plant; however, the lake is open for public recreational use including boating, swimming, and fishing. The lake also provides drinking water for over 4,500 people residing in Williamson, Johnson, and Union counties. In 2019, Hanson collected five samples from the lake including one background sample, two samples near the shore closest to Emery Pond, and two samples downstream, including one sample in the vicinity of the public water supply intake. Sampling indicates no surface water standard exceedances due to groundwater impacts from the Site (Hanson, 2021c).

Golder reviewed public records and found five water wells located within a 1-mile radius of the approximate operating limits (ISGS, 2021a). The closest wells are identified on Figure 6. The nearest water well is located at the Lake of Egypt Country Club. This well is approximately 2,500 ft south/southeast (upgradient) of the former Emery Pond. This well is screened from 60-95 ft bgs in sandstone and has a pumping rate of 5 gpm (ISGS, 2021a). This well is on SIPC property.

There are no nature preserves located within the 1-mile radius of the approximate operating limits. According to Illinois State Geological Survey (ISGS), no active or abandoned mines exist within the town of Marion (ISGS, 2021b).

4.6.2 Identification of Potential Migration Pathways

In 2019, Hanson completed several direct push borings around Emery Pond to further characterize the nature and extent of potential groundwater impacts. In this assessment Hanson mapped preferential flow paths primarily based on the bedrock topography. The preferential flow paths are displayed in Figure 7. Groundwater flows east/northeast along these preferential flow paths toward the Lake of Egypt.

4.6.3 Groundwater Classification

The unlithified unit is classified as Class II groundwater because the unit does not contain a sand, gravel, or sand & gravel deposit greater than 5 ft thick and the slug test results (Table 1, Hanson, 2019b and 2019c) are generally less than 1 x 10^{-4} cm/s. Hanson calculated a hydraulic conductivity higher than 1 x 10^{-4} cm/s in test well EP-4 and EP-4a, however, both of these wells are screened in man-made or fill materials. The upper portion of the bedrock is classified as Class II because the unit contains less than 10 ft of sandstone, less than 15 ft of fractured carbonate rock, and the packer test results (Table 1, Hanson, 2019b) are less than 1 x 10^{-4} cm/s. The lower bedrock unit is classified as Class I groundwater because the unit has two continuous segments of sandstone that exceed 10 ft in thickness.

Although groundwater in the unlithified and upper bedrock are classified as Class II groundwater, SIPC has agreed to monitor and conduct corrective action, as necessary and appropriate, for the purpose of achieving compliance with Class I standards.

5.0 GROUNDWATER MONITORING RESULTS

This section includes a description of the groundwater monitoring system, the CCR Rule monitoring program status, a discussion of the groundwater data, a summary of the Assessment of Corrective Measures, and a summary of the Selection of Remedy.

5.1 Monitoring System Design

The groundwater monitoring system was installed in 2017 to meet the requirements of the CCR Rule. The now-closed unit currently has one background monitoring well (EBG) located approximately 800 ft upgradient of the former Emery Pond. Four downgradient monitoring wells (EP-1, EP-2, EP-3, and EP-4) are located along the southern, eastern, and northeastern boundaries of the former Emery Pond. Three additional wells (EP-5, EP-6, and EP-7) were installed in October 2021 to evaluate groundwater at the limits of the groundwater management zone (GMZ) and located between the former Emery Pond and the Lake of Egypt (Figure 2). The wells consist of 2-inch diameter, schedule 40 polyvinyl chloride (PVC) pipe with 10-ft long, 0.010-inch slotted well screens. A silica sand (grain size 10/20) filter medium was used to construct the sand pack around each well screen. Bentonite chips were placed above the sand pack filling the borehole to 2-3 ft bgs or a minimum thickness of 2 ft. A steel protective outer casing was installed for each well with a concrete pad extending from ground surface to the top of the bentonite seal (AECOM, 2018). The monitoring wells are screened at the unlithified/bedrock unit interface. This zone has a low hydraulic conductivity (less than 1×10^{-4} cm/s, see Section 4.5.2) and only a few feet of saturated thickness (5-10 ft; Hanson, 2019b and 2019c). Because Emery Pond was constructed directly on top of the existing bedrock and following CSM reasoning in interpreting Site geologic/hydrogeologic conditions, these monitoring wells are appropriately screened to monitor groundwater quality at the former waste boundary.

5.2 Monitoring Program Status

In 2017, following the installation of a groundwater monitoring system, groundwater monitoring at the Site was completed to evaluate background water quality consistent with 40 CFR § 257.90. In March 2018, the first round of Detection Monitoring was completed pursuant to the requirements of 40 CFR § 257.94. The results of Detection Monitoring indicated statistically significant increases (SSIs) and triggered Assessment Monitoring in 2018.

The first Assessment Monitoring sampling event was completed in August 2018. The results of Assessment Monitoring indicated statistically significant levels (SSLs) which triggered the requirement for preparation of an Assessment of Corrective Measures. The Assessment of Corrective Measures was completed in March 2019. The selected remedy, closure by removal, was completed in 2021. The former Emery Pond is currently in Corrective Action Monitoring.

5.3 History of Known Exceedances

The former Emery Pond is subject to the groundwater protection standards (GPS) listed in 35 IAC § 845.600(a). The GPS is equal to the numeric standard listed in 35 IAC § 845.600(a), or the background concentration, whichever is higher.

As described above in Section 4.5.3, groundwater at the Site has been classified as Class II: General Resource Groundwater (35 IAC 620.240) in the Unlithified Unit and the upper (approximately 11 ft) of the Bedrock Unit; however, SIPC has agreed to monitor and conduct Corrective Action, as necessary and appropriate, for the purpose of achieving compliance with Class I groundwater quality standards. The calculated background concentrations, IEPA standards listed in 35 IAC § 845.600(a)(1), GPS, Class I groundwater standards, and Class II groundwater standards are all listed below in Table 4.

Table 2: Relevant Groundwater Standards

Parameter	Background	IEPA Part 845 Standard	GPS	Class I Standard	Class II Standard
Antimony	ND	0.006	0.006	0.006	0.024
Arsenic	ND	0.01	0.01	0.01	0.2
Barium	0.28	2	2	2	2
Beryllium	ND	0.004	0.004	0.004	0.5
Boron	0.14	2	2	2	2
Cadmium	ND	0.005	0.005	0.005	0.05
Calcium	63		63		
Chloride	86	200	200	200	200
Chromium	ND	0.1	0.1	0.1	1
Cobalt	0.018	0.006	0.018	1	1
Fluoride	0.64	4	4	4	4
Lead	ND	0.0075	0.0075	0.0075	0.1
Lithium	0.082	0.04	0.082		
Mercury	ND	0.002	0.002	0.002	0.01
Molybdenum	0.007	0.1	0.1		
pH	6.00-7.04 SU	6.5-9.0 SU	6.0-9.0 SU	6.5-9.0 SU	6.5-9.0 SU
Selenium	0.007	0.05	0.05	0.05	0.05
Sulfate	100.7	400	400	400	400
Thallium	ND	0.002	0.002	0.002	0.02
Total Dissolved Solids	591.1	1200	1200	1200	1200

Parameter	Background	IEPA Part 845 Standard	GPS	Class I Standard	Class II Standard
Radium 226 and 228 Combined	4.706 pCi/L	5 pCi/L	5 pCi/L	20 pCi/L*	

*Standard is for Radium 226 and Radium 228 individually
All standards are in mg/L unless otherwise indicated.
ND indicates the majority of the results in the background dataset are non-detect and a background limit was not calculated

The groundwater data collected to date as part of the CCR Rule sampling is provided in Appendix F. The following bullets summarize detections in downgradient well samples above the relevant standards for the Part 257, Appendix III parameters:

- Boron: The GPS and the Class I Standard are both 2 milligrams per liter (mg/L). Boron was detected above 2 mg/L in all groundwater samples collected to date from EP-4. All other boron samples collected to date from other downgradient monitoring wells are below 2 mg/L.
- Calcium: There are no health-based standards for calcium. The calculated background concentration is 63 mg/L. Calcium was detected above background in all samples collected from EP-1, EP-2, and EP-4 and intermittently from samples collected from EP-3.
- Chloride: The GPS and Class I Standard are both 200 mg/L. Chloride was detected above 200 mg/L intermittently from samples collected from EP-3 and most samples collected from EP-4.
- Fluoride: The GPS and Class I Standard are both 4 mg/L. Fluoride has not been detected above 4 mg/L in any downgradient monitoring well groundwater samples collected to date.
- pH: The GPS, in which the lower value is based on background data, is 6.0-9.0. The Class I groundwater standard is 6.5-9.0. With the exception of the May through August 2017 samples collected from EP-1, which were between 6.5 and 6.90, and the January 2020 sample from EP-1 which was above 6.90, all downgradient samples have pH results below 6.5. Additionally, pH has been measured intermittently below 6.0 in samples collected from EP-2 and EP-3 and in most samples collected EP-4.
- Sulfate: The GPS and Class I Standard are both 400 mg/L. Sulfate has been detected above 400 mg/L from all samples collected from EP-1, in most samples from EP-2 and EP-4, and intermittently in samples collected from EP-3.
- TDS: The GPS and Class I Standard are both 1200 mg/L. TDS has been detected above 1200 mg/L in most samples collected from EP-1, EP-2, and EP-4 and intermittently in samples collected from EP-3.

The following bullets summarize detections above the relevant standards for the Part 257, Appendix IV parameters:

- Antimony: The GPS and Class I Standard are both 0.006 mg/L. Antimony has not been detected above 0.006 mg/L in any groundwater samples collected to date.
- Arsenic: The GPS and Class I Standard are both 0.01 mg/L. Arsenic has been detected intermittently above 0.01 mg/L, in samples collected from EP-4.

- Barium: The GPS and Class I Standard are both 2 mg/L. Barium has not been detected above 2 mg/L in any groundwater samples collected to date.
- Beryllium: The GPS and Class I Standard is 0.004 mg/L. Beryllium has not been detected above 0.004 mg/L in any groundwater sample collected to date; however, some samples were analyzed with laboratory reporting limits above 0.004 mg/L.
- Cadmium: The GPS and Class I Standard is 0.005 mg/L. Cadmium was detected in one sample from EP-1 (0.006 mg/L) and one sample from EP-4 (0.0052 mg/L).
- Chromium: The GPS and Class I Standard are both 0.1 mg/L. Chromium has not been detected above 0.1 mg/L in any groundwater sample collected to date.
- Cobalt: The GPS is based on background concentrations and is 0.018 mg/L. The Class I Standard is 0.1 mg/L. Cobalt has been detected in all samples from EP-3 and EP-4 and intermittently in samples collected from EP-2 above the GPS. Cobalt has not been detected above the Class I Standard in any groundwater sample collected to date.
- Lead: The GPS and Class I Standard is 0.0075 mg/L. Lead has been intermittently detected above the GPS in samples collected from EP-4. Lead was not detected above 0.0075 mg/L.
- Lithium: The GPS is based on background and is 0.082 mg/L. There is no Class I Standard for lithium. Lithium was detected above 0.082 mg/L in three samples collected from EP-3, however, some samples were analyzed with reporting limits above 0.082 mg/L.
- Mercury: The GPS and Class I Standard are both 0.002 mg/L. Mercury has not been detected above 0.002 mg/L in groundwater samples collected to date.
- Molybdenum: The GPS is 0.1 mg/L. There is no Class I Standard for molybdenum. Molybdenum has not been detected above 0.1 mg/L in groundwater samples collected to date.
- Radium-226/228: The GPS is 5 pCi/L. The Class I standard for Radium-226 and Radium-228, individually, is 20 pCi/L. There is no Class I Standard for combined radium. Radium has not been detected above 5 pCi/L in groundwater samples collected to date.
- Selenium: The GPS and Class I Standard is 0.05 mg/L. Selenium has not been detected above 0.05 mg/L in groundwater samples collected to date.
- Thallium: The GPS and Class I Standard is 0.002 mg/L. Thallium has been detected above 0.002 mg/L in several samples collected from EP-4, however, the most recent two samples are non-detect. Thallium has not been detected above 0.002 mg/L in any other samples, however, some samples were analyzed with reporting limits above 0.002 mg/L.

5.4 Corrective Measures Assessment

The original Assessment of Corrective Measures (ACM) is required by 40 CFR 257.96 due to detections above the GPS. The ACM, included in the Corrective Action and Selected Remedy Plan, was originally completed in March 2019 and revised in March 2021. The complete Corrective Action and Selected Remedy Plan is attached in Appendix G.

5.5 Remedy Selection

The "Corrective Action and Selected Remedy Plan" (Hanson, Revised March 30, 2021), outlines the selection of a remedy to address 1) the 35 IAC Part 620 exceedances attributed to the Site as alleged in Illinois EPA's Violation Notice No. 6364 issued on July 3, 2018, and 2) any additional Part 620 exceedances attributable to the Site. The selected remedy for impacted groundwater is also consistent with the federal CCR rule, including 40 CFR 257.97 and 40 CFR 257.98. SIPC's selected remedy consisted of:

- closure of the Emery Pond and adjacent FGD storage area by removal;
- construction of a CCR-compliant composite liner system in the footprint of the former Emery Pond to continue storm water management functions;
- construction of a perimeter drain at the toe of the liner system to protect the liner from external hydrostatic pressure with the additional benefit of recovering contaminated groundwater; and
- installation of three new monitoring wells, continuing to monitor the natural attenuation of contaminants in groundwater, and the establishment of a GMZ.

Closure construction activities began in late 2020. Emery Pond, and the adjacent FGD storage area, were dewatered and excavated. The removal and decontamination of Emery Pond was completed April 5, 2021 and the final inspection was completed May 28, 2021. The Closure Plan completed by Hanson Professional Services, Inc. (Hanson) in March 2019, and revised in April 2021 (Hanson 2021b), is attached in Appendix B. The Decontamination Certification and Closure Completion Certification is provided in Appendix C. The complete Corrective Action and Selected Remedy Plan is attached in Appendix G.

6.0 REQUIRED DOCUMENTATION

The section includes a brief discussion of the other documentation required by 35 IAC § 845.230(d)(3) to be included in the Application.

6.1 Permanent Marker Installation

The permanent marker required by 35 IAC § 845.130 was installed on June 3, 2021. Photographic proof of the installation of the permanent marker is attached in Appendix H.

6.2 Documentation of Slope Protection

35 IAC § 845.230(d)(3) requires documentation that the CCR surface impoundment, if not incised, will be operated and maintained with one of the forms of slope protection specified in 35 IAC § 845.430; however, as described in Section 1.2, Emery Pond was closed by removal. Therefore, this requirement for CCR management units no longer applies.

6.3 Emergency Action Plan

35 IAC § 845.230(d)(3) requires the inclusion of the Emergency Action Plan certification; however, as described in Section 1.2, Emery Pond was closed by removal. Therefore, the preparation and certification of an Emergency Action Plan are no longer applicable requirements.

6.4 Groundwater Monitoring System Design and Construction

The groundwater monitoring system was designed and constructed according to the requirements of 35 IAC § 845.630. The certified design and construction plans are included in the March 24, 2021 revision of the "Groundwater Monitoring Plan" attached in Appendix I (Hanson, 2021d).

6.5 Groundwater Sampling and Analysis Program

The details of the groundwater sampling and analysis program are included in the "Groundwater Monitoring Plan" (Hanson, 2021b) and the corresponding Addendum # 1 (Golder, 2021) attached in Appendix I and Appendix J, respectively. The statistical methods used for evaluation of the data are included in Addendum # 1. The statistical methods certification is provided in Appendix K. The groundwater sampling and analysis program, including the statistical methods, meet the requirements of 35 IAC § 845.640.

As described in the United States Environmental Protection Agency's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance*), dated March 2009, during the Detection and Assessment monitoring phases, the goal of the statistical monitoring program is to identify SSIs relative to background or the established criteria, allowing the owner/operator to determine if a release(s) has occurred and to respond by implementing Corrective Action (i.e., a groundwater remedy), if necessary. Conversely, the goal of the post-remedy Corrective Action monitoring program is to demonstrate compliance with the GPS. Thus, the goal of the statistical analysis procedures being employed is to analyze the data to determine when groundwater concentrations are consistently below the established criteria, which the *Unified Guidance* refers to as "statistically significant decreases" (SSDs). In order to calculate SSDs, the statistical methods in Addendum #1 propose confidence intervals to be calculated on a well-constituent pair basis for each constituent in 35 IAC §845.600. A minimum of four values are required to calculate a confidence interval. Closure by removal of the former Emery Pond was completed on April 5, 2021 with the first post-closure groundwater monitoring event completed in May 2021. Thus, the first Corrective Action statistical analysis will be completed following the first quarter 2022 monitoring event, which will be the fourth Corrective Action monitoring event following the completion of the closure by removal.

6.6 Groundwater Monitoring Program

The groundwater monitoring program was designed according to the requirements of 35 IAC § 845.650. A description of the monitoring program is included in the "Groundwater Monitoring Plan" (Hanson, 2021b) and the corresponding Addendum # 1 (Golder, 2021) attached in Appendix I and Appendix J, respectively.

To meet the requirements of 35 IAC § 845.610(b)(3) SIPC will:

1) Conduct groundwater monitoring according to the "Groundwater Monitoring Plan" (Hanson, 2021b) and the corresponding Addendum # 1 (Golder, 2021) attached in Appendix I and Appendix J, respectively;

2) Determine compliance with the GPS (calculate SSDs) starting after the fourth post-closure monitoring event; and

3) Submit all groundwater data collected and calculated SSDs to the IEPA within 60 days of completing each quarterly sampling event.

6.7 Post-Closure Plan

A post-closure plan is not required for the former Emery Pond because according to 35 IAC § 845.780(d), this requirement is not applicable for units that have closed by removal.

7.0 CLOSING

This operating permit will be maintained until completion of the groundwater monitoring required under 35 IAC § 845.740(b), three years after groundwater monitoring does not show an exceedance of the groundwater protection standard. According to 35 IAC § 845.230(e), this operating permit will be renewed on or before October 31, 2026.

8.0 REFERENCES

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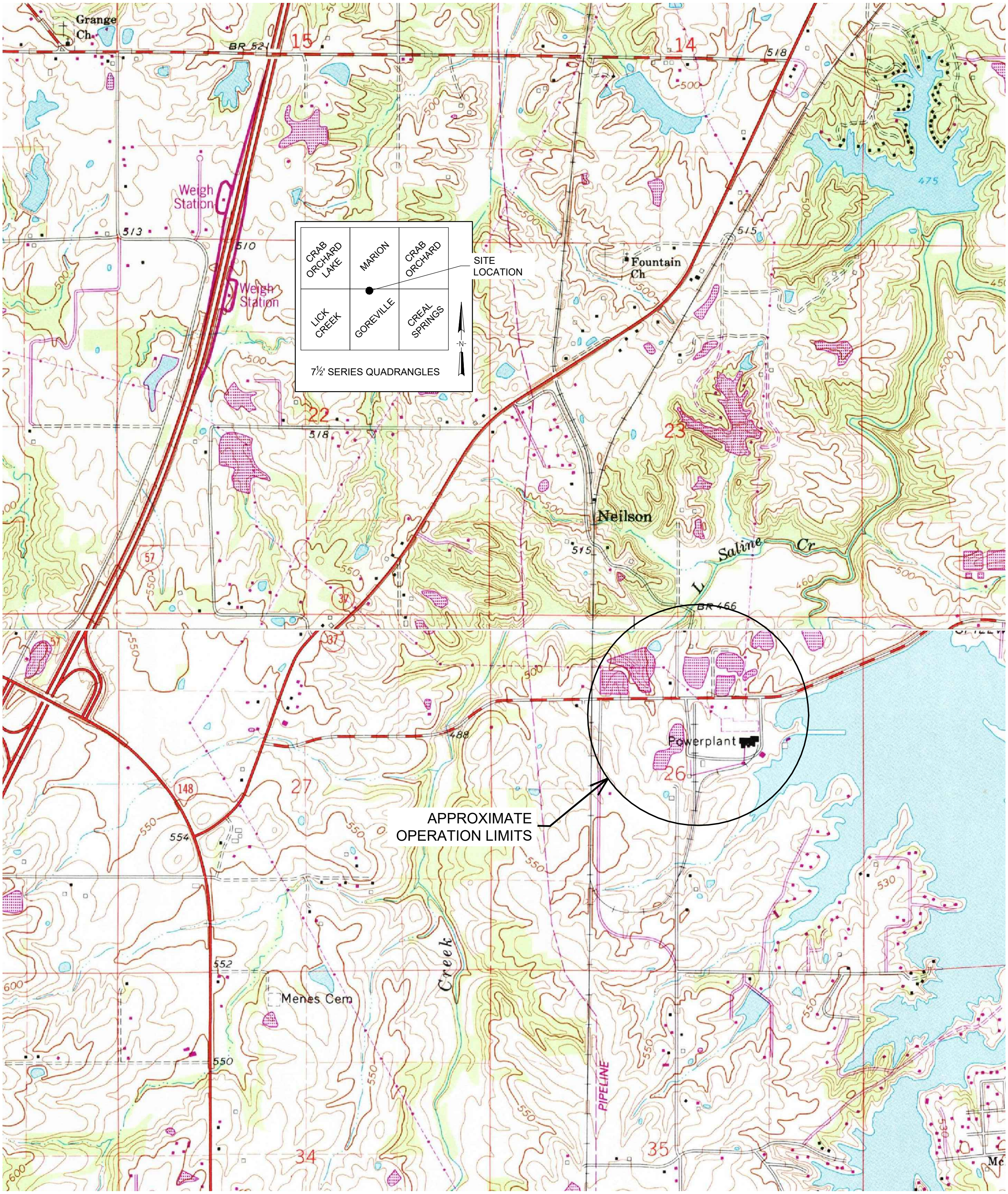
Figures



SCALE

2,000 0 2,000 4,000

1 inch = 2,000 feet Contour interval = 10 feet

Approximate Site Location: n½ of Section 26; T10S., R2E.

SITE LOCATION MAP

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE 1

MAR 15, 2019 10:01 AM HASEN01154
I:\18JOBS\18E0022A\ADMIN\14-REPORTS\HYDROGEO\FIG_1SITEMAP_20190314.DWG

LEGEND

- Background Monitoring Well
- Downgradient Monitoring Well
- Approximate Limits of the Former Emery Pond

PRIVILEGED AND CONFIDENTIAL:
PREPARED AT THE REQUEST OF COUNSEL

0 100 200
1 " = 100 Feet Feet

NOTE(S)

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1983 STATEPLANE ILLINOIS EAST FIPS 1201 FEET
2. IMAGERY SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY
3. MONITORING WELL LOCATION DATA RECEIVED FROM SOUTHERN ILLINOIS POWER COOPERATIVE

CLIENT
SOUTHERN ILLINOIS POWER COOPERATIVE

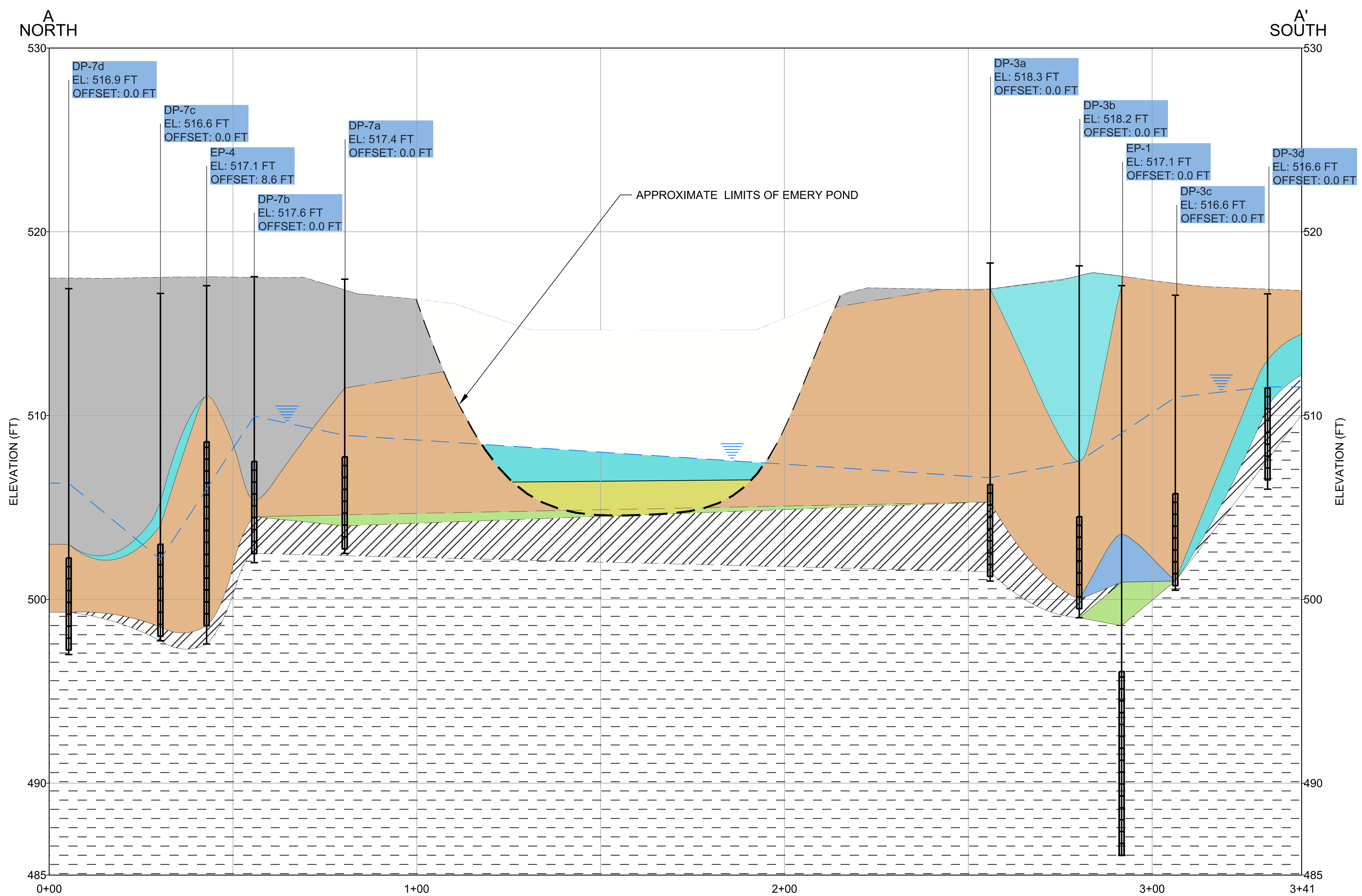
PROJECT
OPERATING PERMIT APPLICATION
MARION POWER PLANT

TITLE
MONITORING WELL LOCATION MAP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-27
DESIGNED	DPJ
PREPARED	TBH
REVIEWED	DFS
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
21467997	-	-	2



LEGEND

- GROUNDWATER
- WATER
- FILL CONTAINING COAL COMBUSTION RESIDUAL
- FILL, ASPHALT AND/OR GRAVEL
- BLACK TO YELLOWISH BROWN SILT
- BROWNISH TAN TO ORANGE CLAYEY SILT
- BROWN SILTY CLAY
- RED/ORANGE FINE SAND
- YELLOWISH BROWN WEATHERED SANDSTONE
- YELLOWISH BROWN WEATHERED SHALE

GAMW-06 = WELL I.D.
EL: 624.4 FT = GROUND SURFACE ELEVATION
OFFSET: 33.5 FT = OFFSET DISTANCE
C/L = CENTERLINE

= GROUNDWATER ELEVATION (10/15/18)
= WELL SCREEN
= END OF BORING LOCATION

NOTE(S)

1. GEOLOGIC CONTACTS ILLUSTRATED BETWEEN AND BELOW BORINGS ARE INFERRED AND SHOULD NOT BE INTERPRETED AS EXACT INDICATORS OF GEOLOGIC CONDITIONS AT, BETWEEN, OR BELOW BORINGS.
2. GOLDER DEVELOPED THE GEOLOGIC CROSS-SECTIONS USING BORINGS LOGS COMPLETED BY AECOM IN 2017 AND HANSON 2019.

REFERENCE(S)

1. HANSON PROFESSIONAL SERVICES INC, "CLOSURE PLAN", REVISED APRIL 15, 2021.
2. AECOM, "2017 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT COAL COMBUSTION RESIDUAL (CCR) RULE", JANUARY 2018.

KEY MAP

0 20 40
1" = 20' FEET

CLIENT
SOUTHERN ILLINOIS POWER COOPERATIVE

PROJECT
OPERATING PERMIT APPLICATION
MARION POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-07-06
DESIGNED	MKS
PREPARED	AAZ
REVIEWED	DFSC
APPROVED	MAH

TITLE
INTERPRETED SUBSURFACE PROFILE A

PROJECT NO.	CONTROL	REV.	FIGURE
21467997	0001	0	3

I:\20jobs\20E0006\Admin\14-Reports\MidyearRpt\FIG_B1PZ20200130_20200728.srf

SCALE: 1 in. = 135 ft.

0 ft. 100 ft. 200 ft. 300 ft. 400 ft.

CONTOUR INTERVAL = 1 ft.

HANSON
Hanson Professional Services Inc.

POTENTIOMETRIC SURFACE MAP

2019 ANNUAL GROUNDWATER REPORT
EMERY POND - MARION POWER PLANT
MARION, WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 20E0006 FIGURE NO. B-1

SCALE: 1 in. = 135 ft.

0 ft. 100 ft. 200 ft. 300 ft. 400 ft.

CONTOUR INTERVAL = 1 ft.

HANSON
Hanson Professional Services Inc.

POTENTIOMETRIC SURFACE MAP

2019 ANNUAL GROUNDWATER REPORT
EMERY POND - MARION POWER PLANT
MARION, WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 20E0006 FIGURE NO. B-2

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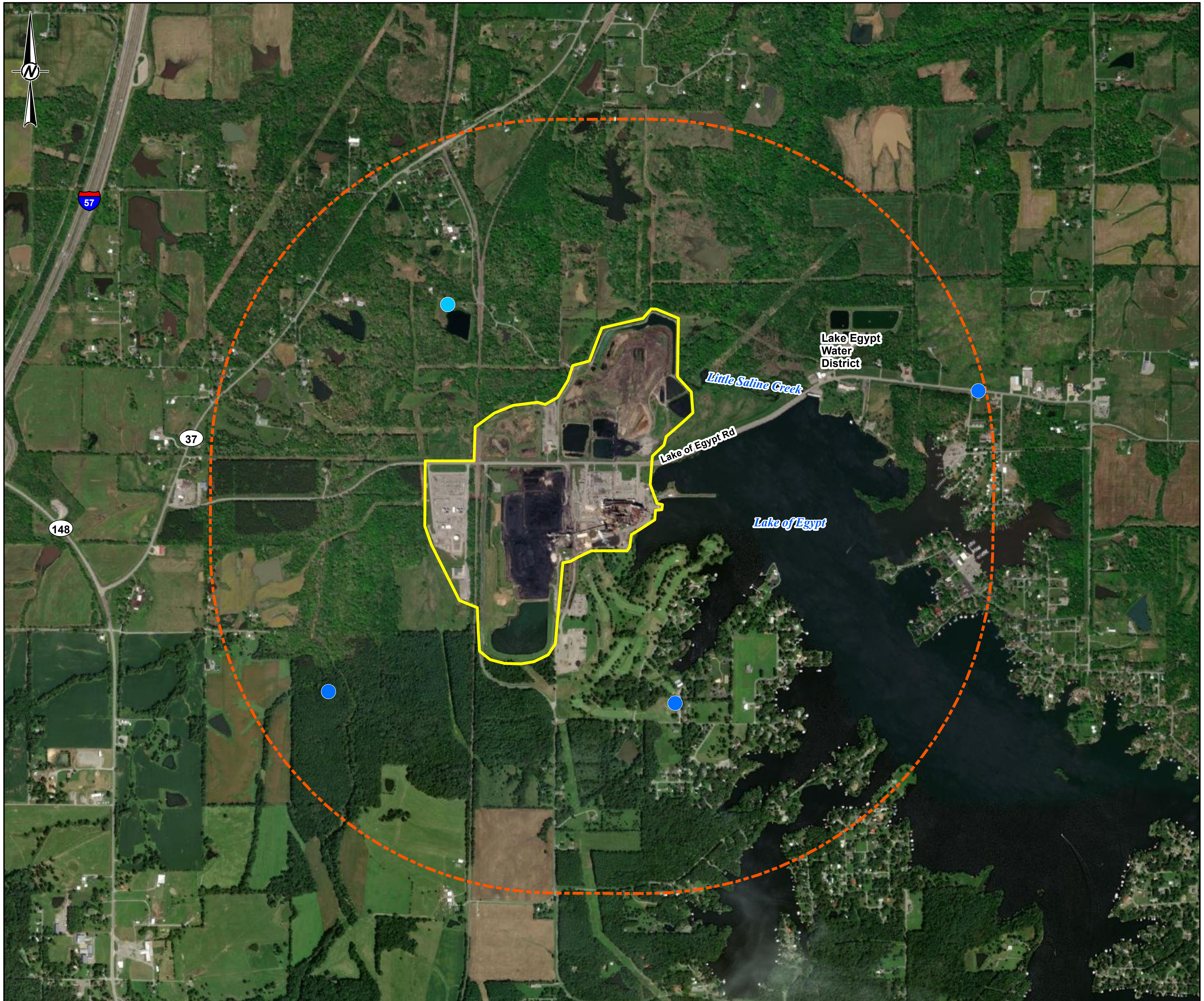
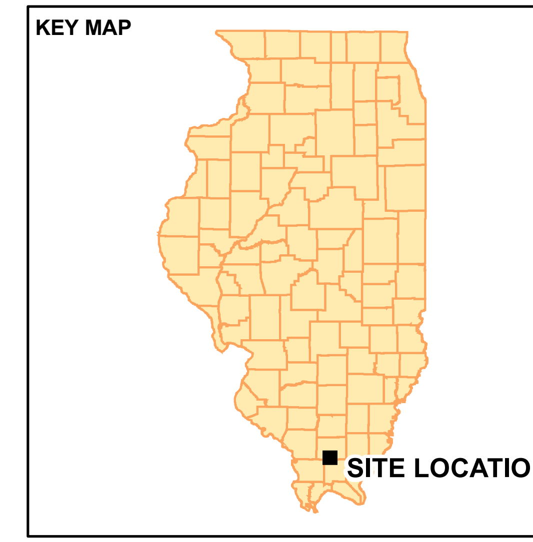


LEGEND

Water Well Location and Frequency

- Single Water Well Location
- 2 Overlapping Water Well Locations
- 1 Mile Buffer
- Approximate Operating Limits



PRIVILEGED AND CONFIDENTIAL:
PREPARED AT THE REQUEST OF COUNSEL

0 1,500 3,000

1 " = 1,500 Feet Feet

FIGURE NARRATIVE

THIS FIGURE SHOWS GROUNDWATER WELL LOCATIONS NEAR THE MARION POWER PLANT BASED ON THE ILLINOIS WATER AND RELATED WELLS DATASET FROM THE ILLINOIS STATE GEOLOGICAL SURVEY AND THE PRAIRIE RESEARCH INSTITUTE. COLOR FLOODING REPRESENTS MULTIPLE WELL RECORDS AT ONE LOCATION. GOLDER DID NOT FIELD VERIFY ANY OF THE WELL LOCATIONS, WHICH SHOULD ONLY BE USED FOR QUALITATIVE PURPOSES. DATA ARE CURRENT AS OF JULY 6, 2021. ADDITIONAL WELLS MAY BE PRESENT.

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1983 STATEPLANE ILLINOIS EAST FIPS 1201 FEET
2. IMAGERY SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY
3. WELL DATA DOWNLOADED FROM ILLINOIS WATER AND RELATED WELLS BY THE ILLINOIS STATE GEOLOGICAL SURVEY AND THE PRAIRIE RESEARCH INSTITUTE ON JULY 6TH 2021

CLIENT

SOUTHERN ILLINOIS POWER COOPERATIVE

PROJECT

OPERATING PERMIT APPLICATION
MARION POWER PLANT

TITLE

IDENTIFICATION OF NEARBY WATER WELLS AND SURFACE WATER

CONSULTANT

GOLDER
MEMBER OF WSP

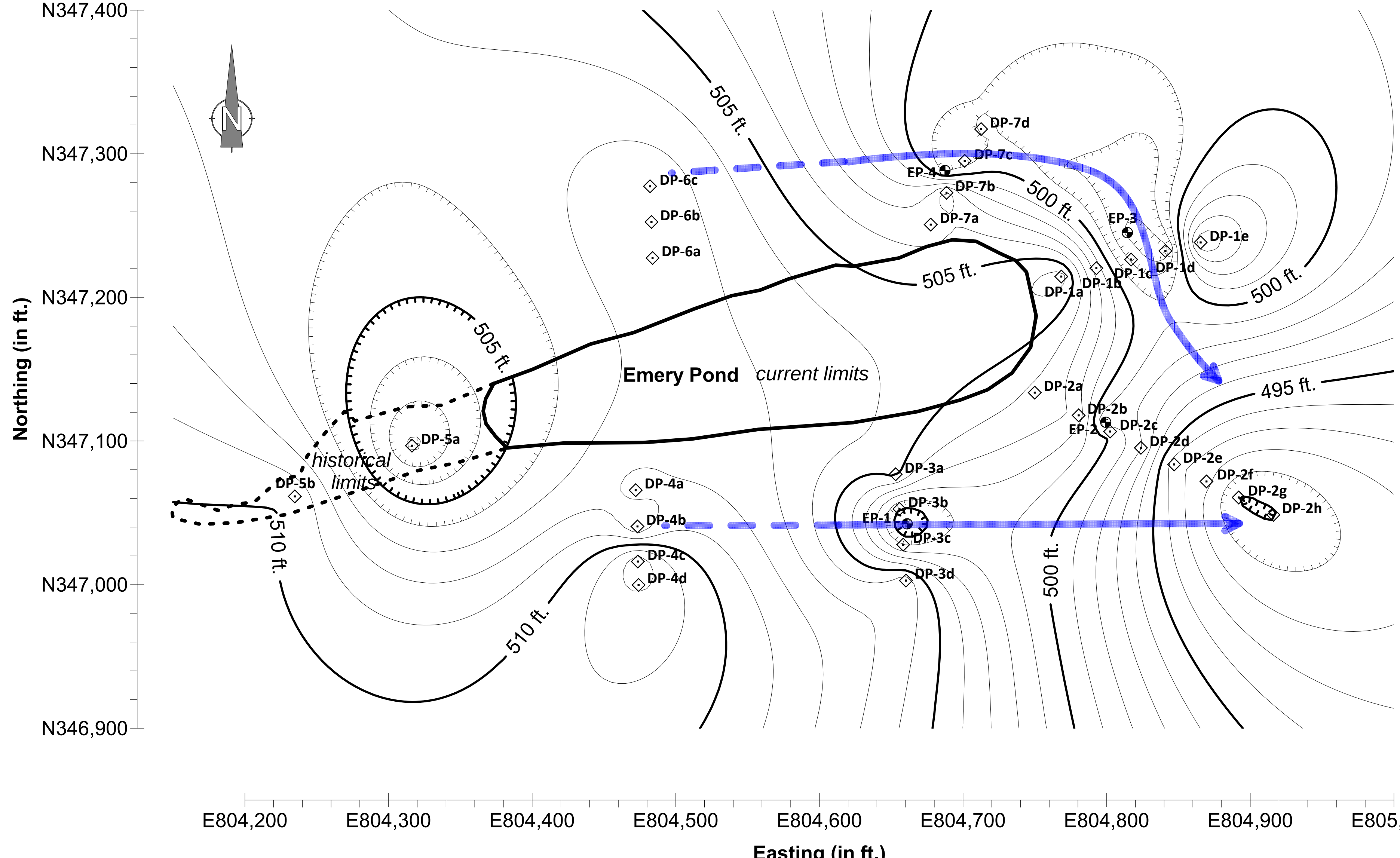
YYYY-MM-DD	2021-10-27
DESIGNED	DFS
PREPARED	TBH
REVIEWED	DFS
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
21467997	-	-	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 1 in

B:\Southern_Illinois_Power_Cooperative\Marion_Power_Plant\99_PROJ\21467997_Operating_Permit_Application\0001_Water_Well_Survey\40_PROD\21467997-0001-HS-0001.mxd



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot

SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

HANSON
Hanson Professional Services Inc.

Preferential Flow Paths (Bedrock Surface)

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE 4

APPENDIX A

Boring Logs

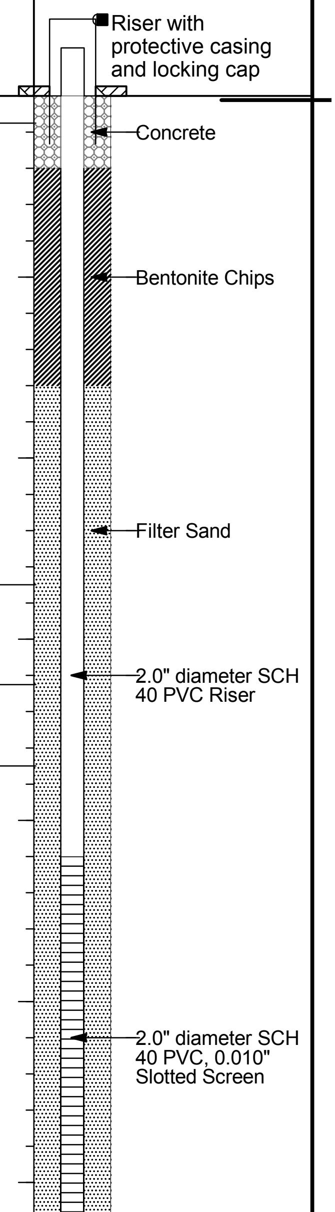
Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EP-1
Sheet 1 of 1

Date(s) Drilled and Installed	**2/7/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**31.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**519.72 ft, msl** **517.07 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347042.306 ft** **804661.174 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0		NR	Topsoil	Black TOPSOIL, moist
			NR	CL	Brownish tan silty CLAY, moist, medium plasticity (CL)
	5		NR		
510			NR		becomes orangish with trace coarse sand and gravel, with rust colored mottles
	10		NR		becomes very stiff
			NR		becomes medium-stiff, low plasticity
	15		NR	ML	Brownish tan to oragne clayey SILT, trace gravel and rust colored mottles, stiff, non-plastic, moist (ML)
500			NR	SP	Red orange SAND with orange-brown silty clay, moist (SP)
	20		NR	SNDSTN	SANDSTONE, with interbedded limestone and shale
			NR		
	25		NR		
490			NR		
	30		NR		
	35				Boring terminated at 31.0 ft. bgs on 2/7/2017. Monitoring well installed to 31.0 ft. bgs on 2/7/2017. NR = Not Recorded

WELL CONSTRUCTION DETAILS



AECOM

Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

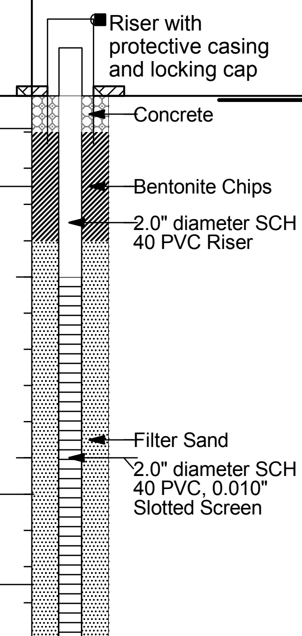
Log of EP-2

Sheet 1 of 1

Date(s) Drilled and Installed	**2/7/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**15.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**513.79 ft, msl** **511.15 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347113.029 ft** **804799.408 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: Sample Interval	SAMPLES: % Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0		NR	Fill		Asphalt and GRAVEL (FILL)
510			NR	CL		Brown to tan silty CLAY, medium stiff, moist (CL)
						brown to tan silty CLAY, soft to medium, medium to high plasticity, moist (CL)
	5		NR	CL		medium plasticity, with rust color oxidation, trace sand and gravel
			NR			
	10		NR			
500			NR	ML		Tan clayey SILT, stiff, low plasticity, moist (ML)
			NR	SNDSTN		SANDSTONE
	15					Boring terminated at 15.0 ft. bgs on 2/7/2017. Monitoring well installed to 15.0 ft. bgs on 2/7/2017. NR = Not Recorded
	20					
490						
	25					
	30					
480						
	35					

WELL CONSTRUCTION DETAILS



AECOM

Client: Southern Illinois Power Cooperative **Project Name: SIPC Marion CCR** **Project Location: SIPC Marion** **Project Number: 60535846**	**Log of EP-3** Sheet 1 of 1

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**26.5 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**518.95 ft, msl** **518.95 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347245.08 ft** **804814.534 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0		NR	Fill	GRAVEL (FILL)
			NR	ML	Brown clayey SILT, moist (ML)
				CL	Olive green to gray silty CLAY, trace sand, medium, low to medium plasticity, moist (CL)
	5		NR		
			NR		
510	10		NR		2 inch layer of cinders, clay becomes tan-brown
			NR		becomes loose, moist, brown/gray/tan, with gravel, some sand and cinders
	15		NR	ML	Light gray to tan clayey SILT, stiff, low plasticity, moist (ML)
			NR	ML	Gray SILT, trace clay, stiff, non-plastic, moist (ML)
500				CL	Gray silty CLAY with yellow-gold gypsum, moist to wet (CL)
	20		NR	SNDSTN	SANDSTONE
			NR		
	25		NR		
			NR		
					Boring terminated at 26.5 ft. bgs on 2/8/2017. Monitoring well installed to 26.5 ft. bgs on 2/8/2017. NR = Not Recorded
490	30				
	35				

WELL CONSTRUCTION DETAILS

- Riser with protective casing and locking cap
- Concrete
- 2.0" diameter SCH 40 PVC Riser
- Bentonite Chips
- Filter Sand
- 2.0" diameter SCH 40 PVC, 0.010" Slotted Screen

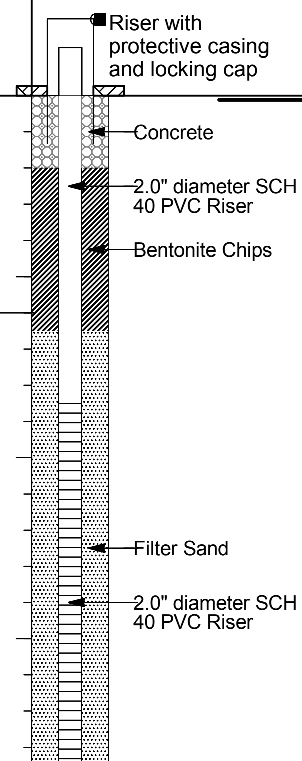
AECOM

Client: Southern Illinois Power Cooperative	Log of EP-4
Project Name: SIPC Marion CCR	Sheet 1 of 1
Project Location: SIPC Marion	
Project Number: 60535846	

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**18.5 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**519.74 ft, msl** **517.07 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347288.297 ft** **804687.527 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: Sample Interval	SAMPLES: % Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0		NR	Fill		GRAVEL, sand, silt (FILL)
			NR			old abandoned pipe
	5		NR			
510			NR	CL		Brown silty CLAY with some gravel, high plasticity, moist to wet (CL)
	10		NR			
			NR			becomes brown-gray, with some layering of black fine sand, high plasticity
	15		NR			becomes wet becomes tan-gray, moist to wet, high plasticity
500			NR			becomes brown/tan/gray, trace fine sand
			NR	Shale		SHALE, gray
	20					Boring terminated at 19.5 ft. bgs on 2/8/2017. Monitoring well installed to 18.5 ft. bgs on 2/8/2017. NR = Not Recorded
	25					
490						
	30					
	35					

WELL CONSTRUCTION DETAILS



AECOM

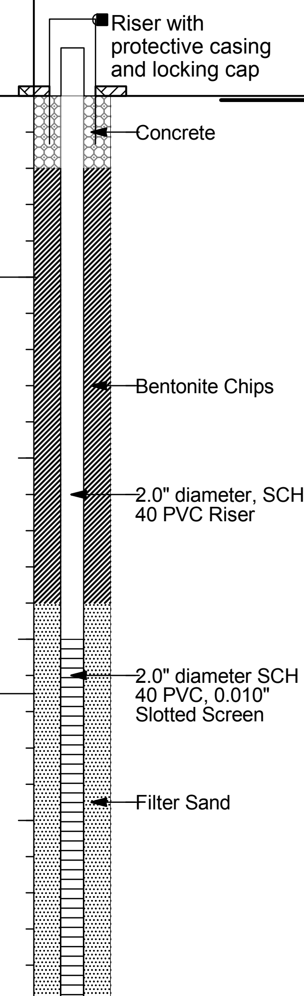
Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EBG

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**25.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**524.87 ft, msl** **521.74 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**346358.14 ft** **804168.155 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0	X	NR	ML		Brownish tan, clayey SILT, stiff, non-plastic, moist (ML)
520						
		X	NR			
	5	X	NR	CL		Brownish tan silty CLAY, very soft, medium to high plasticity, moist (CL)
						becomes low to medium plasticity
	10	X	NR			with black fines
510		X	NR			becomes brown/orange/gray, trace black fines, low plasticity
	15	X	NR			trace rust colored oxidation with red mottling
		X	NR	SHALE		SHALE, gray
	20	X	NR			
500		X	NR			
		X	NR			
	25					Boring terminated at 25.0 ft. bgs on 2/7/2017. Monitoring well installed to 25.0 ft. bgs on 2/7/2017. NR = Not Recorded
	30					
490						
	35					

WELL CONSTRUCTION DETAILS



AECOM

KEY TO SYMBOLS

Hanson Professional Services Inc.
1525 S. Sixth Street
Springfield, Illinois 62703
(217) 788-2450

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

ASPHALT	ASHPALT
BASALT	BASALT
BLDRCBBL	BOULDERS AND COBBLES
BRECCIA	BRECCIA
CH	HIGH PLASTICITY CLAY
CL	LOW PLASTICITY CLAY
COAL	COAL
CONC.	CONCRETE
FILL	FILL
GC	CLAYEY GRAVEL
GM	SILTY GRAVEL
GPS	SANDY GRAVEL
GP	POORLY GRADED GRAVEL
GW	WELL GRADED GRAVEL
LIMESTONE	
MH	ELASTIC SILT
ML	SILT
OH	HIGH PLASTICITY ORGANIC SILT
OL	LOW PLASTICITY SILT
PT	PEAT
SANDSTONE	
SC	CLAYEY SAND
SHALE	
SILTSTONE	
SM	SILTY SAND
SP	POORLY GRADED SAND
SW	WELL GRADED SAND
TILL	GLACIAL TILL
TOPSOIL	

SAMPLER SYMBOLS

- GRAB / AUGER CUTTINGS HAND AUGER [AUG or HA]
- SPLIT SPOON / SPT [SS]
- SHELBY TUBE [SH]
- ROCK CORE [RC]
- CONTINUOUS OR MACROSAMPLER [CS or DP]
- BLIND DRILL [BD]
- MODOFIED CALIFORNIA SAMPLER [MC]

WELL SYMBOLS

- CONCRETE SURFACE SEAL
- HIGH-SOLIDS BENTONITE GROUT
- BENTONITE CHIP SEAL
- SAND PACK W/SOLID RISER
- SAND PACK W/SCREEN

ABBREVIATIONS

LL	Liquid Limit (%)	NP	Non-Plastic
PL	Plastic Limit (%)	Qu	Unconfined Compressive Strength (tsf)
woh	Weight of Hammer	Qp (P)	Pocket Penetrometer
wor	Weight of Rods	TV	Torvane
MaxGS	Maximum Grain Size	PID	Photoionization Detector
<#200	Percent Passing No. 200 Sieve	ppm	Parts per Million

GROUNDWATER LEVELS

- Level during drilling, or as indicated
- Level after 24 hours, or as indicated
- Level as indicated

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Storm Water Basin Monitoring Wells
Location: Marion Power Station, Marion, IL
Project: 21E0079
DATES: Start: 10/5/2021
Finish: 10/5/2021
WEATHER: Foggy, cool (low 60's)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model: Bobcat T630 with auger attachment
Drilling Method: 3¼" Hollow Stem Auger
FIELD STAFF: Driller: J. Carter
Helper: J. Taylor
Eng/Geo: R. Hasenyager

BOREHOLE ID: EP-5
Well ID: EP-5
Surface Elev: 524.64 ft. MSL
Completion: 16.32 ft. BGS
Station: 347,001.63N
804,473.78E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S; **Range** 2E

WATER LEVEL INFORMATION:
▽ = Dry - during drilling
▼ = Dry - at completion
▼ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	0/60 *0%*	AGR					0–5	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	0/60 *0%*	AGR					5–10				
	0/60 *0%*	AGR					10–15				
	0/16 *0%*	AGR					15–16.3				
							16–16.3	Yellowish brown (10YR5/8), weathered SANDSTONE.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16
Elevation scale: 524, 522, 520, 518, 516, 514, 512, 510

EOB = 16.3 ft.

NOTE(S): Boring drilled adjacent to DP-4d.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Storm Water Basin Monitoring Wells
Location: Marion Power Station, Marion, IL
Project: 21E0079
DATES: Start: 10/4/2021
Finish: 10/4/2021
WEATHER: Sunny, mild (high 70's)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model: CME 550X
Drilling Method: 3¼" Hollow Stem Auger with split spoon
FIELD STAFF: Driller: J. Carter
Helper: J. Taylor
Eng/Geo: R. Hasenyager

BOREHOLE ID: EP-6
Well ID: EP-6
Surface Elev: 502.08 ft. MSL
Completion: 13.62 ft. BGS
Station: 347,034.68N
804,941.94E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S; **Range** 2E

WATER LEVEL INFORMATION:
▽ = Dry - during drilling
▼ = 13.00 - at completion
▼ =

SAMPLE 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	Elevation ft. MSL	Remarks
	0/12 *0%*	BD								
2A	17/24 *71%*	SS	*5-7* *7-5* N=14	18.7		*3.5*	2	Yellowish brown (10YR5/4) mottles, moist, medium, SILT with few clay and trace sand.	500	
3A	24/36 *67%*	SS	*2-2* *4-4* N=6	24.6		*1.5*	4	Gray (10YR5/1) with 10% Yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.	498	
4A	23/24 *96%*	SS	*1-1* *4-4* N=5	20.7		*3.5*	6	Yellowish brown (10YR5/6) wuth 20% Gray (10YR6/1) mottles, moist, medium, SILT with few clay, trace sand, and trace gravel.	496	
5A	27/36 *75%*	SS	*7-8* *13-13* N=21	12.1		*4.0*	8	Strong brown (7.5YR5/8), moist, dense, very fine- to coarse-grained SAND with some silt.	494	
6A	21/21 *100%*	SS	*4-10* *27-60/3"* N=37	15.0		*4.0*	10	Strong brown (7.5YR5/8) with 10% gray (7.5YHR5/1) mottles, moist, hard, weathered SHALE.	492	
	0/10 *0%*	BD					12		490	

EOB = 13.6 ft.

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Storm Water Basin Monitoring Wells
Location: Marion Power Station, Marion, IL
Project: 21E0079
DATES: Start: 10/4/2021
Finish: 10/4/2021
WEATHER: Sunny, mild (low 70's)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model: CME 550X
Drilling Method: 3¼" Hollow Stem Auger with split spoon
FIELD STAFF: Driller: J. Carter
Helper: J. Taylor
Eng/Geo: R. Hasenyager

BOREHOLE ID: EP-7
Well ID: EP-7
Surface Elev: 512.49 ft. MSL
Completion: 18.50 ft. BGS
Station: 347,219.28N
804,890.26E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S; **Range** 2E

WATER LEVEL INFORMATION:
▽ = 13.00 - during drilling
▼ = 16.00 - at completion
▼ =

SAMPLE / TESTING

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type
	0/12 *0%*	BD				
2A	15/24 *63%*	SS	*2-2* *3-3* N=5	14.6		*1.0*
3A	32/36 *89%*	SS	*2-5* *13-7* N=18	17.3		*2.0*
4A	16/24 *67%*	SS	*2-1* *2-1* N=3	21.4		*1.0*
5A	17/36 *47%*	SS	*1-2* *2-3* N=4	21.8		*1.0*
6A	15/24 *63%*	SS	*woh-1* *3-4* N=4	24.0		*1.0*
7A	27/36 *75%*	SS	*1-2* *2-3* N=4	26.2		*0.5*
8A	20/24 *83%*	SS	*woh-1* *4-5* N=5	24.3		*0.5*
	0/6 *0%*	BD				

Lithologic Description (Depth ft. BGS; Elevation ft. MSL)

Lithologic Description
Light bluish gray (5PB8/1), moist, dense, GRAVEL with some sand and some silt.
Black (10YR2/1), moist, loose, very fine- to coarse-grained SAND with some silt and trace gravel (Bottom Ash).
Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.
Grayish brown (10YR5/2) with 15% yellowish brown (10YR5/6) mottles, moist, medium CLAY with some silt, trace sand, and trace gravel.
Pale brown (10YR6/3), moist, soft, SILT with few clay and trace sand.
Yellowish brown (10YR5/4), moist, soft, CLAY with some silt and trace sand.
Gray (10YR5/1), moist, soft, SILT with few clay and trace sand.
Yellowish brown (10YR5/4), moist, soft, CLAY with some silt dand trace sand.
Yellowish brown (10YR5/8), moist, dense, very fine- to medium-grained SANDSTONE.

EOB =18.5 ft.

Depth ft. BGS: 2, 4, 6, 8, 10, 12, 14, 16, 18

Elevation ft. MSL: 512, 510, 508, 506, 504, 502, 500, 498, 496, 494

Borehole Detail

Remarks

NOTE(S):

APPENDIX B

Closure Plan

Emery Pond

Closure Plan

Marion Power Plant
Southern Illinois Power Cooperative
Marion, Williamson County, Illinois

March 29, 2019
revised April 15, 2021

HANSON
Engineering | Planning | Allied Services

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Appendices

Abbreviations

BGS – below ground surface
CCR – Coal Combustion Residuals
CFR – Code of Federal Regulations
FGD – Flue-Gas Desulphurization
IAC – Illinois Administrative Code
SWPPP – Storm Water Pollution Prevention Plan

1. Introduction

The pond at issue, Emery Pond, is located near the northwestern shore of Lake of Egypt on the site of Southern Illinois Power Cooperative's (SIPC) power plant near Marion, Illinois (Site). SIPC has owned and operated a coal-fired power plant at the Site since 1963.

The Emery Pond is a less-than-1-acre detention pond located on the south side of the main stack at the power plant facility. The pond has received coal combustion residuals (CCR) and other non-CCR material in waste streams and in runoff that flows by gravity to the pond, particularly air heater wash, and other miscellaneous boiler and precipitator wastes. The pond is occasionally dredged due to the ongoing sediment carried into the pond via various plant and natural effluent streams. The pond is incised on the north, west and south sides, with a wide berm separating the pond from nearby Lake of Egypt to the east. This berm is approximately 140 feet in width at the crest, with a height of approximately 10 feet. The pond has a maximum volume of approximately 6.6 acre-feet. The pond is unlined and, therefore, does not meet the liner design criteria of the federal CCR Rule, 40 CFR 257.71.

Emery Pond is a significant hazard potential classification CCR surface impoundment, according to 40 CFR 257.73. The pond is exempt from the structural stability assessment and safety factor assessment requirements of 40 CFR 257.73 due to an impoundment height of less than 20 feet and impoundment volume of less than 20 acre-feet.

The original pond footprint was reduced around 2009 when a Flue-Gas Desulphurization (FGD) gypsum belt dewatering loadout facility was built on the western end of the existing pond. Direct push borings collected at the site indicate that the previous footprint beneath the FGD Loadout Area contains approximately 7,200 cubic yards of bed ash material. Direct push boring logs and a map of the boring locations are included in Appendix E.

In the fall of 2020, SIPC plans to commence closure of the pond and adjacent FGD Loadout Area by removal of existing CCR. A new pond, designated as Storm Water Basin, will replace Emery Pond within the existing footprint. Construction activities are summarized as follows:

- The area currently occupied by Emery Pond will be closed to meet current Federal and State of Illinois regulations, and at Illinois EPA's request this plan, and related plans have been prepared to align with the state CCR surface impoundment rule as currently proposed. For instance, Section 3.8 below addresses CCR transportation and management during closure activities in a manner consistent with the proposed state CCR rule. CCR materials currently contained in the pond will be removed and disposed of off-site. This closure plan will be implemented in connection with ongoing discussions between SIPC and Illinois EPA regarding resolution of claims that Emery Pond has caused exceedances of state groundwater standards. In that regard, it is expected that the closure activities described herein will decontaminate the source of such alleged exceedances, and thus contribute toward achieving relevant groundwater standards. See also the Corrective Action and Selected Remedy Plan submitted contemporaneously herewith.
- A new Storm Water Basin will be constructed within the existing footprint of Emery Pond to collect local drainage. Though it has been designed to meet the requirements of 40 CFR 257, the new basin will not meet the definition of a regulated CCR unit because it will no longer receive CCR. Nonetheless, the basin will be designed to meet the liner criteria for new CCR surface impoundments of 40 CFR 257.72 and the structural integrity criteria of 40 CFR 257.74. The basin will be constructed with a composite liner system meeting the federal requirements of

40 CFR 257.71. The Storm Water Basin will be permitted and operated as a water treatment device under 35 IAC 309, Subpart B.

- The FGD Loadout Area will be closed by removing surface FGD material and bed ash deposits. The area will be filled with compacted clean soil material and surfaced with crushed aggregate. This area, if closed in place, would have require approximately 5,900 square yards of final cover.
- The installation of a permanent dewatering system around the base of the basin liner system will provide protection from hydraulic pressures to the liner system and will collect groundwater in the vicinity of the new basin.
- Although SIPC maintains that an NPDES permit modification and construction permit are not needed with respect to the closure of Emery Pond and installation of the new Storm Water Basin, SIPC has submitted an NPDES permit modification application and a construction permit application to Illinois EPA per Illinois EPA request.

2. Definitions

Closed means placement of CCR in a CCR unit has ceased, and the owner or operator has completed closure of the CCR unit in accordance with applicable state and/or federal regulation and has initiated post-closure care.

Coal combustion residuals (CCR) means fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers.

CCR surface impoundment or impoundment means a natural topographic depression, man-made excavation, or diked area, which is designed to hold an accumulation of CCR and liquids, and the unit treats, stores, or disposes of CCR.

CCR unit means any CCR landfill, CCR surface impoundment, or lateral expansion of a CCR unit, or a combination of more than one of these units, based on the context of the paragraph(s) in which it is used. This term includes both new and existing units, unless otherwise specified.

Dewatering means removal of freely drained pore water from CCR sediments or soil.

Operator means the person(s) responsible for the overall operation of a CCR unit.

Qualified person means a person or persons trained to recognize specific appearances of structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit by visual observation and, if applicable, to monitor instrumentation. Qualified professional engineer means an individual who is licensed by a state as a Professional Engineer to practice one or more disciplines of engineering and who is qualified by education, technical knowledge, and experience to make the specific technical certifications required under this subpart. Professional engineers making these certifications must be currently licensed in the state where the CCR unit(s) is located.

Recognized and generally accepted good engineering practices means engineering maintenance or operation activities based on established codes, widely accepted standards, published technical reports, or a practice widely recommended throughout the industry. Such practices generally detail approved ways to perform specific engineering, inspection, or mechanical integrity activities.

Unwatering means removal of surface (free) water from a site.

3. CCR Removal Activities

Major removal activities include dewatering, contaminated riprap removal, CCR sediment removal, and minor re-grading. CCR removal will be performed in accordance with the construction quality assurance procedures described in Appendix A and documented by an Illinois-licensed professional engineer. Figures showing the Emery Pond Closure and Storm Water Basin design are included in Appendix B and an estimated construction schedule is included in Appendix C.

3.1 CCR Removal

Completion of the activities described below will result in closure of the Emery Pond through removal of CCR sediment. This closure plan includes construction quality assurance (CQA) procedures consistent with the construction requirements for permitted CCR units in Illinois.

In addition to CCR material contained within Emery Pond, FGD material on the ground surface and bed ash and other deposits buried beneath the FGD Loadout Area and within Emery Pond will be excavated and transported to one or more of the following permitted disposal facilities:

- Perry Ridge Landfill, Inc.
- Southern Illinois Regional Landfill, Inc.
- West End Disposal Facility

3.2 Erosion and Sediment Control Measures

Best management practices (BMPs) consisting of interim and permanent stabilization and structural features will be implemented at the site for erosion and sediment control. Perimeter control measures such as silt filter fences and/or storm drain inlet protection will be installed prior to excavation activities. Permanent stabilization practices include gravel surfacing of perimeter roadways. Permanent stabilization practices will be initiated as soon as practicable in portions of the site where construction activities have permanently ceased, or within seven days in portions of the site where construction activities have temporarily ceased (unless construction activity on those portions of the site will resume within 14 days). The gravel surfacing mixture described in Section 3.11 will be used for permanent stabilization.

Structural features include floating suction strainers (for dewatering pumps), silt filter fences, storm drain inlet protection, rock outlet protection, and rolled excelsior, straw bales, or aggregate ditch checks.

BMPs will be implemented and maintained until construction activities are completed and the site is stabilized. SIPC's Storm Water Pollution Prevention Plan (SWPPP) has been included in Appendix D**Error! Reference source not found.**. Note that the construction contractor will need to prepare and file their own SWPPP.

3.3 Emery Pond Unwatering

Emery Pond must be unwatered for CCR sediment removal to be accomplished using conventional earthmoving equipment. Unwatering will be done using an existing pump station at the east end of the pond. This pump station transfers water from Emery Pond to the South Fly Ash Pond for discharge through NPDES Outfall 002.

Once the pond is substantially unwatered, additional methods may be required to dewater the remaining sediment deposits. These options include various combinations of temporary sump pits and/or drainage trenches. The option selected must result in sufficient dewatering in a manner that minimizes re-entrainment of solids and erosion at the discharge location(s). All dewatering activities must be conducted using appropriate best management practices (BMPs) for, and in compliance with the conditions of the Construction Permit. Installation of a permanent dewatering system is described in Section 3.9.

Unwatering of the Emery Pond is estimated to be completed within two (2) days. This is based on a total pumping volume and rate of 195 thousand gallons (at a pond operating water surface elevation of 509.0) and 120 thousand gallons per day, respectively.

3.4 CCR Sediment Dewatering

Dewatering of excavated CCR will be performed by laying out the wet material on perched drying pads within the pond and FGD storage area. Free water that drains out of the material will be directed to drain back into the pond for collection and pumping. The estimated dewatering volume is 587,000 gallons, assuming a free water volume of 25% within the CCR material. The CCR material will be hauled for disposal once sufficient free liquids have discharged to meets the Paint Filter Liquids Test criteria outlined in Section 3.5.

3.5 CCR Sediment Sampling

CCR sediment from the Emery Pond will be transported to a permitted facility for disposal. The sediment will be sampled and tested as necessary to satisfy disposal prequalification requirements. Sampling activities will be conducted in accordance with the construction quality assurance procedures in Section 4.4 of this Plan. Dewatering of sediment must be conducted such that the transported materials do not contain “free liquids” as defined by the Paint Filter Liquids Test (as referenced in 35 IAC 811.107(m)(3)(A)), prior to placement or transport.

3.6 Riprap Excavation

Stone riprap was placed in the Emery Pond to protect the side slopes from wave action and minimize erosion near the inlets and outlet. A total of approximately 600 cubic yards of riprap is present around the perimeter of the Emery Pond. It is visually apparent that CCR sediment has settled in, and adhered to, the portions of the riprap in contact with the pond water.

The riprap will be excavated and transported to a permitted facility for disposal.

3.7 CCR Sediment Excavation

Based on sampling activities, the CCR sediment material is a brown to gray color, loose to very loose consistency, non-cohesive silt to sand size ash and/or FGD material that is often cemented to various degrees. The underlying pond subgrade material is bedrock consisting of weathered shale or weathered sandstone. Bedrock depths measured at the Emery Pond site are found in Appendix E.

The CCR sediment is to be excavated using conventional earthmoving equipment such as a tracked excavator or loader. An estimated 3,500 cubic yards of sediment must be removed to reach the underlying subgrade surface. Sediment excavation will be conducted in accordance with the construction quality assurance procedures as directed by the site CQA Officer or his designee. Upon completion, removal will be certified as described in Section 5.3.

3.8 CCR Management During Closure and Transportation

CCR removed from the Site will be responsibly handled and transported in accordance with draft rule 35 IAC 845.740 as follows:

1) When transporting CCR by motor vehicle, manifests must be carried as specified in 35 IAC 809.
2) The Contractor transporting CCR off-site shall develop, and submit a CCR transportation plan for Owner approval, which shall include:
    a) the frequency, time of day, and routes of CCR transportation;
    b) measures to minimize noise, traffic, and safety concerns caused by the transportation of the CCR;
    c) measures to limit fugitive dust from any transportation of CCR;
    d) installation and use of a vehicle washing station;
    e) a means of covering the CCR for any mode of CCR transportation, including conveyor belts; and
    f) a requirement that, for transport by motor vehicle, the CCR is transported by a permitted special waste hauler pursuant to 35 IAC 809.201.
3) The Contractor must develop and implement on site dust controls, which must include:
    a) A water spray or other commercial dust suppressant to suppress dust in CCR handling areas and haul roads; and
    b) CCR must be handled to minimize airborne particulates and offsite particulate movement during any weather event or condition.
4) The Contractor must provide the following public notices:
    a) signage must be posted at the property entrance warning of the hazards of CCR dust inhalation; and
    b) when CCR is transported off-site, a written notice explaining the hazards of CCR dust inhalation, the transportation plan and tentative transportation schedule must be provided to units of local government through which the CCR will be transported.
5) The Contractor must take measures to prevent contamination of surface water, groundwater, soil, and sediments from the removal of CCR, including but not limited to the following:
    a) CCR removed from the surface impoundment must be stored in a CCR storage pile.
    b) CCR storage piles shall:
        i) be tarped or constructed with wind barriers to suppress dust and to limit stormwater contact with storage piles;
        ii) be periodically wetted or have periodic application of dust suppressants;
        iii) have an impervious storage pad or geomembrane liner that is properly sloped to allow appropriate drainage;
        iv) be tarped over the edge of the storage pad where possible;
        v) be constructed with fixed and mobile berms where appropriate to reduce run-on and run-off of stormwater to and from the storage pile and minimize stormwater-CCR contact.
    c) The Contractor shall incorporate general housekeeping procedures such as daily cleanup of CCR, tarping of trucks, maintaining the pad and equipment, and good practices during unloading and loading.
    d) The Contractor must minimize the amount of time the CCR is exposed to precipitation and wind.

3.9 Permanent Dewatering System

Once the CCR Sediment Excavation is complete, earthwork to establish the base grade may commence. A permanent dewatering system (also referred to as the perimeter toe drain) will be installed around the perimeter of the excavated area to control groundwater levels prior to and during construction of the Storm Water Basin base grade (see Sheets C303, C304, and C305 in Appendix B for details and materials). The lowered groundwater elevation will facilitate construction by eliminating seeps and reducing hydraulic pressure during structural fill placement and soil liner construction. The dewatering system will be composed of a gravel-filled trench with a perforated pipe all wrapped with a geotextile filter. The piping system will drain to collection riser pipes placed at low points in the system, as dictated by bedrock elevations. Water will be pumped from the collection riser pipes to an existing pond discharge structure, where it will then be pumped to the South Fly Ash Pond for discharge through NPDES Outfall 002.

The permanent dewatering system will remain in operation for the life of the new Storm Water Basin to prevent soil liner uplift.

3.10 FGD Loadout Area

CCR material will be excavated and removed from the FGD Loadout Area and removal will be deemed complete upon visual inspection/certification by the CQAO. The excavation will be backfilled with compacted clean soil material. The surface will receive a layer of crushed limestone for the plant to utilize for non-CCR related purposes. The entire FGD Loadout Area will be sloped to drain toward the proposed Storm Water Basin to prevent surface water run-off.

3.11 Permanent Stabilization of Disturbed Areas

The perimeter roadway currently surrounding Emery Pond will be permanently stabilized with gravel surfacing. Gravel surfacing material will be crushed limestone coarse aggregate placed on disturbed areas to minimize wind and water erosion. The coarse aggregate mixture will be Illinois Department of Transportation (IDOT) Gradation CA-6. The perimeter roadway will be graded to drain toward the pond at a slope between 2 and 4 percent.

4. Construction Activities

Major construction activities include establishing the base grade, installation of a composite liner system and structural modifications to the pond discharge structure. Construction activities will be performed in accordance with the construction quality assurance procedures described in a subsequent section of this plan and documented by an Illinois-licensed professional engineer.

Figures showing the proposed Storm Water Basin design are included in Appendix B. In accordance with Appendix C, construction activities are scheduled to conclude in November.

4.1 Description

The new Storm Water Basin pond will not be used for CCR treatment, storage, or disposal. In that regard, SIPC and Illinois EPA have agreed that the expected waste streams to the new basin, as described in connection with the application for a construction permit under 35 IAC 309, Subpart B (water treatment device), are not regulated CCR waste streams. Nonetheless, as a compromise and as part of the resolution of the asserted groundwater claims, the new basin will be designed to meet the

CCR impoundment requirements of 40 CFR 257.100. The proposed Storm Water Basin will be constructed by re-grading the pond base and side slopes and installing a composite liner system.

4.2 Base Grading

The base grade for the Storm Water Basin will be constructed using the following design criteria. The bottom surface of the pond will be established by removal of the upper 2 feet of weathered bedrock material to create a stable base. The interior slopes of the pond will be constructed using compacted earth fill materials to create uniform side slopes with a maximum slope of 2.5H:1V.

4.3 Composite Liner System

After completion of the base grade, a composite liner system will be installed. The composite liner will consist of two components; an upper component consisting of, at a minimum, a 60-mil high density polyethylene (HDPE) geomembrane liner (GM), and a lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). The GM or upper liner component will be installed in direct and uniform contact with the compacted soil or lower liner component. Construction of the composite liner system is expected to take two weeks.

Existing drainage piping that discharge into Emery Pond will be inspected for integrity and repaired and/or extended as necessary to match the proposed basin geometry. The pipes will be sealed where they intersect the liner system using generally accepted engineering practices.

4.4 Discharge Structure Rehabilitation

The existing sump discharge structure that currently pumps water from Emery Pond to the South Fly Ash Pond will remain in place. The structure will be inspected after CCR sediment excavation is complete. Any structural deficiencies noted during the inspection will be repaired and the existing wing-walls will be modified to conform with the proposed pond geometry. An intake extension will be installed into the structure to facilitate free drainage and stable pond side slopes. The extension will be constructed of precast box culvert sections which will be integrated to the existing open face of the pump station structure. The composite liner system will be mechanically connected to the discharge structure using batten strips to attach the HDPE geomembrane.

4.5 Operation and Maintenance

The Storm Water Basin will not operate as a CCR surface impoundment. Soil sediment, though, may accumulate within the new pond over time. Cleanout of the new pond using mechanical equipment could compromise that composite liner system, therefore the pond will be periodically cleaned using suction dredging or other non-damaging means.

5. Construction Quality Assurance Procedures

Closure of Emery Pond and construction of the Storm Water Basin will be monitored and documented in accordance with the requirements of the construction quality assurance (CQA) procedures described in the following sections. Performance of CQA activities will confirm that the construction activities are conducted in accordance with the plan through documenting that specified procedures are followed.

5.1 Personnel

Prior to initiation of construction activities, SIPC will designate an independent third-party CQA Officer (CQAO). The CQAO will be a professional engineer registered in the State of Illinois, who is a person other than the contractor or an employee of SIPC, and who will supervise and be responsible for all inspection, testing, and other activities required to be implemented as part of the CQA procedures. The CQAO will also be responsible for, and will provide direct supervision to, other engineers and/or engineering technicians (inspectors) who will perform the inspections, sampling, and testing required by the CQA program. The CQAO will assume responsibility for the performance of the inspections, sampling, and testing, as described more specifically below. The CQAO or his designated representative will be on-site full-time for all the activities specified herein.

5.2 Construction Management Activities

The General Contractor may, after exercising due diligence to locate required information, request from the Construction Manager, clarification, or interpretation of the contract documents. The General Contractor will make specific reference to the contract document in question and include estimates of any schedule or cost impacts that could possibly be associated with the request for information (RFI).

The General Contractor will initiate the RFI in a timely manner using Form CQAP1 - Request for Information. The Construction Manager will, with reasonable promptness, respond to the RFI on the same form and return a copy of the completed form to the party making the request as final disposition of the matter.

5.3 Inspection Activities

The CQAO or his designated representative will be present to observe and document the following activities:

- CCR Sediment Excavation
- Base Grade Earthwork
- Composite Liner System Installation
- Booted liner penetrations of the composite liner system
- Discharge Structure Modifications

As part of these inspection activities, the CQAO will certify that the CCR sediment excavation has been completed using the following language:

> *I hereby certify, as a Professional Engineer in the State of Illinois that to the best of my knowledge the removal of CCR was completed at the existing CCR surface impoundment known as Emery Pond, in general accordance with applicable state and/or federal regulations. The removal and final inspection were complete as of Month Day, 202x.*

5.4 Sampling and Analysis/Testing

Representative CCR sediment material will be sampled and analyzed for the criteria on the Illinois EPA Bureau of Land Special Waste Preacceptance Form (LPC 680). This activity must be completed prior to transportation of the material to a permitted facility. Additional samples will be analyzed if the CQAO or the landfill operator identify or suspect any significant change in material. An independent laboratory will be responsible for the analyses.

Custody of samples and transfer from the sampling location to the independent laboratory will be established and documented using Form CQAP2 - Chain of Custody Record. The sampling party will enter sample descriptions (including proposed use), sampling dates and times, and types/quantities of samples on the form, including methods or types of testing to be carried out, and relinquish custody of the samples to the laboratory by signing and dating the form at the bottom. The samples will be shipped or delivered to the laboratory with a copy of the form. The sampling party will retain a copy for its records.

The independent laboratory will document receipt of the samples by signing and dating the form at the bottom and retaining a copy for its records. The laboratory will return a copy of the form to the sampling party and the CQAO with the submittal of test results.

The General Contractor will be responsible for the Paint Filter Liquids Testing prior to transport of the sediment to a permitted facility in accordance with IAC requirements. This testing can be completed in the field and will be observed and documented by the CQAO or designee. The CQAO or his designee will select the specific locations for sampling and testing exercising professional judgment to ensure that sampling and testing fairly represent the material. The results of the sampling and testing will be documented by the CQAO or his designated representative on Form CQAP3 - Daily Summary Report.

5.5 CCR Sediment Excavation

The CQAO or his designee will make observations necessary to identify areas requiring sediment removal. Those areas will be determined solely on these observations based on the previously described physical properties of the sediment and foundation materials. The CQAO will inform the General Contractor of areas requiring sediment removal. Upon removal of the sediment, the CQAO or his designee will attach appropriate documentation for the work to Form CQAP3 - Daily Summary Report.

5.6 Base Grade Construction

The CQAO or his designee will observe earth excavation and fill activities during the establishment of the Storm Water Basin base grade. Compaction of fill materials will be conducted to verify moisture and density.

Following base grade earthwork, the CQAO or the Construction Manager will direct a surveyor to record the grades. Elevations will be surveyed on a 100-foot grid pattern for the base grade. The points surveyed for side slopes will be at the top and toe. In addition, all breaks in grade will be surveyed. The points will be documented on record drawings furnished to the CQAO by the surveyor.

5.7 Composite Liner System Installation

The CQAO or his designee will observe placement of the compacted soil liner. Testing of fill materials will be conducted to verify moisture and density. Additional samples (thin wall tubes) will be obtained for verification of in place hydraulic conductivity.

The placement of the geomembrane and field testing of the welds will be observed by the CQAO. Destructive testing of geomembrane samples well be review for compliance with manufacturer’s specifications.

Following the compacted soil liner construction, the CQAO or the Construction Manager will direct a surveyor to verify that the actual grades are in accordance with the design. Elevations will be surveyed on a 100-foot grid pattern for the top of the compacted soil liner to verify thickness. The points surveyed for side slopes will be at the top, midpoint, and toe. In addition, all breaks in grade will be surveyed. The points will be documented on record drawings furnished to the CQAO by the surveyor.

6. Documentation

SIPC's Project Manager and the CQAO will document that closure of the Emery Pond and construction of the Storm Water Basin are performed in accordance with the design. Documentation drawings depicting as-built conditions will accompany the documentation. All activities will be documented in accordance with the construction quality assurance procedures. CQA documentation will be retained by SIPC as part of the Storm Water Basin operating record. This operating record will be available for inspection by Illinois EPA upon request. The CQA documentation may also be submitted directly to Illinois EPA pursuant to regulation or permit requirements.

6.1 General

The CQAO will be responsible for the overall administration and control of the project CQA documents.

The CQAO will verify that a filing system is implemented that will include:

- Date,
- Copy of the Closure Plan, updated as necessary,
- Photographic documentation,
- Survey measurements,
- Field and laboratory testing results,
- Daily summary reports including appropriate documentation, and
- Deficiency, nonconformity, and corrective action information.

Files will be updated with new data as such data become available. Documentation will be transmitted by the CQAO to SIPC and to any other parties designated by SIPC.

6.2 Daily Summary Reports

Each day of activity will be documented by a daily summary report. The report will be prepared by the CQAO or his designated representative and contain the following information:

- Date,
- Summary of weather conditions,
- Summary of locations where activity is occurring,
- Equipment and personnel on the project,
- Summary of any meetings held and attendees, and
- Description of all materials used and references or results of inspections, sampling, and testing, and documentation.

6.3 Photographic Documentation

Construction documentation may be supported with photographs, as appropriate. Photographs may be utilized to document activities, project progress, and acceptability. Any photographs will be maintained by the CQAO. CQA personnel will note the location, date, time, and description of the activity for record photographs.

6.4 Acceptance Report

An acceptance report will be prepared. The acceptance report will provide written evidence that the CQA procedures were implemented as described and that the project proceeded in accordance with the design, plans, and specifications.

The following information will be included in the acceptance report:

- Documentation by the CQAO that the construction has been implemented in general accordance with the engineering design,
- Documentation drawings, and
- All daily summary reports.

The acceptance report will be prepared under the direction of the CQAO and will be forwarded to SIPC for distribution as SIPC deems appropriate.

6.5 Corrective Action Completion Report

Upon completing the closure activities described in 35 IAC 845.760 a Closure Completion Report and Certification, meeting the requirements of 35 IAC 845.760(e) will be prepared and submitted to Illinois EPA.

7. Licensed Professional Signature/Seal

As a qualified professional engineer as defined by 40 CFR 257 Subpart D, I have personally examined and am familiar with this closure plan. Based on my inquiry of those individuals immediately responsible for obtaining the information contained therein, I believe that the information is true, accurate and complete. I certify that The Closure Plan for Marion Power Station Emery Pond meets the requirements set forth in the applicable state and/or federal regulation.

David B. Hoots, P.E.
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, IL 62703-2886
(217) 788-2450
Registration No. 062-055737

Seal:

Expires 11/30/2021

Signature: David B. Hoots

Date: 29 October 2020

8. References

US EPA, 2015. “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule – 40 CFR Parts 257 and 261”, Environmental Protection Agency in Federal Register, April 17, 2015, Vol. 80, No. 74. US Government Printing Office, Washington, D.C., 201 pp.

US EPA, 2018. “Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One – 40 CFR Part 257”, Environmental Protection Agency in Federal Register, July 30, 2018, Vol. 83, No. 146. US Government Printing Office, Washington, D.C., 22 pp.

Appendix A

Construction Quality Assurance Program Forms

REQUEST FOR INFORMATION
(Form CQAP1 - Revision 1)

RFI #: C-_____-_____

DATE: _____

FROM: _____
COMPANY: _____
PHONE: _____
FAX: _____

TO: _____, CQA Officer
PHONE: _____
FAX: _____

RE: _____

CHECK CATEGORY:

☐ Information not shown on contract documents:
☐ Interpretation Requirements
☐ Conflict in Requirements
☐ Coordination Problem
☐ Other Category

Contract Drawing Reference: _____
Shop Drawing Reference: _____
Specification Reference: _____
Possible Cost Impact: _____
Possible Time Impact: _____
Describe: _____

DESCRIPTION (Use Attached Sheets as Necessary)

_____

CC: RFI File
_____
_____
_____
_____

ATTACHMENTS: ☐ Yes ☐ No

RESPONSE
(Use Attached Sheets as Necessary)

_____

DATE: _____

RESPONSE BY: _____

Chain of Custody Record
(Form CQAP2 - Revision 1)

Emery Pond Closure & Storm Water Basin Construction Plans
SIPC Marion Power Plant, Williamson Co., Illinois

Client	**Southern Illinois Power Company**	Analysis and/or Method Requested	Analysis and/or Method Requested						Remarks or Observations
Address	**11543 Lake of Egypt Road**								
City, State Zip Code	**Marion, IL 62959**								
Phone / Facsimile No.	**(618) 964-1448 / (618) 964-1867**								
Client Project									
Location									
Sampler(s) / Phone	/								
Turnaround Time	Standard [ ] Rush [ ] Date Required:								
P.O. # or Invoice To									
Contact Person									

Sample Description	Sampling		Sample Type[1]	# of Containers								
	Date	Time										

(1) Sample Type: S = Soil; GM = Geomembrane; GT = Geotextile; GCL = Geosynthetic Clay Liner; DM = Drainage Media; O = Other

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment

Special Instructions:

Page ____ of ____

Copies (circle one): Sampler - Testing Firm - CQA Officer

DAILY SUMMARY REPORT
(Form CQAP3 - Revision 1)

1. SUMMARY OF WEATHER CONDITIONS:

Date: _____

AM Conditions: _____

AM Temperature: _____

PM Conditions: _____

PM Temperature: _____

2. LOCATIONS WHERE CONSTRUCTION IS OCCURRING:

Location 1: East _____ North _____ **Location 2:** East _____ North _____

Location 3: East _____ North _____ **Location 4:** East _____ North _____

Other Description: _____

3. EQUIPMENT & PERSONNEL ON SITE:

Equipment: _____

Personnel: _____

Visitors: _____

4. SUMMARY OF MEETINGS HELD/ATTENDEES:

☐ **None** ☐ **See Sheet 2 of 2** ☐ **See Attached Meeting Minutes**

5. MATERIALS USED & TESTING OR OBSERVATION RESULTS:

Materials Used: ☐ Culvert Pipe ☐ Foundation Fill ☐ Stockpiled Soil ☐ Subgrade Soil ☐ Riprap ☐ Other: _____

Testing and/or Observation Results: ☐ None ☐ See Attached

Calibration Records for Equipment: ☐ None ☐ See Attached

Prepared By: _____

(Signature of CQA Officer or Designated Representative)

_____

(Signature)

Original Report/Attachments To: Document Controller

Copies to: _____

DAILY SUMMARY REPORT

ADDITIONAL NOTES: **Date: _____**

_____

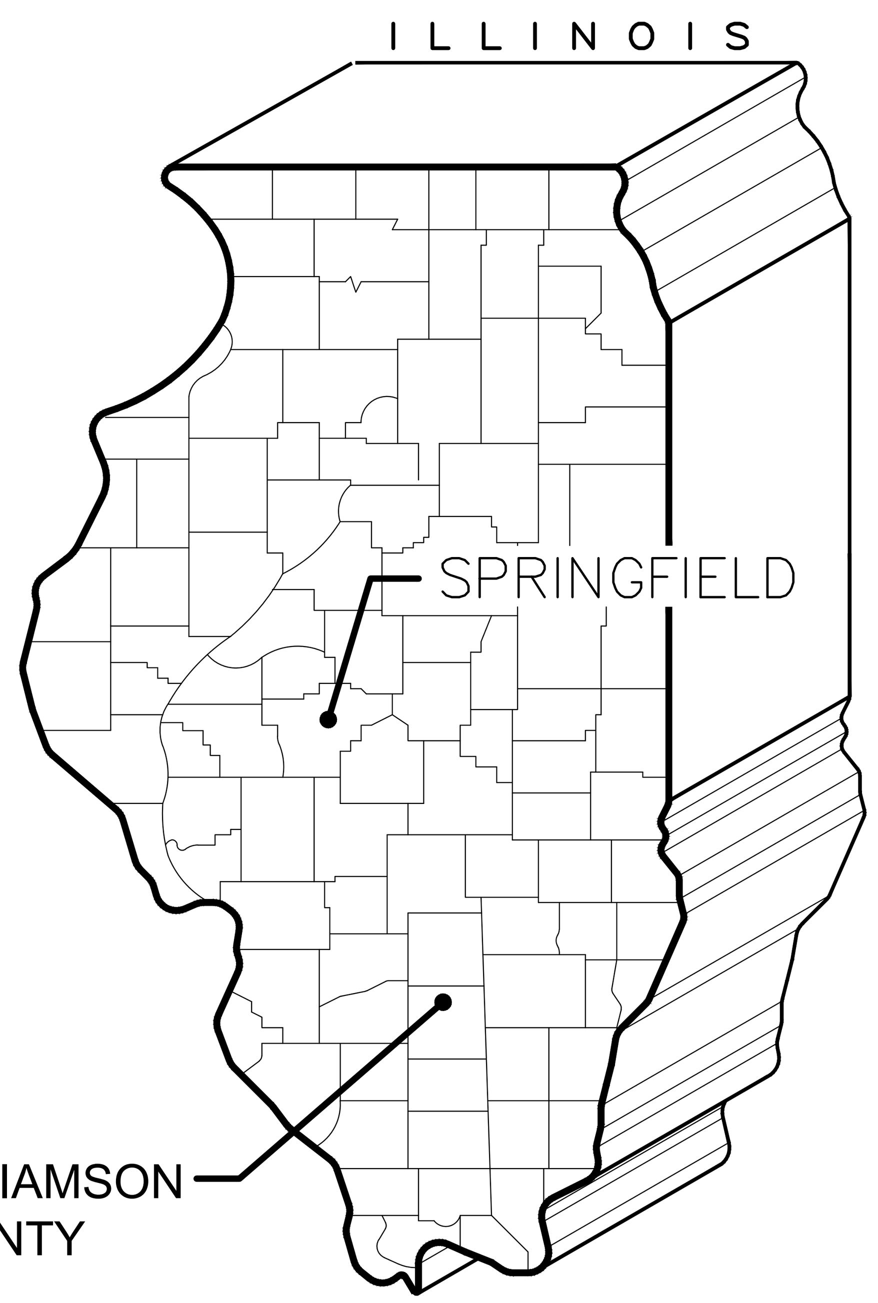
Appendix B

Closure Plan Figures

EMERY POND CLOSURE & STORM WATER BASIN CONSTRUCTION PLANS

MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

ISSUED FOR REVIEW - 07/14/2020



WILLIAMSON COUNTY

STATE MAP

PROJECT LOCATION

NORTH

VICINITY MAP

INDEX OF SHEETS

HANSON

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CONSULTANTS

EMERY POND CLOSURE & STORM WATER CONSTRUCTION PLANS

SOUTHERN ILLINOIS POWER COOPERATIVE (SIPC)

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

MARION POWER PLANT
WILLIAMSON CO.
ILLINOIS

MARK	DATE	DESCRIPTION
		DES / DRN / REV

ISSUE:	07-14-2020
PROJECT NO:	18E0022A
CAD FILE:	
DESIGN BY:	DBH
DRAWN BY:	SKB
REVIEWED BY:	JMH

SHEET TITLE

TITLE & INDEX OF SHEETS

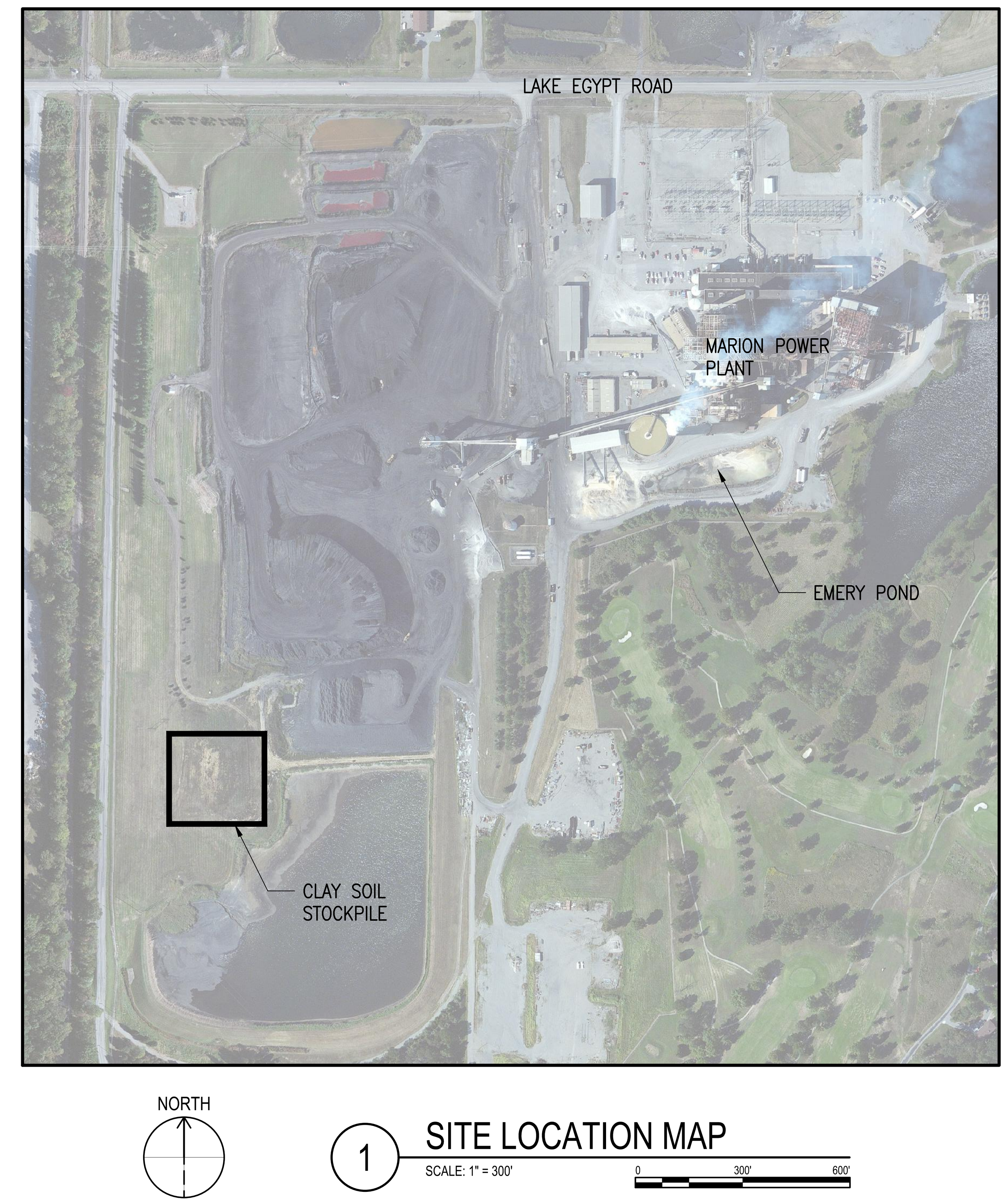
G001

GENERAL NOTES

1. "IDOT STANDARD SPECIFICATIONS", WHERE REFERENCED IN THE PLANS OR TECHNICAL SPECIFICATIONS, REFERS TO THE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" ADOPTED APRIL 1, 2016, PUBLISHED BY THE ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT).
2. ALL REINFORCEMENT BARS SHALL CONFORM TO ASTM A615, GRADE 60.
3. ALL SECTIONS, DETAILS, AND NOTES SHOWN ON THE DRAWINGS ARE INTENDED TO BE TYPICAL AND SHALL APPLY TO SIMILAR SITUATIONS ELSEWHERE, UNLESS OTHERWISE SHOWN.
4. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS BEFORE STARTING WORK. IF CONDITIONS VARY FROM THOSE INDICATED ON THE DRAWINGS, THE OWNER SHALL BE NOTIFIED AND NO WORK SHALL BE DONE IN THE AREA WITHOUT HIS APPROVAL.
5. SCALE FOR THE DRAWINGS IS FOR GENERAL INFORMATION ONLY. LOCATIONS AND DIMENSIONS SHALL BE TAKEN AS SHOWN AND NOT SCALED.
6. WHERE SPECIFIED, IDOT SPECIFICATIONS ARE SPECIFIED, THE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION", ADOPTED APRIL 1, 2016 SHALL APPLY.
7. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ASCERTAIN EXISTING FIELD CONDITIONS BEFORE BIDDING ON THIS PROJECT, ORDERING MATERIALS, OR BEGINNING CONSTRUCTION.
8. CONTRACTOR'S WORK ACTIVITIES SHALL BE RESTRICTED TO AREAS WITHIN THE LIMITS OF CONSTRUCTION. CONTRACTOR'S ACTIVITIES AND VEHICLES SHALL NOT BE ALLOWED OUTSIDE OF THESE LIMITS UNLESS APPROVED BY THE OWNER.
9. ALL ROCK AND DEBRIS SHALL BE DISPOSED OF OUT OF THE EMERY POND AREA IN A LOCATION DESIGNATED ON THE PLANS.
10. DISTURBED EARTH SURFACES SHALL BE SEEDED PER THE PROJECT SPECIFICATIONS.
11. CONTRACTOR IS RESPONSIBLE FOR THE SITE RESTORATION WITHIN THE LIMITS OF CONSTRUCTION.
12. ALL HDPE GEOMEMBRANE SHALL BE TEXTURED.
13. CUSHION GEOTEXTILES SHALL MEET THE REQUIREMENTS OF GEOSYNTHETIC RESEARCH INSTITUTE (GRI) SPECIFICATION GRI-GT12(a) "TEST METHODS AND PROPERTIES FOR NONWOVEN GEOTEXTILES USED AS PROTECTION (OR CUSHIONING) MATERIALS FOR THE MASS/UNIT AREA SPECIFIED.ON THE PLANS. THE MINIMUM OVERLAP BETWEEN ADJACENT PANELS SHALL BE 24 INCHES.
14. TEMPORARY EROSION CONTROL SYSTEMS SHALL BE INSTALLED IN ACCORDANCE WITH IDOT STANDARD DRAWING 280001-07 TEMPORARY EROSION CONTROL SYSTEMS. AND ARTICLE 280 OF THE IDOT STANDARD SPECIFICATIONS.
15. PRECAST BOX CULVERTS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM C1577-SPECIFICATION FOR PRECAST REINFORCED CONCRETE MONOLITHIC BOX SECTIONS FOR CULVERTS, STORM DRAINS, AND SEWERS DESIGNED ACCORDING TO AASHTO LRFD. PRECAST BOX CULVERT SECTIONS SHALL HAVE PREFORMED RUBBER JOINTS IN ACCORDANCE WITH ASTM C 1677-11A STANDARD SPECIFICATION FOR JOINTS FOR CONCRETE BOX, USING RUBBER GASKETS.
16. PRECAST BOX CULVERTS SHALL BE INSTALLED IN ACCORDANCE WITH ARTICLE 540 OF THE IDOT STANDARD SPECIFICATIONS, ALL SECTIONS SHALL BE MECHANICALLY TIED TOGETHER USING IDOT STANDARD 540-22 - MECHANICAL JOINTS FOR CONCRETE PIPE AND BOX CULVERTS. ALL BOX CULVERT SECTIONS SHALL BE EXTERNALLY WATERPROOFED WITH SEALING BANDS PER ASTM C 877-SPECIFICATION FOR EXTERNAL SEALING BANDS FOR CONCRETE PIPE, MANHOLES AND PRECAST BOX SECTIONS.
17. ALL OPEN EXCAVATION WORK SHALL BE PERFORMED IN ACCORDANCE WITH OSHA 29 CFR 1926, SUBPART P- "EXCAVATIONS". THE SUBCONTRACTOR SHALL DESIGNATE A QUALIFIED "COMPETENT PERSON" AS DEFINED IN OSHA SECTION 1926.650(b) PRIOR TO THE COMMENCEMENT OF ANY EXCAVATION ACTIVITIES.

SURVEY AND LAYOUT

1. THE DESIGN PLANS INCLUDED WERE BASED UPON A HORIZONTAL COORDINATE SYSTEM BASED ON THE NORTH AMERICAN DATUM OF 1983 (NAD83), ILLINOIS STATE PLANE EAST ZONE AND VERTICAL ELEVATIONS BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RE-ESTABLISHING ANY PROPERTY MONUMENTS THAT BECOME DAMAGED OR DESTROYED DURING CONSTRUCTION ACTIVITIES.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROPER ALIGNMENT (VERTICAL AND HORIZONTAL) AT ALL INTERFACES BETWEEN NEW AND EXISTING WORK TO ASSURE PROPER INSTALLATION AND USAGE.



1 SITE LOCATION MAP
SCALE: 1" = 300'

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GENERAL CIVIL NOTES

C001

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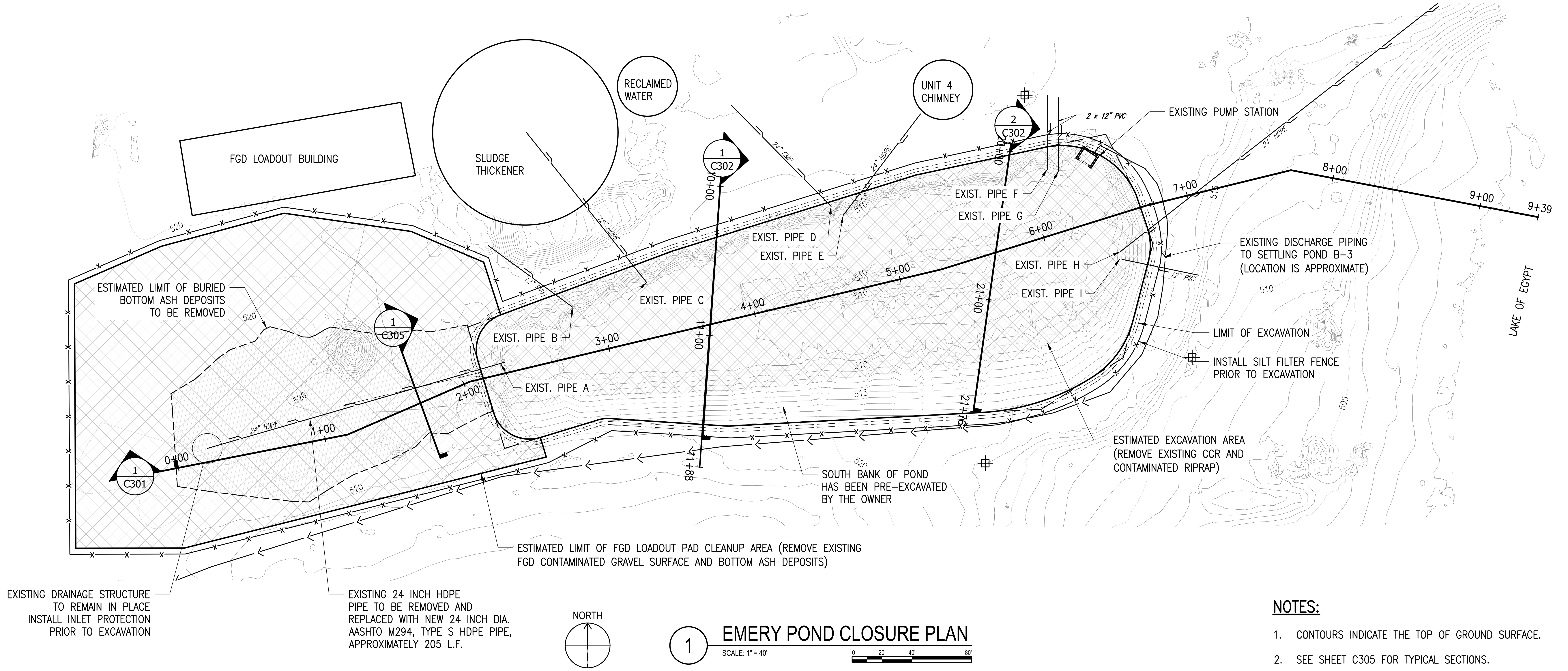


1 EMERY POND CLOSURE PLAN

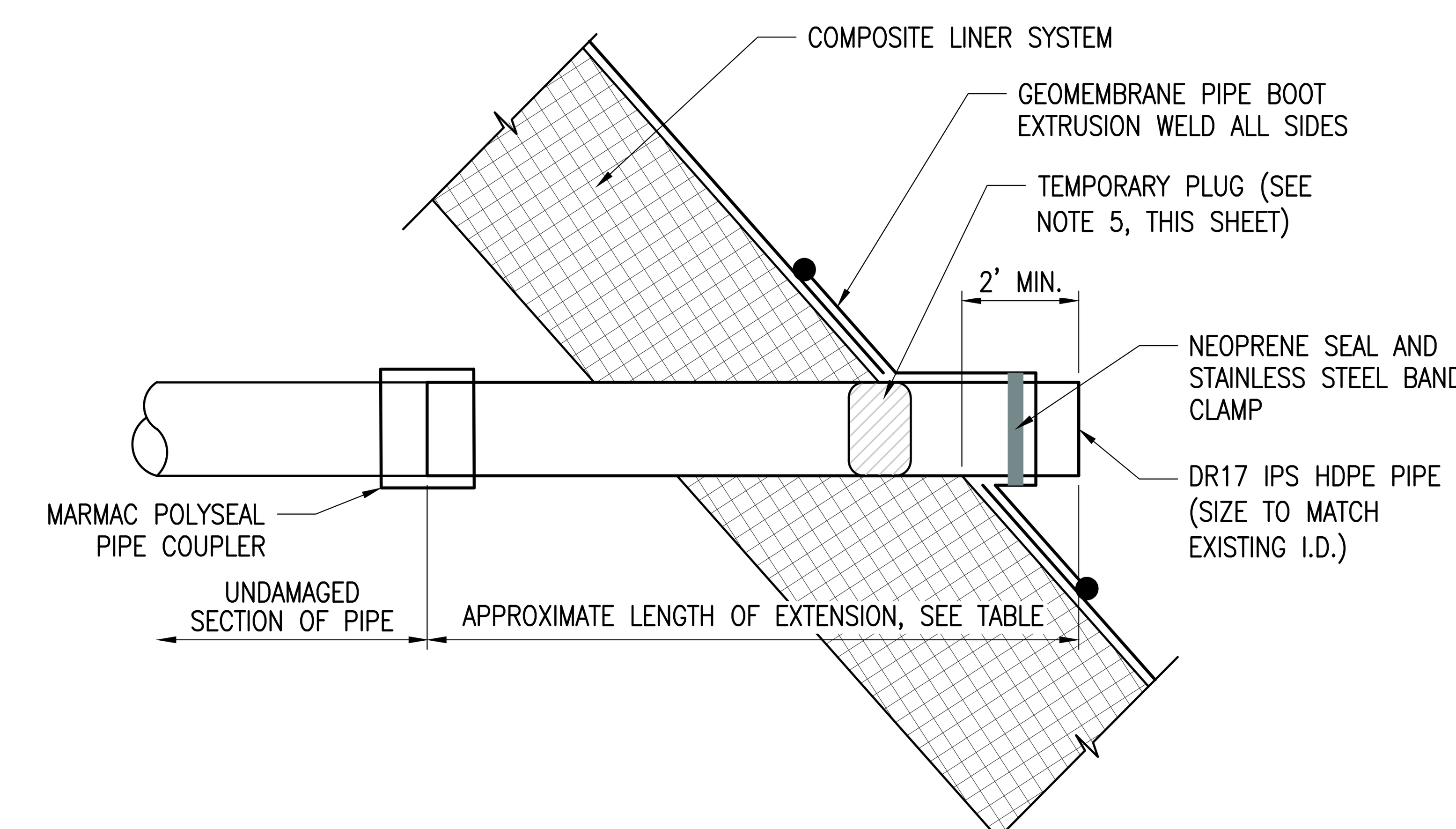
SCALE: 1" = 40'

NOTES:

1. CONTOURS INDICATE THE TOP OF GROUND SURFACE.
2. SEE SHEET C305 FOR TYPICAL SECTIONS.
3. EXISTING INFLOW PIPES SHALL BE REPAIRED AND EXTENDED THROUGH THE PROPOSED COMPOSITE LINER PER DETAIL 2 OF THIS SHEET. DAMAGED PIPING THAT IS REMOVED SHALL BE DISPOSED OF IN A LEGAL MANNER AS CONTAMINATED CCR MATERIALS.
4. PROPOSED PIPES TO BE REPLACED AND PIPE EXTENSIONS SHALL MATCH THE GRADE OF THE EXISTING PIPING.
5. CONTRACTOR SHALL INSTALL TEMPORARY PLUGS INSIDE OF ALL INCOMING PIPES TO PREVENT DISCHARGE DURING CONSTRUCTION. CONTRACTOR SHALL MAINTAIN OPERATION OF THE PLUGS DURING THE DURATION OF THE PROJECT. THE TEMPORARY PLUGS SHALL BE REMOVED UPON COMPLETION OF THE PROJECT.
6. CCR MATERIAL EXCAVATED FROM EMERY POND MAY BE PILED ON THE EXISTING FGD STOCKPILE AREA FOR FINAL DEWATERING. ALL SURFACE WATER THAT COMES INTO CONTACT WITH THIS CCR MATERIAL SHALL BE DIRECTED BACK INTO EMERY POND DURING DEWATERING. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTION OF ANY TEMPORARY BERMS AND/OR GRADING REQUIRED TO MAINTAIN SURFACE WATER FLOW INTO EMERY POND.
7. THE PLANT MAY ELECT TO PARTIALLY EXCAVATE CCR MATERIAL PRIOR TO CONTRACTOR MOBILIZATION. CCR EXCAVATION AND DISPOSAL PERFORMED BY THE CONTRACTOR WILL BE DONE BASED ON A TIME AND MATERIALS BASIS.

PIPE BOOT REPAIR DATA

PIPE ID	DIAMETER	MATERIAL	EXTENSION LENGTH
A	24"	HDPE	5.52 FT
B	12"	PVC	12.92 Ft
C	12"	HDPE	7.87 Ft
D	24"	CMP	20.02 FT
E	24"	HDPE	11.82 FT
F	12"	PVC	5.17 FT
G	12"	PVC	4.35 FT
H	24"	HDPE	9.90 FT
I	12"	PVC	5.92 FT



2 PIPE BOOT / REPAIR DETAIL

NO SCALE

LEGEND

- MONITORING WELL LOCATION
- EXISTING DRAINAGE OR PROCESS WATER PIPING
- EXISTING PUMP STATION DISCHARGE PIPING

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SHEET TITLE

EMERY POND CLOSURE PLAN

C101

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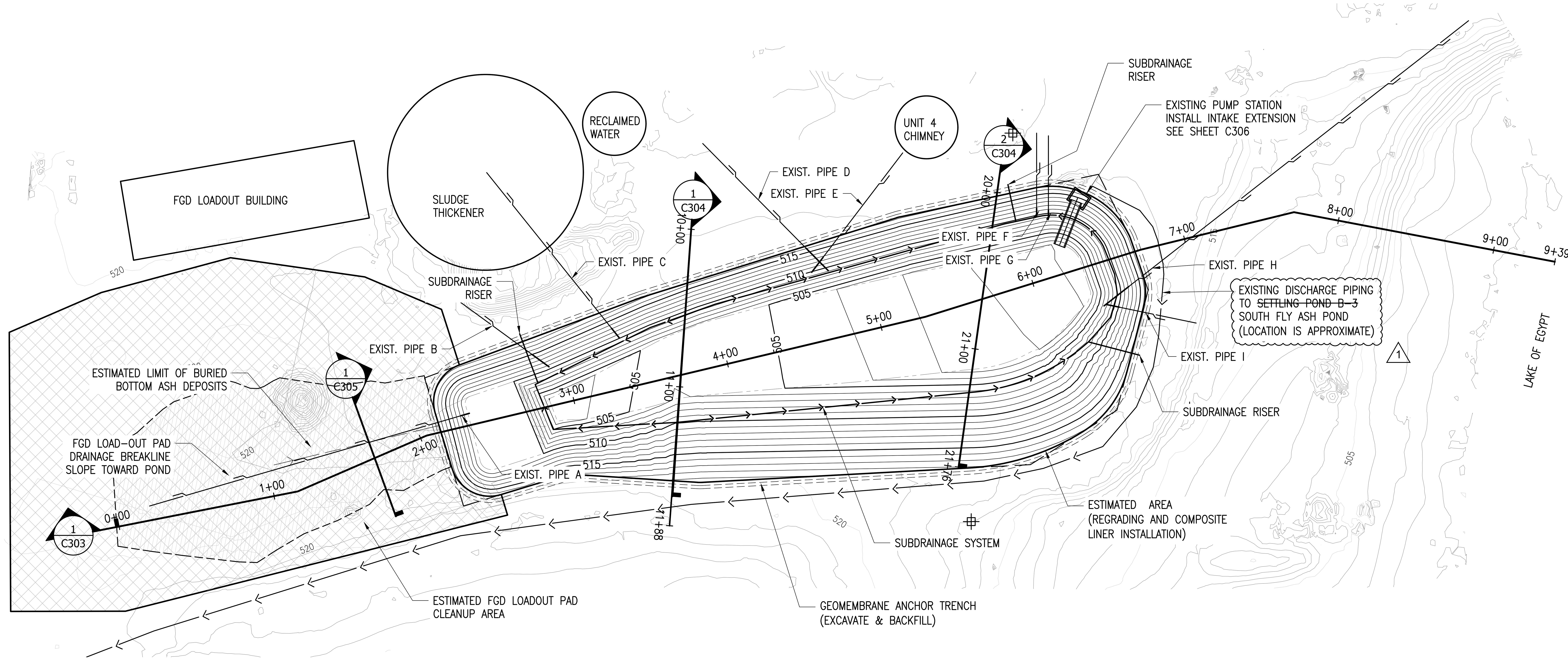

NORTH

1 STORM WATER BASIN PLAN

SCALE: 1" = 40'

0 20' 40' 80'

NOTES:

1. LIGHT CONTOURS INDICATE THE TOP OF GROUND SURFACE.
2. HEAVY CONTOURS INDICATE TOP OF BASE GRADE.
3. SEE SHEET C305 FOR TYPICAL SECTIONS.
4. SEE SHEET C103 AND C104 FOR GRADING CONTROL POINTS.

LEGEND

- MONITORING WELL LOCATION
- EXISTING DRAINAGE OR PROCESS WATER PIPING
- EXISTING PUMP STATION DISCHARGE PIPING
- TOE OF SLOPE
- SUBDRAINAGE SYSTEM PIPING

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SHEET TITLE

STORM WATER BASIN PLAN

C102

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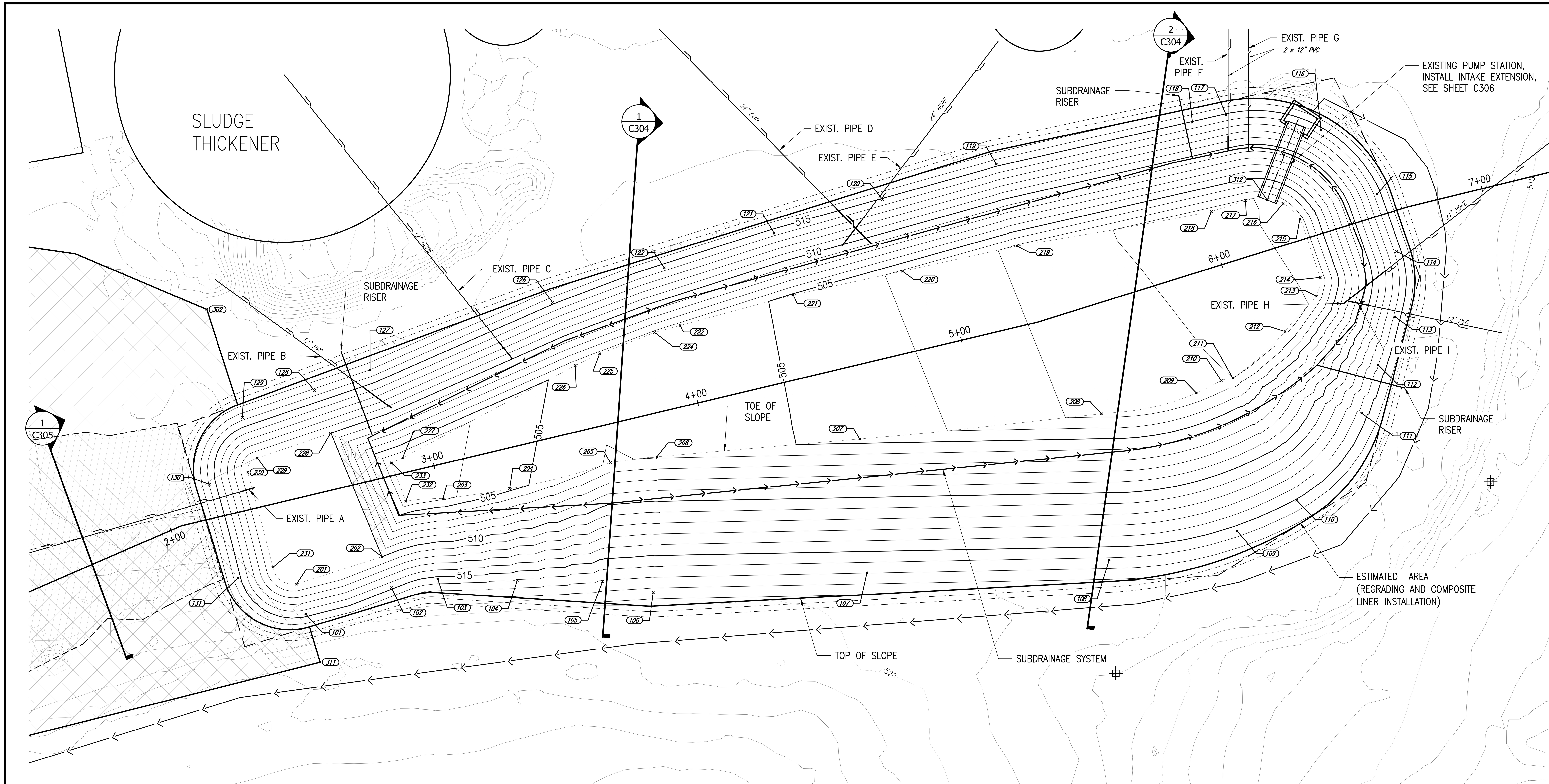

NORTH

1 STORM WATER BASIN GRADING & LAYOUT PLAN

SCALE: 1" = 20'

0 20 40

NOTES:

1. LIGHT CONTOURS INDICATE THE TOP OF GROUND SURFACE.
2. HEAVY CONTOURS INDICATE TOP OF BASE GRADE.
3. SEE SHEET C305 FOR TYPICAL SECTIONS.
4. SEE SHEET C105 FOR GRADING CONTROL POINT TABLES.

LEGEND

MONITORING WELL LOCATION

EXISTING DRAINAGE OR PROCESS WATER PIPING

EXISTING PUMP STATION DISCHARGE PIPING

TOE OF SLOPE

SUBDRAINAGE SYSTEM PIPING

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STORM WATER BASIN GRADING & LAYOUT PLAN

C103

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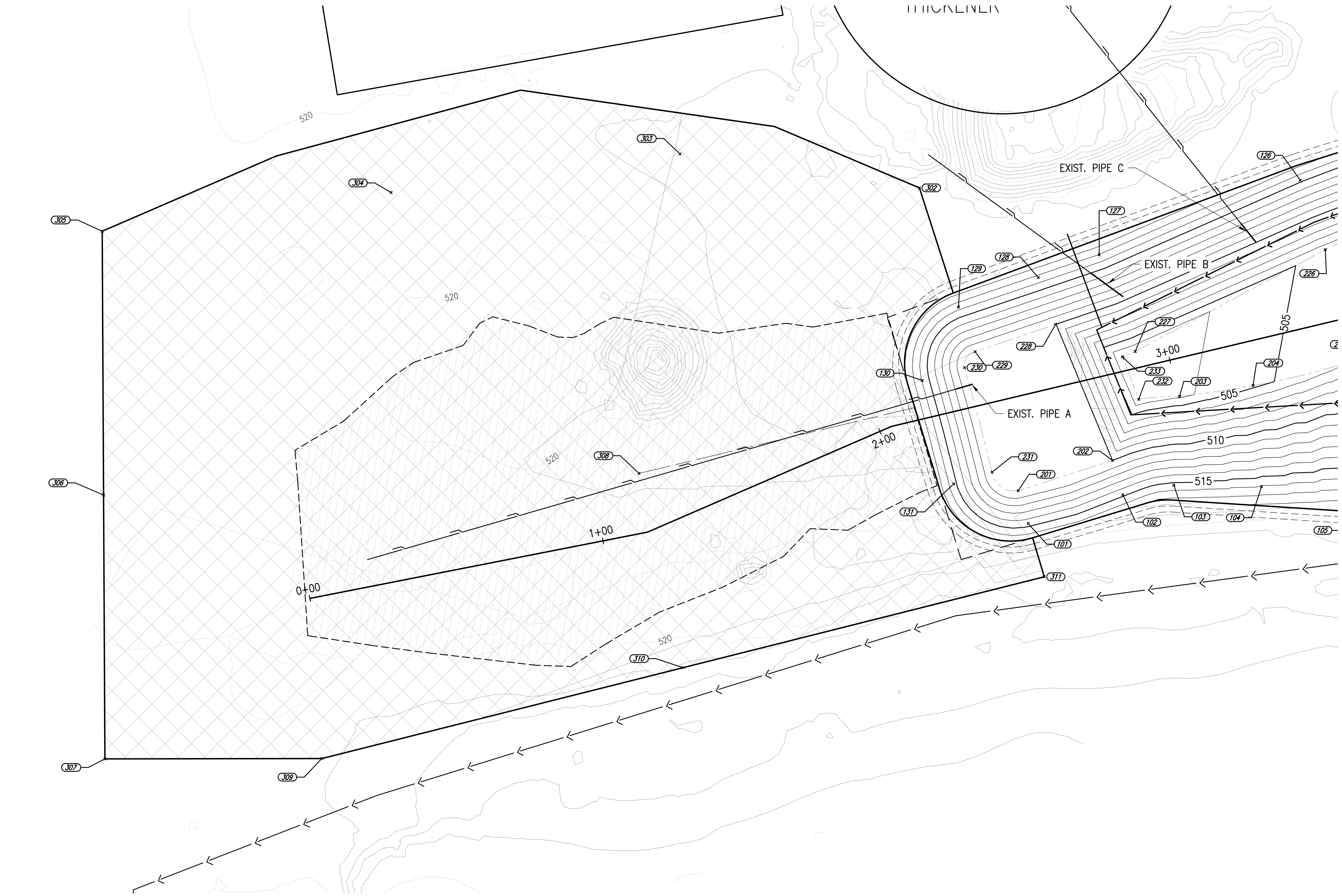

NORTH

1 FGD AREA GRADING & LAYOUT PLAN

SCALE: 1" = 20'

0 20 40

NOTES:

1. LIGHT CONTOURS INDICATE THE TOP OF GROUND SURFACE.
2. HEAVY CONTOURS INDICATE TOP OF BASE GRADE.
3. SEE SHEET C305 FOR TYPICAL SECTIONS.
4. SEE SHEET C105 FOR GRADING CONTROL POINT TABLES.

LEGEND

- MONITORING WELL LOCATION
- EXISTING DRAINAGE OR PROCESS WATER PIPING
- EXISTING PUMP STATION DISCHARGE PIPING
- TOE OF SLOPE
- SUBDRAINAGE SYSTEM PIPING

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FGD AREA GRADING & LAYOUT PLAN

C104

GRADING CONTROL POINTS

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
101	347064.26	804362.27	514.61	TOP OF SLOPE
102	347073.91	804393.97	514.79	TOP OF SLOPE
103	347077.11	804411.04	515.33	TOP OF SLOPE
104	347076.68	804440.38	516.09	TOP OF SLOPE
105	347076.21	804471.85	517.11	TOP OF SLOPE
106	347072.15	804490.55	518.41	TOP OF SLOPE
107	347079.40	804569.33	516.98	TOP OF SLOPE
108	347084.22	804658.72	516.20	TOP OF SLOPE
109	347094.89	804705.92	515.48	TOP OF SLOPE
110	347106.23	804727.89	515.11	TOP OF SLOPE
111	347138.39	804751.80	514.42	TOP OF SLOPE
112	347156.19	804757.99	513.97	TOP OF SLOPE
113	347174.00	804764.18	514.21	TOP OF SLOPE
114	347198.10	804764.74	514.35	TOP OF SLOPE
115	347219.25	804757.53	514.46	TOP OF SLOPE
116	347242.91	804736.88	514.66	TOP OF SLOPE
117	347248.51	804701.84	514.85	TOP OF SLOPE
118	347245.84	804689.41	514.92	TOP OF SLOPE
119	347230.32	804617.14	515.30	TOP OF SLOPE
120	347217.28	804575.08	514.85	TOP OF SLOPE

GRADING CONTROL POINTS

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
121	347204.80	804535.09	514.35	TOP OF SLOPE
122	347192.14	804494.54	514.46	TOP OF SLOPE
126	347179.25	804453.34	515.26	TOP OF SLOPE
127	347154.25	804386.03	516.95	TOP OF SLOPE
128	347146.67	804365.63	516.70	TOP OF SLOPE
129	347136.75	804338.93	516.37	TOP OF SLOPE
130	347112.17	804326.76	515.94	TOP OF SLOPE
131	347077.56	804337.31	515.38	TOP OF SLOPE
201	347075.27	804358.92	510.00	TOE OF SLOPE
202	347085.38	804390.48	510.00	TOE OF SLOPE
203	347106.82	804412.94	503.81	TOE OF SLOPE
204	347110.47	804437.54	504.74	TOE OF SLOPE
205	347120.17	804474.67	506.10	TOE OF SLOPE
206	347122.29	804491.90	505.88	TOE OF SLOPE
207	347128.84	804566.66	504.60	TOE OF SLOPE
208	347138.14	804655.81	502.70	TOE OF SLOPE
209	347145.81	804690.91	502.19	TOE OF SLOPE
210	347150.42	804700.05	502.05	TOE OF SLOPE
211	347151.28	804704.35	502.00	TOE OF SLOPE
212	347168.51	804723.61	501.63	TOE OF SLOPE

GRADING CONTROL POINTS

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
213	347181.56	804735.13	502.20	TOE OF SLOPE
214	347188.49	804736.55	502.43	TOE OF SLOPE
215	347210.03	804729.02	502.60	TOE OF SLOPE
216	347215.77	804722.89	502.46	TOE OF SLOPE
217	347216.83	804709.07	501.85	TOE OF SLOPE
218	347212.88	804696.48	501.43	TOE OF SLOPE
219	347200.07	804624.67	502.83	TOE OF SLOPE
220	347190.79	804582.48	503.84	TOE OF SLOPE
221	347182.03	804542.19	504.81	TOE OF SLOPE
222	347170.72	804500.39	505.59	TOE OF SLOPE
224	347168.18	804491.07	505.75	TOE OF SLOPE
225	347160.26	804470.75	505.66	TOE OF SLOPE
226	347155.99	804461.71	505.34	TOE OF SLOPE
227	347121.86	804398.06	503.13	TOE OF SLOPE
228	347130.97	804371.46	510.00	TOE OF SLOPE
229	347121.81	804344.48	510.00	TOE OF SLOPE
230	347116.50	804340.97	510.00	TOE OF SLOPE
231	347081.48	804350.18	510.00	TOE OF SLOPE
232	347105.85	804399.25	503.29	TOE OF SLOPE
233	347120.07	804393.82	503.00	TOE OF SLOPE

GRADING CONTROL POINTS

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
302	347176.67	804325.84	518.84	FGD PAD LIMIT
303	347188.06	804245.66	518.76	FGD PAD LIMIT
304	347175.11	804148.95	519.13	FGD PAD LIMIT
305	347162.15	804052.24	519.50	FGD PAD LIMIT
306	347073.80	804052.69	519.86	FGD PAD LIMIT
307	346985.45	804053.14	520.23	FGD PAD LIMIT
308	347081.06	804231.94	519.45	FGD PAD BREAKLINE
309	346985.57	804125.78	520.78	FGD PAD LIMIT
310	347016.00	804246.71	521.29	FGD PAD LIMIT
311	347046.43	804367.65	521.80	FGD PAD LIMIT
312	347217.06	804716.99	505.57	INVERT, 6'W BOX CULVERT

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GRADING CONTROL POINTS

C105

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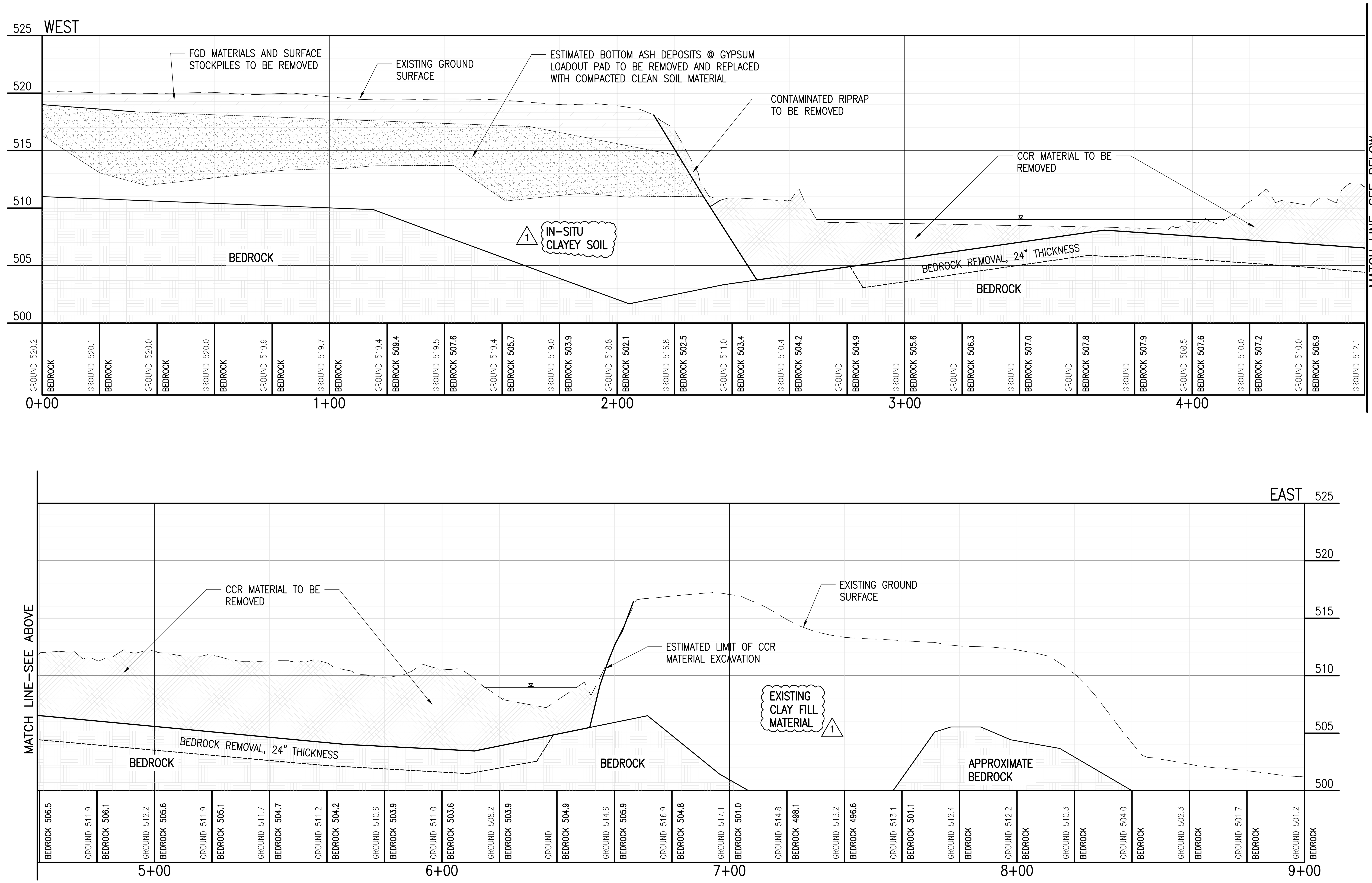

1 EXCAVATION CROSS SECTION

SCALES:

HORIZONTAL:

VERTICAL:

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EXCAVATION CROSS SECTIONS

C301

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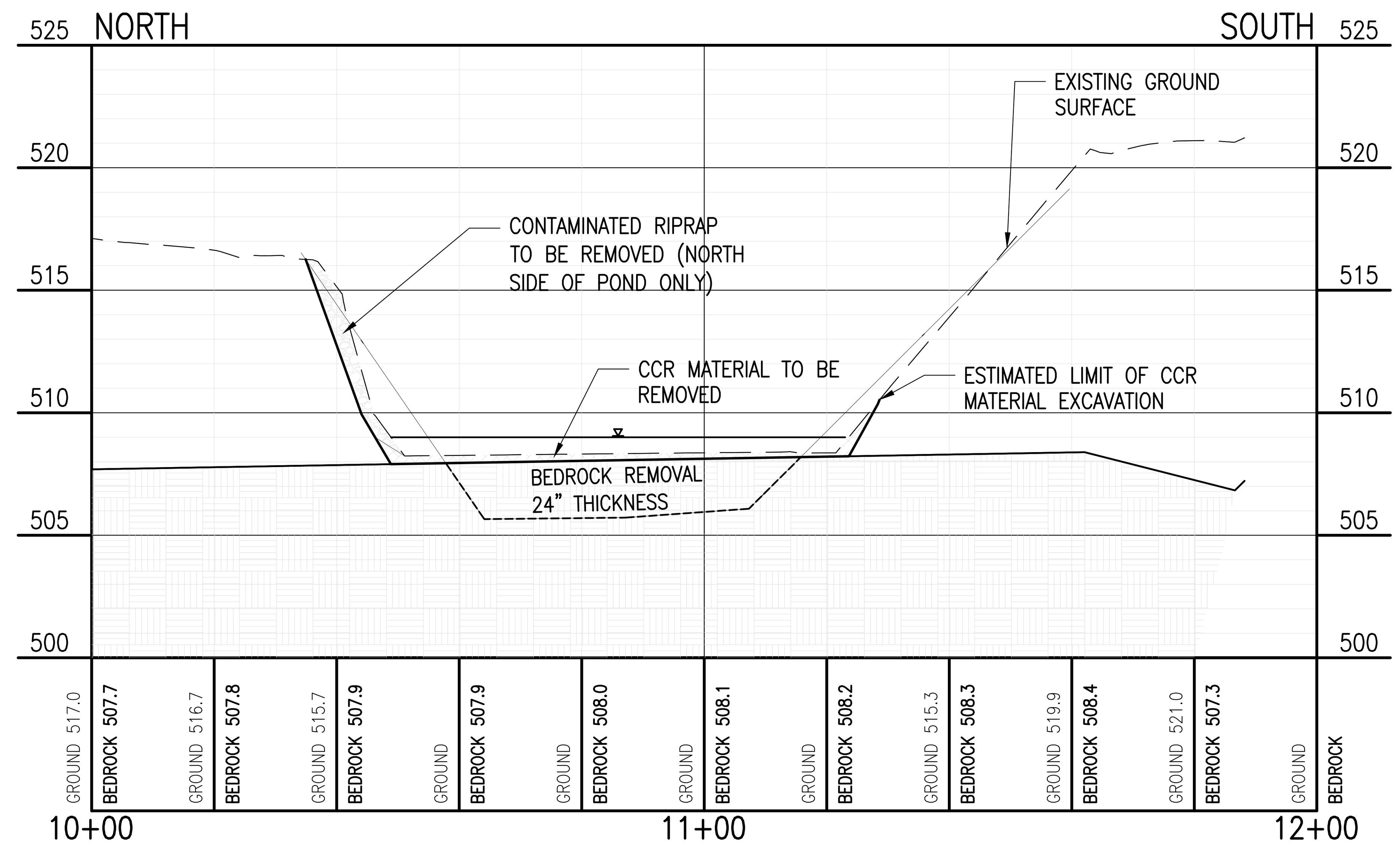
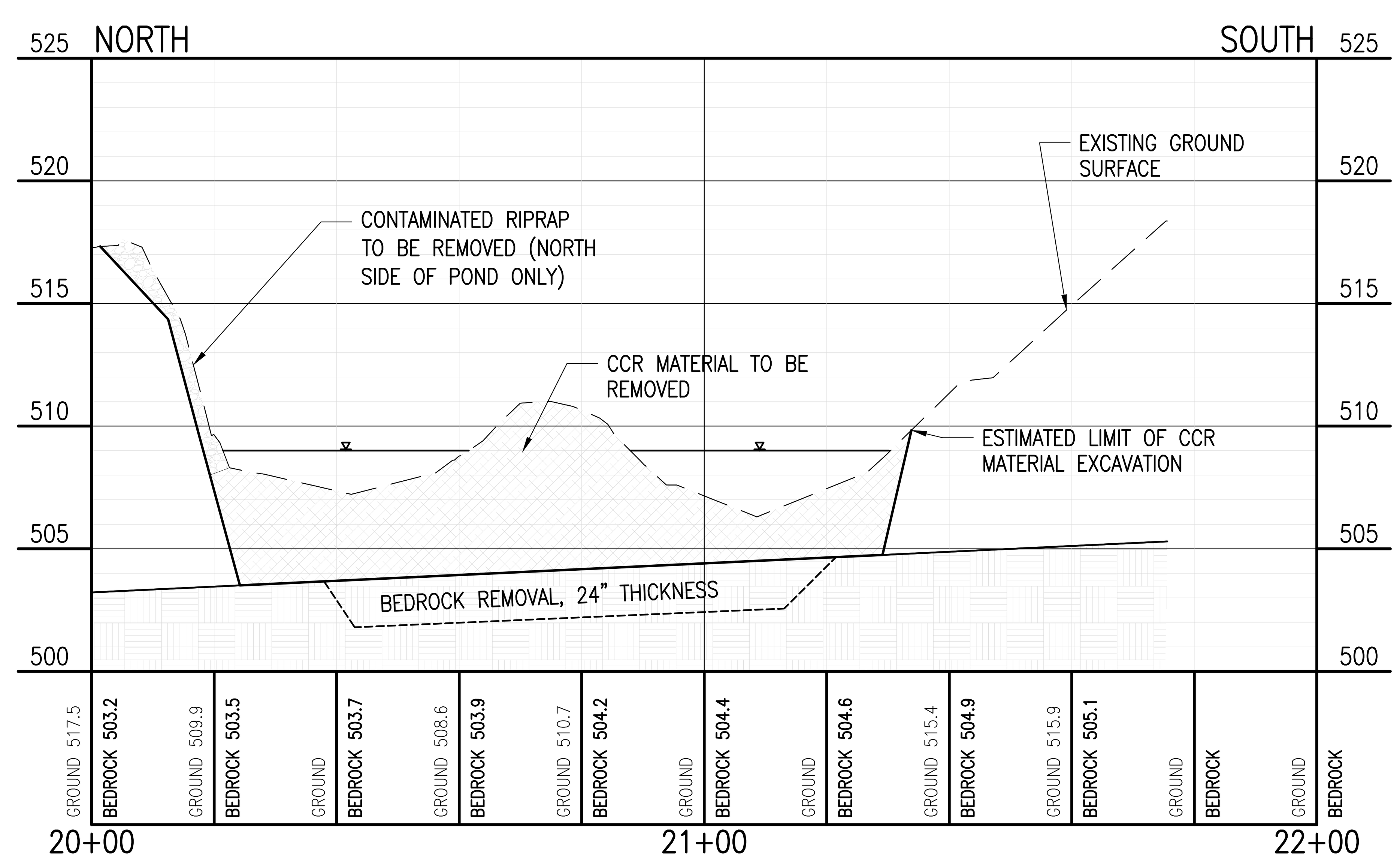


1 EXCAVATION CROSS SECTION

SCALES:

HORIZONTAL: 0 10' 20' 40'

VERTICAL: 0 5 10



2 EXCAVATION CROSS SECTION

SCALES:

HORIZONTAL: 0 10' 20' 40'

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EXCAVATION CROSS SECTIONS

C302

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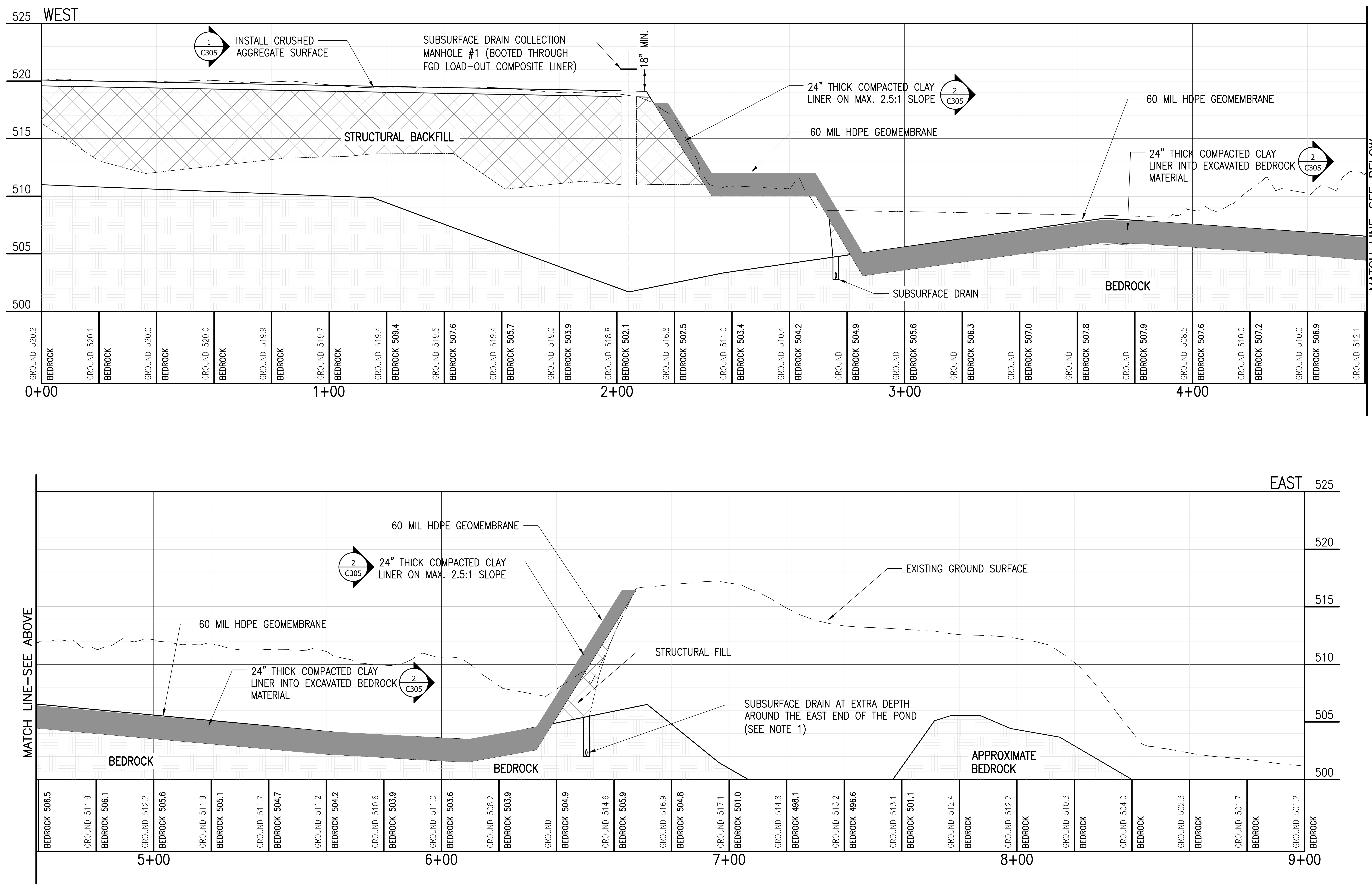

1 CROSS SECTION

SCALES:

HORIZONTAL: 0 10' 20' 40'

VERTICAL: 0 5 10

NOTES:

1. INSTALL SUBSURFACE DRAINS EAST OF STATION 6+12 AT EXTRA DEPTH TO PROVIDE POSITIVE DRAINAGE TOWARD SUBSURFACE DRAINAGE MANHOLE #2.
2. STRUCTURAL FILL SHALL NOT BE COMPOSED OF ANY TYPE OF CCR OR CCB.

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CONSULTANTS

EMERY POND CLOSURE & STORM WATER CONSTRUCTION PLANS

SOUTHERN ILLINOIS POWER COOPERATIVE — SIPC

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

MARION POWER PLANT
WILLIAMSON CO.
ILLINOIS

MARK	DATE	DESCRIPTION		
1	3/18/21	PERMIT REVISIONS		
		DBH	DBH	JMH
		DES	DRN	REV

ISSUE:	07-14-2020
PROJECT NO:	18E0022A
CAD FILE:	
DESIGN BY:	DBH
DRAWN BY:	SKB
REVIEWED BY:	JMH

SHEET TITLE

GRADING CROSS SECTIONS

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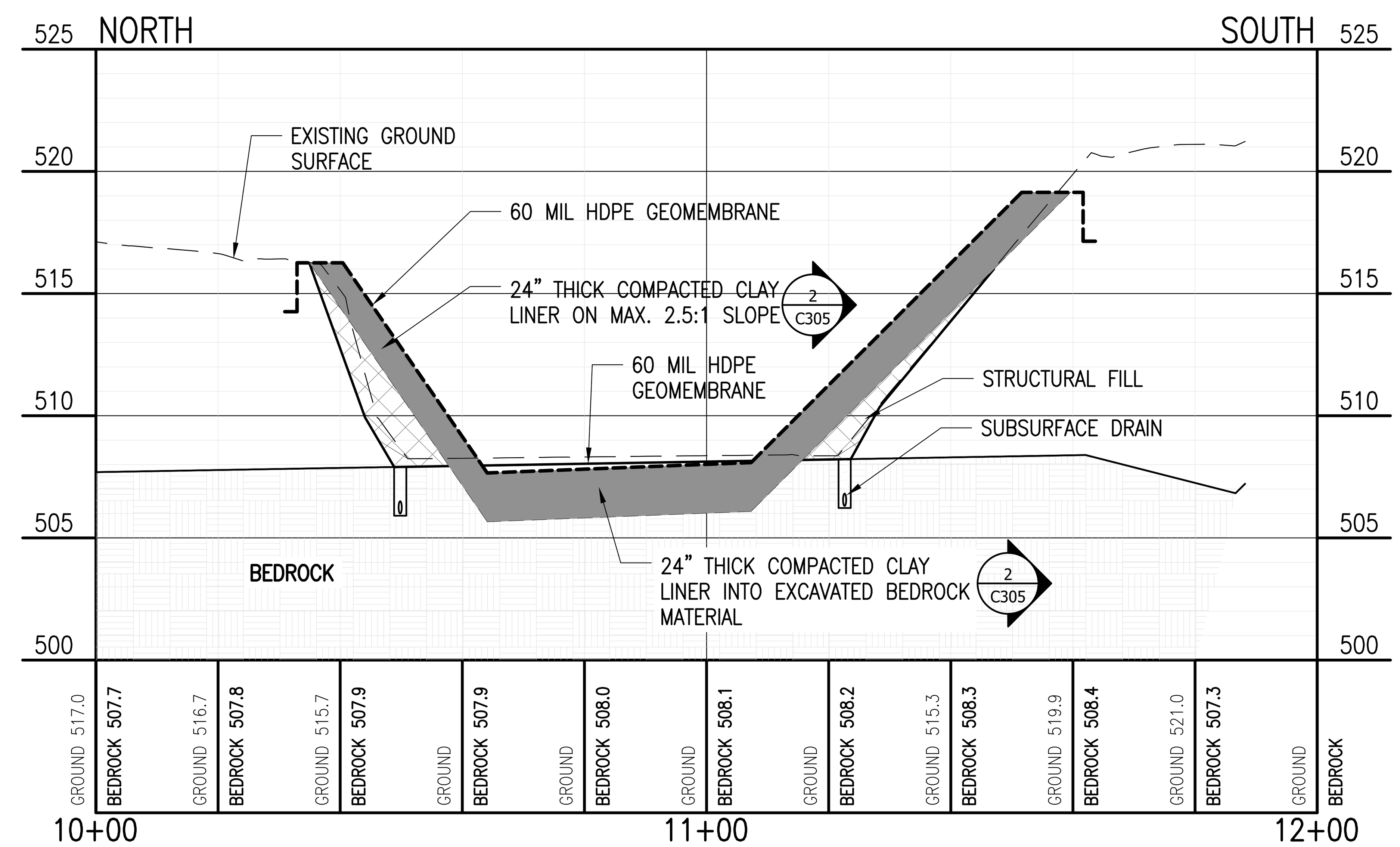

1 CROSS SECTION

SCALES:

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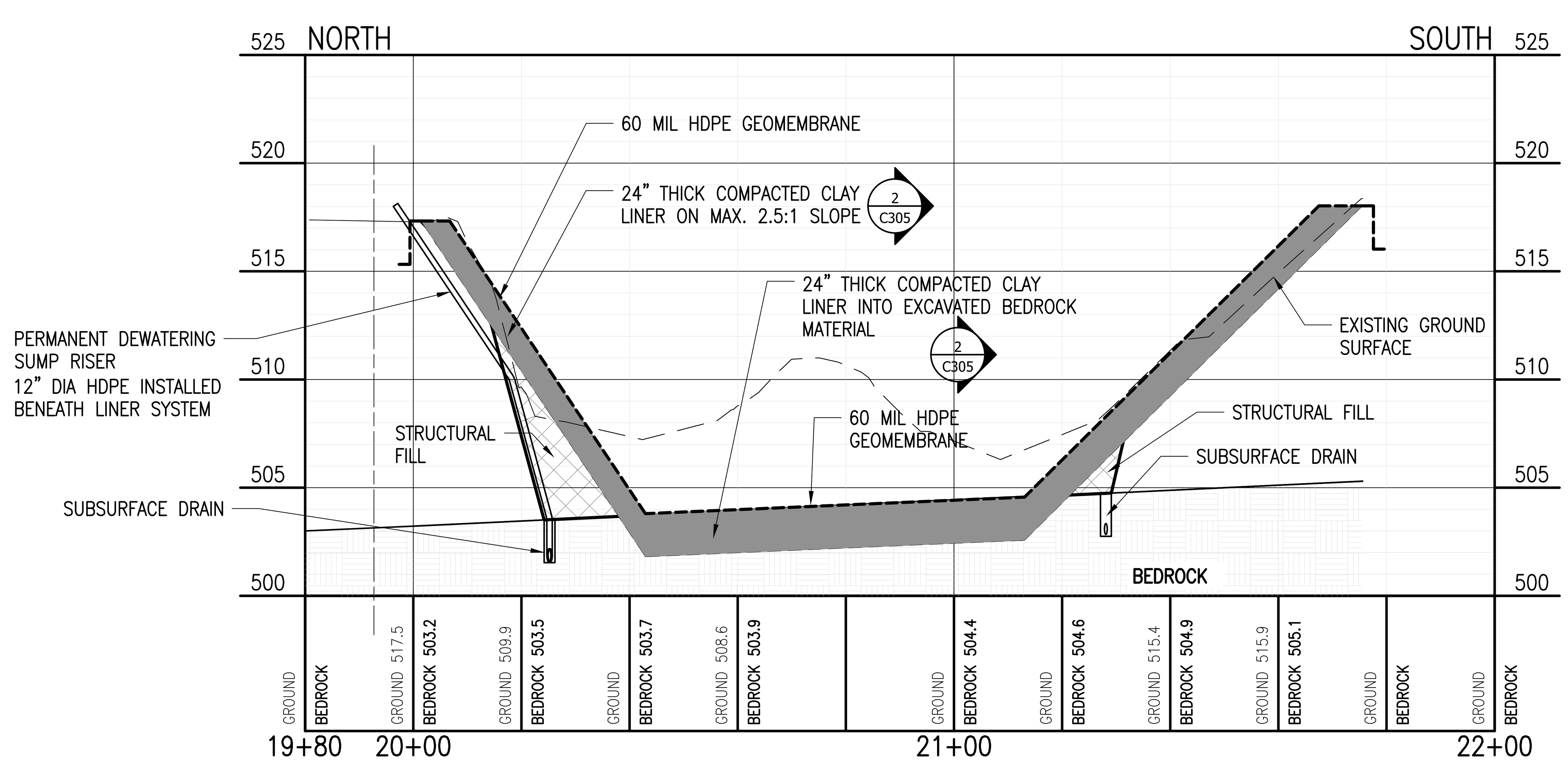
VERTICAL: 0 5 10



2 CROSS SECTION

SCALES:

HORIZONTAL: 0 10' 20' 40'

VERTICAL: 0 5 10

NOTES:

1. STRUCTURAL FILL SHALL NOT BE COMPOSED OF ANY TYPE OF CCR OR CCB. 1

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SHEET TITLE

GRADING
CROSS SECTIONS

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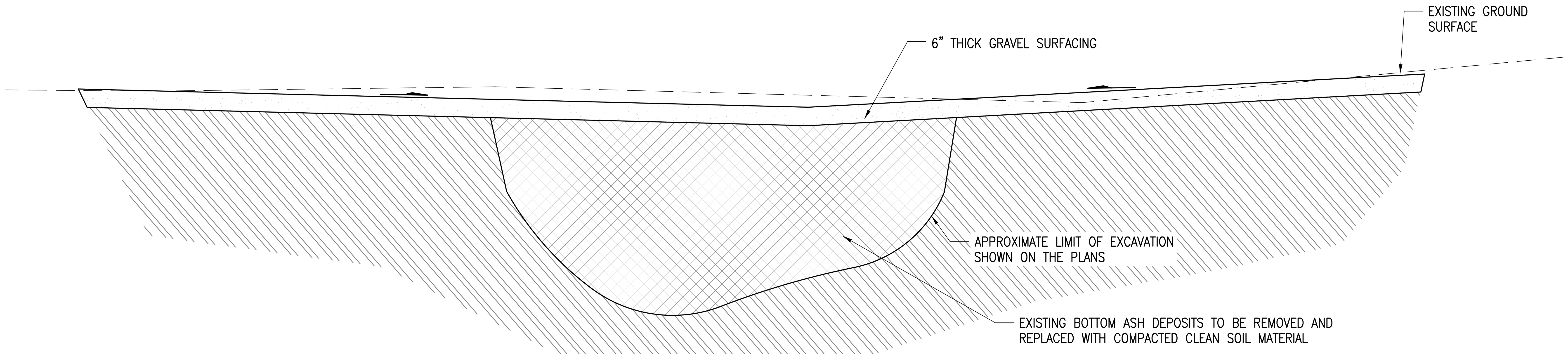
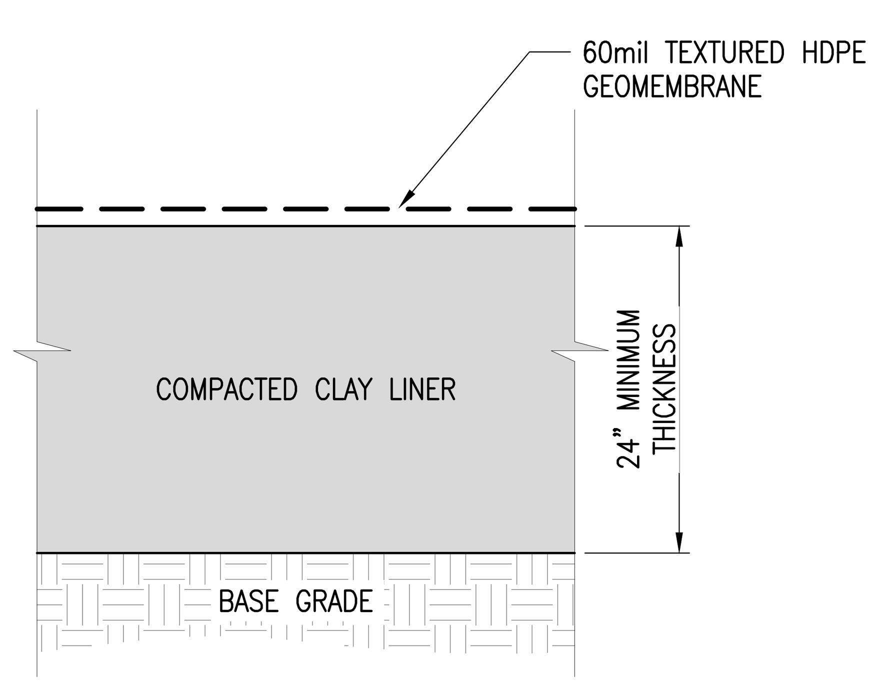
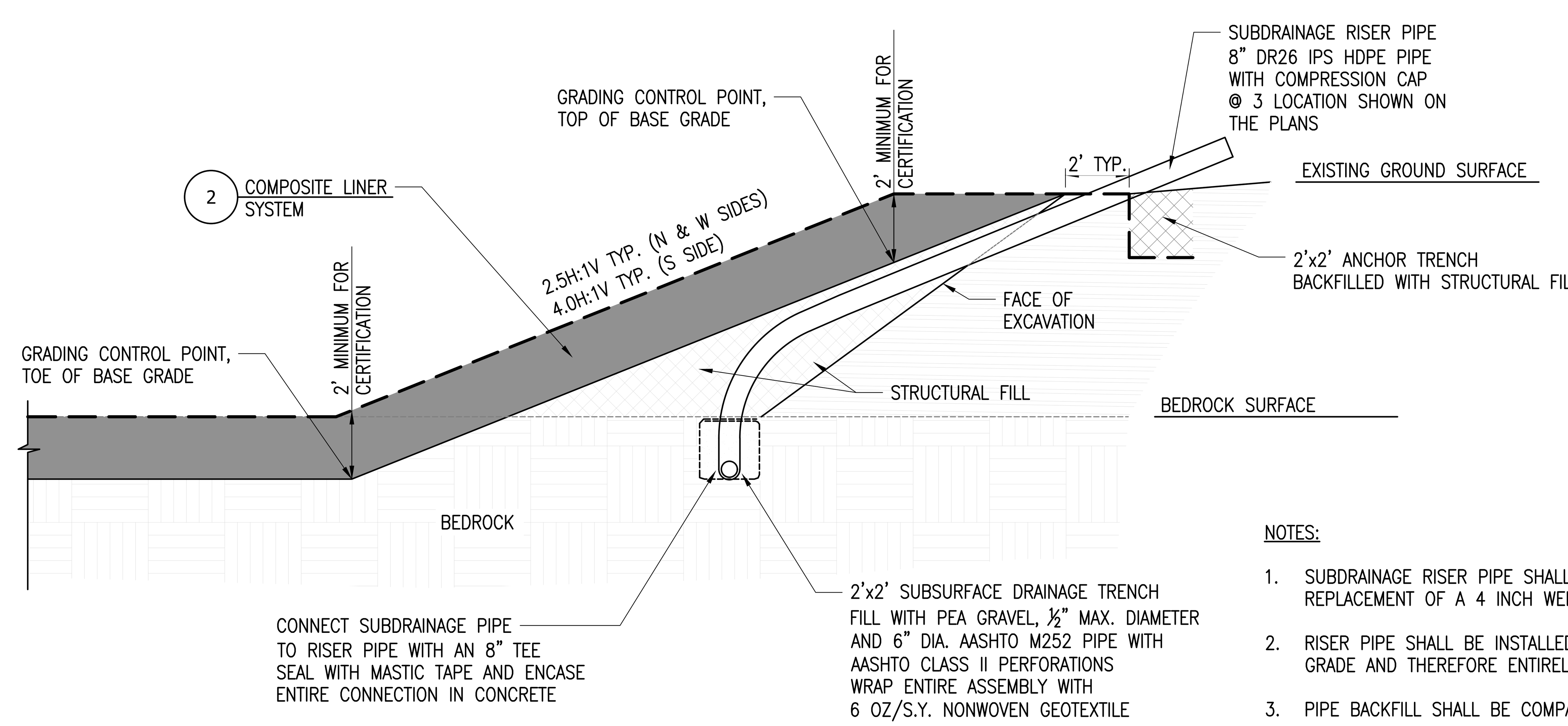


1 FGD LOADOUT AREA CLEANUP
NOT TO SCALE



2 COMPOSITE LINER SYSTEM
NOT TO SCALE



3 TYPICAL SECTION
NOT TO SCALE

NOTES:

1. SUBDRAINAGE RISER PIPE SHALL BE FIELD BENT TO ALLOW INSTALLATION AND REPLACEMENT OF A 4 INCH WELL PUMP, SAFETY CABLE AND WIRING HARNESS.
2. RISER PIPE SHALL BE INSTALLED A MINIMUM OF 8 INCHES BELOW THE BASE GRADE AND THEREFORE ENTIRELY BENEATH THE COMPOSITE LINER SYSTEM,
3. PIPE BACKFILL SHALL BE COMPACTED CLAY LINER MATERIAL.
4. STRUCTURAL FILL SHALL NOT BE COMPOSED OF ANY TYPE OF CCR OR CCB.

1

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CAD FILE:	
DESIGN BY:	DBH
DRAWN BY:	SKB
REVIEWED BY:	JMH

SHEET TITLE

TYPICAL SECTIONS

C305

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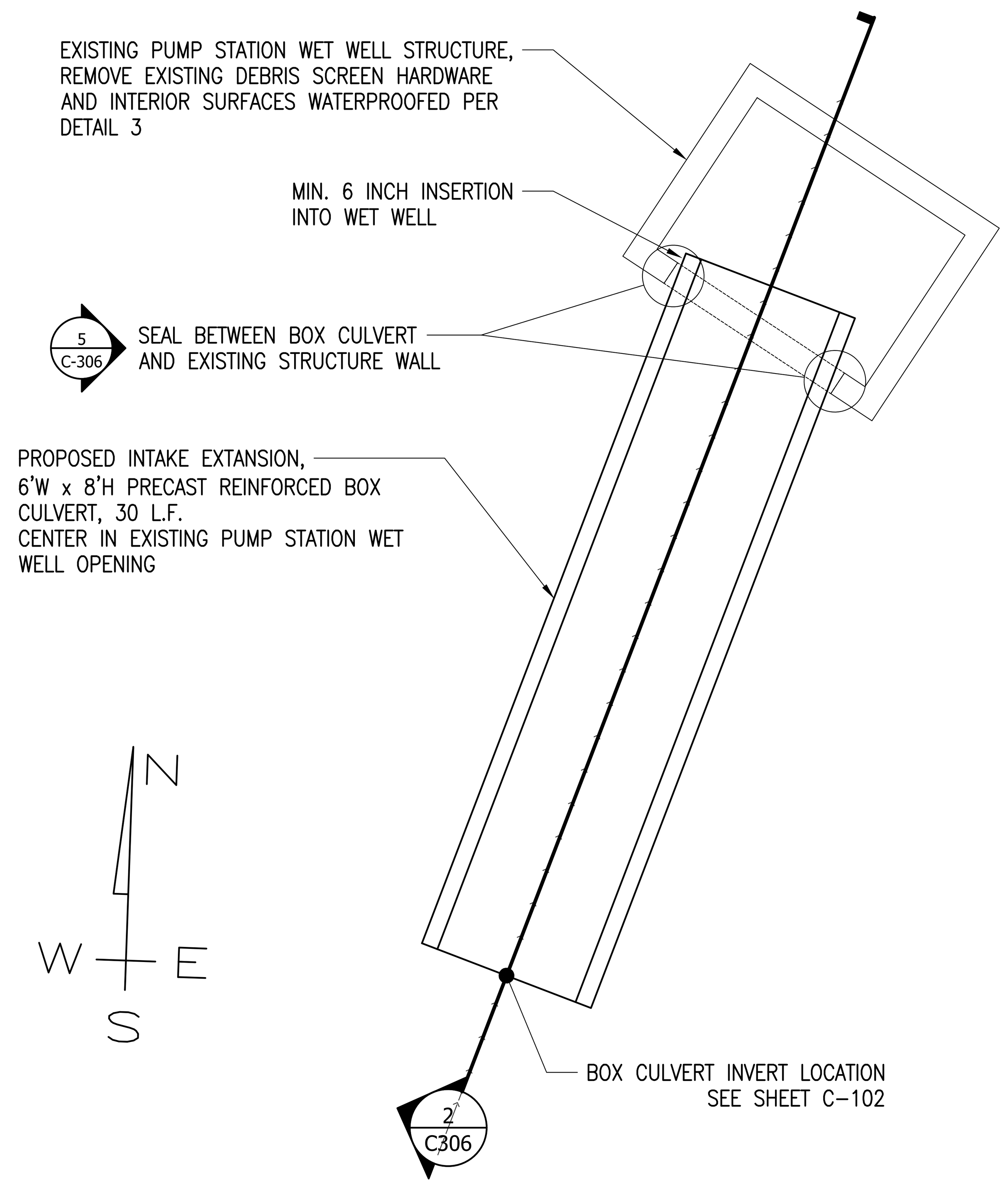
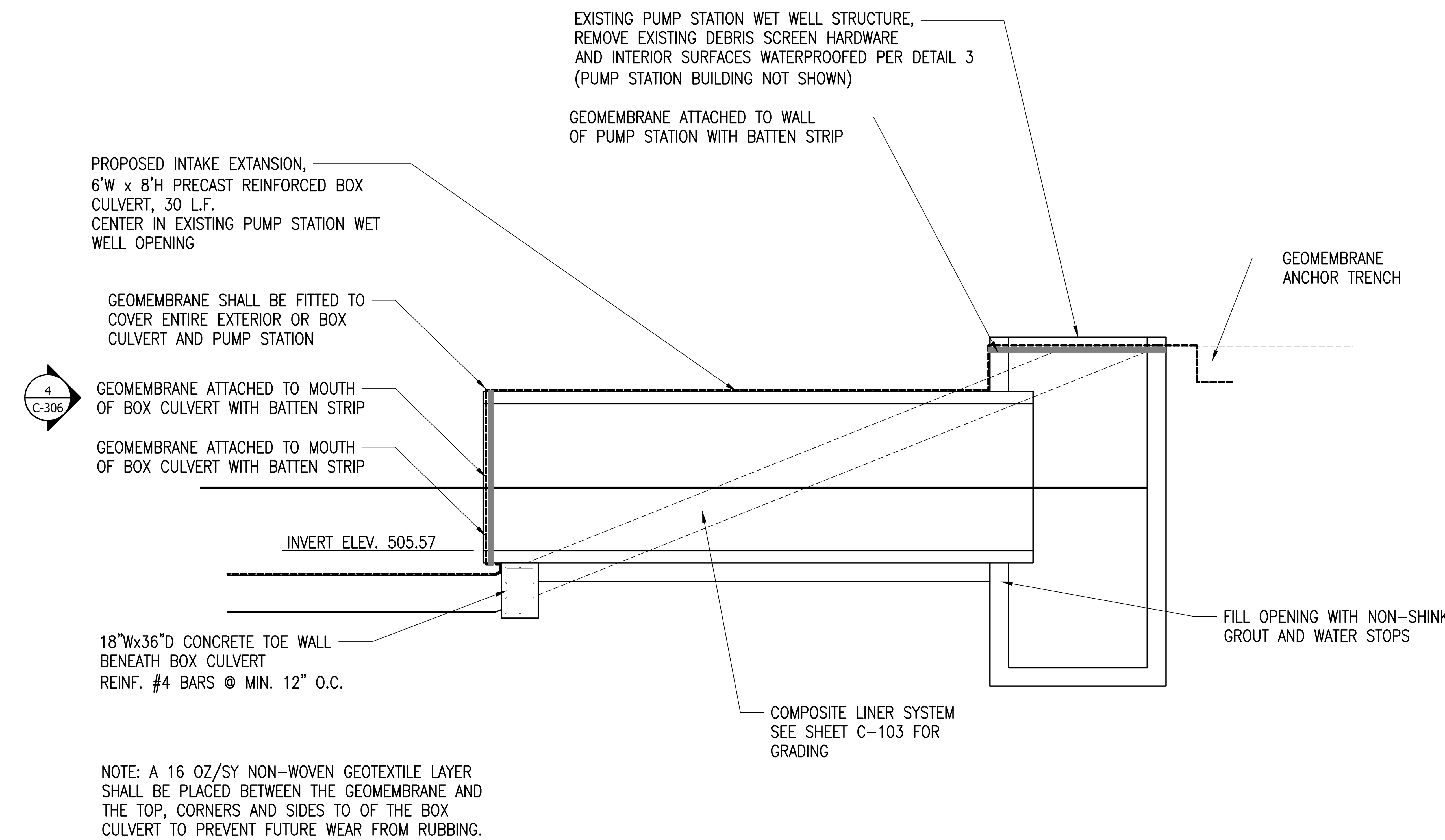
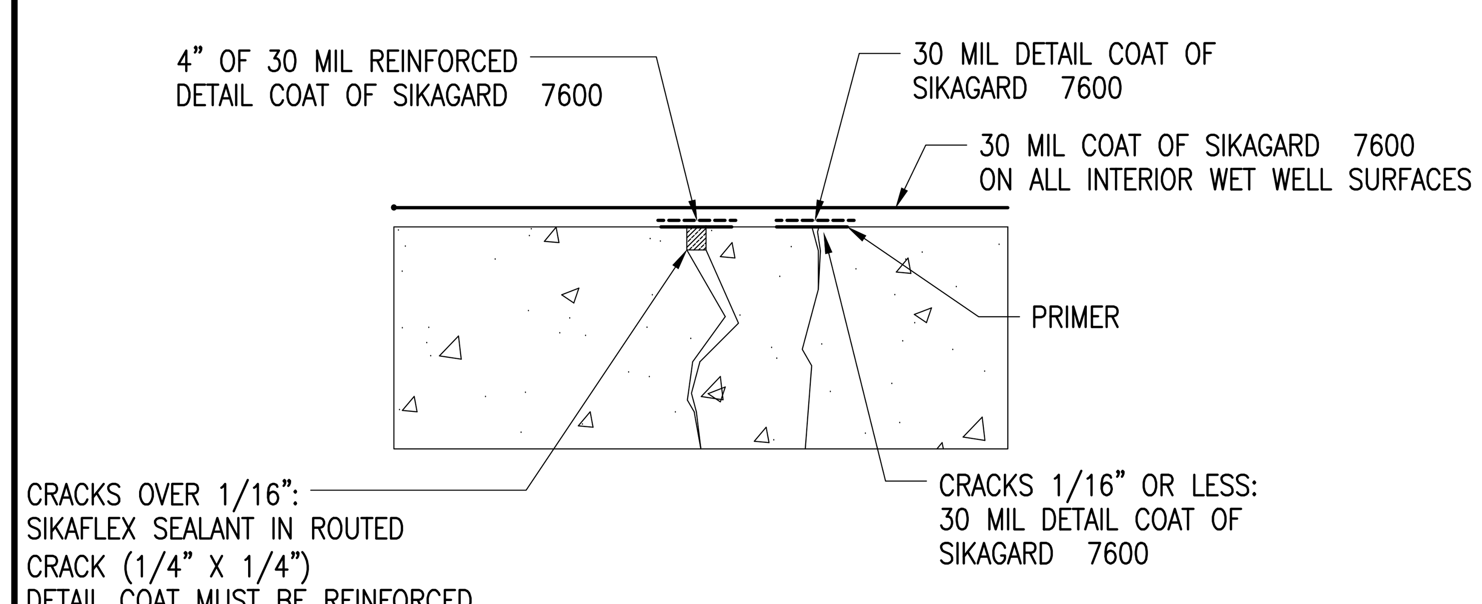


1 PUMP STATION INTAKE EXTENSION
PLAN - NOT TO SCALE

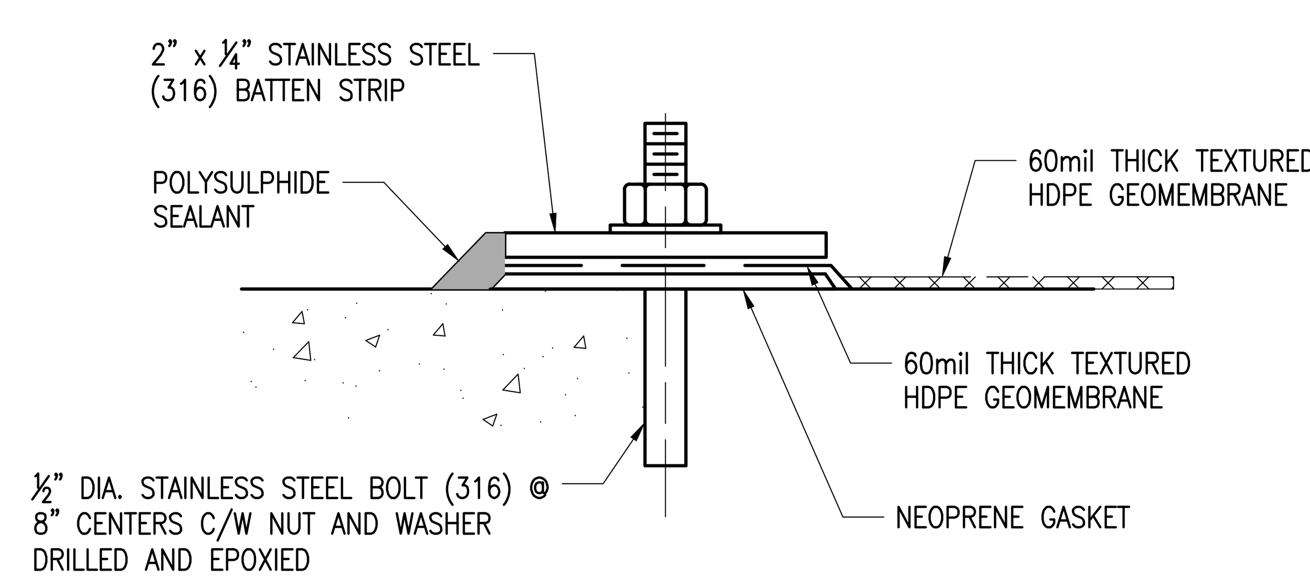


2 PUMP STATION INTAKE EXTENSION
PROFILE - NOT TO SCALE

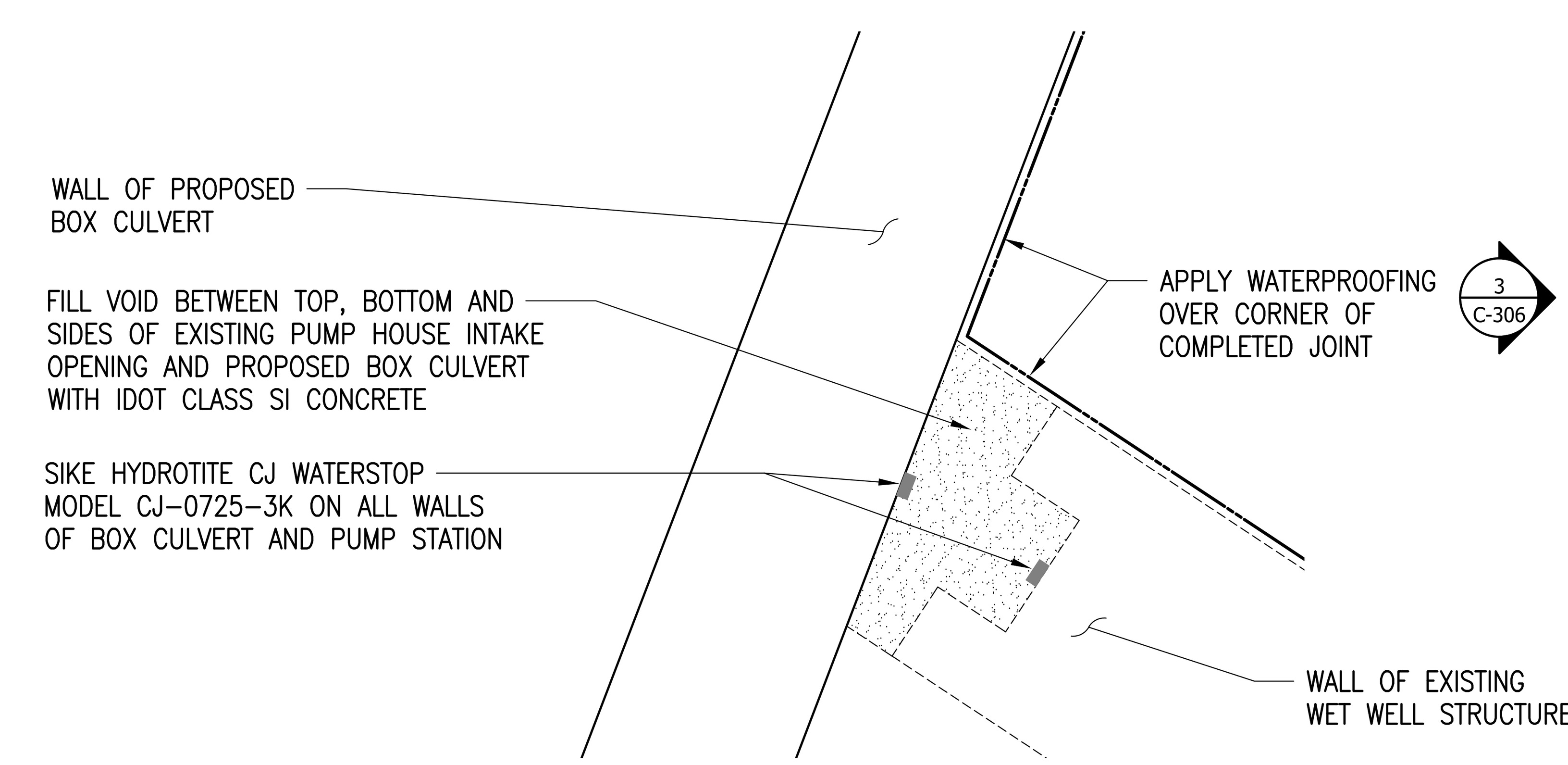


3 WET WELL WATERPROOFING
SECTION - NOT TO SCALE

ALL SURFACES OF WET WELL TO BE WATERPROOFED SHALL BE CLEANED AND PREPARED PER SIKAGARD MANUFACTURERS INSTRUCTIONS



4 BATTEN STRIP DETAIL
SECTION - NOT TO SCALE



5 SEAL DETAIL
SECTION - NOT TO SCALE

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DESIGN BY:	DBH
DRAWN BY:	SKB
REVIEWED BY:	JMH

SHEET TITLE
PUMP STATION INTAKE EXTENSION

C306

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Appendix C

Construction Schedule

Table C-1. Construction Schedule

Activities		Week															
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	Submit notification to the Illinois Environmental Protection Agency	■															
2	Implement and Maintain BMP Erosion and Sediment Control Measures	■	■	■	■	■	■	■	■	■							
3	Unwater Emery Pond	■															
4	Continue unwatering/dewatering as necessary to conduct excavation activities		■	■	■	■	■	■	■	■							
5	Install process water and drainage bypass pumping system		■														
6	Sample CCB sediment			■													
7	Initial Dewatering			■													
8	Excavate riprap			■	■												
9	Excavate CCR sediment, FGD & Bottom Ash				■	■	■	■	■								
10	Install subsurface drainage system								■								
10	Earthwork to establish retrofitted pond base grade									■	■						
11	Install low permeability clay liner											■	■	■			
12	Install HDPE Geomembrane														■		
13	Conduct Construction Quality Assurance			■	■	■	■	■	■	■	■	■	■	■	■		
14	Finalize retrofit documentation															■	■

Appendix D

SIPC Storm Water Pollution Prevention Plan

Southern Illinois Power Cooperative
Storm Water Pollution Plan

Jason McLaurin
Effective: 8/20/2007
Reviewed: 8/17/2018

TABLE OF CONTENTS

GENERAL FACILITY INFORMATION

Name of Facility: Southern Illinois Power Cooperative

Facility Address: 11543 Lake of Egypt Road
Marion, Illinois 62959

Facility Contact:

Name: Jason McLaurin

Title: Environmental Coordinator

Telephone: 618-964-1448

Mailing Address: Same As Facility Address

Owner: Southern Illinois Power Cooperative

NPDES Permit Information:

Designated Name: Southern Illinois Power Cooperative

Permit Number: IL0004316

Effective Date of Coverage: 03-01-07

Number of Storm Water Outfalls: (1 Active)

Receiving Waters: Little Saline Creek
Lake of Egypt

1.0 OVERVIEW

1.1 GENERAL OVER VIEW OF SIPC

Southern Illinois Power Cooperative owns and operates a coal-fired, electric generating station at its Lake of Egypt site south of Marion, Illinois. Coal and Coal combustion byproducts consisting of bottom ash, flyash, and scrubber sludge are routinely stored on the station's property. In addition, support products such as sulfuric acid, dibasic acid, sodium hydroxide, iron and steel, and petroleum-based products are routinely stored and used in such a manner that allows them to be exposed to rain water.

The amount of land in which SIPC owns in and around the Lake of Egypt Area is approximately 4,554 acres. However the amount of land the power plant uses for day-to-day operation is approximately 225 acres. Of those 225 acres, 2.2 % or 5 acres of them is either covered is some form or another by buildings, or is impervious by things such as concrete or pavement.

1.2 INTRODUCTION

This storm water pollution prevention plan (SWPPP) covers the operations at Southern Illinois Power Cooperative. It has been developed as required under Special Condition 15 of SIPC National Pollutant Discharge Elimination System (NPDES) general permit for storm water discharges and in accordance with good engineering practices. This SWPPP describes this facility and its operations, identifies potential sources of storm water pollution at the facility, recommends appropriate best management practices (BMPs) or pollution control measures to reduce the discharge of pollutants in storm water runoff, and provides for periodic review of this SWPPP.

1.3 OBJECTIVES

The objective of this SWPPP is three-fold:

1. To identify potential sources of pollution at: Southern Illinois Power Cooperative.

2. To describe best management practices (BMPs), which are to be used at Southern Illinois Power Cooperative.

3. To provide other elements such as, but not limited to, a facility inspection program, site compliance evaluation program, and a record keeping and reporting program that will help Southern Illinois Power Cooperative comply with the terms and conditions of their storm water discharge permit

2.0 STORMWATER POLLUTION PREVENTION TEAM

The storm water pollution prevention team is responsible for developing, implementing, maintaining, and revising this SWPPP. The members of the team are familiar with the management and operations of Southern Illinois Power Cooperative.

The member(s) of the team and their primary responsibilities are as follows:

Name & Title	Responsibility
Wendell Watson-Environmental Services Manager	**Assure that SIPC complies with all environmental laws and regulations.**
Jason Mclaurin – Environmental Coordinator	**Oversee the required policies of this plan and SIPC NPDES permit.**
Company Lab technicians	**Retrieving and testing samples from the Power Plants outfalls.**
Coal Handling Department	**Help in the day-to-day maintenance of the stormwater system.**

3.0 SIPC STORM WATER SYSTEM

The storm water treatment system at the Marion station is the series of retention ponds shown on the attached maps. The ponds are used to balance pH, settle out solids, and assure a clean discharge into little Saline Creek. These ponds are used to treat the storm water as well as the process water from the plant. A few, non-industrial areas will discharge rainwater directly to the Lake of Egypt. The runoff from such areas is a sheeting runoff and does not lend itself to be sampled during a rain event. The other small percentage of storm water that leaves the plant boundaries without being captured by the NPDES system is typically sheeting rainfall passing over grassy fields owned by the plant.

4.0 POTENTIAL SOURCES OF POLLUTANTS

4.1 SITE MAP

The attached Maps present a site map of the facility showing the following features (as required by the permit):

- Property boundaries
- Buildings and other permanent structures
- Storage or disposal areas for significant materials
- Areas used for outdoor operations, including activities thet generate significant quantities of dust or particulates.
- Storm water discharge outfalls
- Location of storm water inlets contributing to each outfall
- Outlines of drainage areas contributing to each outfall
- Storm Water conveyance and discharge structures
- Location of NPDES permitted discharges other than storm water
- Structural runoff controls and storm water settling ponds
- Areas of vegetation
- Areas of exposed and/or eroding soils
- Impervious surfaces (roof tops, asphalt, concrete)
- Names and locations of receiving waters
- Locations where the following activities are exposed to storm water:
  - Fixed fueling operations
  - Vehicle and equipment maintenance and/or cleaning areas
  - Loading/unloading areas
  - Waste storage or disposal areas
  - Liquid storage tanks
  - Equipment operating areas
  - Storage areas

4.2 INVENTORY OF EXPOSED MATERIALS

The permit requires a general inventory of significant materials on site. For each significant material on site an evaluation is to be conducted to determine the potential for these materials to be contributed to the runoff being discharged from the facility. Such areas to focus on may include:

- Loading and unloading areas
- Material handling operations (fuel pumps, etc.)
- Outdoor storage areas
- Processes which generate dust or particulate matter
- Yard drains, stacks, and blowers
- Waste generating areas
- Waste disposal areas
- Maintenance and cleaning practices for vehicles and equipment
- Sites of environmental contamination
- Areas where spills of polluting materials have occurred in the past three years
- Any other areas deemed appropriate

Included are the ways in which these materials might be exposed to the storm water runoff. And the identified outfall from which the materials may be discharged if a release should occur.

Area/Process	Material	Method of Exposure	Outfall
Plant Yard Drains	OIL and Grease, metals	Storm water runoff, accidental release, Daily operations	002
Coal Pile Runoff	Metals	Storm water runoff	002
Floor drains and equipment drains	Oil and grease, metals, chemicals, solvents	Storm water runoff, accidental release, Daily operations	002
Process wastewater	Metals, oil and grease	Daily operations	002
Boiler Evaporations and Blowdowns	TSS, TDS	Daily operations	002
Bottom ash slurry	Metals, oil and grease	Storm water runoff	002
Slag storage pile runoff	Metals, oil and grease	Storm water runoff	002

Scrubber sludge disposal area runoff	Metals, oil and grease	Storm water runoff	002
Ammonia from SCR unit Operation	Ammonia	Accidental release	002
Chlorine from the chlorination process at intake screen of the plants circulating (cooling) water.	Chlorine	Accidental release	003
Equipment fueling locations	Diesel fuel	Accidental release	002
Equipment maintenance locations	Used oil, Fuel, Solvents, fuel conditioner, hydraulic oil	Spills, leaks	002
Accidental release from waste and oil contamination areas	Used oil	Accidental release	002
Sodium Formate from the sludge thickener and reclaimed water tank.	Sodium Formate	Accidental release	002

4.3 SUMMARY OF SAMPLING DATA

The following is a summary of the sampling data available for SIPC. The summary gives a list of the possible pollutants and the effected outfall number. For information on the frequency of testing required and concentration limits and parameters please see SIPC NPDES permit No. IL0004316.

Outfall	Analysis	Outfall	Analysis
002	PH-Daily max & min	005	PH-Daily max & min
002	Suspended solids	005	Suspended solids
002	Iron	005	Iron
002	Boron	005	Boron
002	Mercury	005	Mercury
002	Copper	005	Copper
002	Oil & Grease	005	Oil & Grease
002	Dissolved Solids	005	Dissolved Solids
002	Daily Flow	005	Daily Flow
002	Fluoride	005	Zinc
003	Max. Chlorine		
003	Water Temp		
003	Daily Flow		

4.4 SEDIMENT AND EROSION CONTROL

Sediment and erosion issues at SIPC are controlled by a settling pond system. Sedimentation is monitored by plant personnel through preventive maintenance such as cleaning ditches and ponds that handle rainwater. Such actions assure the proper diversion of rainwater to the NPDES settling ponds as outlined in our NPDES permit. Erosion has the potential to be an issue in very few areas at SIPC. The areas most vulnerable to erosion are the slopes and waterways in and around our settling pond area. These areas are inspected by plant personnel for erosion and other problem areas. Planting grass on slopes and the use of rock and riprap in waterways has controlled erosion in these areas. Traffic in these areas is also kept to a minimum to help prevent wear on the grass, ground rutting, and other damage that might alter ground water flow or accelerate ground erosion. Other areas around the plant where erosion could be at issue would include gravel roads within the plant that are used by plant personnel for plant operational issues. Again these roads are also subject to monitoring and preventive maintenance to insure they don't become a problem for our NPDES system. The Marion Station has a track hoe, dozer, and a fleet of end loaders that are used to accomplish these tasks.

5.0 STORM WATER MANAGEMENT PRACTICES

The following are the Storm water management controls, or best management practices (BMPs) that have been implemented or will be implemented to help reduce the amount of pollutants in the storm water discharge from Southern Illinois Power Cooperative.

- The Marion station uses a series of retention/settling ponds to reduce the amount of pollution in its storm water discharge.
- The retention/settling ponds are fed by the conveyance structures and grassy waterways that were built around the facility with the sole purpose of funneling all the rainwater that falls on the Power Stations grounds into the ponds.
- Berms and slopes of the retentions ponds are planted with grass to prevent soil erosion.

5.1 STRUCTURAL CONTROLS

In order to meet the objectives of the SWPPP and help maintain compliance with our NPDES permit SIPC will use structural controls. The structural controls listed will help meet one of three issues: (1) To insure all rainwater that falls on the Power Stations ground is properly funneled to the retention pond system, or (2) Prevent accidental or unnecessary contamination from the potential pollutants which had been identified (3) Decrease the amount of pollutants in the storm water discharge. Such structural controls include:

1. The use of berms and grass waterways to insure that the rainwater that falls onto the plant is conveyed into the retention pond system.

2. The Plant should periodically inspect this conveyance system to insure that it is functioning properly and all stormwater is being diverted as planned.

3. SIPC uses berms and levies to direct potentially polluted stormwater away from water bodies such as the Lake of Egypt.

4. SIPC has constructed berms, levies, or other secondary containment around outside fuel storage facilities to prevent against leaks and spills.

5. Use grading where applicable to divert storm water from high-risk areas.

6. ~~The use of booms and oil absorbing pillows in the ponds to protect against~~ accidental release.

7. Hazardous waste is stored in a proper containment area. The current waste area is located outside of warehouse C and can be located on the attached maps. The

waste that is accumulated is removed in a timely manner. This will prevent possible build up and decrease the potential for accidental contamination.

8.The plant uses covered storage for much of the equipment and materials.

* It should be noted that many of these structural controls are also considered Best Management Practices.

<u>Best Management Practices</u> used by SIPC

9. SIPC installed an oil / water separator at its combustion turbine site when it was constructed.

10. On a daily basis the plant uses a watering truck and a sprinkler system to help keep down dust and air borne particles during dry times of the year.

11. The plant keeps the yard in a clean and orderly fashion.

- **Other Controls**
  There are other control measures that can be used that may not fit into one of the previously mentioned categories. The use of such controls is encouraged. Additional controls that have to been used at the facility include sumps, oil/water separators, rock filters, vegetative filters, basins (collection, retention, detention), reduce, reuse, and recycle materials, etc.

Area	Material	Control Measure
Settling Ponds	50-lb rock filter	Decrease sedimentation to downstream pond
Settling Ponds	Sediment removal	Increase retention time of water in ponds

5.2 NON-STRUCTURAL CONTROLS

The following Non-Structural Controls are being used by SIPC:

- **Annual Inspections**

  The NPDES discharge system will be inspected by the Environmental Coordinator at least once per year. This inspection consists of checking of checking pond levels, checking the operability of all pumps, assuring that water sampling equipment is properly working, assuring that berms and levies are intact and not leaking, noting the coloration of the outfalls, and assuring that the security gates are locked. Berms or levy problems are reported to the grounds caretaker for repair. Eroded areas that are found during the inspection are repaired at the earliest opportunity. Other areas included in these inspections include all waste storage areas, oil storage areas, coal yard, and sludge storage area; all of which could be a site of possible pollution. Through these inspections, SIPC can assure that any problems with the NPDES and settling pond system, which controls the storm water, can be addressed in a timely fashion.

  The Environmental Coordinator will also inspect SIPC's hazardous waste emergency response equipment as it pertains to its SPCC plan. These inspections are to insure SIPC is prepared in case of accidental spill.

- **Good Housekeeping and Preventive Maintenance Practices**
  The following practices have been implemented to be used by SIPC in order to maintain an efficient stormwater discharge system.

Area / Equipment	**Frequency**
Preventive maintenance of ditches and ponds	As Required
Proper storage of waste and oil in containment areas	Daily
Removal or recycle of all waste and used oil in a timely matter	As Needed

Use of booms and pillows in ponds in case of accidental spill Checking of pumps, oil and water separators, and sampling equipment;	As Needed Weekly
Making sure ditch drains are free of debris and sedimentation	Daily
Covered storage of as much plant equipment as possible	Daily
Proper labeling of all significant materials	Always
Maintaining the plant as clean and orderly as possible	Daily
Training of employees of company policy, hazardous waste handling procedures, proper storage and labeling of hazardous waste, SPCC program, Waste Minimization, Good Housekeeping methods	Annually
Checking the emergency spill kits on-site in accordance with the companies SPCC plan	At Least Annually
Monitor performance of water pumps and sumps during a storm event	During One Rain Event

- **Spill Prevention and Response Procedures (SPCC PLAN)**

This SPCC plan specifies material handling procedures and storage requirements for significant materials. It specifies equipment and procedures necessary for cleaning up spills and preventing the spilled materials from being discharged have also been identified. All employees are trained to follow the procedures outlined in the plan. SIPC's SPCC plan is located in the Environmental Manager's office at the administration building of the SIPC facility. Described in this plan would be the location of emergency spill minimization materials; which happen to be in Warehouse A and D.

Area	**Materials Present**	**Emergency Response Equipment Locations**
Turbine Deck	Turbine oil	Warehouse A and D, Concrete curbed, inside building
Oil Storage Area	Lube Oils, Used Oil, Antifreeze	Warehouse A and D, inside building

Maintenance Shop	Used Oil	Warehouse A and D, inside building
Storeroom Area	Chemicals	Warehouse A and D, inside building
Boiler Areas	Lube Oil, Compressor Oil, Boiler Chemicals, Ammonia	Warehouse A and D, inside building, curbed concrete
Ammonia Storage and Handling Areas	Anhydrous Ammonia	Water mist, SCBA's located plant wide
Chlorine Handling & Storage areas	Chlorine	SCBA's located plant wide, Emergency alarms located in the chlorine bldg. alert the plants control room if a leak should occur, Warning light on top of Chlorine Bldg. Is activated once a leak is detected.
Coal Handling Area	Fuel, Oil, Antifreeze, Fuel Conditioners	Warehouse A and D
Used oil Area	Used Oil	Warehouse A and D, Inside Covered Concrete Basin

- **Employee Training**

The following is a description of the employee training programs that are conducted to inform personnel at all levels of their responsibility to carry out the components and goals of the SWPPP.

Topic	**Frequency**
Hazardous Waste	Yearly
SPCC	Yearly
Good Housekeeping	Yearly
Waste Minimization	Yearly
SWPPP	Yearly

6.0 RECORD KEEPING AND REPORTING

6.1 SWPPP RECORD KEEPING

The SWPPP for SIPC will be maintained on-site at the office of the Environmental Coordinator. The SWPPP will be revised and updated when changes are made at

SIPC that will impact the exposure of significant materials to stormwater or the overall effectiveness of the SWPPP. When an inspection determines that changes to the SWPPP are necessary, or when the SWPPP is ineffective in accomplishing the stated objectives, the Environmental Coordinator will make appropriate revisions to the SWPPP. In addition, the Environmental Coordinator will review the SWPPP at least annually, and the SWPPP will be revised as necessary.

The Environmental Coordinator will maintain a record of the results of site inspections (indicating implementation of BMPs) or identify any incident(s) of non-compliance.

The Environmental Coordinator will maintain a record of incidents of spills or leaks of significant materials that could impact stormwater runoff, along with corrective actions, surface water discharge (if any), and other relevant information. Records of inspection and maintenance activities such as cleaning and repairing stormwater control and treatment facilities will also be maintained.

Accompanying reports and changes to the SWPPP will be retained on-site for at least (3) years.

6.2 ANNUAL REPORT & INSPECTION

NPDES permit number IL 0004316 requires that Southern Illinois Power Cooperative conduct an annual facility inspection to verify that all elements of the plan, including the site map, potential pollutant sources, and structural and non-structural controls to reduce pollutants in industrial storm water discharges are accurate. Observations and the appropriate responses to the observations shall be retained as part of the plan. Records documenting significant observations made during the site inspection shall be submitted to the IL Environmental Protection Agency as required by the reporting requirements of the SIPC NPDES permit. As part of the annual inspection report, the company will document any event (spill, treatment unit malfunction, etc,) that required an inspection, results of the inspection, and any corrective actions that followed.

In addition to the annual inspection, at least once per year, the Environmental Coordinator shall inspect the entire plant boundary during a rain event. During this inspection, the coordinator will look for storm water being discharged to lakes, ponds, streams, other bodies of water that do not flow through the facility's NPDES impoundments. If such water flows are found, the coordinator shall take a sample of the water and have it analyzed for all pertinent pollutants. Results of this analysis will be included in the annual submission to the IEPA.

6.3 Annual Inspection Form

This form will be used to check and document the facilities annual inspection. The form will also used to assign corrective actions if something is found during an inspection that requires a corrective action. This form will be kept on file in the Environmental Coordinator's Office for up to (3) years.

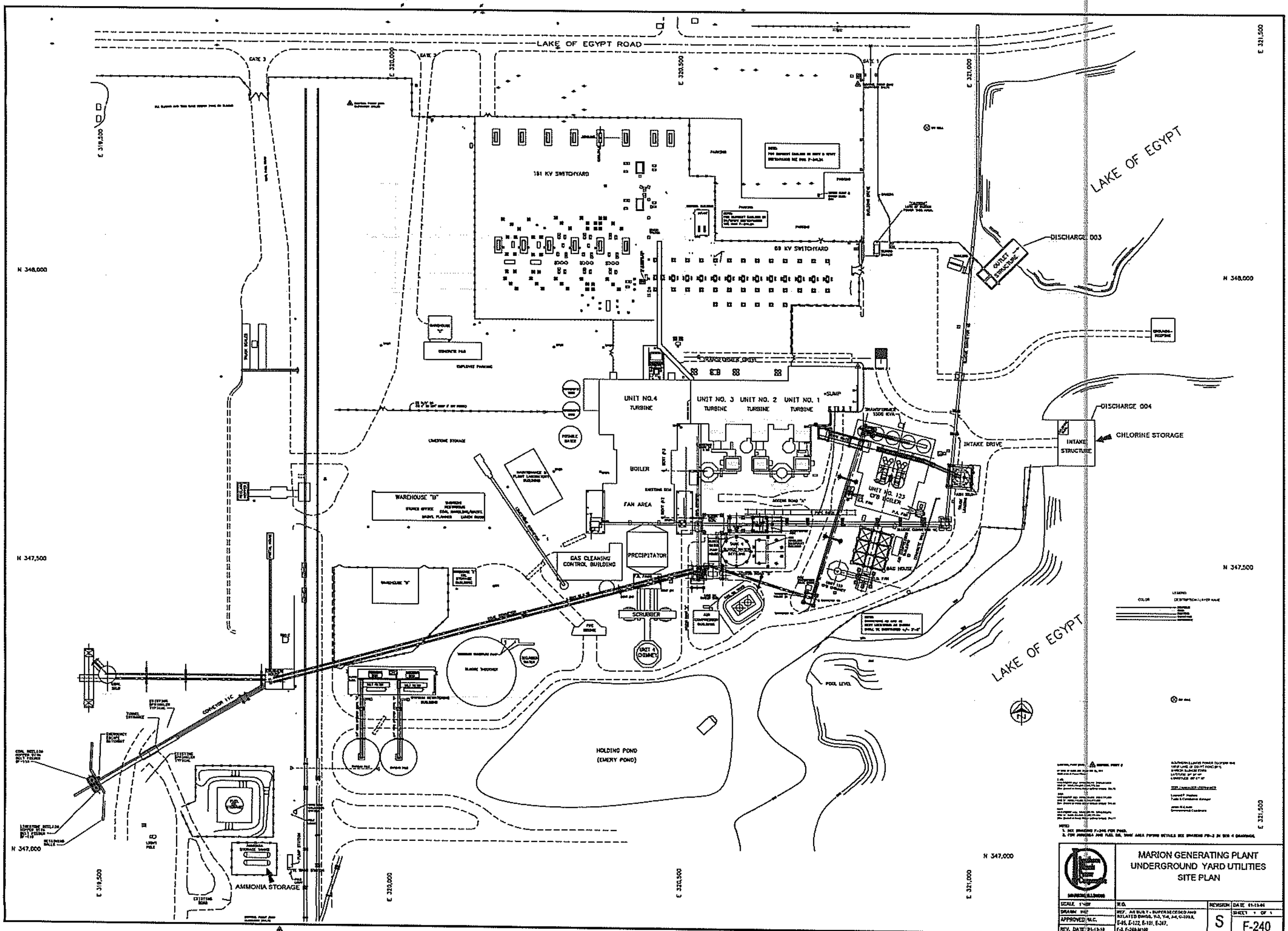
7.0 CERTIFICATION OF THE SWPPP

I certify under penalty of law that this SWPPP has been developed in accordance with good engineering practices. To the best of my knowledge and belief, the information submitted is true, accurate, and complete. In addition, at the time this plan was completed, no unauthorized discharges were present. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Jason A McL	241-17-2063
(Signature of Certified Operator)	(Certification Number)
JASON A MCLAURIN	8/17/2018
(Printed Name)	(Date)
SAME AS ABOVE	
(Signature of Corporate Officer)	(Date)
(Printed Name)	(Title)

This SWPPP becomes effective as of <u>August 20, 2007</u>

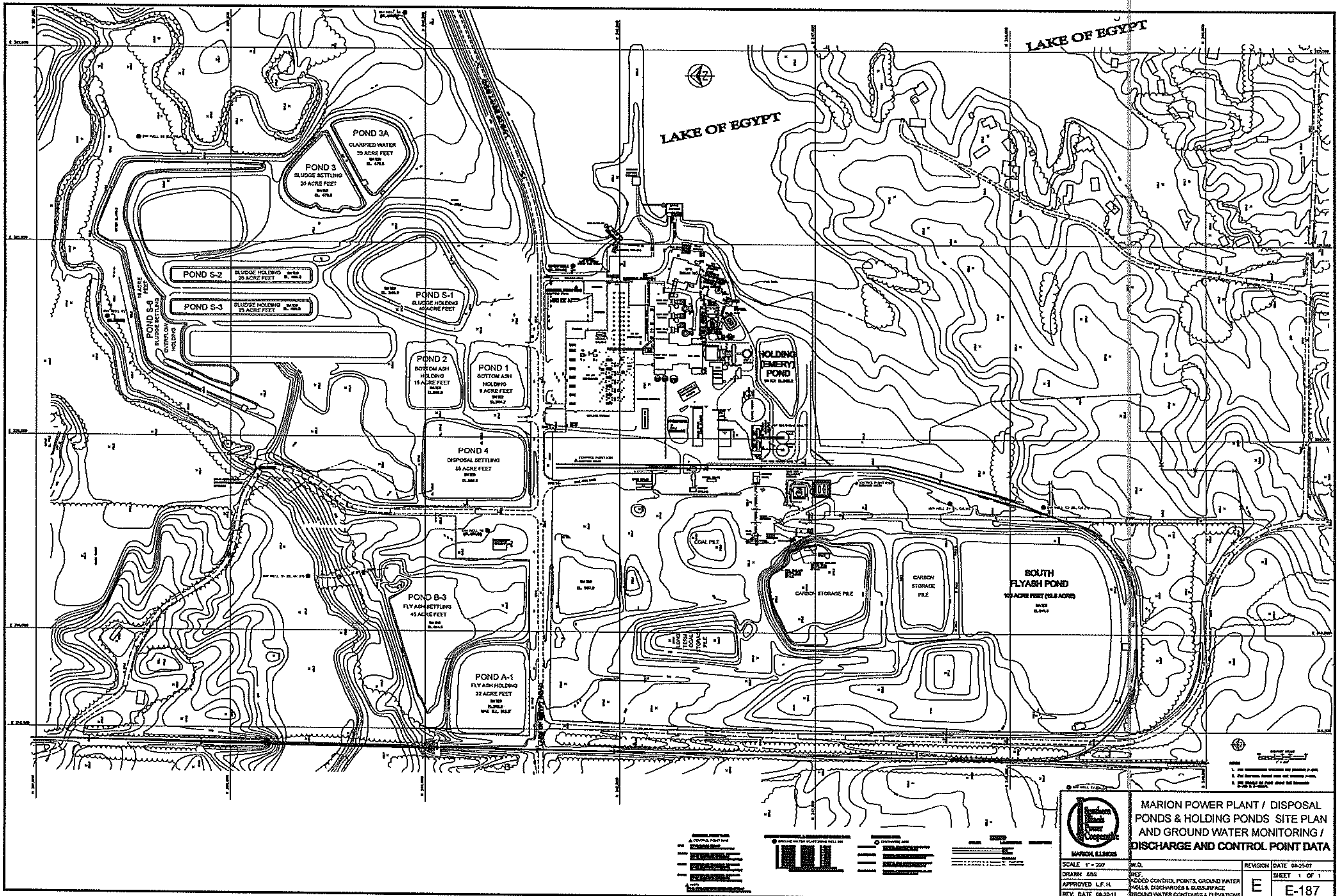
Reviewed: <u>August 18, 2018</u>

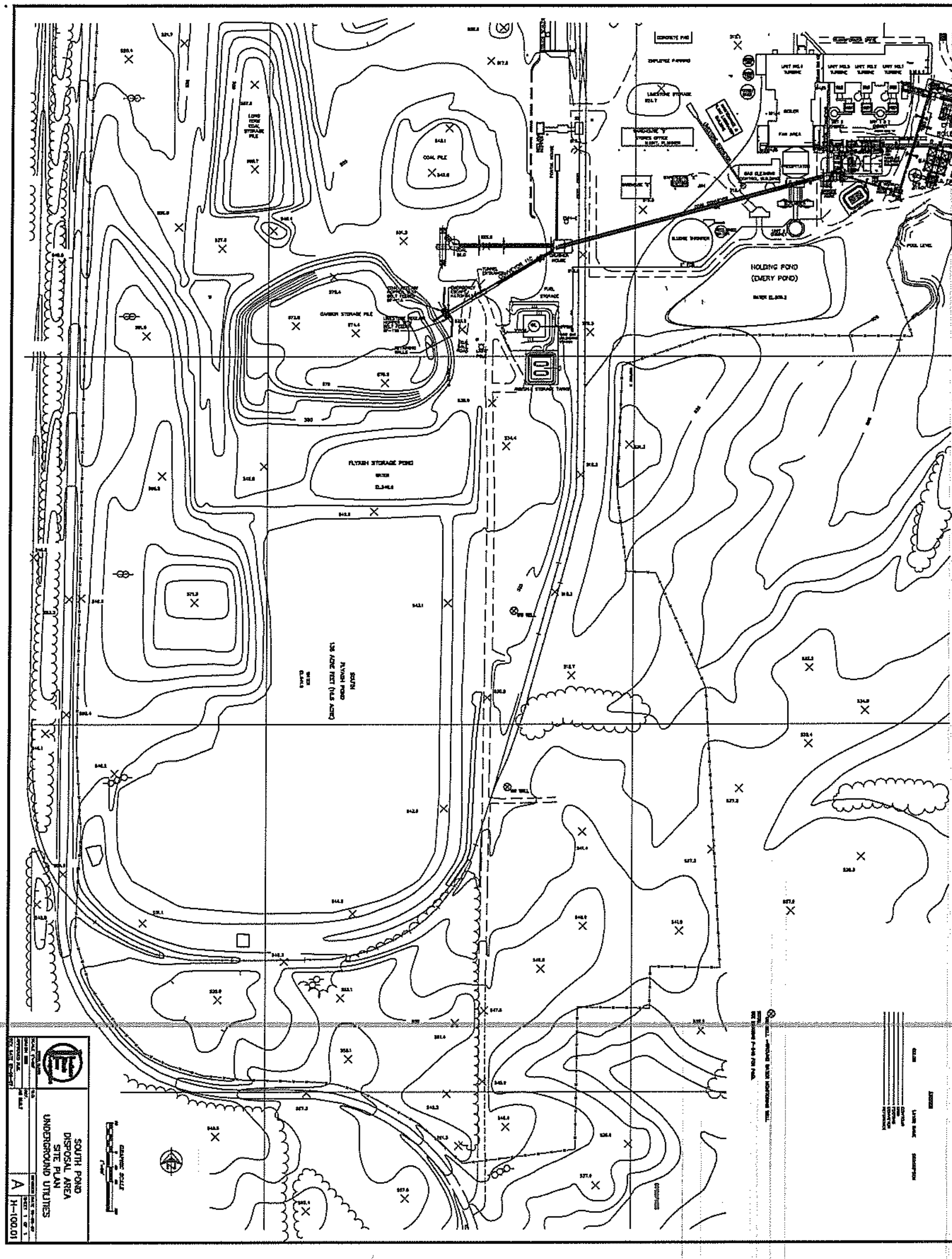


MARION GENERATING PLANT
UNDERGROUND YARD UTILITIES
SITE PLAN

REVISION S

F-240

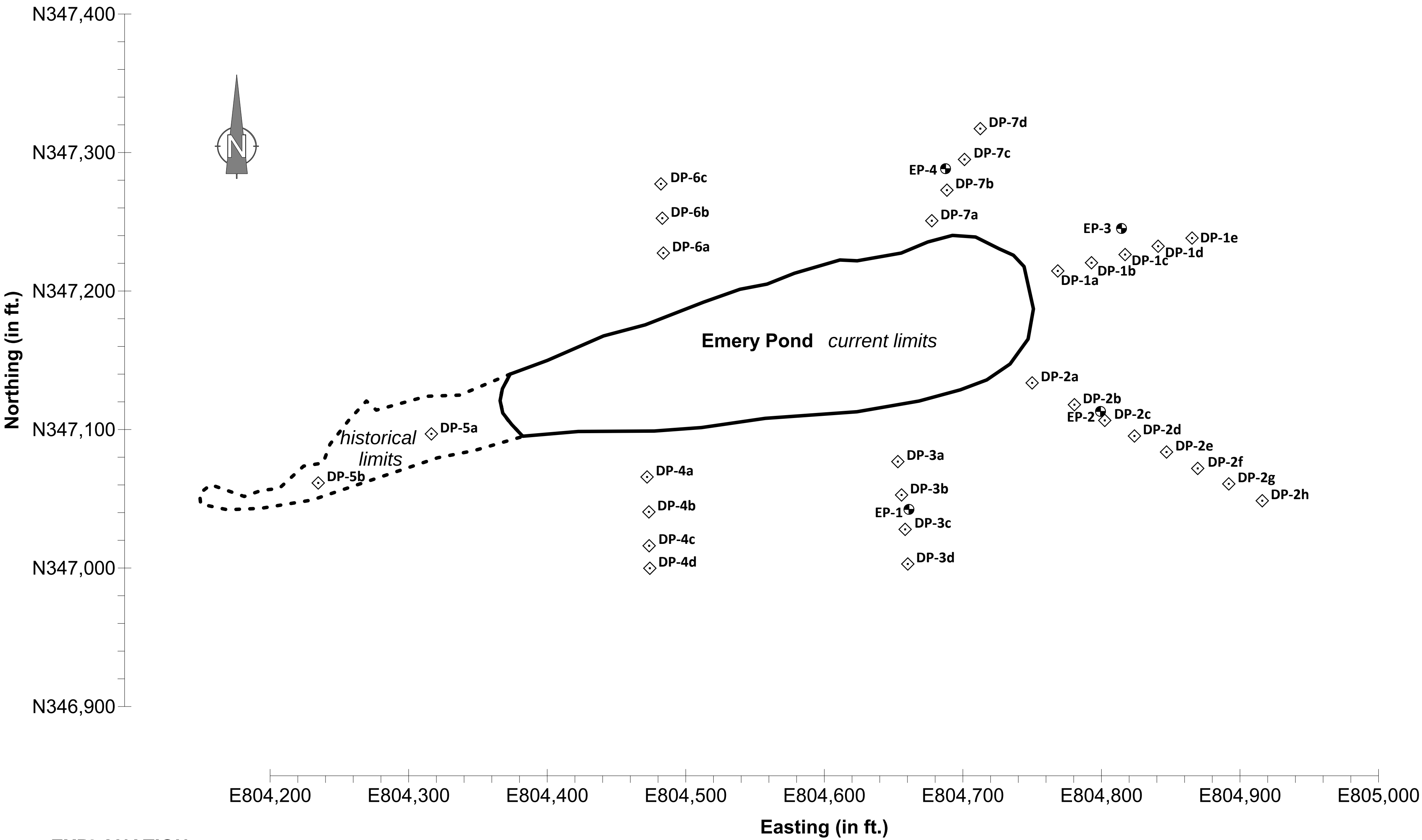

LAKE OF EGYPT
LAKE OF EGYPT
POND 3A
CLARIFIED WATER
20 ACRE FEET
POND 3
SLUDGE SETTLING
20 ACRE FEET
POND S-2
SLUDGE HOLDING
25 ACRE FEET
POND S-3
SLUDGE HOLDING
25 ACRE FEET
POND S-1
SLUDGE HOLDING
40 ACRE FEET
POND S-6
SLUDGE SETTLING
OVERFLOW
HOLDING
16 ACRE FEET
POND 2
BOTTOM ASH
HOLDING
15 ACRE FEET
POND 1
BOTTOM ASH
HOLDING
9 ACRE FEET
POND 4
DISPOSAL SETTLING
55 ACRE FEET
HOLDING
(EMERY)
POND
COAL PILE
POND B-3
FLY ASH SETTLING
45 ACRE FEET
CARBON STORAGE PILE
CARBON
STORAGE
PILE
SOUTH
FLYASH POND
LONG
TERM
COAL
STORAGE
PILE
POND A-1
FLY ASH HOLDING
32 ACRE FEET
MARION POWER PLANT / DISPOSAL
PONDS & HOLDING PONDS SITE PLAN
AND GROUND WATER MONITORING /
DISCHARGE AND CONTROL POINT DATA
MARION, ILLINOIS
SCALE 1" = 200'
DRAWN 60S
APPROVED L.F.H.
REV. DATE 08-30-11
W.O.
REF.
ADDED CONTROL POINTS, GROUND WATER
WELLS, DISCHARGES & SUBSURFACE
GROUND WATER CONTOURS & ELEVATIONS
REVISION
E
DATE 08-25-07
SHEET 1 OF 1
E-187



SOUTH POND
DISPOSAL AREA
SITE PLAN
UNDERGROUND UTILITIES
A
H-100.01
HOLDING POND
(EMERY POND)
FLYASH STORAGE POND
COAL PILE
BOILER
SLUDGE THICKENER
FUEL STORAGE
GARBAGE STORAGE PILE
EMPLOYEE PARKING
LIMESTONE STORAGE
POOL LEVEL
SOUTH
FLYASH POND

Appendix E

Geotechnical Data



EXPLANATION

- Monitoring Well
- Direct Push Boring

Contour Interval = 1 foot

SCALE: 1 inch equals 100 feet

0 ft. 30 ft. 61 ft. 91 ft.

Hanson Professional Services Inc.

Boring Location Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE E-1

I:\18jobs\18E0022A\Admin\15-Field-Laboratory Data\BoringLocationMap-AppE_20210318.srf

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1a
Well ID: DP-1a
Surface Elev: 516.52 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,214.45N
804,768.52E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = Dry - 3/1/2019 @ 8:30
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	44/60 *73%*	DP					0–1.7	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
							1.7–5.0	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).			
	28/48 *58%*	DP					5.0–10.0	Dark yellowish brown (10YR4/4), moist, soft, CLAY with some silt and trace sand. (FILL)			
	32/48 *67%*	DP					10.0–17.0	Brownish yellow (10YR6/6), weathered SHALE.			
	40/48 *83%*	DP									

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16. Elevation scale: 516, 514, 512, 510, 508, 506, 504, 502, 500.

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1b
Well ID: DP-1b
Surface Elev: 517.05 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,220.35N
804,792.89E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 15.95 - 3/1/2019 @ 8:25
▽ =

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
	48/60 *80%*	DP					0–0.3	Black (10YR2/1) ASPHALTI. (FILL)			
							0.3–2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							2–2.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		514	
							2.8–6.4	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		512	
	42/48 *88%*	DP					6.4–7.9	Yellowish brown (10YR5/6) RANDOM FILL (clay, silt, and gravel in 4 to 6 inch lifts).		510	
							7.9–9	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		508	
	27/48 *56%*	DP					9–12.5	Gray (10YR5/1) RANDOM FILL (clay, silt, and gravel in 4 to 6 inch lifts).		506	
							12.5–15.6	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand.		504, 502	
	32/48 *67%*	DP					15.6–17 (▼ 15.95)	Yellowish brown (10YR5/8), weathered SHALE.			

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1c
Well ID: DP-1c
Surface Elev: 514.27 ft. MSL
Completion: 19.00 ft. BGS
Station: 347,226.27N
804,817.11E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.37 - 3/1/2019 @ 8:10
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–0.8	Dark grayish brown (10YR4/2), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		514	
							0.8–1.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)			
	38/60 *63%*	DP					2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, few bottom ash, and trace sand. (FILL)		512	
								Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)			
							4	Light yellowish brown (10YR6/4), moist, hard, weathered SHALE. (FILL)		510	
	38/48 *79%*	DP					6	Black (10YR2/1) mottled yellowish brown (10YR5/6) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		508	
							8	Dark yellowish brown (10YR4/4) RANDOM FILL (clay, silt, and gravel in 4 to 6 inch lifts).		506	
	40/48 *83%*	DP					10 ▼	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		504	
							12			502	
	42/48 *88%*	DP					14	Yellowish brown (10YR5/8), moist, soft, CLAY with some silt and trace sand.		500	
							16			498	
								Yellowish brown (10YR5/8), weathered SANDSTONE.			
	24/24 *100%*	DP					18	Brownish yellow (10YR6/8), weathered SHALE.		496	

End of Boring = 19.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1d
Well ID: DP-1d
Surface Elev: 513.11 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,232.30N
804,841.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.60 - 2/28/2019 @ 15.45
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) / % Recovery	SAMPLE: Type	TESTING: Blows / 6 in / N - Value / RQD	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) Qp (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	60/60 100%	DP					0–2.2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		512	
							2.2–3.3	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		510	
	48/48 100%	DP					3.3–7.1	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508	
							7.1–10.5	Black (10YR2/1), moist, medium, CLAY with some silt, little sand, few bottom ash, and trace gravel.		506, 504	
	37/48 77%	DP					10.5–11.2 (▼ 10.6)	Yellowish brown (10YR5/8), wet, soft, CLAY with some silt and trace sand.		502	
							11.2–13.0	Black (10YR2/1), wet, soft, CLAY with some silt and trace sand.		500	
	40/48 83%	DP					13.0–16.9	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		498	
							16.9–17.0	Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1e
Well ID: DP-1e
Surface Elev: 512.80 ft. MSL
Completion: 8.00 ft. BGS
Station: 347,238.19N
804,865.50E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 0.00 - 2/28/2019 @ 15:25
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	60/60 *100%*	DP					0–2.3	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		512	
							2.3–4	Dark yellowish brown (10YR4/4), moist, medium, CLAY with some silt and trace sand. (FILL)		510	
	36/36 *100%*	DP					4–7.7	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.		508, 506	
							7.7–8	Yellowish brown (10YR5/6), SANDSTONE.			

End of Boring = 8.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2a
Well ID: DP-2a
Surface Elev: 516.53 ft. MSL
Completion: 13.50 ft. BGS
Station: 347,133.62N
804,750.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 14.26 - 2/27/2019 @ 8:15
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: 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
								Black (10YR2/1), moist, loose, medium- to very coarse-grained SAND, with some silt and trace gravel. (FILL)		516	
								Black (10YR2/1), moist, stiff, CLAY with some silt, little sand, and trace gravel.			
	60/60 100%	DP					2	Brownish yellow (10YR6/6), moist, stiff, CLAY with some silt and trace sand.		514	
							4	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, medium, CLAY with some silt and trace sand.		512	
	35/48 73%	DP					6, 8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		510, 508	
	31/48 65%	DP					10, 12	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		506, 504	
	6/6 100%	DP						Yellowish brown (10YR5/6), weathered SHALE.			
								Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 13.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2b
Well ID: DP-2b
Surface Elev: 516.65 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,117.86N
804,780.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 9.38 - 2/27/2019 @ 8:35
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: 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
	31/60 52%	DP					0–2.3	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							2.3–5	Yellowish brown (10YR5/8) with 40% Black (10YR2/1) mottles, moist, medium CLAY with some silt and trace sand. (FILL)		514, 512	
	34/48 71%	DP					5–7	Dark gray (10YR4/1), moist, medium, CLAY with some silt and trace sand.		510	
	35/48 73%	DP					7–13.1	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		508, 506, 504	
							13.1–13.9	Yellowish brown (10YR5/6), wet, soft, SILT with few clay and little very fine-grained sand.			
	36/36 100%	DP					13.9–16	Yellowish brown (10YR5/8), weathered SHALE.		502	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2c
Well ID: DP-2c
Surface Elev: 510.46 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,106.55N
804,802.49E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 7.34 - 2/27/2019 @ 8:55
▽ =

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
							0 – 1.5	Dark gray (10YR4/1) with 30% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.		510	
	40/60 *67%*	DP					1.5 – 7.8	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.		508, 506, 504	
	43/48 *90%*	DP					7.8 – 10.4	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		502	
	41/48 *85%*	DP					10.4 – 15.6	Yellowish brown (10YR5/8), moist, hard, weathered SHALE		500, 498, 496	
	36/36 *100%*	DP					15.6 – 16	Yellowish brown (10YR5/8) SANDSTONE.			

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Emery Pond	**Rig mfg/model:** AMS Power Probe 9500-VTR	**BOREHOLE ID:**	DP-2d
Location: SIPC Marion Power Plant	**Drilling Method:** Direct Push	**Well ID:**	DP-2d
Project: 18E0022A		**Surface Elev:**	508.64 ft. MSL
DATES: Start: 2/26/2019	**FIELD STAFF: Driller:** J Edwards	**Completion:**	15.50 ft. BGS
Finish: 2/26/2019	**Helper:** S Guy	**Station:**	347,095.26N
WEATHER: Ptly cloudy, mild (hi 40's)	**Eng/Geo:** R. Hasenyager		804,823.89E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ = 1.35 - 2/26/2019 @ 17:10
▽ =

SAMPLE 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
	53/60 *88%*	DP					0–0.9	Very dark gray (10YR3/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		508	
	42/48 *88%*	DP					0.9–9.0	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		506, 504, 502, 500	
	44/48 *92%*	DP					9.0–10.5	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	29/30 *97%*	DP					10.5–14.3	Yellowish brown (10YR5/8), weathered SHALE.		498, 496	
							14.3–15.5	Yellowish brown (10YR5/8) SANDSTONE.		494	

End of Boring = 15.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2e
Well ID: DP-2e
Surface Elev: 507.37 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,083.66N
804,847.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 2.31 - 2/27/2019 @ 9:10
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) Qp (tsf) Failure Type
	60/60 *100%*	DP				
	39/48 *81%*	DP				
	48/48 *100%*	DP				
	27/36 *75%*	DP				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0 – 0.8	Very dark gray (10YR3/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)	506
0.8 – 5	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.	504
5 – 12.9	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	502, 500, 498, 496
12.9 – 13.7	Yellowish brown (10YR5/6), wet, soft, SILT with few clay and little very fine-grained sand.	494
13.7 – 14.3	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.	
14.3 – 16	Yellowish brown (10YR5/8), weathered SHALE.	492

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative	**CONTRACTOR:** Bulldog Drilling, Inc.				
Site: Emery Pond	**Rig mfg/model:** AMS Power Probe 9500-VTR	**BOREHOLE ID:** DP-2f			
Location: SIPC Marion Power Plant	**Drilling Method:** Direct Push	**Well ID:** DP-2f			
Project: 18E0022A		**Surface Elev:** 506.32 ft. MSL			
DATES: Start: 2/26/2019	**FIELD STAFF: Driller:** J Edwards	**Completion:** 15.50 ft. BGS			
Finish: 2/26/2019	**Helper:** S Guy	**Station:** 347,071.83N			
WEATHER: Ptly cloudy, mild (hi 40's)	**Eng/Geo:** R. Hasenyager	804,869.56E			

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 3.55 - 2/27/2019 @ 9:25
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–0.7	Very dark gray (10YR3/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		506	
	60/60 *100%*	DP					0.7–5.6	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		504, 502	
	44/48 *92%*	DP					5.6–7.7	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium CLAY with some silt and trace sand.		500	
							7.7–9.0	Dark yellowish brown (10YR4/6), wet, medium dense, very fine- to medium-grained SAND with few clay and silt.		498	
	45/48 *94%*	DP					9.0–14.0	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		496, 494	
	28/30 *93%*	DP					14.0–15.5	Light yellowish brown (10YR6/4) SANDSTONE.		492	

End of Boring = 15.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2g
Well ID: DP-2g
Surface Elev: 505.12 ft. MSL
Completion: 15.40 ft. BGS
Station: 347,060.68N
804,891.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 9.00 - during drilling
▼ = 11.60 - 2/26/2019 @ 17:30
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING 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
							0–0.6	Gray (10YR5/1), moist, loose, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
	46/60 77%	DP					0.6–2.6	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		504	
							2.6–5.3	Yellowish brown (10YR5/6), medium CLAY with some silt and trace sand.		502, 500	
	34/48 71%	DP					5.3–6.6	Gray (10YR5/1), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	35/48 73%	DP					6.6–15.1	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.		498, 496, 494, 492	
	29/30 97%	DP					15.1–15.4	Yyellowish brown (10YR5/8) SANDSTONE.		490	

End of Boring = 15.4 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: DP-2h
Well ID: DP-2h
Surface Elev: 503.54 ft. MSL
Completion: 15.00 ft. BGS
Station: 347,048.55N
804,916.15E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = -0.30 - 2/26/2019 @ 17:40
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	45/60 *75%*	DP					0–0.9	Gray (10YR5/1), moist, loose, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
							0.9–7.0	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		502, 500, 498	
	33/48 *69%*	DP					7.0–10.3	Gray (10YR6/1) with 20% yellowish brown (10YR5/6) mottles, wet, medium SILT with few clay and little very fine-grained sand.		496, 494	
	42/48 *88%*	DP					10.3–13.0	Yellowish brown (10YR5/8), moist, stiff, CLAY with some silt and trace sand.		492	
							13.0–13.6	Yellowish brown (10YR5/8), moist, stiff, CLAY with some silt, little sand, and trace gravel.		490	
	24/24 *100%*	DP					13.6–15.0	Brownish yellow (10YR6/8) SANDSTONE.			

End of Boring = 15.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-3a
Well ID: DP-3a
Surface Elev: 518.30 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,076.80N
804,653.12E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 11.68 - 2/26/2019 @ 8:55
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0–0.9	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)	518	
	49/60 *82%*	DP					0.9–9	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	516, 514, 512, 510	
	30/48 *63%*	DP								
	32/48 *67%*	DP					9–13	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.	508, 506	
	36/48 *75%*	DP					13–16.8	Yellowish brown (10YR5/8), weathered SHALE.	504, 502	
							16.8–17	Yellowish brown (10YR5/8), SANDSTONE.		

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-3b
Well ID: DP-3b
Surface Elev: 518.15 ft. MSL
Completion: 19.00 ft. BGS
Station: 347,052.67N
804,655.84E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.63 - 2/26/2019 @ 9:15
▽ =

SAMPLE 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	Elevation ft. MSL	Remarks
	60/60 100%	DP					0–1.3	Black (10YR2/1), moist, soft, CLAY with some silt and trace sand.	518	
							1.3–2.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	516	
	48/48 100%	DP					2.8–10.7	Yellowish brown (10YR5/6), moist, medium, SILT with few clay, and trace very fine-grained sand.	514, 512, 510, 508	
	39/48 81%	DP					10.7–11.6	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.		
							11.6–13	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.	506	
	42/48 88%	DP					13–14.2	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.	504	
							14.2–15.2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		
							15.2–17	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and few very fine-grained sand.	502	
	23/24 96%	DP					17–18.2	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.	500	
							18.2–18.5	Light yellowish brown (10YR6/4) SANDSTONE.		
							18.5–19	Yellowish brown (10YR5/8), weathered SHALE.		

End of Boring = 19.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-3c
Well ID: DP-3c
Surface Elev: 516.55 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,027.84N
804,658.41E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 6.44 - 2/26/2019 @ 9:30
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–0.5	Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace sand.		516	
	60/60 *100%*	DP					0.5–6.6	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		514, 512	
	41/48 *85%*	DP					6.44 ▼			510	
	40/48 *83%*	DP					6.6–15.5	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		508, 506, 504, 502	
	38/48 *79%*	DP					15.5–16	Brownish yellow (10YR6/8), weathered SANDSTONE.			

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP3d
Well ID: DP3d
Surface Elev: 516.62 ft. MSL
Completion: 10.30 ft. BGS
Station: 347,002.83N
804,660.29E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 5.06 - 2/26/2019 @ 9:45
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0 – 0.3	Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace sand.		516	
	53/60 *88%*	DP					0.3 – 3.2	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		514	
							3.2 – 6.1	Yellowish brown (10YR5/6), moist, medium, SILT with few clay, and trace very fine-grained sand.		512	
	36/48 *75%*	DP					6.1 – 7.1	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		510	
							7.1 – 10.0	Yellowish brown (10YR5/6), weathered SHALE.		508	
	16/18 *89%*	DP					10.0 – 10.3	Yellowish brown (10YR5/6), weathered SANDSTONE.			

End of Boring = 10.3 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4a
Well ID: DP-4a
Surface Elev: 520.39 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,065.72N
804,472.12E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 14.26 - 2/27/2019 @ 8:15
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) % Recovery	SAMPLE: Type	TESTING: Blows / 6 in N - Value RQD	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–0.3	Brown (10YR5/3), moist, medium, CLAY with some silt, little sand, and trace gravel. (FILL)		520	
							0.3–1.2	Light gray (10YR7/1), moist, dense, medium- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
	42/60 70%	DP					2, 4			518, 516	
	48/48 100%	DP					6, 8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.		514, 512	
	48/48 100%	DP					10, 12			510	
							12–13	Yellowish brown (10YR5/8), weathered SANDSTONE.		508	
	48/48 100%	DP					13–16.3 (▼ 14)	Yellowish brown (10YR5/8), weathered SHALE.		506	
							16.3–17	Yellowish brown (10YR5/8), weathered SILTSTONE.		504	

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4b
Well ID: DP-4b
Surface Elev: 520.64 ft. MSL
Completion: 14.50 ft. BGS
Station: 347,040.46N
804,473.43E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 13.55 - 2/27/2019 @ 8:15
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	60/60 *100%*	DP					0–6.8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.			
	46/48 *96%*	DP					6.8–11.6	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	37/48 *77%*	DP					11.6–13.7	Yellowish brown (10YR5/8), weathered SHALE.			
	18/18 *100%*	DP					13.7–14.5	Brownish yellow (10YR6/6) SANDSTONE.			

Depth scale (ft. BGS): 2, 4, 6, 8, 10, 12, 14
Elevation scale (ft. MSL): 520, 518, 516, 514, 512, 510, 508

End of Boring = 14.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4c
Well ID: DP-4c
Surface Elev: 523.14 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,016.05N
804,473.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 13.61 - 2/27/2019 @ 8:15
▽ =

SAMPLE: Number	Recov / Total (in) / *% Recovery*	Type	TESTING: *Blows / 6 in* / N - Value / **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp* (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	60/60 *100%*	DP					0–0.3	Brown (10YR4/3), moist, soft, CLAY with some silt and trace sand.		
							0.3–7.2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		
	46/48 *96%*	DP					7.2–10.2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		
	35/48 *73%*	DP					10.2–17.0	Yellowish brown (10YR5/8), weathered SHALE.		
	28/48 *58%*	DP								

Depth scale (ft. BGS): 2, 4, 6, 8, 10, 12, 14, 16
Elevation scale (ft. MSL): 522, 520, 518, 516, 514, 512, 510, 508

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4d
Well ID: DP-4d
Surface Elev: 524.09 ft. MSL
Completion: 17.00 ft. BGS
Station: 346,999.74N
804,474.16E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 2.10 - 2/26/2019 @ 8:25
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–0.3	Dark yellowish brown (10YR4/4), moist, soft, CLAY with some silt, little sand, and trace gravel.			
	60/60 *100%*	DP					0.3–7.5 (▼ 2.10)	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		522, 520, 518	
	46/48 *96%*	DP					7.5–10.2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		516, 514	
	37/48 *77%*	DP					10.2–12	Yellowish brown (10YR5/8), weathered SHALE.		512	
							12–13	Yellowish brown (10YR5/8), weathered SANDSTONE.			
	28/48 *58%*	DP					13–17	Yellowish brown (10YR5/8), weathered SHALE.		510, 508	

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-5a
Well ID: DP-5a
Surface Elev: 518.48 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,096.77N
804,316.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 15.00 - during drilling
▼ = 6.62 - 2/26/2019 @ 7:50
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	40/60 *67%*	DP					0–11.5	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL)			
	48/48 *100%*	DP									
	48/48 *100%*	DP					11.5–12.5	Light brownish gray (10YR6/2), moist, dense, very fine-grained SAND with some silt. (FILL)			
							12.5–15	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL)			
	26/48 *54%*	DP					15–16.8	Very dark brown (10YR2/2), wet, dense, bottom ASH. (FILL)			
							16.8–17	Very pale brown (10YR7/4), weathered SANDSTONE			

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-5b
Well ID: DP-5b
Surface Elev: 519.57 ft. MSL
Completion: 9.80 ft. BGS
Station: 347,061.40N
804,234.84E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 7.02 - 2/26/2019 @ 8:05
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–1.1	Yellow, (10YR7/6) wet, soft, GYPSUM (FILL)			
	49/60 *82%*	DP					1.1–9.6	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL)		518, 516, 514	
	48/48 *100%*	DP					▼ 7.02			512	
	8/8 *100%*	DP					9.6–9.8	Yellowish brown (10YR5/8), weathered SANDSTONE		510	

End of Boring = 9.8 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: DP-6a
Well ID: DP-6a
Surface Elev: 516.69 ft. MSL
Completion: 9.50 ft. BGS
Station: 347,227.38N
804,483.91E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 6.32 - 2/28/2019 @ 9:10
▽ =

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
							0–2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
	51/60 *85%*	DP					2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand. (FILL)		514	
								Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)			
							4	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
								Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		512	
							6 ▼	Gray (10YR5/1), moist, soft, SILT with few clay and little very fine-grained sand.			
	34/48 *71%*	DP						Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		510	
							8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508	
	6/6 *100%*	DP						Yellowish brown (10YR5/6), SANDSTONE.			

End of Boring = 9.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-6b
Well ID: DP-6b
Surface Elev: 517.23 ft. MSL
Completion: 11.50 ft. BGS
Station: 347,252.51N
804,483.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.63 - 2/29/2019 @ 7:55
▽ =

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
	59/60 *98%*	DP				
	31/48 *65%*	DP				
	28/30 *93%*	DP				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		
		516	
2	Black (10YR2/1), moist, dense, BOTTOM ASH. (FILL)		
	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand. (FILL)	514	
4	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)		
		512	
6	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.		
		510	
8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		
	Dark gray (10YR4/1), moist, soft, SILT with few clay and little very fine-grained sand.	508	
10	Yellowish brown (10YR5/8), weathered SHALE.		
▼			
	Yellowish brown (10YR5/8), SANDSTONE.	506	

End of Boring = 11.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-6c
Well ID: DP-6c
Surface Elev: 516.49 ft. MSL
Completion: 8.00 ft. BGS
Station: 347,277.30N
804,482.16E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 1.00 - during drilling
▼ = 1.00 - 2/28/2019 @ 9:30
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0–1.8	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
	54/60 *90%*	DP					1.8–2.4	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		514	
							2.4–5.5	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)		512	
	26/36 *72%*	DP					5.5–7.5	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		510	
							7.5–8	Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 8.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7a
Well ID: DP-7a
Surface Elev: 517.42 ft. MSL
Completion: 15.00 ft. BGS
Station: 347,250.66N
804,677.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 13.50 - during drilling
▼ = 8.49 - 2/28/2019 @ 8:00
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0	Black (10YR2/1), moist, loose, SILT and very fine- to coarse-grained SAND with few clay and trace gravel. (FILL)		
								Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		
								Black (10YR2/1), wet, soft SILT with few clay and trace very fine-grained sand. (FILL)	516	
	43/60 *72%*	DP					2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand and gravel. (FILL)	514	
							5	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)	512	
	31/48 *65%*	DP					6	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	510	
	38/48 *79%*	DP					9	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.	508, 506, 504	
	22/24 *92%*	DP					13.5	Black (10YR2/1), wet, medium loose, very fine- to medium-grained SAND with few silt and little clay.		
							14.2	Yellowish brown (10YR5/8), SANDSTONE.		

End of Boring = 15.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7b
Well ID: DP-7b
Surface Elev: 517.56 ft. MSL
Completion: 15.50 ft. BGS
Station: 347,272.79N
804,688.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ = 7.59 - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	58/60 *97%*	DP					0–2.9	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
	26/48 *54%*	DP					2.9–7.2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		514, 512	
	31/48 *65%*	DP					7.2–11.9	Yellowish brown (10YR5/8), moist, stiff, CLAY with some silt, little sand, and trace gravel. (FILL)		510, 508, 506	
							11.9–12.2	Light gray (10YR7/1), moist, dense, very fine- to very coarse-grained SAND with few silt and trace gravel. (FILL)			
							12.2–13.0	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	30/30 *100%*	DP					13.0–14.1	Black (10YR2/1), wet, medium dense, weathered SANDSTONE.		504	
							14.1–15.0	Yellowish brown (10YR5/4), weathered SHALE.			
							15.0–15.5	Yellowish brown (10YR5/8) SANDSTONE.			

End of Boring = 15.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7c
Well ID: DP-7c
Surface Elev: 516.65 ft. MSL
Completion: 19.00 ft. BGS
Station: 347,294.97N
804,701.22E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 11.60 - during drilling
▼ = 14.47 - 2/28/2019 @ 14:55
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	46/60 77%	DP					0–2.2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		
							2.2–5.3	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		
	35/48 73%	DP					5.3–5.8	Light gray (10YR7/1), moist, dense, very fine- to very coarse-grained SAND with few silt and trace gravel. (FILL)		
							5.8–10.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		
	27/48 56%	DP					10.8–11.6	Gray (10YR6/1), moist, soft, CLAY with some silt, little sand, and trace gravel. (FILL)		
							11.6–12.6	Black (10YR2/1), wet, soft, SILT with few clay and trace very fine-grained sand.		
	25/48 52%	DP					12.6–16.5	Dark gray (10YR4/1), moist, soft, CLAY with some silt and trace sand.		
							16.5–17.5	Light yellowish brown (10YR6/4), moist, medium, CLAY with some silt, little sand, and trace gravel.		
	20/24 83%	DP					17.5–18.2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.		
							18.2–19.0	White (10YR8/1), weathered SHALE.		

Depth scale (ft. BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18
Elevation scale (ft. MSL): 516, 514, 512, 510, 508, 506, 504, 502, 500, 498

End of Boring = 19.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7d
Well ID: DP-7d
Surface Elev: 516.91 ft. MSL
Completion: 20.00 ft. BGS
Station: 347,317.15N
804,712.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.59 - 2/28/2019 @ 8:45
▽ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	TESTING 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
	56/60 93%	DP					0–2.6	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							2.6–5	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		514	
	30/48 63%	DP					5–7	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand. (FILL)		512	
	48/48 100%	DP					7–11.9	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand. (FILL)		510, 508, 506	
							11.9–12.8	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand. (FILL)			
							12.8–13.5	Gray (10YR5/1), moist, soft, SILT with few clay and trace very fine-grained sand. (FILL)		504	
							13.5–14	Gray (10YR5/1), moist, dense, very fine- to very coarse-grained SAND with few silt and trace gravel. (FILL)			
	33/48 69%	DP					14–15.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		502	
							15.8–17.8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		500	
	29/36 81%	DP					17.8–20	Yellowish brown (10YR5/8), weathered SANDSTONE.		498	

End of Boring = 20.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

APPENDIX C

Decontamination Certification and Closure Completion Certification

Decontamination Certification and Closure Completion Certification
Emery Pond

I am a Professional Engineer (P.E.) in the State of Illinois and President of Clarida & Ziegler Engineering Co. I am the P.E. with oversight for the Clarida & Ziegler Engineering Co. contract with Southern Illinois Power Cooperative for construction observation and oversight for the contract with 06 Environmental related to the closure of Emery Pond and the FGD Loadout Area at the Marion Power Station ("Emery Pond Site"). I have personal knowledge of the 06 Environmental Emery Pond Site closure activities and related documentation performed pursuant to the design documents produced by Hanson Professional Services, Inc. titled "Emery Pond Closure & Storm Water Basin Construction Plans," dated July 14, 2020, and included as Appendix B to the Emery Pond closure plan dated April 15, 2021.

I hereby certify that to the best of my knowledge, and based upon visual observation and other information, all CCR was removed from the Emery Pond Site in connection with the performed Emery Pond Site closure, and the CCR removal action at the Emery Pond Site was completed in general accordance with 35 Ill. Adm. Code 845.740(a) and with the Emery Pond Closure & Storm Water Basin Construction Plans dated July 14, 2020, and included as Appendix B to the Emery Pond closure plan. I further certify that to the best of my knowledge closure of the Emery Pond Site was completed in general accordance with those provisions of the Emery Pond closure plan that apply to the closure activities for which Clarida & Ziegler Engineering Co. had oversight responsibility or as to which SIPC has provided information, including documentation, confirming the work performed. [1]

The removal and decontamination of the Emery Pond Site was complete as of April 5, 2021, and final inspection was complete as of May 28, 2021.

W. Brian Ziegler, P.E.,

Printed Name

July 14, 2021

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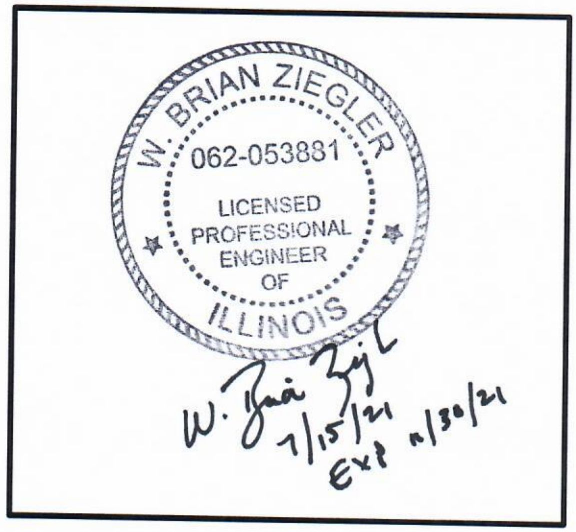

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[1] Clarida & Ziegler Engineering Co. was responsible for closure work oversight except for the following activities outlined in the Emery Pond Closure Plan produced by Hanson Professional Services, Inc., revision date April 15, 2021: Section 3.4 CCR Sediment Dewatering; Section 3.5 CCR Sediment Sampling; Section 3.8 CCR Management During Closure and Transportation; Section 3.10 FGD Loadout Area; and Section 5.4 Sampling and Analysis/Testing. SIPC has provided information, including documentation, confirming that CCR, including material from the FGD loadout area, was sampled, hauled off site and disposed of properly to meet the requirements of Sections 3.4, 3.5, 3.10 and 5.4 of the closure plan, as to which Clarida & Ziegler Engineering Co. did not have field oversight responsibility.

APPENDIX D

Hydrogeologic Investigation Report

Emery Pond

Hydrogeologic Investigation Report

Marion Power Plant
Southern Illinois Power Cooperative
Marion, Williamson County, Illinois

March 29, 2019

HANSON
Engineering | Planning | Allied Services

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Figures and Tables

Figures

Tables

Abbreviations

ft. – feet
cm/s – centimeters per second
BGS – below ground surface
CFR – Code of Federal Regulations
IAC – Illinois Administrative Code

1. Introduction

Marion Power Plant (Plant) is owned and operated by the Southern Illinois Power Cooperative (SIPC). The Emery Pond (Site), an active coal combustion residuals (CCR) impoundment at the Plant, has functioned from the late-1980's to the present as a storm water storage structure for drainage from the Marion Power Plant (Plant) area and the adjacent gypsum loadout area. Figure 1 shows the Site location on a USGS Topographic Map.

2. Project Background

2.1 Physical Setting

The site is located in the Shawnee Hills section within the Interior Low Plateaus (physiographic) Province (Leighton et al., 1948). Site geology consists of glacially-derived deposits of the Wisconsian and Illinoisan Stages overlying Pennsylvanian Age bedrock. The existing topography is a maturely eroded upland of gently sloping knolls and ridges (see Figure 2).

The "Berg Circular" indicates that the Site has less than 6 m (< 19.7 ft.) of loess overlying silty and sandy diamictons† of the Glasford Formation, overlying the Pennsylvanian Caseyville Formation (Berg et al., 1987).

2.2 Climate Data

Average climatic data was obtained from the Illinois State Water Survey. The data was recorded between 1990 and 2018 from Carbondale, Illinois, which is located approximately twenty miles northwest of the Site. The data includes monthly maximum and monthly minimum daily temperatures and average rainfall for each month calculated from daily values collected over the 28 year period. The data is summarized in Table 1.

Table 1: Average Monthly Temperature Extremes and Precipitation for Carbondale, IL

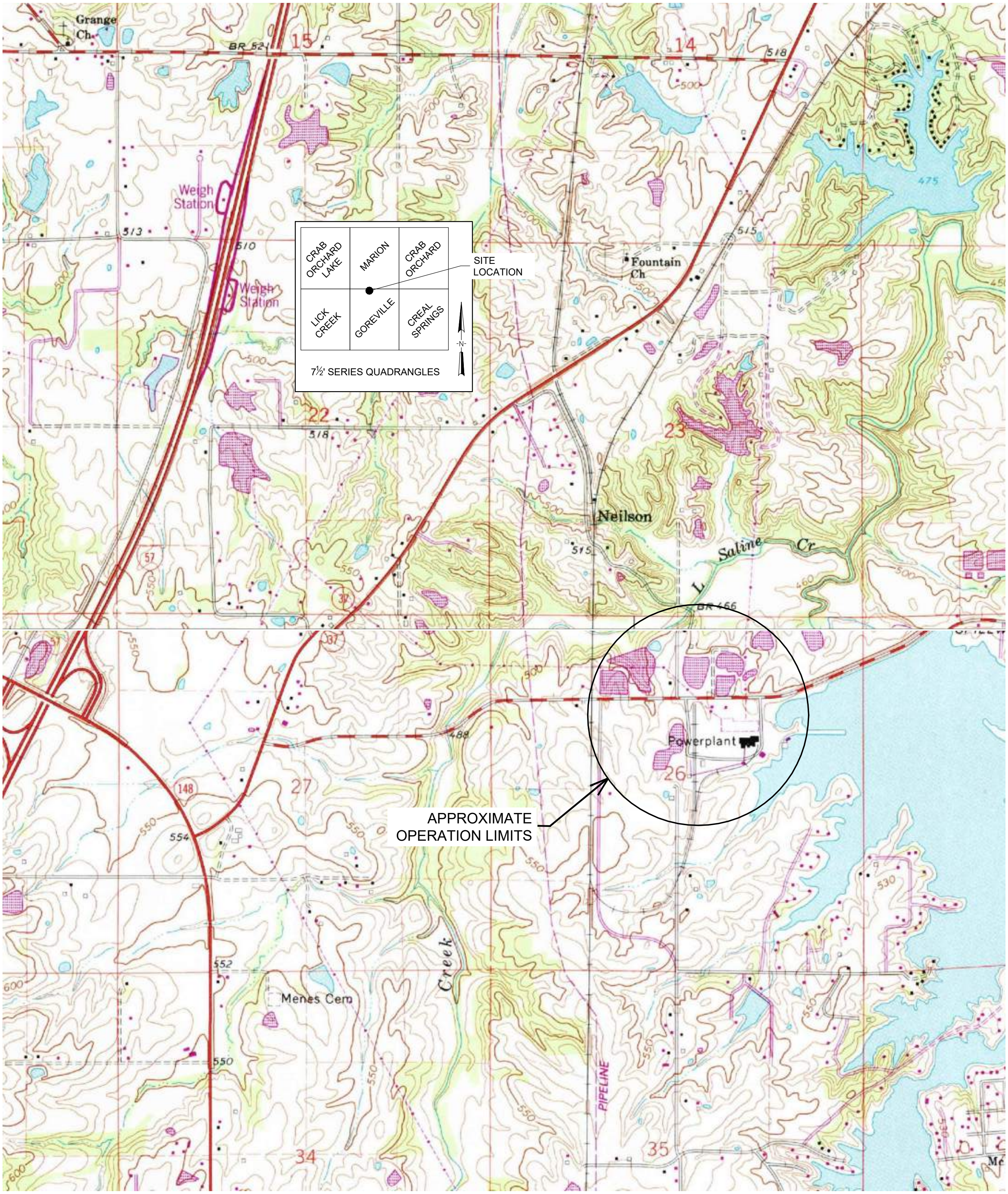
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Max Temp - °F	42.1	46.6	56.5	67.3	75.8	84.1	86.9	86.2	79.8	68.9	55.9	44.9	68.2
Min Temp - °F	24.2	27.5	35.5	44.9	54.8	63.5	67.0	64.5	56.1	45.1	35.5	27.7	45.5
Precip. - inches	3.09	2.96	4.37	5.23	4.43	3.92	3.68	3.07	3.24	3.35	4.35	3.74	45.4

Source: Water and Atmospheric Resources Monitoring Program. Illinois Climate Network. (2019). Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL.

2.3 Bedrock Stratigraphy

The study area is located just north of the Mississippi Embayment. Hundreds of feet of sedimentary rock underlie this region. The bedrock in the study area dips gently northward toward the center of the Illinois Basin. The near-surface bedrock at the Site consists of primarily sandstones of the Caseyville Formation (Willman et al., 1995).

† **diamicton** (di-a-mic'-ton) A comprehensive, nongenetic term proposed by Flint et al. (1960) for a non-sorted or poorly sorted, non-calcareous, terrigenous sediment that contains a wide range of particle sizes, such as sand and/or larger particles in a muddy matrix.



SCALE

2,000 0 2,000 4,000

1 inch = 2,000 feet Contour interval = 10 feet

Approximate Site Location: n½ of Section 26; T10S., R2E.

SITE LOCATION MAP

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 1

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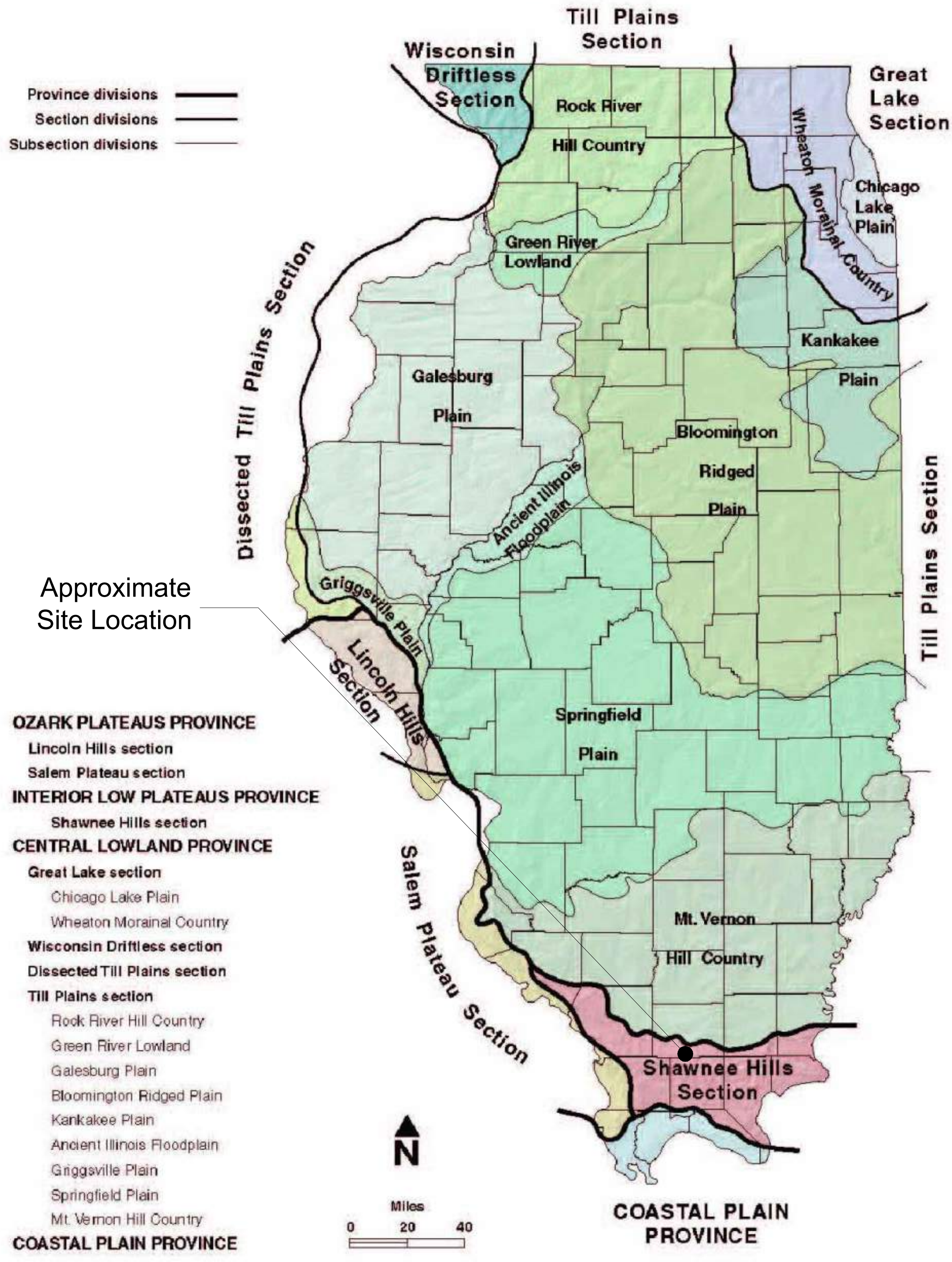

after Leighton et al., 1948

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PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE 2

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2.4 Unlithified Deposits

Regionally, the unlithified deposits consist of a thin veneer of Roxana Loess overlying silty and sandy diamictons of the Glasford Formation. These deposits are generally thin (less than 20 feet). In the case of the Roxana Loess, it is found intermittently. The Glasford Formation is leached of carbonates and weathered to yellowish brown to strong brown in color (Jacobson, 1992).

2.5 Structural Geology

The regional structural geology of the area is presented on Figure 3. The principal structures in the area are the Cottage Grove Fault System, located north of the Site and the Little Cache Fault Zone located southeast of the Site. The Cottage Grove Fault System is a principal tectonic feature of Southern Illinois. It presents a classic pattern of right-lateral strike-slip faulting. The Little Cache Fault Zone consisting of high-angle normal faulting. There have been no Pleistocene displacements along faults in this part of Illinois (Nelson, 1995).

2.6 Seismic Risk

Earthquakes are formed when the stresses within the bedrock reach a point at which rupture or breakage of bedrock occurs. This breakage releases a tremendous amount of energy known as an earthquake. Williamson County is located adjacent to two seismic impact zones, the New Madrid and the Wabash Valley Seismic Zones. Records dating from 1811 and 1812 indicate that multiple earthquakes greater than a Richter Scale Magnitude 8.0 occurred along the New Madrid Seismic Zone. Away from the fault, earthquakes occur at random patterns across a large area and are often too small to detect except by instruments. Occasional earthquake events may attain a 5.0 to 6.0 magnitude. The earthquake epicenters appear to be the result of modern regional stress fields and are not related to the nearby inactive faults (Nelson, 1995).

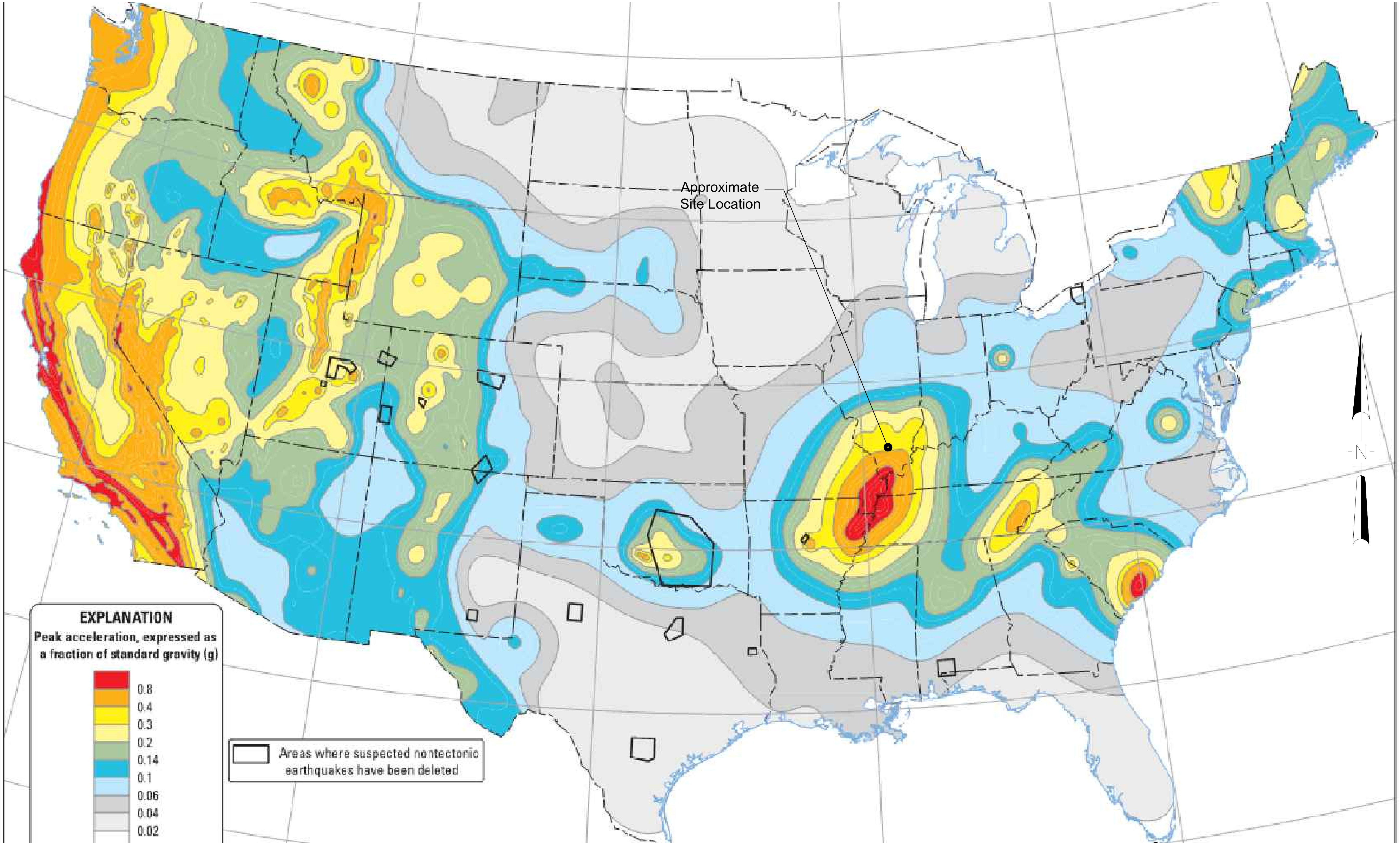
The Site is not located on an active fault, based on: 1) historical records of earthquakes felt in the area over the last 180 years and 2) observation of the bedrock profiles and the lack of displacement of Holocene Age deposits. However, there is possible seismic risk associated with the facility due to the Site's close proximity to the Cottage Grove Fault System and the more active New Madrid and Wabash Valley seismic zones. According to Nelson (1995) the Cottage Grove Fault System appears to have undergone only one major episode of movement, during the Appalachian Orogeny. Consideration has been given to the possible attenuation of the shear wave created by the maximum credible earthquake along any of the active faults in the regional area of the Site (see Figure 4).

2.7 Groundwater

2.7.1 Sole Source Aquifers

Pursuant to 35 IAC 811.302(b), no part of the facility is located over or within the recharge area of a US EPA designated sole source aquifer. The US EPA Sole Source Aquifer Protection Program web site[‡] indicates 89 sole source aquifer exist within the continental United States, Hawaii and Guam. In March 2015, the US EPA designated the Mahomet Aquifer[§] in east-central Illinois as a sole source aquifer, and is the closest sole source aquifer located approximately 165 miles north of the Site.

[‡] https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=9ebb047ba3ec41ada1877155fe31356b
[§] https://www.epa.gov/il/mahomet-sole-source-aquifer



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PEAK GROUND ACCELERATION-2500 YEARS

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE 4

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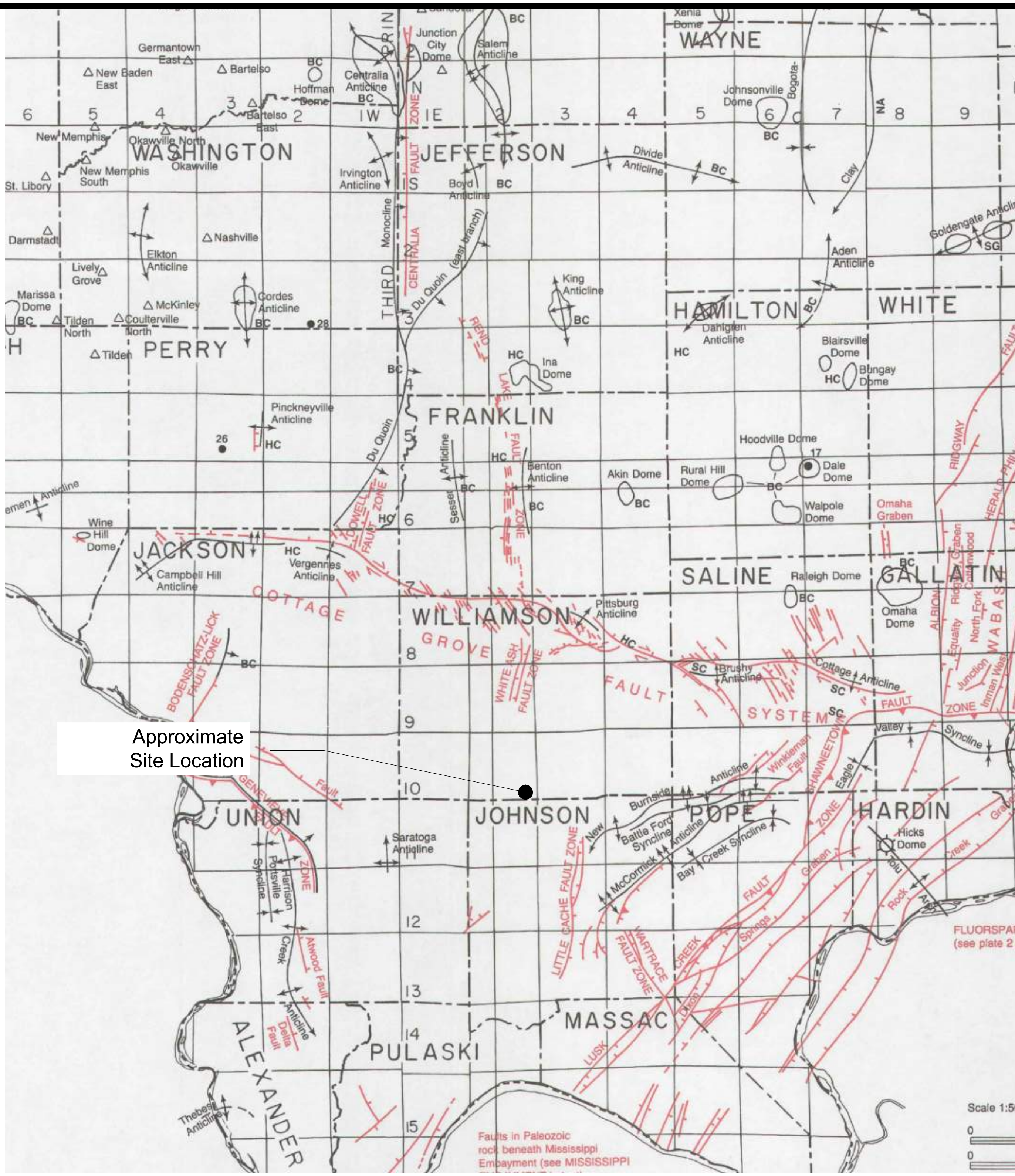

12 0 12 24

SCALE: 1 inch = 12 miles

-N-

Source: Nelson, W. J., 1993, "Structural Features in Illinois" ISGS Bulletin 100, Plate 1.

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PRINCIPAL STRUCTURAL FEATURES MAP

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE 3

MAR 15, 2019 10:03 AM HASEN01154
I:\18JOBS\18E0022A\ADMIN\14-REPORTS\HYDROGEO\FIG_3STRUCFEATURES_20190310.DWG

2.7.2 Potable Well Water Setback Zones

Setback zones are regulated under Sections 14.2 and 14.3 of the Illinois Environmental Protection Act (the Act). The minimum setback for a potable water well (domestic or community) is 200 feet, but this distance is doubled for wells in more permeable zones [pursuant to 77 IAC 920.50(b)(2)]. The Act also specifies there is a 75 ft. setback for wells located on-site and owned by the owner of the primary or secondary source. There are no community water supply wells (with or without maximum setback zones) near the Site.

2.7.3 Local Well Records

The Illinois State Geological Survey water well database (ILWATER) was queried for the domestic water wells in the vicinity of the Site. Figure 5 illustrates the locations of the water wells. The depth of the well/boring is the numeric value adjacent to the feature symbol. The result of the review indicates potable water near the Site may be obtained from bedrock wells that are generally over 150 feet deep.

2.8 Mining Activities

The areas immediately surrounding the facility have never been mined. A review of the topographic maps show no quarry or mining symbols within three sections of the Site.

3. Hydrogeologic Investigation Methodology

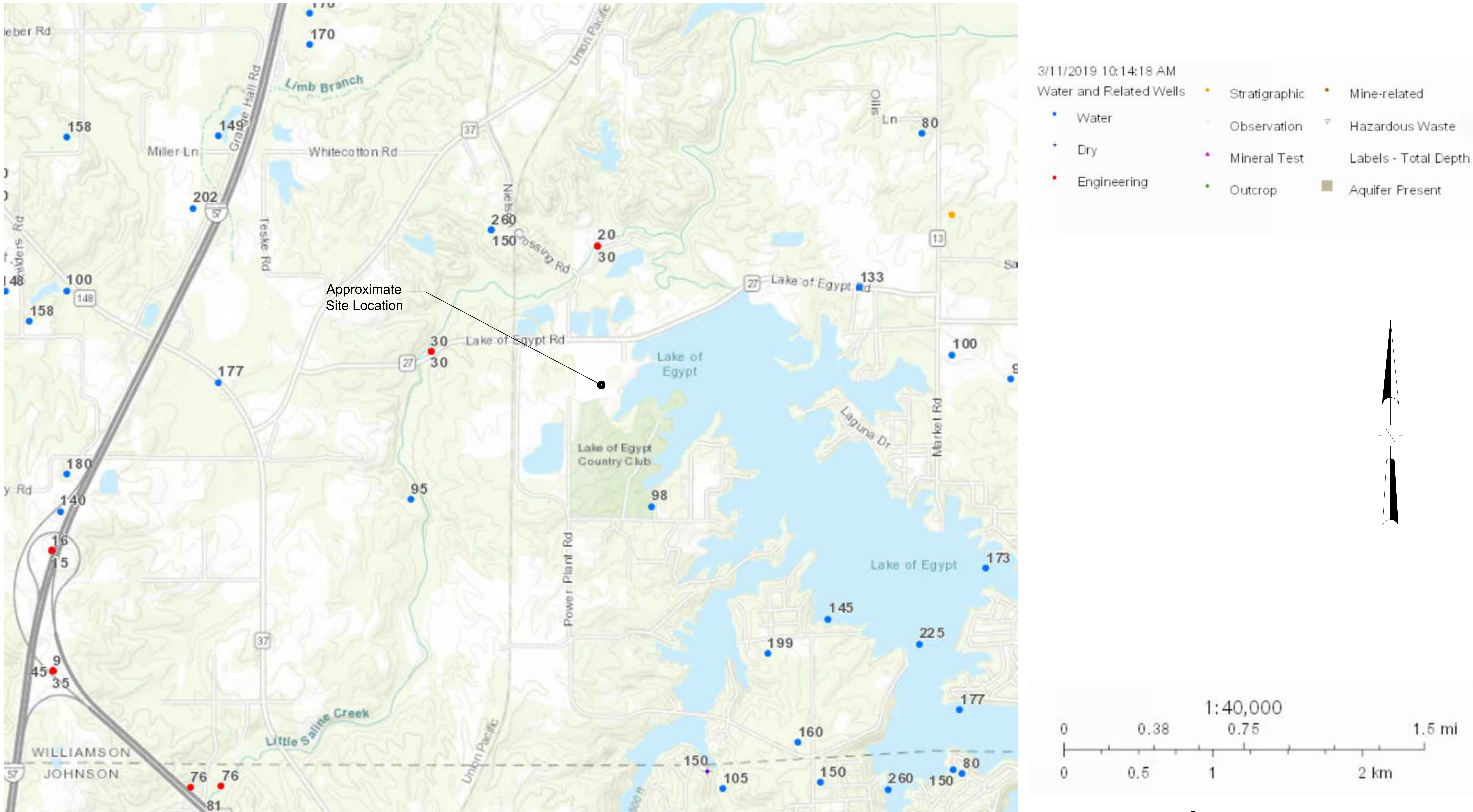
3.1 Drilling and Field Procedures

An experienced geologist or engineer under the direction of an Illinois Licensed Professional Geologist performed the field investigation. Prior to drilling, the location of each boring was determined and staked. For the bedrock boring, a Central Mine Equipment (CME) 750 drill mounted on an all-terrain (balloon tire) vehicle equipped with an NX wireline rock coring system was used for the investigation. For the extent of contamination study an AMS Power Probe 9500-VTR direct push drill mounted on an all-terrain (tracked) vehicle was used. The field staff maintained the daily drilling records and logged the soil and rock samples. The boring logs are included in Appendix A. Figure 6 shows the location of the monitoring wells and investigation borings.

3.2 Monitoring Well Installation

Five (5) monitoring wells were installed at five (5) boring locations around the facility by Holcomb Foundation Engineering Inc. in early-February 2017 under the direction of AECOM (2018). The wells consisted of 2-inch diameter, schedule 40 PVC pipe with 10-ft long, 0.010-inch slotted well screens. A silica sand (grain size 10/20) filter medium was used to construct the sand pack around each well screen. The depth of the screen and the depth to the top of the filter pack were measured and recorded in the field by the geologist. Bentonite chips were placed on top of the sand pack filling the borehole to 2 to 3 ft. below the ground surface or a minimum thickness of 2 ft.

A steel, locking, protective outer casing was installed for each well. A concrete monument was constructed around the outer casing with the concrete extending from the ground surface to the top of the bentonite seal. After installation, the locations and elevations of the wells were surveyed using the State Plane horizontal grid and elevation system. All surveying was performed under the direction of an Illinois Licensed Professional Land Surveyor.



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

Web AppBuilder for ArcGIS
Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA | Illinois State Geological Survey |

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DOMESTIC WATER WELL (ILWATER) DATA

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A FIGURE 5

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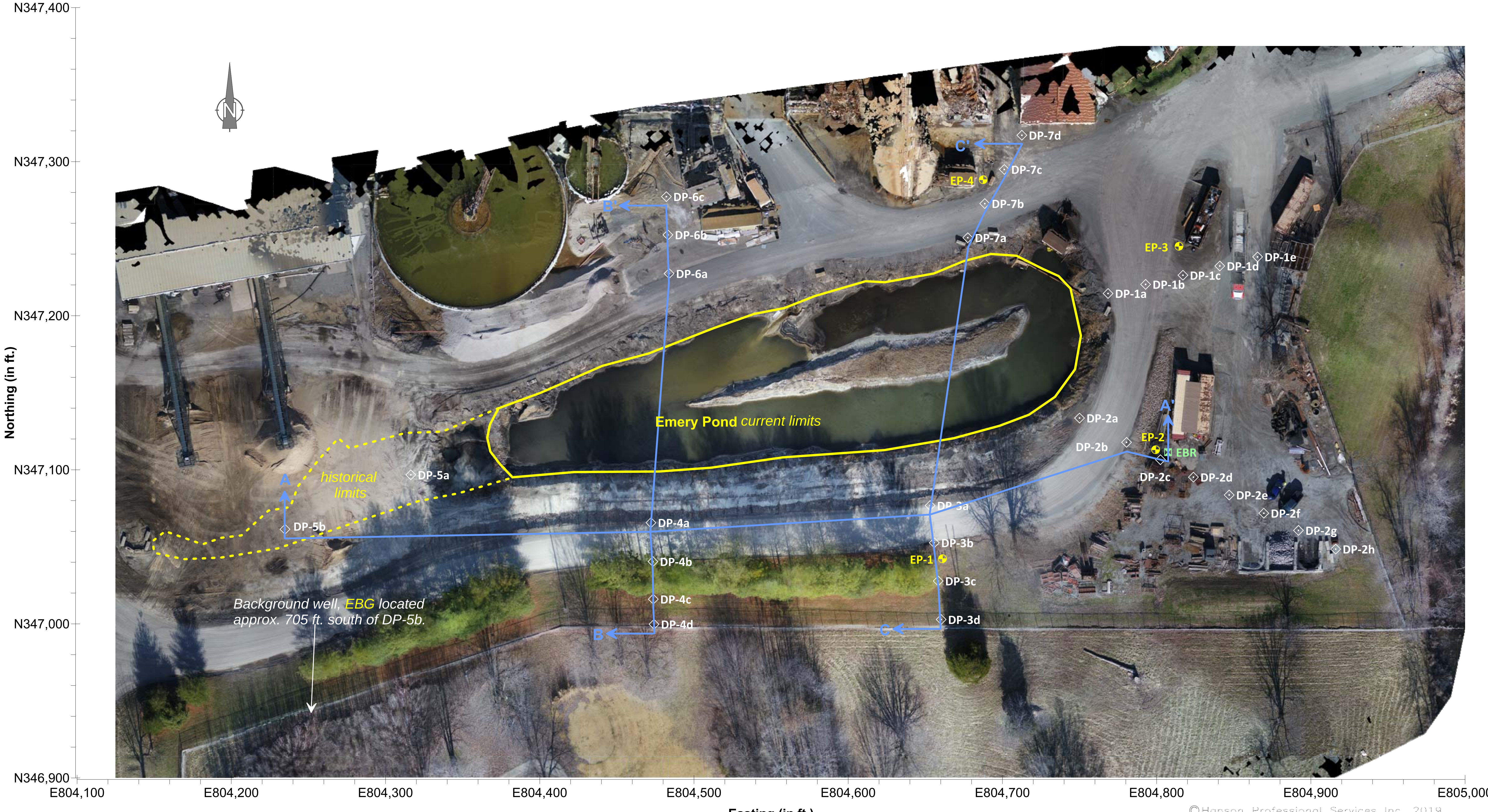

EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

SCALE: 1 inch equals 60 feet

0 ft. 60 ft. 120 ft. 180 ft. 240 ft.

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Boring Location Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE NO. 6

3.3 Field Hydraulic Conductivity Testing

Instantaneous change in head (slug) tests were performed to determine the hydraulic conductivity of the unlithified deposits at each monitoring well location. Packer tests were performed to determine the hydraulic conductivity of the lithified deposits at EBR. The testing procedures and test results are summarized below.

3.3.1 Single Well Aquifer Tests

Instantaneous change in head (slug) tests were performed on a total of five (5) monitoring wells. A slug test can be used to estimate the hydraulic conductivity of the formation in the immediate vicinity of a monitoring well. To perform a slug test, the water level is displaced (typically by inserting or removing a solid PVC "slug"), and the rate at which the water level falls or rises back to static conditions is measured. Such tests are referred to as falling head or rising head slug tests, respectively.

Falling head tests were performed by lowering a solid cylindrical section of PVC (nominal 4-ft by 1-inch OD) into a well which displaced the water level in the well approximately 2 ft. to 3 ft. above the static level. As the water level recovered to the static level, a data logger with a pressure transducer measured water levels at discreet time intervals. For wells which responded rapidly to the initial head change, a data logger was necessary to record the change in water level at small time increments (typically <2 seconds). After the falling head test was completed, the slug was removed, and water level data were collected using the data logger for a rising head test.

Water level displacement data were analyzed using the Bouwer and Rice Method (Bouwer and Rice, 1976; Bouwer, 1989). Slug test results and plots of water level displacement are provided in Appendix B. A summary of the test results is provided in Table 2.

Table 2: Single Well Hydraulic Conductivity Test Results

Well ID	Falling Head (cm/sec)	Rising Head (cm/sec)	Geometric Mean (cm/sec)	Solution Method
EBG	3.00×10^{-6}	9.10×10^{-7}	1.65×10^{-6}	Bouwer-Rice
EP-1	2.80×10^{-5}	3.45×10^{-5}	3.11×10^{-5}	Bouwer-Rice
EP-2	6.00×10^{-6}	8.40×10^{-6}	7.10×10^{-6}	Bouwer-Rice
EP-3	3.10×10^{-5}	2.50×10^{-5}	2.78×10^{-5}	Bouwer-Rice
EP-4	3.30×10^{-5}	3.25×10^{-5}	3.27×10^{-5}	Bouwer-Rice
Geometric Mean			1.27×10^{-5}	

3.3.2 Borehole Packer Tests

Borehole packer tests were performed at multiple intervals in bedrock boring EBR. A packer test evaluates horizontal hydraulic conductivity by pressurizing a layer of rock between two inflatable packers that seal the borehole above and below the test interval. Water is pumped under pressure into this interval and the volume of water taken up by the formation is recorded over a period of time. Each zone is evaluated over a range of pressures (typically 3), and then the pressures are backed off to see if the formation was damaged (hydraulically fractured) or if the bedding planes absorbed the water and released it as the pressure dropped. Packer test results are provided in Appendix C. A summary of the testing is provided in Table 3.

Table 3: Packer Test Hydraulic Conductivity Results

Test	Interval (ft. BGS)	Geometric Mean (cm/sec)	Test	Interval (ft. BGS)	Geometric Mean (cm/sec)
A	160.55	2.99×10^{-6}	H	87.70	1.04×10^{-5}
B	149.50	8.36×10^{-6}	I	77.55	1.84×10^{-7}
C	139.45	1.15×10^{-5}	J	67.20	6.35×10^{-7}
D	128.80	1.42×10^{-5}	K	56.70	2.03×10^{-7}
E	118.50	3.74×10^{-6}	L	46.25	5.44×10^{-5}
F	108.30	1.76×10^{-5}	M	37.75	3.00×10^{-5}
G	97.85	1.72×10^{-5}	N	26.20	1.68×10^{-5}

4. Interpreted Site Geology

The Site geology was characterized from the hydrogeologic investigation of the facility. Boring logs are provided in Appendix A. The results of the hydrogeologic investigation indicate three principal units are present at the Site. These include: 1) Glasford Formation (with intermittent Roxana Loess), 2) Fill Materials, and 3) Caseyville Formation (bedrock). Based upon our review of the regional stratigraphy previously described, these units are the principal geologic units of concern. Figure 7 provides a Generalized Stratigraphic Column of the Site geology.

Geologic cross sections were prepared from the hydrogeologic investigation and can be found in Appendix D. The location of the subsurface investigation borings and groundwater monitoring wells can be found on Figure 6. Geologic cross-section A-A' shows the east-west trend in the subsurface. Cross-sections B-B' and C-C’ illustrate the north-south geology across the Site. A more detailed description of the site-specific geologic units is provided in the following sections.

4.1 Unlithified Deposits

Three principal unlithified deposits exist at the facility. These geologic units are the Roxana Loess and the Glasford Formation (combined for the Isopach and Structural Contour Map), but there are also significant amounts of Fill Materials (random soils, bottom ash, and sand/gravels). Elevations used to generate the Structural Contour Maps (surface elevation maps) and thicknesses used to produce the Isopach Maps (thickness maps) are found in Table 4.

4.1.1 Glasford Formation

The Glasford Formation was encountered throughout the Site. This unit consists of silt, sand, clay, and gravel. The Glasford Formation ranged in thickness from just over 1 ft. in Boring DP7b to 18.5 ft. in Boring EP-1. A structural contour and an isopach map, illustrating the top elevation and thickness of the Glasford Formation are provided in Figure 8 and Figure 9, respectively. For simplicity, the intermittently occurring Roxana Loess was included in the Glasford Formation maps.

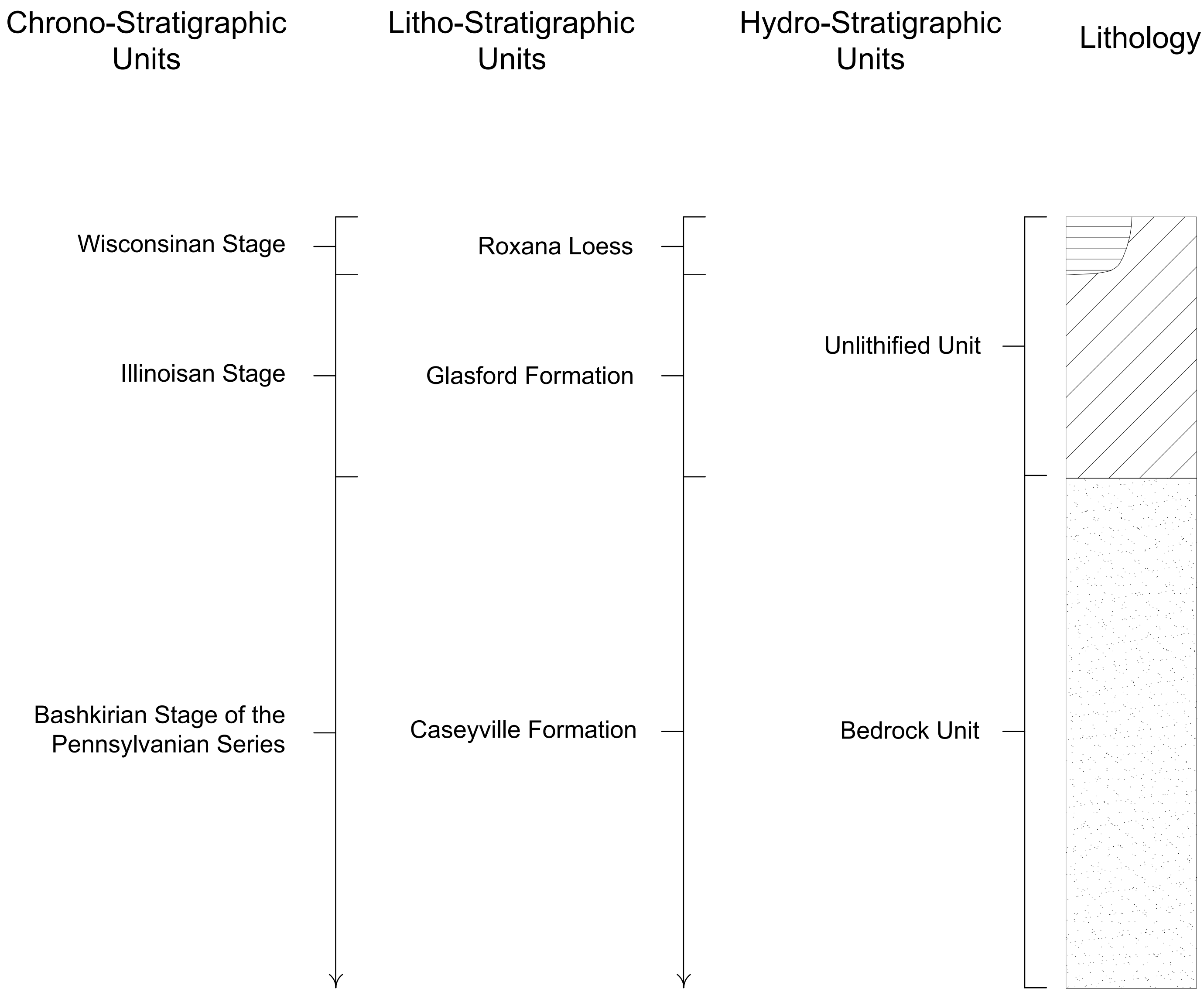
4.1.2 Fill Materials

Fill Materials were found at various locations and thicknesses around the Site. The Fill Materials consisted of excavated Roxana Loess and Glasford Formation materials, bottom ash, and sand/gravel layers used for roadways, etc. Hanson believes these materials were used to provide level surfaces for construction of the Plant. Figure 10 shows the thickness of Fill Materials found during this investigation.

Table 4: Summary of Site Investigation Unit Thickness and Elevations

Boring ID	Ground Elevation	Fill Material Thickness	Top Elevation of Glasford Fm.	Glasford Fm. Thickness	Top Elevation of Caseyville Fm.
DP-1a	516.52	5.00	511.52	5.00	506.52
DP-1b	517.05	12.50	504.55	3.10	501.45
DP-1c	514.27	13.70	500.57	2.70	497.87
DP-1d	513.11	3.30	509.81	13.60	496.21
DP-1e	512.80	4.00	508.80	3.70	505.10
DP-2a	516.53	0.40	516.13	12.40	503.73
DP-2b	516.65	5.00	511.65	8.90	502.75
DP-2c	510.46	●	510.46	10.40	500.06
DP-2d	508.64	0.90	507.74	9.60	498.14
DP-2e	507.37	0.80	506.57	13.20	493.37
DP-2f	506.32	0.70	505.62	13.30	492.32
DP-2g	505.12	0.30	504.82	14.90	489.92
DP-2h	503.54	0.90	502.64	12.70	489.94
DP-3a	518.30	0.90	517.40	12.10	505.30
DP-3b	518.15	●	518.15	18.20	499.95
DP-3c	516.55	●	516.55	15.60	500.95
DP-3d	516.62	●	516.62	10.00	506.62
DP-4a	520.39	1.20	519.19	10.80	508.39
DP-4b	520.64	●	520.64	13.70	506.94
DP-4c	523.14	●	523.14	10.20	512.94
DP-4d	524.09	●	524.09	12.00	512.09
DP-5a	518.48	16.80	501.68	0.00	501.68
DP-5b	519.57	9.70	509.87	0.00	509.87
DP-6a	516.69	3.90	512.79	5.10	507.69
DP-6b	517.23	4.70	512.53	5.00	507.53
DP-6c	516.49	5.50	510.99	3.10	507.89
DP-7a	517.42	6.00	511.42	8.20	503.22
DP-7b	517.56	11.90	505.66	1.10	504.56
DP-7c	516.65	11.60	505.05	6.60	498.45
DP-7d	516.91	14.00	502.91	3.80	499.11
EBG	521.74	●	521.74	16.00	505.74
EP-1	517.07	●	517.07	18.50	498.57
EP-2	511.15	0.90	510.25	12.60	497.65
EP-3	516.24	12.00	504.24	6.50	496.74
EP-4	517.07	6.00	511.07	12.50	498.57

● Unit not encountered during drilling



Hanson Professional Services Inc.

GENERALIZED STRATIGRAPHIC COLUMN

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE 7

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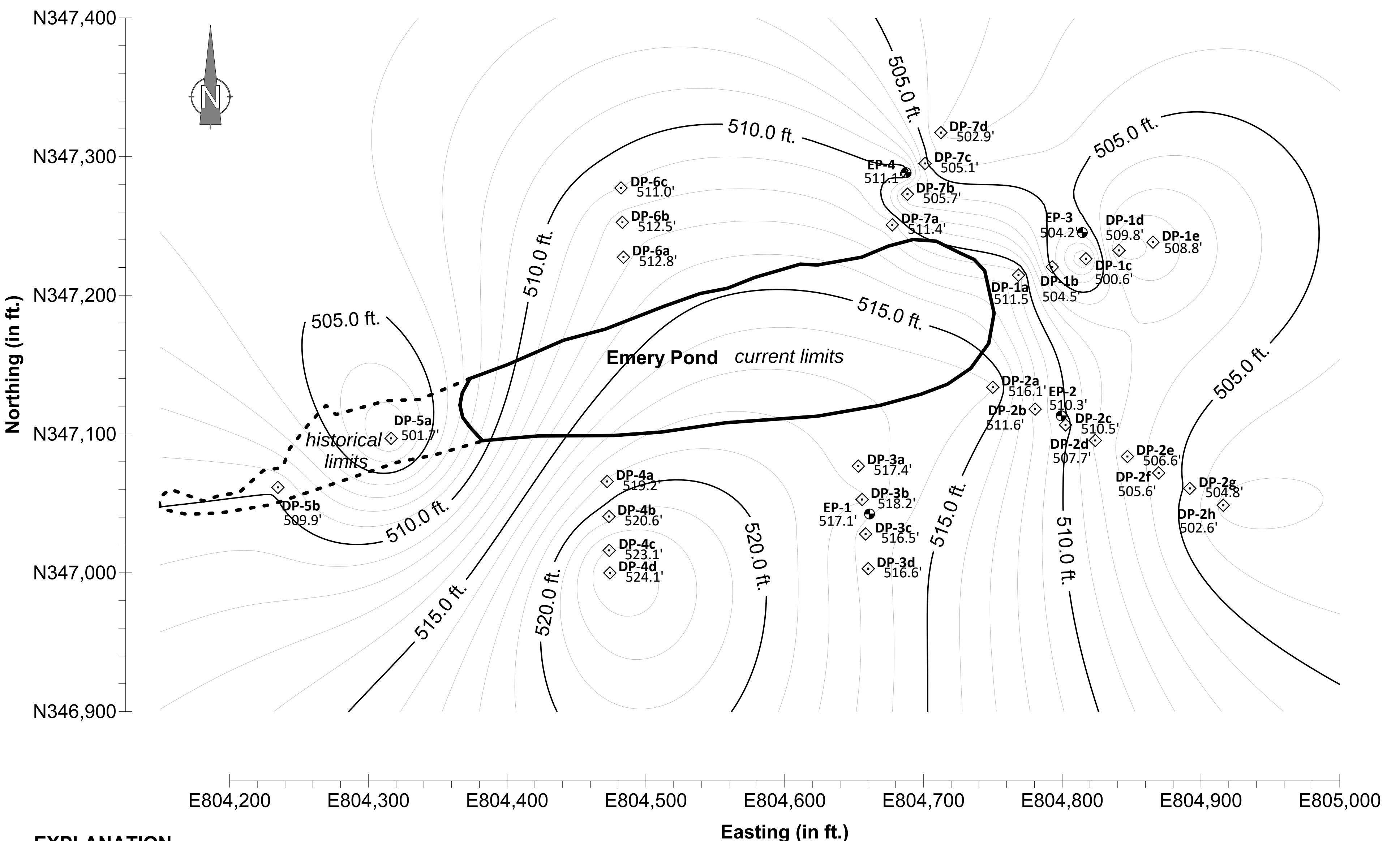


EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot

SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

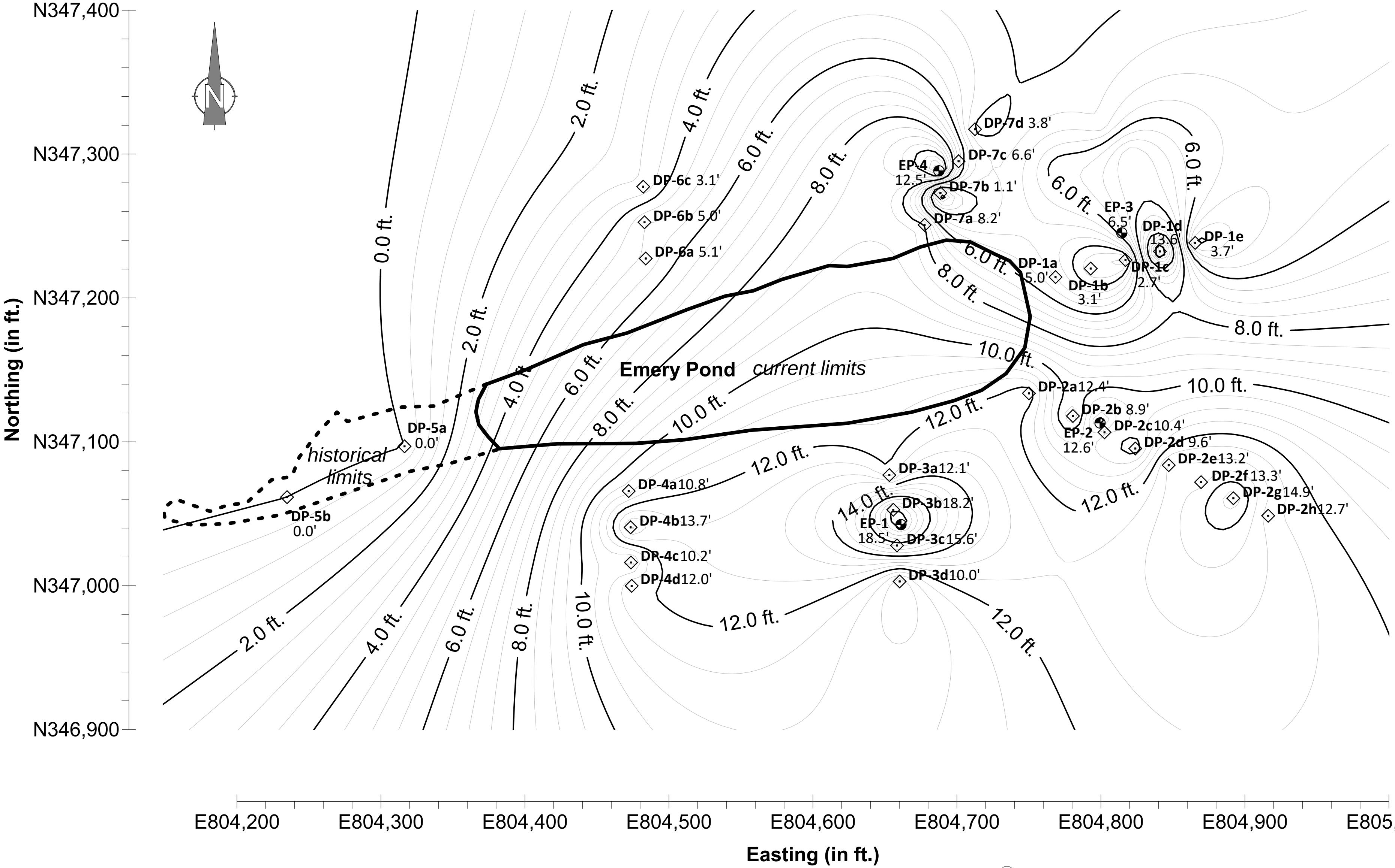
HANSON
Hanson Professional Services Inc.

Glasford Formation Sturctural Contour Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 8



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

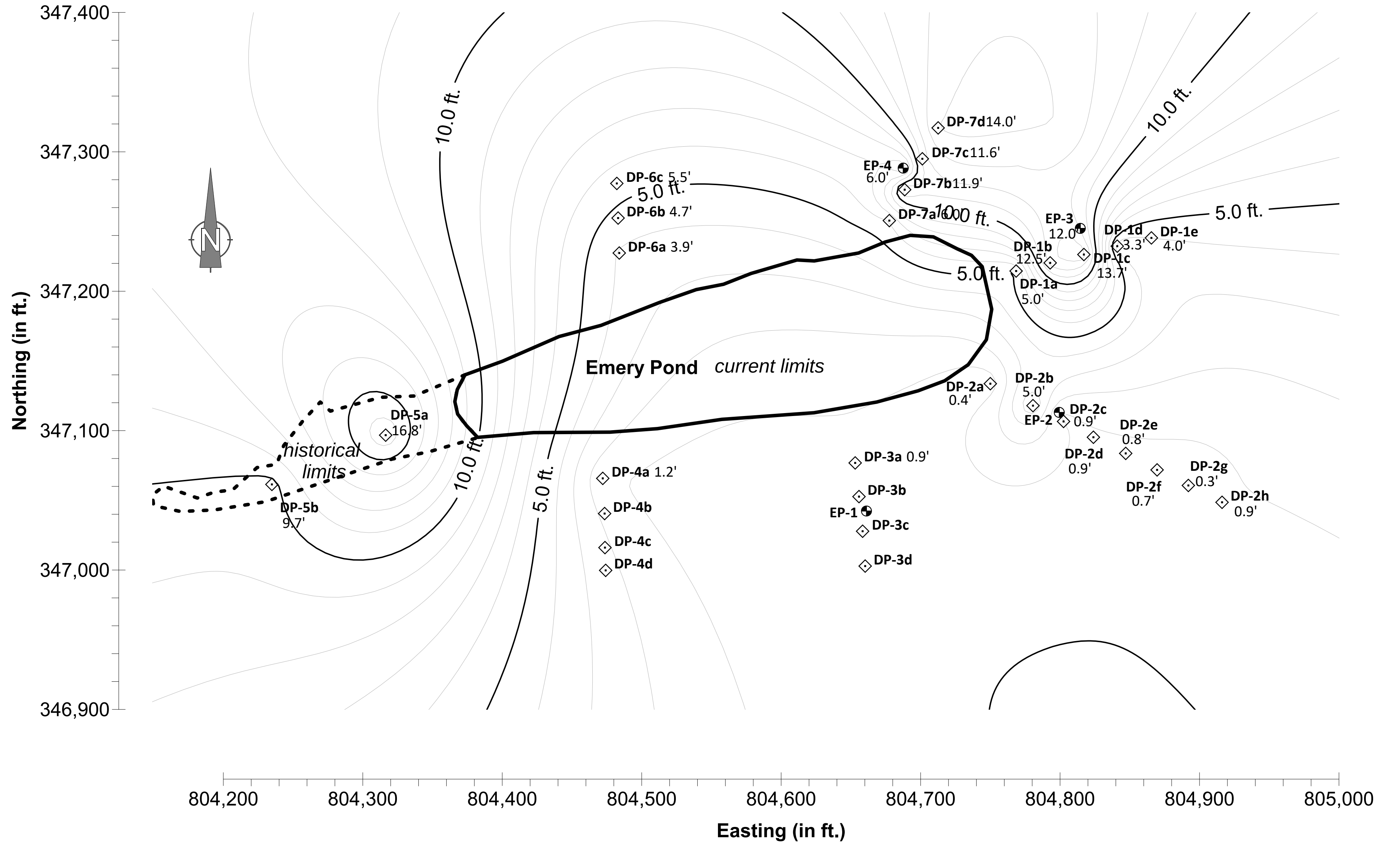
HANSON
Hanson Professional Services Inc.

Glasford Formation Isopach Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 9



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

HANSON
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Fill Materials Isopach Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 10

4.2 Bedrock Stratigraphy

The bedrock stratigraphy at the facility has been characterized by borings drilled during the hydrogeologic investigation. The bedrock at the Site is the Caseyville Formation, consisting of primarily sandstone with intermittent shale beds. A map of the bedrock surface can be found as Figure 11.

5. Interpreted Site Hydrogeology

The results of the hydrogeologic investigation indicate the materials encountered at the Site display a rather narrow range of hydrogeologic characteristics. An overview of the potentiometric surface maps and horizontal groundwater flow characteristics are discussed in detail later in this section. An overview of the hydrogeologic characteristics encountered at the facility is provided in the following paragraphs.

5.1 Hydrogeologic Characteristics of the Units

The hydrogeologic characteristics of the units at the Site were evaluated based upon the results of laboratory testing, field testing, and field measurements. The unlithified deposits possess a narrow range of hydraulic conductivity values. The following paragraphs provide a description of the hydro-stratigraphic units encountered in each of the geologic units.

5.1.1 Unlithified Unit

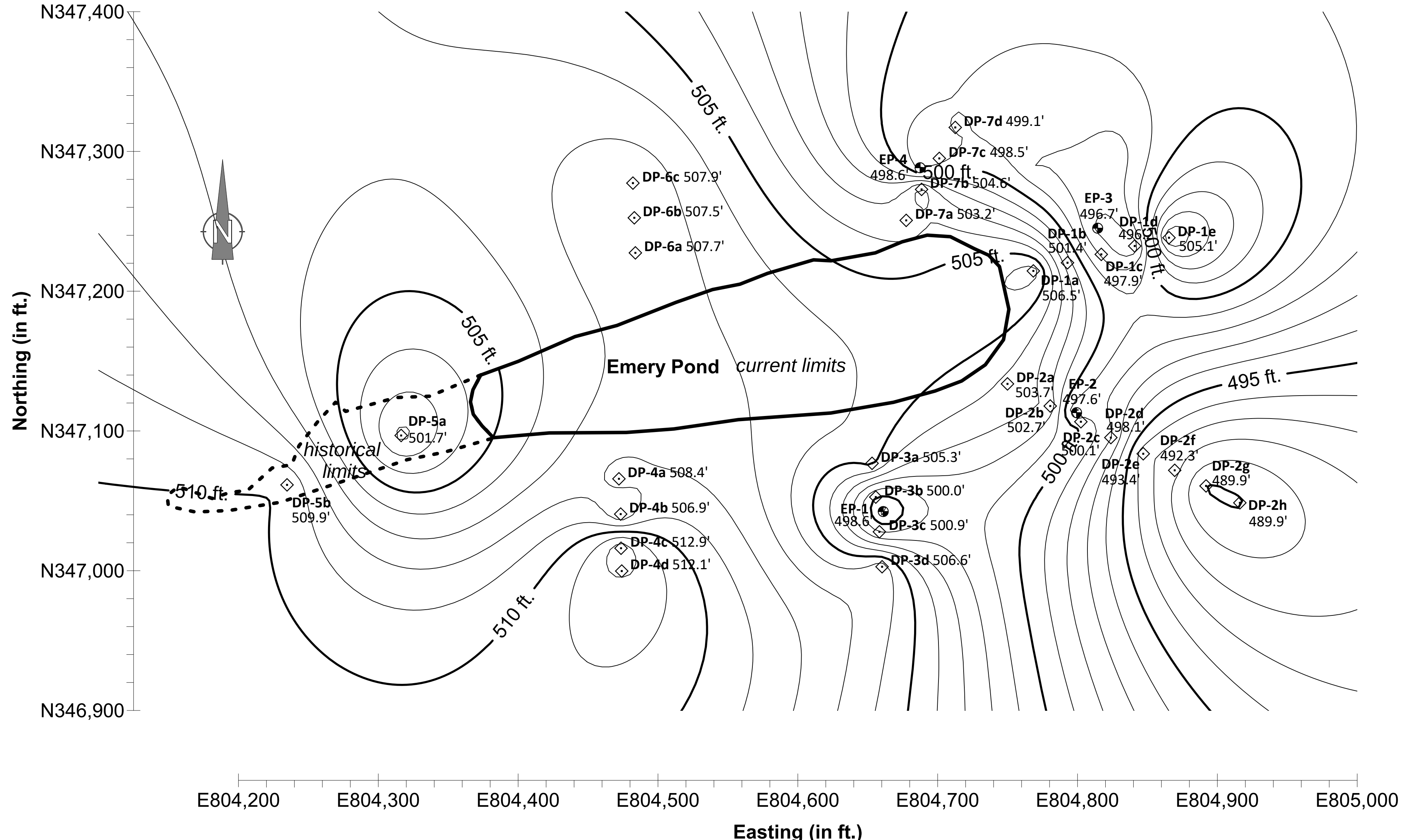
The Unlithified Unit at the Site is associated with the Roxana Loess and Glasford Formation, which are clayey silt to silty clay units. The Unlithified Unit is generally unsaturated and is essentially a vertical percolation zone for shallow groundwater recharge. Horizontal hydraulic conductivity values ranged from the low-10^{-5} cm/s to the high-10^{-6} cm/s. Hanson believes that vertical hydraulic conductivities would be 1 to 2 orders of magnitude lower. This anisotropy is likely due to depositional processes that have been identified in various studies (Warren et al., 1996 and Berger & Belitz, 1997).

5.1.2 Bedrock Unit

The Bedrock Unit at the Site is associated with the Caseyville Formation. As previously noted, this formation is primarily sandstone with intermittent and variably thick shale layers. Like the Unlithified Unit, horizontal hydraulic conductivity values ranged from the low-10^{-5} cm/s to the high-10^{-7} cm/s. Hanson believes that vertical hydraulic conductivities would be 1 to 2 orders of magnitude lower. This anisotropy is likely due to depositional processes that have been identified in various studies (Warren et al., 1996 and Berger & Belitz, 1997).

5.1.3 Upper-most Aquifer

Hanson has concluded, based on the hydraulic conductivity test results that there is not an aquifer (as defined by 40 CFR 257.53 or 35 IAC 620.110) at the Site. It is unlikely that the Unlithified and Bedrock Units are capable of producing “usable” or “economically useful” quantities of water within the tested hydraulic conductivity ranges.



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot

SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

HANSON
Hanson Professional Services Inc.

Caseyville Formation Structural Contour Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 11

5.1.4 Potentiometric Surface Maps

Potentiometric surface maps of the Unlithified Unit are presented for 2017, 2018 and this early-2019 investigation. Water elevations used to prepare the potentiometric surface maps are indicated adjacent to the monitoring well/boring location. The potentiometric surface maps indicate groundwater flow is generally toward the east beneath the Site.

Representative gradients were determined based on changes in water elevations between EP-1 and EP-2. Table 5 lists the calculated gradient values.

Table 5: Gradient Calculations (EP-1 to EP-2)

Date	Elev. @ EP-1 (in ft.)	Elev. @ EP-2 (in ft.)	Change in head (Δh in ft.)	Change in length (Δl in ft.)	Gradient (i)
March 24, 2017	512.42	508.89	3.53	155.28	0.0227
April 24, 2017	513.92	509.89	4.03	155.28	0.0260
May 25, 2017	512.72	509.29	3.43	155.28	0.0221
June 22, 2017	511.72	508.69	3.03	155.28	0.0195
June 29, 2017	511.52	508.79	2.73	155.28	0.0176
July 24, 2017	510.72	507.79	2.93	155.28	0.0189
August 3, 2017	509.42	507.39	2.03	155.28	0.0131
August 31, 2017	508.82	506.99	1.83	155.28	0.0118
March 22, 2018	513.42	509.19	4.23	155.28	0.0272
August 27, 2018	509.52	506.39	3.13	155.28	0.0202
March 1, 2019	513.72	508.79	4.93	155.28	0.0317
Average					0.0210

5.2 Groundwater Classification

Based on the requirements of 35 IAC 620.210, Hanson has concluded that shallow groundwater at the Emery Pond and its immediate vicinity (based on lithologies presented in the Stack Unit Map (Berg & Kempton, 1988)) is Class II: General Resource Groundwater and deep groundwater is Class I: Potable Resource Groundwater for the following reasons:

The Unlithified Unit is classified as Class II groundwater because:

1. The Unit does not contain a sand, gravel, or sand & gravel deposit greater than 5 ft. thick, and
2. The slug test results (see Table 2) are less than 1 x 10^{-4} cm/s.

The upper (approximately 11 ft.) of the Bedrock Unit is classified as Class II groundwater because:

1. The Unit contains less than 10 ft. of sandstone,
2. The Unit contains less than 15 ft. of fractured carbonate rock, and
3. The packer test results (see Table 3) are less than 1 x 10^{-4} cm/s.

The lower Bedrock Unit is classified as Class I groundwater because:

1. The Unit has two continuous segments of sandstone that exceed 10 ft. in thickness, although
2. The packer test results (see Table 3) are less than 1 x 10^{-4} cm/s.

6. Conclusion

A review of published literature and data was utilized to present an overview of the regional climate, geology, and hydrogeology. A hydrogeologic investigation of the Site was completed, testing was performed, and data was compiled to assess the range of site-specific information related to geotechnical, hydrogeological, and geochemical characteristics found at the facility. Based on the regional and site-specific data presented, the Site appears to be located in a hydrogeologic setting that cannot be classified as an aquifer. Hanson concluded that because of the hydraulic conductivity values found beneath the Site, there are not usable or economically useful quantities of groundwater available pursuant to the definition of an “aquifer” under both 40 CFR 257.53 and 35 IAC 620.110. Based on this investigation, groundwater is classified as Class II: General Resource Groundwater pursuant to 35 IAC 620.210 in the Unlithified Hydro-stratigraphic Unit and the upper (approximately) 11 ft. of the Bedrock Hydro-stratigraphic Unit. The remaining Bedrock Hydro-stratigraphic Unit is classified as Class I: Potable Resource Groundwater. The current monitoring wells at the Emery Pond are only screened in the Unlithified Unit and part of the Upper Bedrock Unit which contains Class II: General Resource groundwater.

7. Licensed Professional Signature/Seal

The geological work product contained in this document has been prepared under my personal supervision and has been prepared and administered in accordance with the standards of reasonable professional skill and diligence.

Rhonald W. Hasenyager, P.G.
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, IL 62703-2886
(217) 788-2450
Registration No. 196-000246

Seal:

LICENSED PROFESSIONAL GEOLOGIST
RHONALD W. HASENYAGER
196-000246
ILLINOIS

Expires 31 March 2021

Signature: ______________________ Date: 29 March 2019

8. References

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Appendix A

Boring Logs

A.1

AECOM Monitoring Well Boring Logs

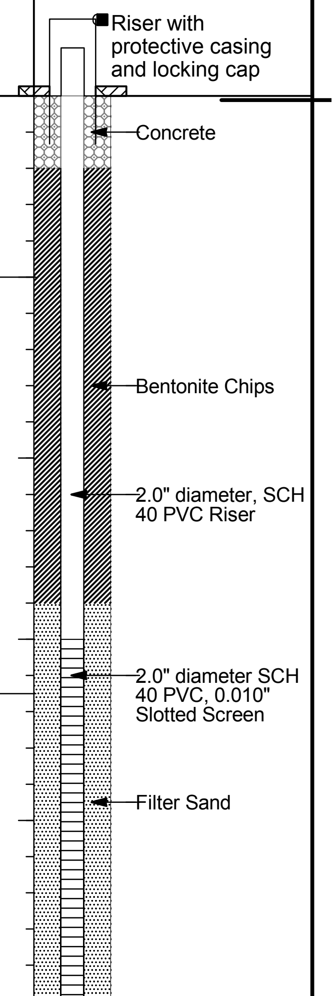
Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EBG

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**25.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**524.87 ft, msl** **521.74 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**346358.14 ft** **804168.155 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: Sample Interval	SAMPLES: % Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0	X	NR	ML		Brownish tan, clayey SILT, stiff, non-plastic, moist (ML)
520						
		X	NR			
	5			CL		Brownish tan silty CLAY, very soft, medium to high plasticity, moist (CL)
		X	NR			becomes low to medium plasticity
	10	X	NR			with black fines
510		X	NR			becomes brown/orange/gray, trace black fines, low plasticity
						trace rust colored oxidation with red mottling
	15	X	NR			
		X	NR	SHALE		SHALE, gray
	20	X	NR			
500		X	NR			
		X	NR			
	25					Boring terminated at 25.0 ft. bgs on 2/7/2017. Monitoring well installed to 25.0 ft. bgs on 2/7/2017. NR = Not Recorded
	30					
490						
	35					

WELL CONSTRUCTION DETAILS



SIPC MARION SIPC MARION.GPJ 10/9/17

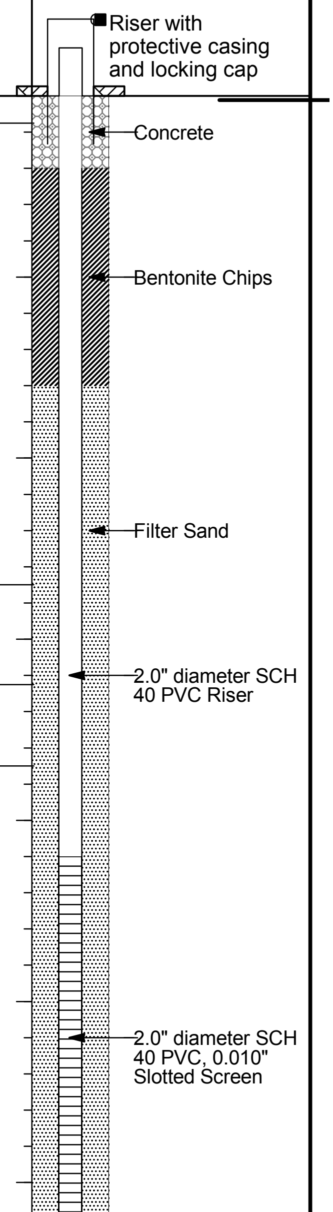
Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EP-1

Date(s) Drilled and Installed	**2/7/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**31.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**519.72 ft, msl** **517.07 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347042.306 ft** **804661.174 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0		NR	Topsoil	Black TOPSOIL, moist
			NR	CL	Brownish tan silty CLAY, moist, medium plasticity (CL)
	5		NR		
510			NR		becomes orangish with trace coarse sand and gravel, with rust colored mottles
	10		NR		becomes very stiff
			NR		becomes medium-stiff, low plasticity
	15		NR	ML	Brownish tan to oragne clayey SILT, trace gravel and rust colored mottles, stiff, non-plastic, moist (ML)
500			NR	SP	Red orange SAND with orange-brown silty clay, moist (SP)
	20		NR	SNDSTN	SANDSTONE, with interbedded limestone and shale
			NR		
	25		NR		
490			NR		
	30		NR		
	35				Boring terminated at 31.0 ft. bgs on 2/7/2017. Monitoring well installed to 31.0 ft. bgs on 2/7/2017. NR = Not Recorded

WELL CONSTRUCTION DETAILS



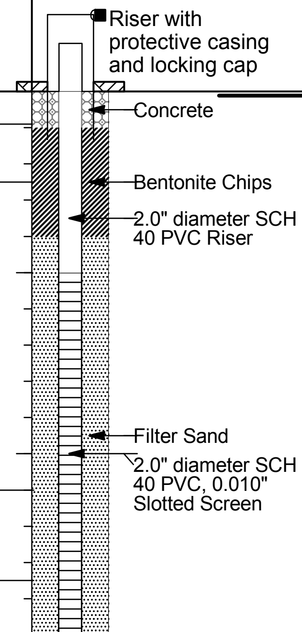
AECOM

Client: Southern Illinois Power Cooperative	Log of EP-2
Project Name: SIPC Marion CCR	Sheet 1 of 1
Project Location: SIPC Marion	
Project Number: 60535846	

Date(s) Drilled and Installed	**2/7/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**15.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**513.79 ft, msl** **511.15 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347113.029 ft** **804799.408 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: Sample Interval	SAMPLES: % Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0		NR	Fill		Asphalt and GRAVEL (FILL)
510			NR	CL		Brown to tan silty CLAY, medium stiff, moist (CL)
						brown to tan silty CLAY, soft to medium, medium to high plasticity, moist (CL)
	5		NR			medium plasticity, with rust color oxidation, trace sand and gravel
			NR	CL		
	10		NR			
500			NR	ML		Tan clayey SILT, stiff, low plasticity, moist (ML)
			NR	SNDSTN		SANDSTONE
	15					Boring terminated at 15.0 ft. bgs on 2/7/2017. Monitoring well installed to 15.0 ft. bgs on 2/7/2017. NR = Not Recorded
	20					
490						
	25					
	30					
480						
	35					

WELL CONSTRUCTION DETAILS



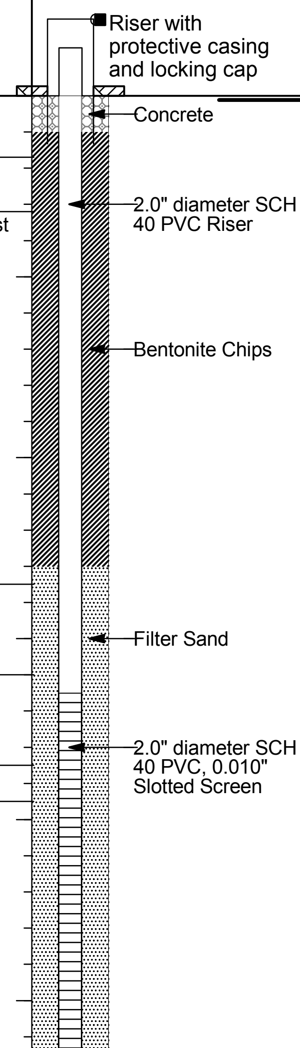
Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EP-3

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**26.5 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**518.95 ft, msl** **518.95 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347245.08 ft** **804814.534 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0	NR	Fill	GRAVEL (FILL)
		NR	ML	Brown clayey SILT, moist (ML)
	5	NR, NR, NR, NR, NR	CL	Olive green to gray silty CLAY, trace sand, medium, low to medium plasticity, moist (CL)
510	10			2 inch layer of cinders, clay becomes tan-brown
				becomes loose, moist, brown/gray/tan, with gravel, some sand and cinders
	15	NR	ML	Light gray to tan clayey SILT, stiff, low plasticity, moist (ML)
		NR	ML	Gray SILT, trace clay, stiff, non-plastic, moist (ML)
500		NR	CL	Gray silty CLAY with yellow-gold gypsum, moist to wet (CL)
	20	NR, NR, NR, NR	SNDSTN	SANDSTONE
	25			
490	30			Boring terminated at 26.5 ft. bgs on 2/8/2017. Monitoring well installed to 26.5 ft. bgs on 2/8/2017. NR = Not Recorded
	35			

WELL CONSTRUCTION DETAILS

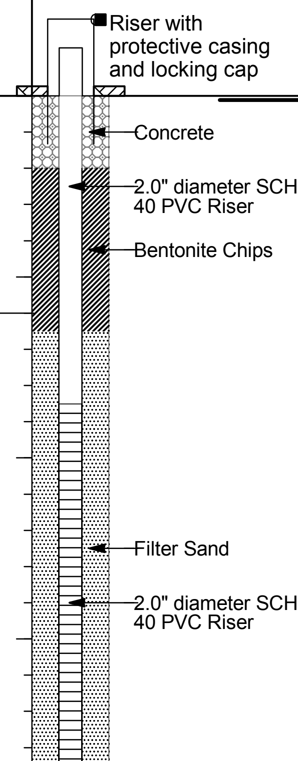


Client: Southern Illinois Power Cooperative **Project Name: SIPC Marion CCR** **Project Location: SIPC Marion** **Project Number: 60535846**	# Log of EP-4 Sheet 1 of 1

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**18.5 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**519.74 ft, msl** **517.07 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347288.297 ft** **804687.527 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: Sample Interval	SAMPLES: % Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0		NR	Fill		GRAVEL, sand, silt (FILL)
			NR			old abandoned pipe
	5		NR			
510			NR	CL		Brown silty CLAY with some gravel, high plasticity, moist to wet (CL)
	10		NR			
			NR			becomes brown-gray, with some layering of black fine sand, high plasticity
	15		NR			becomes wet becomes tan-gray, moist to wet, high plasticity
500			NR			becomes brown/tan/gray, trace fine sand
			NR	Shale		SHALE, gray
	20					Boring terminated at 19.5 ft. bgs on 2/8/2017. Monitoring well installed to 18.5 ft. bgs on 2/8/2017. NR = Not Recorded
	25					
490						
	30					
	35					

WELL CONSTRUCTION DETAILS



AECOM

A.2

Bedrock Boring Log

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system
FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
								Dark gray (10YR4/1) with 30% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.		510	
	0/60 *0%*	BD					2			508	
							4	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.		506	
	0/60 *0%*	BD					6			504	
							8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		502	
							10			500	
	0/55 *0%*	BD					12	Yellowish brown (10YR5/8), moist, hard, weathered SHALE		498	
							14			496	
								Brownish yellow (10YR6/8), weathered SANDSTONE.			
							16	Gray (10YR6/1), weathered SANDSTONE.		494	
	62/67 *93%*	RC					18	Gray (10YR6/1), LIMESTONE with sandstone partings.		492	
							20				

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system
FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

Number	Recov / Total (in) % Recovery	Type	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
								Gray (10YR6/1), LIMESTONE with sandstone partings. *[Continued from previous page]*	490	
								Gray (10YR5/1) SHALE.		
								Gray (10YR5/1) LIMESTONE.		
							22		488	
	120/120 *100%*	RC					24	Yellowish brown (10YR5/8), vuggy, SANDSTONE.	486	
							26		484	
							28	Yellowish brown (10YR5/8) with 35% dark yellowish brown (10YR4/4) mottles, massive, SANDSTONE.	482	
							30		480	
							32	Yellowish brown (10YR5/8) with 35% dark yellowish brown (10YR4/4) mottles, massive, SANDSTONE.	478	
								Yellowish brown (10YR5/8) with 35% dark yellowish brown (10YR4/4) mottles, vuggy, SANDSTONE.		
	120/120 *100%*	RC					34		476	
							36		474	
							38	Dark yellowish brown (10YR5/8), massive with some cross-beds, SANDSTONE.	472	
							40			

NOTE(S):

FIELD BORING LOG

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system

FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

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
							42	Dark yellowish brown (10YR5/8), massive with some cross-beds, SANDSTONE. *[Continued from previous page]*		470, 468	
	120/120 *100%*	RC					44	Red (10R4/8), massive, SANDSTONE.		466	
							46–50	Dark yellowish brown (10YR4/4), massive, SANDSTONE.		464, 462, 460	
								Yellowish brown (10YR5/8), weathered (soft), SHALE.			
	116/120 *97%*	RC					52–54	Red (10R4/8), massive, SANDSTONE.		458, 456	
							56–60	Gray (10YR5/1), massive, SANDSTONE with minor black (10YR2/1) shale partings.		454, 452	

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system
FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
								Gray (10YR5/1), massive, SANDSTONE with minor black (10YR2/1) shale partings. *[Continued from previous page]*		450	
							62			448	
							64	Gray (10YR5/1), massive, micaceous, SANDSTONE with minor black (10YR2/1) shale partings.		446	
	116/120 *97%*	RC					66			444	
							68			442	
							70			440	
							72			438	
							74			436	
	118/120 *98%*	RC					76			434	
							78			432	
							80				

NOTE(S):

FIELD BORING LOG

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system

FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

HANSON

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

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
	118/120 *98%*	RC					80–90	Gray (10YR5/1), massive, micaceous, SANDSTONE with minor black (10YR2/1) shale partings. *[Continued from previous page]*		430–420	
	119/120 *99%*	RC					90–100	Gray (10YR5/1), massive, SANDSTONE with minor black (10YR2/1) shale partings.		420–410	

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system
FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							100–107	Gray (10YR5/1), massive, SANDSTONE with minor black (10YR2/1) shale partings. *[Continued from previous page]*		410–403	
	120/120 *100%*	RC									
							107–111.9	Gray (10YR5/1), massive, micaceous, SANDSTONE with minor black (10YR2/1) shale partings.		403–398	
							111.9–112.4	Gray (10YR5/1) SHALE.		398	
	120/120 *100%*	RC					112.4–118.8	Gray (10YR5/1), massive, SANDSTONE with minor black (10YR2/1) shale partings.		398–391.5	
							118.8–120	Gray (10YR5/1), cross-bedded, SANDSTONE.		391.5–390.3	

Depth scale: 102, 104, 106, 108, 110, 112, 114, 116, 118, 120
Elevation scale: 410, 408, 406, 404, 402, 400, 398, 396, 394, 392

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system
FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
								Gray (10YR5/1), cross-bedded, SANDSTONE. *[Continued from previous page]*		390	
	120/120 *100%*	RC					122–130	Gray (10YR5/1), massive, SANDSTONE.		388, 386, 384, 382	
	120/120 *100%*	RC					130–135.1	Gray (10YR5/1), cross-bedded, SANDSTONE.		380, 378, 376	
							136	Gray (10YR5/1), massive, SANDSTONE with minor black (10YR2/1) shale partings.		374	
							138	Gray (10YR5/1), massive, SANDSTONE with more black (10YR2/1) shale partings.		372	
							140	Black (10YR2/1) SHALE.			

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system
FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
								Black (10YR2/1) SHALE. *[Continued from previous page]*	370	
								Laminated gray (10YR5/1) SANDSTONE and black (10YR2/1) SHALE.		
							142		368	
							144		366	
	120/120 *100%*	RC								
							146	Gray (10YR5/1), massive, SANDSTONE.	364	
							148		362	
								Black (10YR2/1) SHALE.		
							150		360	
							152	Gray (10YR5/1), massive, SANDSTONE.	358	
							154		356	
	118/120 *98%*	RC								
							156		354	
								Black (10YR2/1) SHALE.		
							158		352	
							160			

NOTE(S):

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/11/2019
Finish: 2/14/2019
WEATHER: Rainy, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: NX wireline coring system

FIELD STAFF: Driller: C Clines
Helper: M Hill
Eng/Geo: R. Hasenyager

BOREHOLE ID: EBR
Well ID: n/a
Surface Elev: 510.3 ft. MSL
Completion: 170.0 ft. BGS
Station: 347,111.43N
804,807.42E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - boring flooded for coring
▼ = Dry - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	120/120 *100%*	RC					160–165.4	Black (10YR2/1) SHALE. *[Continued from previous page]*		350, 348, 346	
							165.4–166.8	Gray (10YR5/1), massive, SANDSTONE.		344	
							166.8–167.4	Black (10YR2/1) SHALE.			
							167.4–169.4	Laminated gray (10YR5/1) SANDSTONE and black (10YR2/1) SHALE.		342	
							169.4–170	Gray (10YR5/1), massive, SANDSTONE.			

Depth scale: 162, 164, 166, 168, 170

NOTE(S):

A.3

Investigation Boring Logs

FIELD BORING LOG

CLIENT: Southern Illinois Power Cooperative	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Emery Pond	**Rig mfg/model:** AMS Power Probe 9500-VTR	**BOREHOLE ID:**	DP-1a
Location: SIPC Marion Power Plant	**Drilling Method:** Direct Push	**Well ID:**	DP-1a
Project: 18E0022A		**Surface Elev:**	516.52 ft. MSL
DATES: Start: 2/28/2019	**FIELD STAFF: Driller:** J Edwards	**Completion:**	17.00 ft. BGS
Finish: 2/28/2019	**Helper:** S Guy	**Station:**	347,214.45N
WEATHER: Rainy, cold (lo 30's)	**Eng/Geo:** R. Hasenyager		804,768.52E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = Dry - 3/1/2019 @ 8:30
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	44/60 *73%*	DP					0–1.7	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							1.7–5	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		514, 512	
	28/48 *58%*	DP					5–10	Dark yellowish brown (10YR4/4), moist, soft, CLAY with some silt and trace sand. (FILL)		510, 508	
	32/48 *67%*	DP					10–17	Brownish yellow (10YR6/6), weathered SHALE.		506, 504, 502, 500	
	40/48 *83%*	DP									

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1b
Well ID: DP-1b
Surface Elev: 517.05 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,220.35N
804,792.89E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 15.95 - 3/1/2019 @ 8:25
▽ =

SAMPLE 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
							0–0.3	Black (10YR2/1) ASPHALTI. (FILL)			
	48/60 *80%*	DP					0.3–2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							2–2.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)			
							2.8–6.4	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		514, 512	
	42/48 *88%*	DP					6.4–7.9	Yellowish brown (10YR5/6) RANDOM FILL (clay, silt, and gravel in 4 to 6 inch lifts).		510	
							7.9–9	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		508	
	27/48 *56%*	DP					9–12.5	Gray (10YR5/1) RANDOM FILL (clay, silt, and gravel in 4 to 6 inch lifts).		506	
	32/48 *67%*	DP					12.5–15.6	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand.		504, 502	
							15.6–17 (▼ 16)	Yellowish brown (10YR5/8), weathered SHALE.			

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1c
Well ID: DP-1c
Surface Elev: 514.27 ft. MSL
Completion: 19.00 ft. BGS
Station: 347,226.27N
804,817.11E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.37 - 3/1/2019 @ 8:10
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) / % Recovery	SAMPLE: Type	TESTING: Blows / 6 in / N - Value / RQD	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft³)	TESTING: Qu (tsf) Qp (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Dark grayish brown (10YR4/2), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		514	
								Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)			
	38/60 *63%*	DP					2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, few bottom ash, and trace sand. (FILL)		512	
								Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)			
							4	Light yellowish brown (10YR6/4), moist, hard, weathered SHALE. (FILL)		510	
	38/48 *79%*	DP					6	Black (10YR2/1) mottled yellowish brown (10YR5/6) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		508	
							8	Dark yellowish brown (10YR4/4) RANDOM FILL (clay, silt, and gravel in 4 to 6 inch lifts).		506	
	40/48 *83%*	DP					10 ▼ / 12	Black (10YR2/1) RANDOM FILL (clay, silt, gravel, and some bottom ash in 4 to 6 inch lifts).		504 / 502	
	42/48 *88%*	DP					14 / 16	Yellowish brown (10YR5/8), moist, soft, CLAY with some silt and trace sand.		500 / 498	
								Yellowish brown (10YR5/8), weathered SANDSTONE.			
	24/24 *100%*	DP					18	Brownish yellow (10YR6/8), weathered SHALE.		496	

End of Boring = 19.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/28/2019
Finish: 2/28/2019
WEATHER: Rainy, cold (lo 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-1d
Well ID: DP-1d
Surface Elev: 513.11 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,232.30N
804,841.00E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.60 - 2/28/2019 @ 15.45
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) / % Recovery	SAMPLE: Type	TESTING: Blows / 6 in / N - Value / **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) Qp (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	60/60 *100%*	DP					0–2.2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		512	
							2.2–3.3	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		510	
	48/48 *100%*	DP					3.3–7.1	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508	
	37/48 *77%*	DP					7.1–10.5	Black (10YR2/1), moist, medium, CLAY with some silt, little sand, few bottom ash, and trace gravel.		506, 504	
							10.5–11.2	Yellowish brown (10YR5/8), wet, soft, CLAY with some silt and trace sand.		502	
							11.2–13.0	Black (10YR2/1), wet, soft, CLAY with some silt and trace sand.		500	
	40/48 *83%*	DP					13.0–16.9	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		498	
							16.9–17.0	Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Emery Pond	**Rig mfg/model:** AMS Power Probe 9500-VTR	**BOREHOLE ID:**	DP-1e
Location: SIPC Marion Power Plant	**Drilling Method:** Direct Push	**Well ID:**	DP-1e
Project: 18E0022A		**Surface Elev:**	512.80 ft. MSL
DATES: Start: 2/28/2019	**FIELD STAFF: Driller:** J Edwards	**Completion:**	8.00 ft. BGS
Finish: 2/28/2019	**Helper:** S Guy	**Station:**	347,238.19N
WEATHER: Rainy, cold (lo 30's)	**Eng/Geo:** R. Hasenyager		804,865.50E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 0.00 - 2/28/2019 @ 15:25
▽ =

SAMPLE 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
	60/60 *100%*	DP					0–2.3	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		512	
							2.3–4.0	Dark yellowish brown (10YR4/4), moist, medium, CLAY with some silt and trace sand. (FILL)		510	
	36/36 *100%*	DP					4.0–7.7	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.		508, 506	
							7.7–8.0	Yellowish brown (10YR5/6), SANDSTONE.			

End of Boring = 8.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2a
Well ID: DP-2a
Surface Elev: 516.53 ft. MSL
Completion: 13.50 ft. BGS
Station: 347,133.62N
804,750.03E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 14.26 - 2/27/2019 @ 8:15
∇ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
								Black (10YR2/1), moist, loose, medium- to very coarse-grained SAND, with some silt and trace gravel. (FILL)		516	
								Black (10YR2/1), moist, stiff, CLAY with some silt, little sand, and trace gravel.			
	60/60 *100%*	DP					2	Brownish yellow (10YR6/6), moist, stiff, CLAY with some silt and trace sand.		514	
							4	Brownish yellow (10YR6/6) with 30% gray (10YR6/1) mottles, moist, medium, CLAY with some silt and trace sand.		512	
	35/48 *73%*	DP					6, 8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		510, 508	
	31/48 *65%*	DP					10, 12	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		506, 504	
	6/6 *100%*	DP						Yellowish brown (10YR5/6), weathered SHALE.			
								Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 13.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2b
Well ID: DP-2b
Surface Elev: 516.65 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,117.86N
804,780.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 9.38 - 2/27/2019 @ 8:35
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type
	31/60 *52%*	DP
	34/48 *71%*	DP
	35/48 *73%*	DP
	36/36 *100%*	DP

TESTING: *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
0 – 2.3	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
2.3 – 5.0	Yellowish brown (10YR5/8) with 40% Black (10YR2/1) mottles, moist, medium CLAY with some silt and trace sand. (FILL)		514, 512	
5.0 – 7.0	Dark gray (10YR4/1), moist, medium, CLAY with some silt and trace sand.		510	
7.0 – 13.1	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		508, 506, 504	
13.1 – 13.9	Yellowish brown (10YR5/6), wet, soft, SILT with few clay and little very fine-grained sand.			
13.9 – 16	Yellowish brown (10YR5/8), weathered SHALE.		502	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16 (▼ at approx. 9.4 ft.)

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Emery Pond	**Rig mfg/model:** AMS Power Probe 9500-VTR	**BOREHOLE ID:** DP-2c	
Location: SIPC Marion Power Plant	**Drilling Method:** Direct Push	**Well ID:** DP-2c	
Project: 18E0022A		**Surface Elev:** 510.46 ft. MSL	
DATES: Start: 2/26/2019	**FIELD STAFF: Driller:** J Edwards	**Completion:** 16.00 ft. BGS	
Finish: 2/26/2019	**Helper:** S Guy	**Station:** 347,106.55N	
WEATHER: Ptly cloudy, mild (hi 40's)	**Eng/Geo:** R. Hasenyager	804,802.49E	

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 7.34 - 2/27/2019 @ 8:55
▽ =

SAMPLE 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	Elevation ft. MSL	Remarks
	40/60 *67%*	DP					0–1.5	Dark gray (10YR4/1) with 30% yellowish brown (10YR5/6) mottles, moist, medium, CLAY with some silt and trace sand.		
	43/48 *90%*	DP					1.5–7.8	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace sand.		
	41/48 *85%*	DP					7.8–10.4	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		
	36/36 *100%*	DP					10.4–15.6	Yellowish brown (10YR5/8), moist, hard, weathered SHALE		
							15.6–16	Yellowish brown (10YR5/8) SANDSTONE.		

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2d
Well ID: DP-2d
Surface Elev: 508.64 ft. MSL
Completion: 15.50 ft. BGS
Station: 347,095.26N
804,823.89E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ = 1.35 - 2/26/2019 @ 17:10
▽ =

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
								Very dark gray (10YR3/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		508	
	53/60 88%	DP					2, 4			506	
								Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		504	
	42/48 88%	DP					6, 8			502, 500	
							10	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	44/48 92%	DP					12	Yellowish brown (10YR5/8), weathered SHALE.		498, 496	
	29/30 97%	DP					14	Yellowish brown (10YR5/8) SANDSTONE.		494	

End of Boring = 15.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2e
Well ID: DP-2e
Surface Elev: 507.37 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,083.66N
804,847.08E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 2.31 - 2/27/2019 @ 9:10
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	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
							0–0.8	Very dark gray (10YR3/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
	60/60 *100%*	DP					0.8–5	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.		506, 504	
	39/48 *81%*	DP					5–9	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		502, 500, 498	
	48/48 *100%*	DP					9–12.9			496	
							12.9–13.7	Yellowish brown (10YR5/6), wet, soft, SILT with few clay and little very fine-grained sand.		494	
	27/36 *75%*	DP					13.7–14.3	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.			
							14.3–16	Yellowish brown (10YR5/8), weathered SHALE.		492	

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2f
Well ID: DP-2f
Surface Elev: 506.32 ft. MSL
Completion: 15.50 ft. BGS
Station: 347,071.83N
804,869.56E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 3.55 - 2/27/2019 @ 9:25
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–0.7	Very dark gray (10YR3/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		506	
	60/60 *100%*	DP					0.7–5.6	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		504, 502	
	44/48 *92%*	DP					5.6–7.7	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) mottles, moist, medium CLAY with some silt and trace sand.		500	
							7.7–9.0	Dark yellowish brown (10YR4/6), wet, medium dense, very fine- to medium-grained SAND with few clay and silt.		498	
	45/48 *94%*	DP					9.0–14.0	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		496, 494	
	28/30 *93%*	DP					14.0–15.5	Light yellowish brown (10YR6/4) SANDSTONE.		492	

End of Boring = 15.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

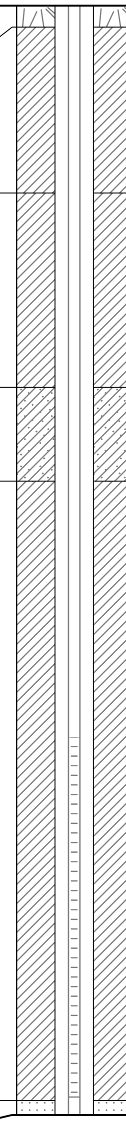
BOREHOLE ID: DP-2g
Well ID: DP-2g
Surface Elev: 505.12 ft. MSL
Completion: 15.40 ft. BGS
Station: 347,060.68N
804,891.97E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 9.00 - during drilling
▼ = 11.60 - 2/26/2019 @ 17:30
▽ =

SAMPLE 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
								Gray (10YR5/1), moist, loose, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
	46/60 77%	DP					2	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		504	
							4	Yellowish brown (10YR5/6), medium CLAY with some silt and trace sand.		502	
	34/48 71%	DP					6	Gray (10YR5/1), moist, medium, CLAY with some silt, little sand, and trace gravel.		500	
	35/48 73%	DP					8, 10, 12, 14	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.		498, 496, 494, 492	
	29/30 97%	DP						Yyellowish brown (10YR5/8) SANDSTONE.		490	

End of Boring = 15.4 ft.



NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/26/2019
Finish: 2/26/2019
WEATHER: Ptly cloudy, mild (hi 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-2h
Well ID: DP-2h
Surface Elev: 503.54 ft. MSL
Completion: 15.00 ft. BGS
Station: 347,048.55N
804,916.15E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 7.00 - during drilling
▼ = -0.30 - 2/26/2019 @ 17:40
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *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
							0–0.9	Gray (10YR5/1), moist, loose, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
	45/60 *75%*	DP					0.9–7.0	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		502, 500, 498	
	33/48 *69%*	DP					7.0–10.3	Gray (10YR6/1) with 20% yellowish brown (10YR5/6) mottles, wet, medium SILT with few clay and little very fine-grained sand.		496, 494	
	42/48 *88%*	DP					10.3–13.0	Yellowish brown (10YR5/8), moist, stiff, CLAY with some silt and trace sand.		492	
							13.0–13.6	Yellowish brown (10YR5/8), moist, stiff, CLAY with some silt, little sand, and trace gravel.		490	
	24/24 *100%*	DP					13.6–15.0	Brownish yellow (10YR6/8) SANDSTONE.			

End of Boring = 15.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-3a
Well ID: DP-3a
Surface Elev: 518.30 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,076.80N
804,653.12E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 11.68 - 2/26/2019 @ 8:55
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: 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
							0–0.9	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		518	
	49/60 *82%*	DP					0.9–9	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		516, 514, 512, 510	
	30/48 *63%*	DP									
	32/48 *67%*	DP					9–13	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508, 506	
	36/48 *75%*	DP					13–16.8	Yellowish brown (10YR5/8), weathered SHALE.		504, 502	
							16.8–17	Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-3b
Well ID: DP-3b
Surface Elev: 518.15 ft. MSL
Completion: 19.00 ft. BGS
Station: 347,052.67N
804,655.84E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.63 - 2/26/2019 @ 9:15
▽ =

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
	60/60 *100%*	DP					0–1.3	Black (10YR2/1), moist, soft, CLAY with some silt and trace sand.		518	
							1.3–2.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		516	
	48/48 *100%*	DP					2.8–10.7	Yellowish brown (10YR5/6), moist, medium, SILT with few clay, and trace very fine-grained sand.		514, 512, 510, 508	
	39/48 *81%*	DP					10.7–11.6	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.			
							11.6–13	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		506	
							13–14.2	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.		504	
	42/48 *88%*	DP					14.2–15.2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.			
							15.2–17	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and few very fine-grained sand.		502	
	23/24 *96%*	DP					17–18.2	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.		500	
							18.2–18.5	Light yellowish brown (10YR6/4) SANDSTONE.			
							18.5–19	Yellowish brown (10YR5/8), weathered SHALE.			

End of Boring = 19.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-3c
Well ID: DP-3c
Surface Elev: 516.55 ft. MSL
Completion: 16.00 ft. BGS
Station: 347,027.84N
804,658.41E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 6.44 - 2/26/2019 @ 9:30
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	60/60 *100%*	DP					0–0.5	Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace sand.			
							0.5–6.6	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.			
	41/48 *85%*	DP					6.6–15.5	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.			
	40/48 *83%*	DP									
	38/48 *79%*	DP					15.5–16	Brownish yellow (10YR6/8), weathered SANDSTONE.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16. Elevation scale: 516, 514, 512, 510, 508, 506, 504, 502.

End of Boring = 16.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP3d
Well ID: DP3d
Surface Elev: 516.62 ft. MSL
Completion: 10.30 ft. BGS
Station: 347,002.83N
804,660.29E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 5.06 - 2/26/2019 @ 9:45
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
							0 – 0.55	Very dark grayish brown (10YR3/2), moist, soft, CLAY with some silt and trace sand.			
	53/60 *88%*	DP					0.55 – 3.2	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		516, 514	
							3.2 – 6.1	Yellowish brown (10YR5/6), moist, medium, SILT with few clay, and trace very fine-grained sand.		512	
	36/48 *75%*	DP					6.1 – 7.1	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		510	
							7.1 – 10.0	Yellowish brown (10YR5/6), weathered SHALE.		508	
	16/18 *89%*	DP					10.0 – 10.3	Yellowish brown (10YR5/6), weathered SANDSTONE.			

End of Boring = 10.3 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4a
Well ID: DP-4a
Surface Elev: 520.39 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,065.72N
804,472.12E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 14.26 - 2/27/2019 @ 8:15
▽ =

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	Elevation ft. MSL	Remarks
							0–0.4	Brown (10YR5/3), moist, medium, CLAY with some silt, little sand, and trace gravel. (FILL)	520	
							0.4–1.2	Light gray (10YR7/1), moist, dense, medium- to coarse-grained GRAVEL with little sand and few silt. (FILL)		
	42/60 *70%*	DP					1.2–12	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.	518, 516, 514, 512, 510	
	48/48 *100%*	DP								
	48/48 *100%*	DP								
							12–13	Yellowish brown (10YR5/8), weathered SANDSTONE.	508	
	48/48 *100%*	DP					13–16.3	Yellowish brown (10YR5/8), weathered SHALE. (▼ 14)	506	
							16.3–17	Yellowish brown (10YR5/8), weathered SILTSTONE.	504	

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4b
Well ID: DP-4b
Surface Elev: 520.64 ft. MSL
Completion: 14.50 ft. BGS
Station: 347,040.46N
804,473.43E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 13.55 - 2/27/2019 @ 8:15
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type
	60/60 *100%*	DP				
	46/48 *96%*	DP				
	37/48 *77%*	DP				
	18/18 *100%*	DP				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0 – ~6.8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.	520 – ~514
~6.8 – ~11.6	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.	~514 – ~509
~11.6 – ~13.7	Yellowish brown (10YR5/8), weathered SHALE.	~509 – ~507
~13.7 – 14.5	Brownish yellow (10YR6/6) SANDSTONE.	

End of Boring = 14.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4c
Well ID: DP-4c
Surface Elev: 523.14 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,016.05N
804,473.64E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 13.61 - 2/27/2019 @ 8:15
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–0.3	Brown (10YR4/3), moist, soft, CLAY with some silt and trace sand.			
	60/60 *100%*	DP					0.3–7.2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		522, 520, 518, 516	
	46/48 *96%*	DP					7.2–10.2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		514	
	35/48 *73%*	DP					10.2–17.0	Yellowish brown (10YR5/8), weathered SHALE.		512, 510, 508	
	28/48 *58%*	DP				▼ (13.61)					

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-4d
Well ID: DP-4d
Surface Elev: 524.09 ft. MSL
Completion: 17.00 ft. BGS
Station: 346,999.74N
804,474.16E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 2.10 - 2/26/2019 @ 8:25
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–0.3	Dark yellowish brown (10YR4/4), moist, soft, CLAY with some silt, little sand, and trace gravel.			
	60/60 *100%*	DP					2 (▼)			522	
							4	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand.		520	
	46/48 *96%*	DP					6			518	
							8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, little sand, and trace gravel.		516	
	37/48 *77%*	DP					10	Yellowish brown (10YR5/8), weathered SHALE.		514	
							12	Yellowish brown (10YR5/8), weathered SANDSTONE.		512	
	28/48 *58%*	DP					14	Yellowish brown (10YR5/8), weathered SHALE.		510	
							16			508	

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-5a
Well ID: DP-5a
Surface Elev: 518.48 ft. MSL
Completion: 17.00 ft. BGS
Station: 347,096.77N
804,316.45E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 15.00 - during drilling
▼ = 6.62 - 2/26/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) % Recovery	Type	TESTING: Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) Qp (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
	40/60 67%	DP					0–5	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL)		
	48/48 100%	DP					5–9	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL)		
	48/48 100%	DP					9–13	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL) (to 11.5); Light brownish gray (10YR6/2), moist, dense, very fine-grained SAND with some silt. (FILL) (11.5–12.5)		
	26/48 54%	DP					13–17	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL) (12.5–15.0); Very dark brown (10YR2/2), wet, dense, bottom ASH. (FILL) (15.0–16.8); Very pale brown (10YR7/4), weathered SANDSTONE		

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16
Elevation scale: 518, 516, 514, 512, 510, 508, 506, 504, 502

End of Boring = 17.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/25/2019
Finish: 2/25/2019
WEATHER: Sunny, cool (hi 30's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-5b
Well ID: DP-5b
Surface Elev: 519.57 ft. MSL
Completion: 9.80 ft. BGS
Station: 347,061.40N
804,234.84E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 7.02 - 2/26/2019 @ 8:05
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							0–1.1	Yellow, (10YR7/6) wet, soft, GYPSUM (FILL)			
	49/60 *82%*	DP					1.1–9.6	Very dark brown (10YR2/2), moist, dense, bottom ASH. (FILL)		518, 516, 514, 512, 510	
	48/48 *100%*	DP					7.02 ▼				
	8/8 *100%*	DP					9.6–9.8	Yellowish brown (10YR5/8), weathered SANDSTONE			

Depth scale: 2, 4, 6, 8

End of Boring = 9.8 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative	**CONTRACTOR:** Bulldog Drilling, Inc.		
Site: Emery Pond	**Rig mfg/model:** AMS Power Probe 9500-VTR	**BOREHOLE ID:**	DP-6a
Location: SIPC Marion Power Plant	**Drilling Method:** Direct Push	**Well ID:**	DP-6a
Project: 18E0022A		**Surface Elev:**	516.69 ft. MSL
DATES: Start: 2/27/2019	**FIELD STAFF: Driller:** J Edwards	**Completion:**	9.50 ft. BGS
Finish: 2/27/2019	**Helper:** S Guy	**Station:**	347,227.38N
WEATHER: Overcast, cool (lo 40's)	**Eng/Geo:** R. Hasenyager		804,483.91E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 6.32 - 2/28/2019 @ 9:10
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
	51/60 *85%*	DP					0–2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							2–2.9	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand. (FILL)		514	
							2.9–3.7	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)			
							3.7–4.3	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
							4.3–6.2	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.		512	
	34/48 *71%*	DP					6.2–6.6	Gray (10YR5/1), moist, soft, SILT with few clay and little very fine-grained sand.		510	
							6.6–7.5	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand.			
							7.5–9	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508	
	6/6 *100%*	DP					9–9.5	Yellowish brown (10YR5/6), SANDSTONE.			

End of Boring = 9.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-6b
Well ID: DP-6b
Surface Elev: 517.23 ft. MSL
Completion: 11.50 ft. BGS
Station: 347,252.51N
804,483.13E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.63 - 2/29/2019 @ 7:55
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
								Black (10YR2/1), moist, dense, BOTTOM ASH. (FILL)		516	
	59/60 *98%*	DP					2				
								Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand. (FILL)		514	
							4	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)		512	
							6	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt and trace sand.			
	31/48 *65%*	DP								510	
							8	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508	
								Dark gray (10YR4/1), moist, soft, SILT with few clay and little very fine-grained sand.			
	28/30 *93%*	DP					10 ▼	Yellowish brown (10YR5/8), weathered SHALE.			
								Yellowish brown (10YR5/8), SANDSTONE.		506	

End of Boring = 11.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push

FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-6c
Well ID: DP-6c
Surface Elev: 516.49 ft. MSL
Completion: 8.00 ft. BGS
Station: 347,277.30N
804,482.16E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 1.00 - during drilling
▼ = 1.00 - 2/28/2019 @ 9:30
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *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
							▼	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
	54/60 *90%*	DP					2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		514	
							4	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)		512	
	26/36 *72%*	DP					6	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		510	
							8	Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 8.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7a
Well ID: DP-7a
Surface Elev: 517.42 ft. MSL
Completion: 15.00 ft. BGS
Station: 347,250.66N
804,677.61E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 13.50 - during drilling
▼ = 8.49 - 2/28/2019 @ 8:00
▽ =

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
	43/60 72%	DP					0–0.6	Black (10YR2/1), moist, loose, SILT and very fine- to coarse-grained SAND with few clay and trace gravel. (FILL)			
							0.6–1.2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)			
							1.2–2	Black (10YR2/1), wet, soft SILT with few clay and trace very fine-grained sand. (FILL)		516	
							2–5	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand and gravel. (FILL)		514	
	31/48 65%	DP					5–6	Gray (10YR5/1), moist, medium, CLAY with some silt and trace sand. (FILL)		512	
							6–9	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.		510	
	38/48 79%	DP					9–13.5	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		508, 506, 504	
	22/24 92%	DP					13.5–14.2	Black (10YR2/1), wet, medium loose, very fine- to medium-grained SAND with few silt and little clay.			
							14.2–15	Yellowish brown (10YR5/8), SANDSTONE.			

End of Boring = 15.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7b
Well ID: DP-7b
Surface Elev: 517.56 ft. MSL
Completion: 15.50 ft. BGS
Station: 347,272.79N
804,688.58E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 13.00 - during drilling
▼ = 7.59 - 2/28/2019 @ 7:50
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type
	58/60 *97%*	DP				
	26/48 *54%*	DP				
	31/48 *65%*	DP				
	30/30 *100%*	DP				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
0 – 2.9	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)	516	
2.9 – 7.2	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)	514, 512	
7.2 – 11.9	Yellowish brown (10YR5/8), moist, stiff, CLAY with some silt, little sand, and trace gravel. (FILL)	510, 508, 506	
11.9 – 12.3	Light gray (10YR7/1), moist, dense, very fine- to very coarse-grained SAND with few silt and trace gravel. (FILL)		
12.3 – 13.1	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.		
13.1 – 14.1	Black (10YR2/1), wet, medium dense, weathered SANDSTONE.	504	
14.1 – 15.0	Yellowish brown (10YR5/4), weathered SHALE.		
15.0 – 15.5	Yellowish brown (10YR5/8) SANDSTONE.		

End of Boring = 15.5 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7c
Well ID: DP-7c
Surface Elev: 516.65 ft. MSL
Completion: 19.00 ft. BGS
Station: 347,294.97N
804,701.22E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = 11.60 - during drilling
▼ = 14.47 - 2/28/2019 @ 14:55
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) / *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* / N - Value / **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* / Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
	46/60 *77%*	DP					0–2.2	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)		516	
							2.2–5.3	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		514, 512	
	35/48 *73%*	DP					5.3–5.9	Light gray (10YR7/1), moist, dense, very fine- to very coarse-grained SAND with few silt and trace gravel. (FILL)			
							5.9–10.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)		510, 508	
	27/48 *56%*	DP					10.8–11.6	Gray (10YR6/1), moist, soft, CLAY with some silt, little sand, and trace gravel. (FILL)		506	
							11.6–12.6	Black (10YR2/1), wet, soft, SILT with few clay and trace very fine-grained sand.			
	25/48 *52%*	DP					12.6–16.5	Dark gray (10YR4/1), moist, soft, CLAY with some silt and trace sand.		504, 502	
							16.5–17.5	Light yellowish brown (10YR6/4), moist, medium, CLAY with some silt, little sand, and trace gravel.		500	
	20/24 *83%*	DP					17.5–18.2	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt and trace sand.			
							18.2–19.0	White (10YR8/1), weathered SHALE.		498	

End of Boring = 19.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 2/27/2019
Finish: 2/27/2019
WEATHER: Overcast, cool (lo 40's)

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: AMS Power Probe 9500-VTR
Drilling Method: Direct Push
FIELD STAFF: Driller: J Edwards
Helper: S Guy
Eng/Geo: R. Hasenyager

BOREHOLE ID: DP-7d
Well ID: DP-7d
Surface Elev: 516.91 ft. MSL
Completion: 20.00 ft. BGS
Station: 347,317.15N
804,712.63E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▼ = Dry - during drilling
▼ = 10.59 - 2/28/2019 @ 8:45
▽ =

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
	56/60 *93%*	DP				
	30/48 *63%*	DP				
	48/48 *100%*	DP				
	33/48 *69%*	DP				
	29/36 *81%*	DP				

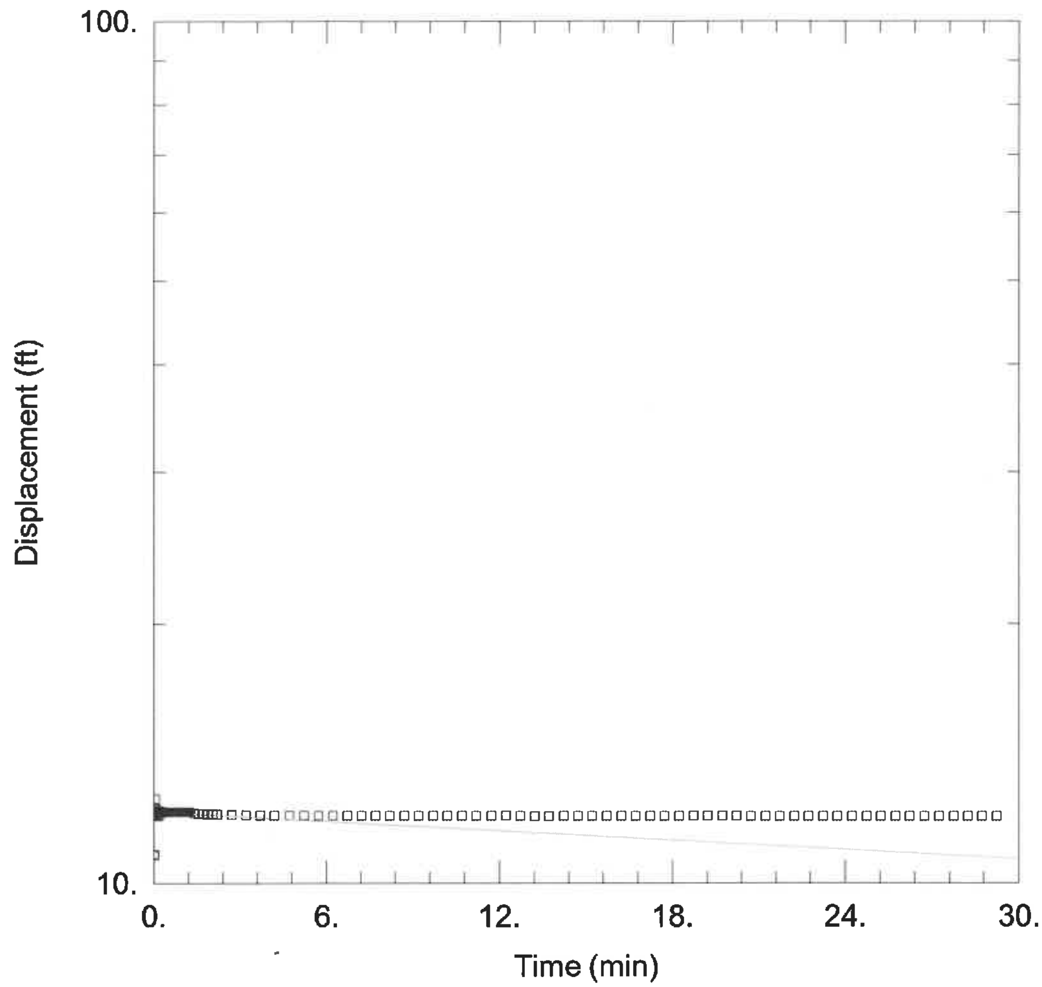
Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
0–2.6	Light gray (10YR7/1), moist, dense, small- to coarse-grained GRAVEL with little sand and few silt. (FILL)	516	
2.6–5	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand. (FILL)	514, 512	
5–7	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand. (FILL)	510	
7–11.9	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt and trace sand. (FILL)	508, 506	
11.9–12.8	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand. (FILL)		
12.8–13.5	Gray (10YR5/1), moist, soft, SILT with few clay and trace very fine-grained sand. (FILL)	504	
13.5–14	Gray (10YR5/1), moist, dense, very fine- to very coarse-grained SAND with few silt and trace gravel. (FILL)		
14–15.8	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt and trace sand.	502	
15.8–18	Yellowish brown (10YR5/8), moist, medium, CLAY with some silt, little sand, and trace gravel.	500	
18–20	Yellowish brown (10YR5/8), weathered SANDSTONE.	498	

End of Boring = 20.0 ft.

NOTE(S): Borehole sealed after sampling with granular bentonite.

Appendix B

Slug Test Results



EBG – FALLING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EBG-fh.aqt
Date: 03/12/19 Time: 14:28:48

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EBG)

Initial Displacement: 4.5 ft
Total Well Penetration Depth: 17.9 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11. ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 3.0E-6 cm/sec y0 = 12.1 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EBG-fh.aqt
Title: EBG – Falling Head Test
Date: 03/12/19
Time: 14:28:50

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 11. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EBG

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 4.5 ft
Static Water Column Height: 11. ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17.9 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	10.78	1.133	12.1
0.03333	10.8	1.15	12.1
0.05	12.53	1.167	12.1
0.06667	12.05	1.183	12.1
0.08333	12.22	1.2	12.1
0.1	11.99	1.217	12.1
0.1167	12.16	1.233	12.1
0.1333	12.09	1.4	12.06
0.15	12.03	1.567	12.05
0.1667	12.14	1.733	12.04
0.1833	11.97	1.9	12.03
0.2	12.11	2.067	12.03
0.2167	12.09	2.233	12.02
0.2333	12.12	2.733	12.
0.25	12.12	3.233	11.99
0.2667	12.08	3.733	11.99
0.2833	12.11	4.233	11.99
0.3	12.09	4.733	11.99
0.3167	12.1	5.233	11.98
0.3333	12.1	5.733	11.98

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	12.1	6.233	11.98
0.3667	12.1	6.733	11.98
0.3833	12.1	7.233	11.98
0.4	12.1	7.733	11.98
0.4167	12.1	8.233	11.98
0.4333	12.1	8.733	11.98
0.45	12.1	9.233	11.97
0.4667	12.1	9.733	11.97
0.4833	12.1	10.23	11.97
0.5	12.1	10.73	11.97
0.5167	12.1	11.23	11.97
0.5333	12.1	11.73	11.97
0.55	12.1	12.23	11.97
0.5667	12.1	12.73	11.97
0.5833	12.1	13.23	11.97
0.6	12.1	13.73	11.97
0.6167	12.1	14.23	11.97
0.6333	12.1	14.73	11.97
0.65	12.1	15.23	11.97
0.6667	12.1	15.73	11.97
0.6833	12.1	16.23	11.97
0.7	12.1	16.73	11.97
0.7167	12.1	17.23	11.97
0.7333	12.1	17.73	11.97
0.75	12.1	18.23	11.97
0.7667	12.1	18.73	11.97
0.7833	12.1	19.23	11.96
0.8	12.1	19.73	11.96
0.8167	12.1	20.23	11.96
0.8333	12.1	20.73	11.96
0.85	12.1	21.23	11.96
0.8667	12.1	21.73	11.96
0.8833	12.1	22.23	11.96
0.9	12.1	22.73	11.96
0.9167	12.1	23.23	11.96
0.9333	12.1	23.73	11.96
0.95	12.1	24.23	11.96
0.9667	12.1	24.73	11.96
0.9833	12.1	25.23	11.96
1.	12.1	25.73	11.96
1.017	12.1	26.23	11.96
1.033	12.1	26.73	11.96
1.05	12.1	27.23	11.96
1.067	12.1	27.73	11.96
1.083	12.1	28.23	11.96
1.1	12.1	28.73	11.96
1.117	12.1	29.23	11.95

SOLUTION

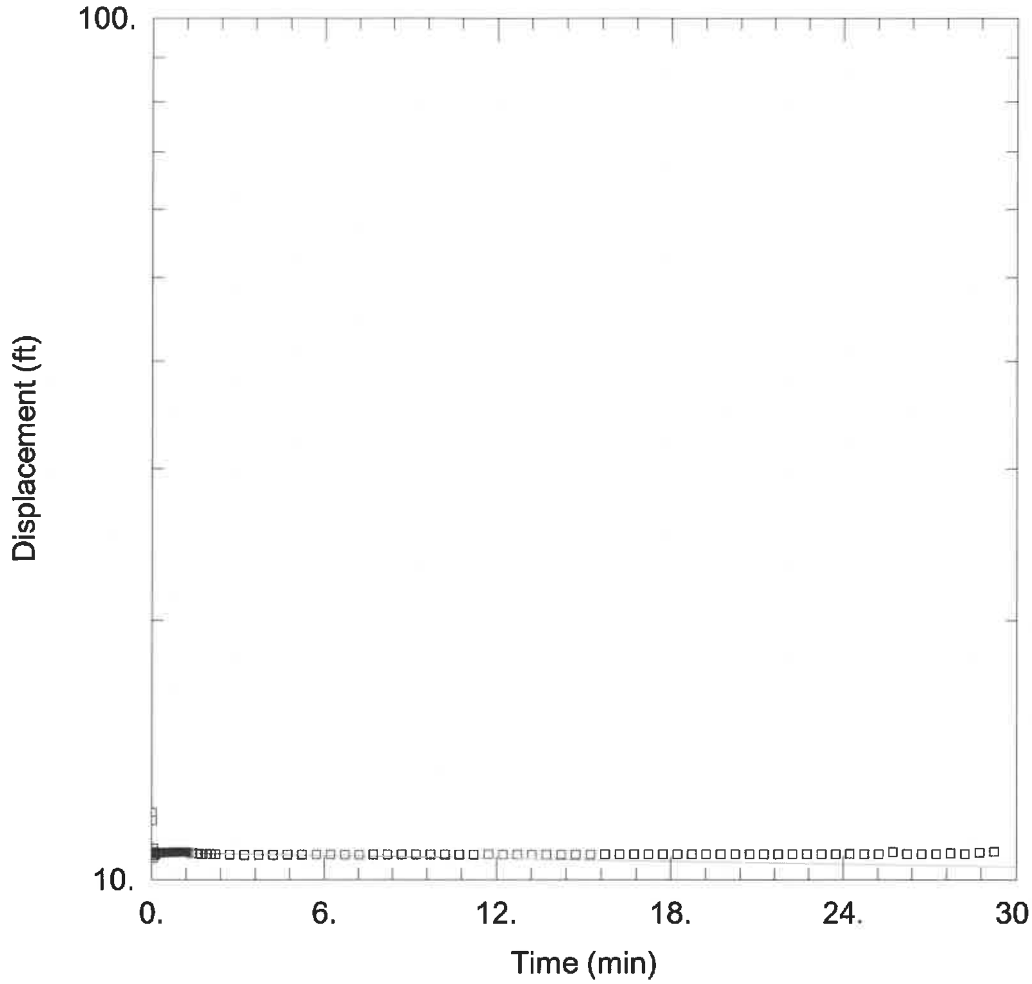
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.066

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	3.0E-6	cm/sec
y0	12.1	ft

$T = K*b = 0.001006\ cm^2/sec$



EBG – RISING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EBG-rh.aqt
Date: 03/12/19 Time: 14:28:52

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 11. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EBG)

Initial Displacement: 4.5 ft
Total Well Penetration Depth: 17.9 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11. ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 9.1E-7 cm/sec
y0 = 10.75 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EBG-rh.aqt
Title: EBG – Rising Head Test
Date: 03/12/19
Time: 14:28:54

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 11. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EBG

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 4.5 ft
Static Water Column Height: 11. ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17.9 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	11.98	1.133	10.76
0.03333	11.71	1.15	10.76
0.05	10.58	1.167	10.76
0.06667	10.88	1.183	10.76
0.08333	10.66	1.2	10.76
0.1	10.66	1.217	10.76
0.1167	10.77	1.233	10.76
0.1333	10.68	1.4	10.73
0.15	10.74	1.567	10.72
0.1667	10.75	1.733	10.72
0.1833	10.72	1.9	10.71
0.2	10.74	2.067	10.71
0.2167	10.74	2.233	10.7
0.2333	10.73	2.733	10.69
0.25	10.73	3.233	10.69
0.2667	10.74	3.733	10.69
0.2833	10.74	4.233	10.69
0.3	10.74	4.733	10.69
0.3167	10.74	5.233	10.69
0.3333	10.74	5.733	10.69

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	10.74	6.233	10.69
0.3667	10.75	6.733	10.69
0.3833	10.75	7.233	10.69
0.4	10.75	7.733	10.69
0.4167	10.75	8.233	10.69
0.4333	10.75	8.733	10.69
0.45	10.75	9.233	10.69
0.4667	10.75	9.733	10.7
0.4833	10.75	10.23	10.69
0.5	10.75	10.73	10.69
0.5167	10.75	11.23	10.7
0.5333	10.75	11.73	10.7
0.55	10.75	12.23	10.7
0.5667	10.76	12.73	10.7
0.5833	10.76	13.23	10.7
0.6	10.76	13.73	10.7
0.6167	10.76	14.23	10.7
0.6333	10.76	14.73	10.7
0.65	10.76	15.23	10.7
0.6667	10.76	15.73	10.7
0.6833	10.76	16.23	10.7
0.7	10.76	16.73	10.7
0.7167	10.76	17.23	10.7
0.7333	10.76	17.73	10.7
0.75	10.76	18.23	10.7
0.7667	10.76	18.73	10.7
0.7833	10.76	19.23	10.7
0.8	10.76	19.73	10.7
0.8167	10.76	20.23	10.7
0.8333	10.76	20.73	10.71
0.85	10.76	21.23	10.71
0.8667	10.76	21.73	10.7
0.8833	10.76	22.23	10.7
0.9	10.76	22.73	10.7
0.9167	10.76	23.23	10.71
0.9333	10.76	23.73	10.71
0.95	10.76	24.23	10.71
0.9667	10.76	24.73	10.71
0.9833	10.76	25.23	10.71
1.	10.76	25.73	10.76
1.017	10.76	26.23	10.72
1.033	10.76	26.73	10.71
1.05	10.76	27.23	10.71
1.067	10.76	27.73	10.73
1.083	10.76	28.23	10.71
1.1	10.76	28.73	10.74
1.117	10.76	29.23	10.77

SOLUTION

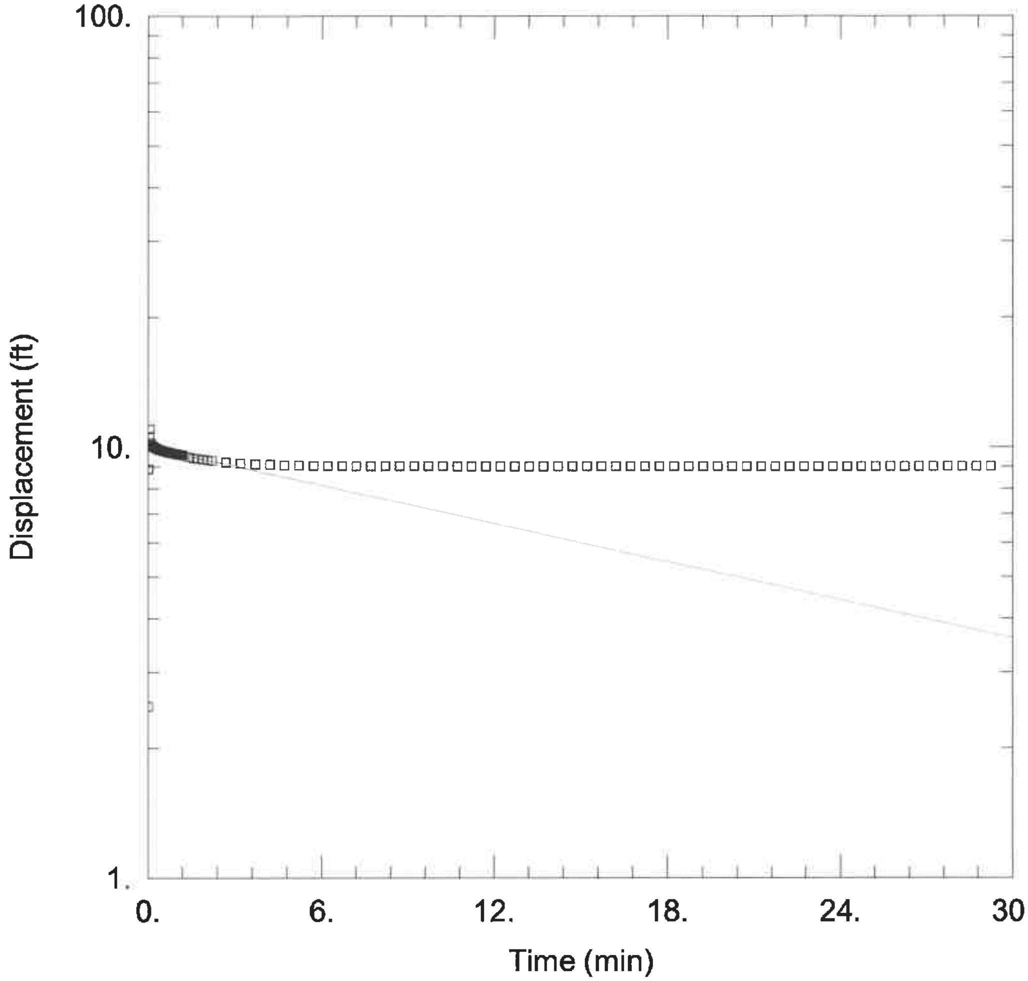
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.066

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	9.1E-7	cm/sec
y0	10.75	ft

T = K*b = 0.0003051 cm^2/sec



EP01 – FALLING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP01-fh.aqt
Date: 03/12/19 Time: 14:28:56

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 8.9 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP01)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 21.4 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 8.9 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.8E-5 cm/sec
y0 = 10. ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP01-fh.aqt
Title: EP01 – Falling Head Test
Date: 03/12/19
Time: 14:28:58

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 8.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP01

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 8.9 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 21.4 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	8.878	1.133	9.607
0.03333	8.899	1.15	9.605
0.05	10.58	1.167	9.6
0.06667	11.02	1.183	9.596
0.08333	10.22	1.2	9.591
0.1	10.23	1.217	9.586
0.1167	10.12	1.233	9.582
0.1333	10.11	1.4	9.485
0.15	10.08	1.567	9.436
0.1667	10.06	1.733	9.396
0.1833	10.04	1.9	9.359
0.2	10.02	2.067	9.326
0.2167	10.01	2.233	9.298
0.2333	9.992	2.733	9.213
0.25	9.971	3.233	9.159
0.2667	9.957	3.733	9.119
0.2833	9.945	4.233	9.091
0.3	9.933	4.733	9.07
0.3167	9.922	5.233	9.054
0.3333	9.91	5.733	9.042

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	9.9	6.233	9.035
0.3667	9.889	6.733	9.028
0.3833	9.879	7.233	9.023
0.4	9.87	7.733	9.021
0.4167	9.861	8.233	9.019
0.4333	9.851	8.733	9.014
0.45	9.844	9.233	9.014
0.4667	9.837	9.733	9.014
0.4833	9.828	10.23	9.012
0.5	9.821	10.73	9.009
0.5167	9.814	11.23	9.009
0.5333	9.807	11.73	9.009
0.55	9.8	12.23	9.009
0.5667	9.793	12.73	9.007
0.5833	9.786	13.23	9.007
0.6	9.779	13.73	9.007
0.6167	9.772	14.23	9.005
0.6333	9.765	14.73	9.007
0.65	9.76	15.23	9.005
0.6667	9.753	15.73	9.005
0.6833	9.748	16.23	9.005
0.7	9.741	16.73	9.005
0.7167	9.734	17.23	9.002
0.7333	9.729	17.73	9.002
0.75	9.722	18.23	9.002
0.7667	9.718	18.73	9.002
0.7833	9.711	19.23	9.002
0.8	9.706	19.73	9.
0.8167	9.699	20.23	9.002
0.8333	9.694	20.73	9.002
0.85	9.69	21.23	9.
0.8667	9.685	21.73	9.
0.8833	9.68	22.23	9.
0.9	9.673	22.73	9.
0.9167	9.668	23.23	9.
0.9333	9.664	23.73	9.002
0.95	9.659	24.23	9.002
0.9667	9.652	24.73	9.
0.9833	9.65	25.23	9.
1.	9.645	25.73	9.
1.017	9.64	26.23	9.
1.033	9.636	26.73	9.
1.05	9.629	27.23	8.997
1.067	9.624	27.73	9.
1.083	9.622	28.23	8.997
1.1	9.617	28.73	9.
1.117	9.612	29.23	8.997

SOLUTION

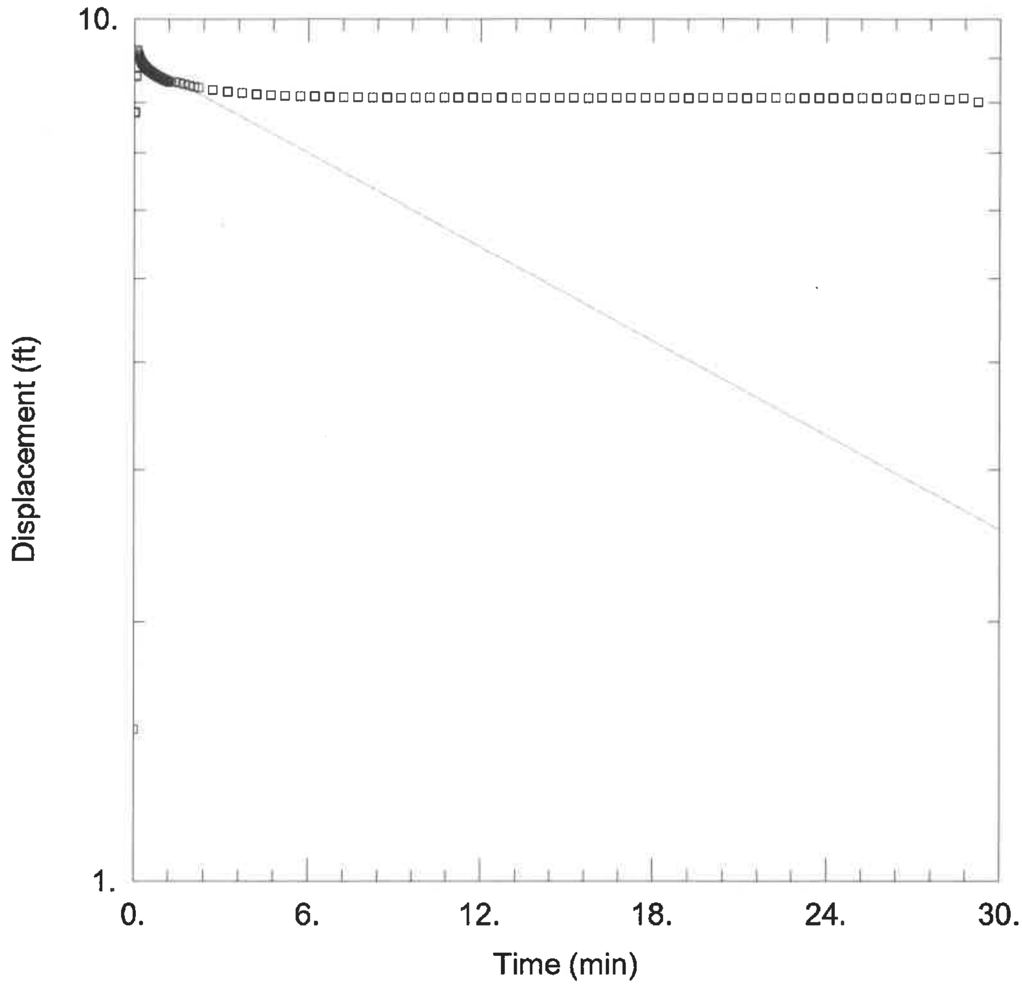
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.153

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	2.8E-5	cm/sec
y0	10.	ft

T = K*b = 0.007596 cm^2/sec



EP01 – RISING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP01-rh.aqt
Date: 03/12/19 Time: 14:29:00

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 8.9 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP01)

Initial Displacement: 1.5 ft Static Water Column Height: 8.9 ft
Total Well Penetration Depth: 21.4 ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 3.45E-5 cm/sec y0 = 9. ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP01-rh.aqt
Title: EP01 – Rising Head Test
Date: 03/12/19
Time: 14:29:01

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 8.9 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP01

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.5 ft
Static Water Column Height: 8.9 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 21.4 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	7.806	1.133	8.481
0.03333	7.796	1.15	8.476
0.05	7.787	1.167	8.471
0.06667	8.605	1.183	8.469
0.08333	8.575	1.2	8.462
0.1	9.206	1.217	8.457
0.1167	9.184	1.233	8.453
0.1333	9.133	1.4	8.46
0.15	9.095	1.567	8.434
0.1667	9.058	1.733	8.404
0.1833	9.025	1.9	8.375
0.2	8.994	2.067	8.35
0.2167	8.969	2.233	8.326
0.2333	8.952	2.733	8.279
0.25	8.919	3.233	8.235
0.2667	8.898	3.733	8.204
0.2833	8.882	4.233	8.176
0.3	8.865	4.733	8.16
0.3167	8.851	5.233	8.146
0.3333	8.835	5.733	8.137

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	8.823	6.233	8.129
0.3667	8.809	6.733	8.125
0.3833	8.797	7.233	8.118
0.4	8.786	7.733	8.118
0.4167	8.774	8.233	8.113
0.4333	8.762	8.733	8.113
0.45	8.753	9.233	8.111
0.4667	8.741	9.733	8.111
0.4833	8.734	10.23	8.111
0.5	8.722	10.73	8.111
0.5167	8.715	11.23	8.108
0.5333	8.706	11.73	8.108
0.55	8.697	12.23	8.106
0.5667	8.69	12.73	8.108
0.5833	8.68	13.23	8.106
0.6	8.673	13.73	8.104
0.6167	8.666	14.23	8.104
0.6333	8.659	14.73	8.104
0.65	8.652	15.23	8.101
0.6667	8.643	15.73	8.099
0.6833	8.638	16.23	8.104
0.7	8.631	16.73	8.104
0.7167	8.624	17.23	8.101
0.7333	8.617	17.73	8.104
0.75	8.61	18.23	8.101
0.7667	8.603	18.73	8.101
0.7833	8.598	19.23	8.099
0.8	8.591	19.73	8.101
0.8167	8.584	20.23	8.101
0.8333	8.579	20.73	8.101
0.85	8.572	21.23	8.099
0.8667	8.568	21.73	8.101
0.8833	8.563	22.23	8.101
0.9	8.556	22.73	8.099
0.9167	8.551	23.23	8.099
0.9333	8.546	23.73	8.097
0.95	8.539	24.23	8.099
0.9667	8.535	24.73	8.099
0.9833	8.528	25.23	8.099
1.	8.523	25.73	8.097
1.017	8.518	26.23	8.097
1.033	8.511	26.73	8.097
1.05	8.507	27.23	8.075
1.067	8.502	27.73	8.092
1.083	8.497	28.23	8.068
1.1	8.49	28.73	8.09
1.117	8.485	29.23	8.005

SOLUTION

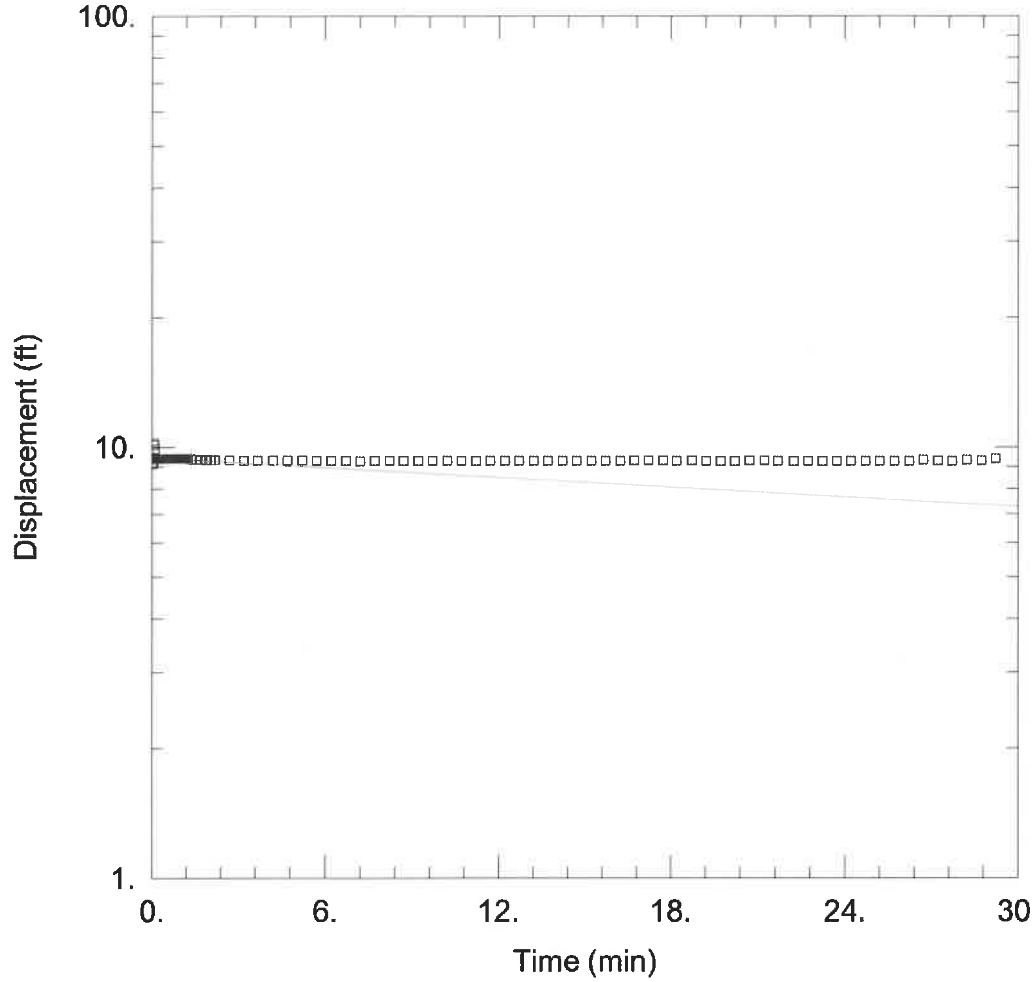
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.153

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	3.45E-5	cm/sec
y0	9.	ft

$T = K*b = 0.009359\ cm^2/sec$



EP02 – FALLING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP02-fh.aqt
Date: 03/12/19 Time: 14:29:04

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 9.4 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP02)

Initial Displacement: 9.4 ft Static Water Column Height: 8. ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 6.0E-6 cm/sec y0 = 9.45 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP02-fh.aqt
Title: EP02 – Falling Head Test
Date: 03/12/19
Time: 14:29:06

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 9.4 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP02

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 9.4 ft
Static Water Column Height: 8. ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	9.148	1.133	9.408
0.03333	9.157	1.15	9.408
0.05	9.167	1.167	9.408
0.06667	9.172	1.183	9.408
0.08333	10.23	1.2	9.408
0.1	10.13	1.217	9.408
0.1167	9.908	1.233	9.408
0.1333	9.451	1.4	9.359
0.15	9.404	1.567	9.352
0.1667	9.394	1.733	9.347
0.1833	9.394	1.9	9.34
0.2	9.401	2.067	9.333
0.2167	9.399	2.233	9.328
0.2333	9.401	2.733	9.309
0.25	9.404	3.233	9.305
0.2667	9.406	3.733	9.3
0.2833	9.406	4.233	9.297
0.3	9.406	4.733	9.295
0.3167	9.406	5.233	9.293
0.3333	9.406	5.733	9.29

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	9.408	6.233	9.29
0.3667	9.408	6.733	9.288
0.3833	9.408	7.233	9.286
0.4	9.408	7.733	9.288
0.4167	9.408	8.233	9.286
0.4333	9.408	8.733	9.286
0.45	9.408	9.233	9.286
0.4667	9.408	9.733	9.283
0.4833	9.408	10.23	9.286
0.5	9.408	10.73	9.286
0.5167	9.408	11.23	9.286
0.5333	9.408	11.73	9.283
0.55	9.408	12.23	9.283
0.5667	9.408	12.73	9.281
0.5833	9.408	13.23	9.281
0.6	9.408	13.73	9.279
0.6167	9.408	14.23	9.281
0.6333	9.408	14.73	9.279
0.65	9.408	15.23	9.279
0.6667	9.408	15.73	9.279
0.6833	9.408	16.23	9.278
0.7	9.408	16.73	9.278
0.7167	9.408	17.23	9.279
0.7333	9.408	17.73	9.279
0.75	9.408	18.23	9.281
0.7667	9.408	18.73	9.278
0.7833	9.408	19.23	9.276
0.8	9.408	19.73	9.276
0.8167	9.408	20.23	9.276
0.8333	9.408	20.73	9.278
0.85	9.408	21.23	9.279
0.8667	9.408	21.73	9.276
0.8833	9.408	22.23	9.274
0.9	9.408	22.73	9.274
0.9167	9.408	23.23	9.274
0.9333	9.408	23.73	9.274
0.95	9.408	24.23	9.274
0.9667	9.408	24.73	9.274
0.9833	9.408	25.23	9.274
1.	9.408	25.73	9.274
1.017	9.408	26.23	9.274
1.033	9.408	26.73	9.328
1.05	9.408	27.23	9.283
1.067	9.408	27.73	9.276
1.083	9.408	28.23	9.311
1.1	9.408	28.73	9.281
1.117	9.408	29.23	9.373

SOLUTION

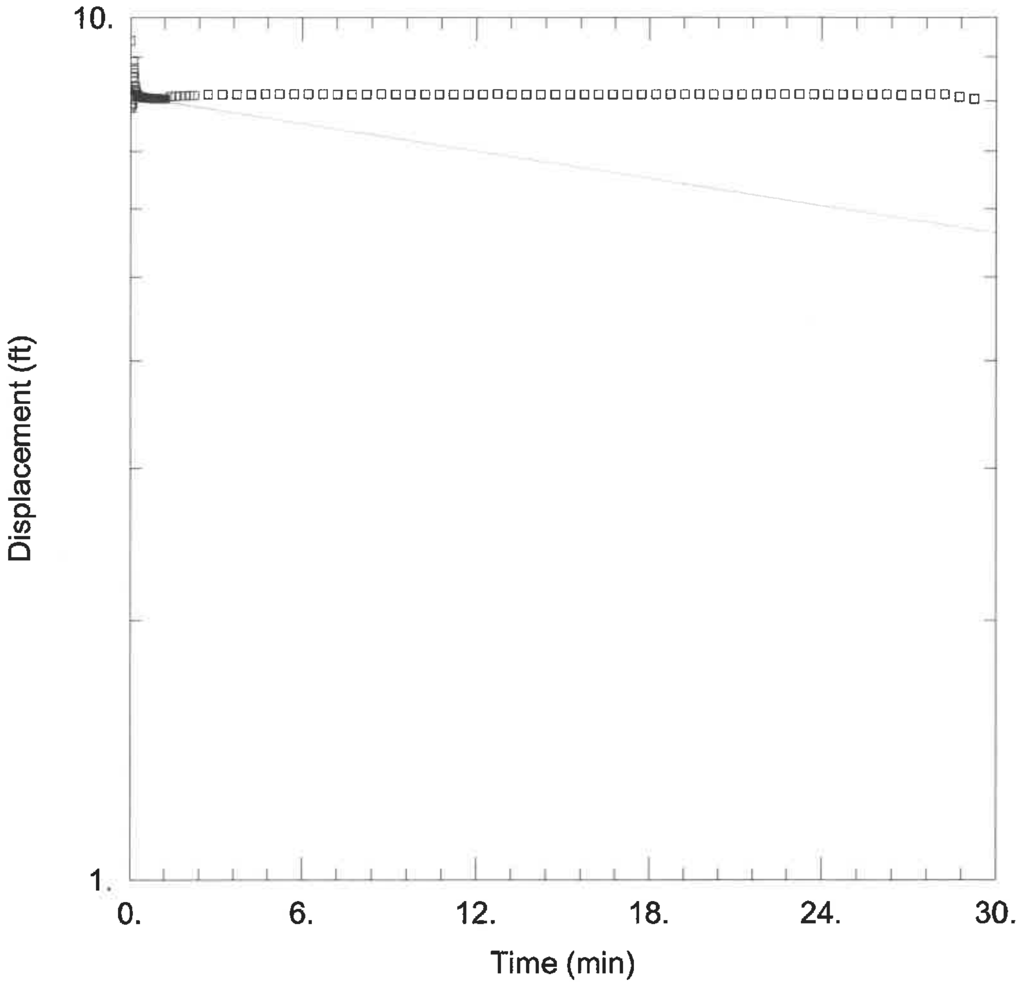
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.682

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	6.0E-6	cm/sec
y0	9.45	ft

T = K*b = 0.001719 cm^2/sec



EP02 – RISING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP02-rh.aqt
Date: 03/12/19 Time: 14:29:08

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 9.4 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP02)

Initial Displacement: 9.4 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 8. ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 8.4E-6 cm/sec y0 = 8.1 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP02-rh.aqt
Title: EP02 – Rising Head Test
Date: 03/12/19
Time: 14:29:09

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 9.4 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP02

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 9.4 ft
Static Water Column Height: 8. ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	7.865	1.133	8.052
0.03333	7.856	1.15	8.052
0.05	7.917	1.167	8.05
0.06667	7.954	1.183	8.05
0.08333	8.529	1.2	8.05
0.1	8.89	1.217	8.05
0.1167	8.735	1.233	8.05
0.1333	8.625	1.4	8.097
0.15	8.44	1.567	8.104
0.1667	8.313	1.733	8.109
0.1833	8.231	1.9	8.114
0.2	8.2	2.067	8.118
0.2167	8.163	2.233	8.118
0.2333	8.146	2.733	8.137
0.25	8.13	3.233	8.14
0.2667	8.121	3.733	8.142
0.2833	8.114	4.233	8.142
0.3	8.109	4.733	8.144
0.3167	8.104	5.233	8.144
0.3333	8.099	5.733	8.144

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	8.095	6.233	8.144
0.3667	8.092	6.733	8.144
0.3833	8.088	7.233	8.142
0.4	8.085	7.733	8.142
0.4167	8.083	8.233	8.142
0.4333	8.081	8.733	8.144
0.45	8.078	9.233	8.142
0.4667	8.076	9.733	8.142
0.4833	8.074	10.23	8.142
0.5	8.074	10.73	8.142
0.5167	8.074	11.23	8.142
0.5333	8.071	11.73	8.142
0.55	8.071	12.23	8.142
0.5667	8.069	12.73	8.144
0.5833	8.069	13.23	8.142
0.6	8.067	13.73	8.14
0.6167	8.067	14.23	8.14
0.6333	8.067	14.73	8.14
0.65	8.064	15.23	8.14
0.6667	8.064	15.73	8.14
0.6833	8.064	16.23	8.14
0.7	8.062	16.73	8.14
0.7167	8.062	17.23	8.14
0.7333	8.062	17.73	8.14
0.75	8.062	18.23	8.14
0.7667	8.062	18.73	8.14
0.7833	8.06	19.23	8.14
0.8	8.06	19.73	8.14
0.8167	8.057	20.23	8.14
0.8333	8.057	20.73	8.14
0.85	8.057	21.23	8.14
0.8667	8.057	21.73	8.14
0.8833	8.057	22.23	8.14
0.9	8.057	22.73	8.14
0.9167	8.055	23.23	8.14
0.9333	8.055	23.73	8.14
0.95	8.055	24.23	8.14
0.9667	8.055	24.73	8.14
0.9833	8.052	25.23	8.14
1.	8.052	25.73	8.14
1.017	8.052	26.23	8.14
1.033	8.052	26.73	8.128
1.05	8.052	27.23	8.135
1.067	8.052	27.73	8.137
1.083	8.052	28.23	8.137
1.1	8.052	28.73	8.083
1.117	8.052	29.23	8.039

SOLUTION

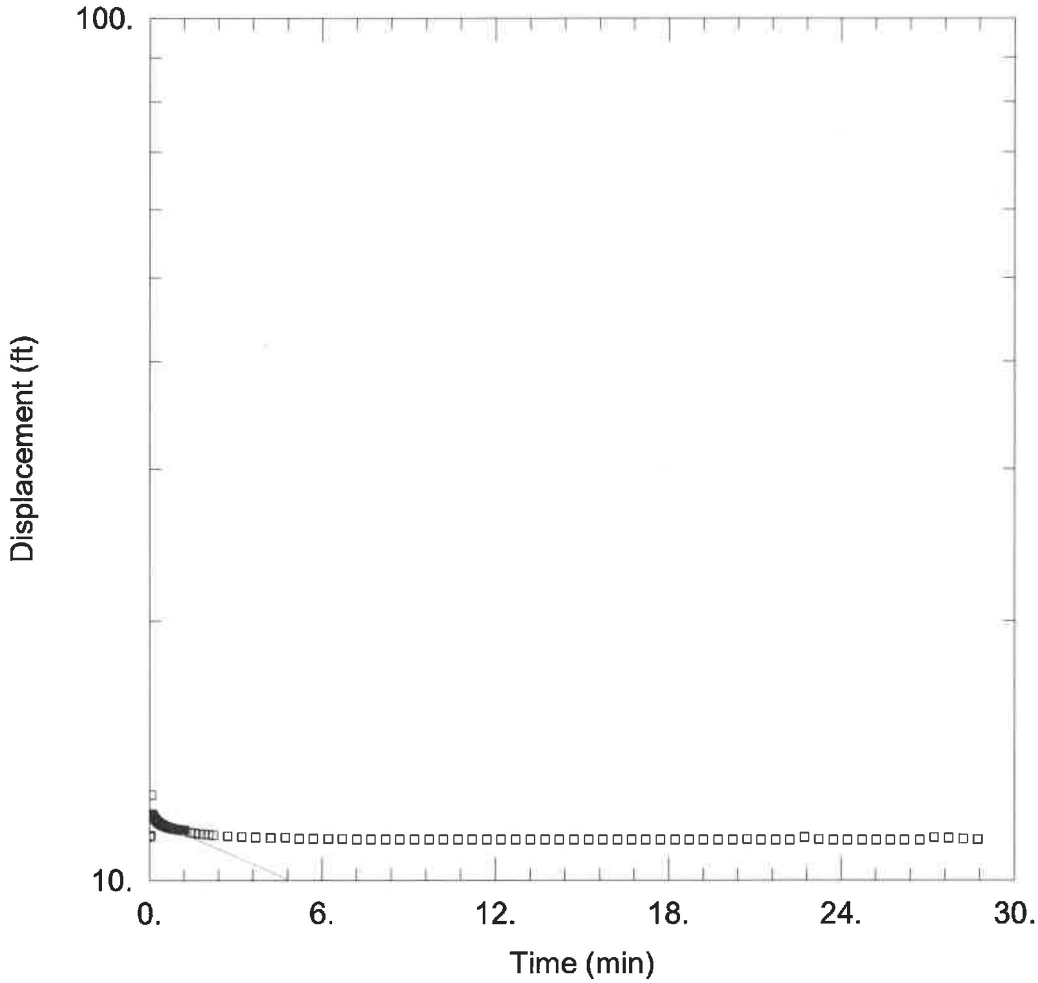
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.682

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	8.4E-6	cm/sec
y0	8.1	ft

T = K*b = 0.002407 cm^2/sec



EP03 – FALLING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP03-fh.aqt
Date: 03/12/19 Time: 14:29:11

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP03)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 11.75 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.2 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.1E-5 cm/sec
y0 = 11.8 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP03-fh.aqt
Title: EP03 – Falling Head Test
Date: 03/12/19
Time: 14:29:13

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP03

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 7.2 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 11.75 ft

No. of Observations: 133

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	11.23	1.133	11.44
0.03333	11.24	1.15	11.44
0.05	11.27	1.167	11.44
0.06667	12.57	1.183	11.43
0.08333	11.92	1.2	11.43
0.1	11.89	1.217	11.43
0.1167	11.94	1.233	11.43
0.1333	11.87	1.4	11.37
0.15	11.85	1.567	11.35
0.1667	11.84	1.733	11.32
0.1833	11.81	1.9	11.31
0.2	11.79	2.067	11.3
0.2167	11.77	2.233	11.29
0.2333	11.75	2.733	11.25
0.25	11.73	3.233	11.22
0.2667	11.72	3.733	11.21
0.2833	11.7	4.233	11.2
0.3	11.69	4.733	11.19
0.3167	11.68	5.233	11.18
0.3333	11.66	5.733	11.18

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	11.65	6.233	11.17
0.3667	11.64	6.733	11.16
0.3833	11.63	7.233	11.16
0.4	11.62	7.733	11.16
0.4167	11.62	8.233	11.15
0.4333	11.61	8.733	11.16
0.45	11.6	9.233	11.15
0.4667	11.59	9.733	11.15
0.4833	11.58	10.23	11.15
0.5	11.57	10.73	11.15
0.5167	11.57	11.23	11.15
0.5333	11.56	11.73	11.15
0.55	11.55	12.23	11.15
0.5667	11.55	12.73	11.14
0.5833	11.54	13.23	11.15
0.6	11.54	13.73	11.14
0.6167	11.54	14.23	11.15
0.6333	11.53	14.73	11.14
0.65	11.52	15.23	11.14
0.6667	11.52	15.73	11.14
0.6833	11.51	16.23	11.14
0.7	11.51	16.73	11.14
0.7167	11.51	17.23	11.14
0.7333	11.5	17.73	11.14
0.75	11.5	18.23	11.15
0.7667	11.49	18.73	11.14
0.7833	11.49	19.23	11.14
0.8	11.49	19.73	11.15
0.8167	11.48	20.23	11.14
0.8333	11.48	20.73	11.15
0.85	11.48	21.23	11.14
0.8667	11.48	21.73	11.14
0.8833	11.47	22.23	11.14
0.9	11.47	22.73	11.22
0.9167	11.47	23.23	11.15
0.9333	11.46	23.73	11.14
0.95	11.46	24.23	11.14
0.9667	11.46	24.73	11.14
0.9833	11.46	25.23	11.14
1.	11.46	25.73	11.14
1.017	11.45	26.23	11.14
1.033	11.45	26.73	11.14
1.05	11.45	27.23	11.21
1.067	11.45	27.73	11.19
1.083	11.44	28.23	11.17
1.1	11.44	28.73	11.15
1.117	11.44		

SOLUTION

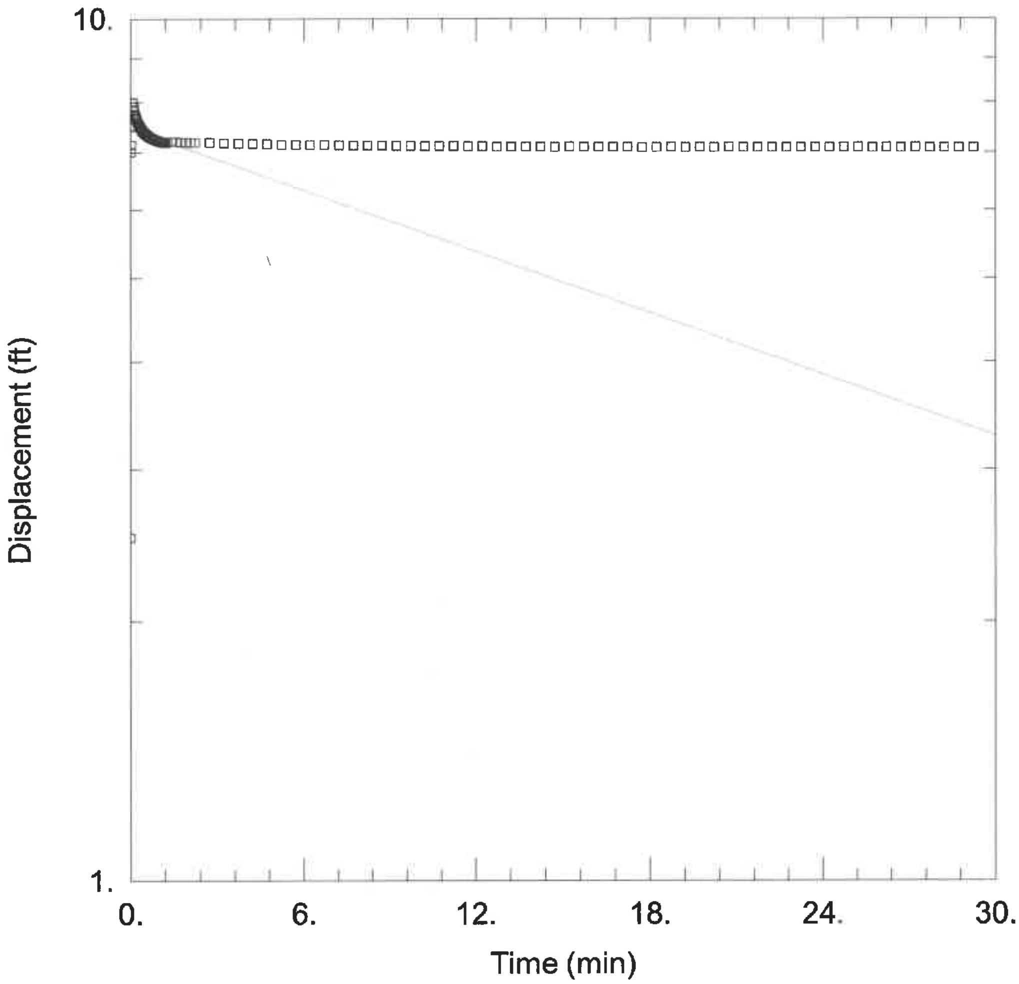
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.741

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	3.1E-5	cm/sec
y0	11.8	ft

T = K*b = 0.006803 cm^2/sec



EP03 – RISING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP03-rh.aqt
Date: 03/12/19 Time: 14:29:16

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP03)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 11.75 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.2 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.5E-5 cm/sec
y0 = 7.45 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP03-rh.aqt
Title: EP03 – Rising Head Test
Date: 03/12/19
Time: 14:29:18

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP03

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 7.2 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 11.75 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	7.002	1.133	7.192
0.03333	7.143	1.15	7.19
0.05	7.502	1.167	7.187
0.06667	7.994	1.183	7.185
0.08333	8.004	1.2	7.185
0.1	7.919	1.217	7.183
0.1167	7.856	1.233	7.18
0.1333	7.818	1.4	7.204
0.15	7.76	1.567	7.202
0.1667	7.725	1.733	7.192
0.1833	7.694	1.9	7.19
0.2	7.664	2.067	7.183
0.2167	7.647	2.233	7.183
0.2333	7.614	2.733	7.183
0.25	7.579	3.233	7.176
0.2667	7.558	3.733	7.169
0.2833	7.539	4.233	7.16
0.3	7.521	4.733	7.155
0.3167	7.504	5.233	7.143
0.3333	7.488	5.733	7.143

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	7.471	6.233	7.136
0.3667	7.457	6.733	7.136
0.3833	7.443	7.233	7.129
0.4	7.429	7.733	7.127
0.4167	7.417	8.233	7.125
0.4333	7.406	8.733	7.122
0.45	7.394	9.233	7.117
0.4667	7.384	9.733	7.118
0.4833	7.375	10.23	7.115
0.5	7.366	10.73	7.113
0.5167	7.356	11.23	7.113
0.5333	7.347	11.73	7.108
0.55	7.34	12.23	7.108
0.5667	7.331	12.73	7.101
0.5833	7.323	13.23	7.103
0.6	7.319	13.73	7.099
0.6167	7.309	14.23	7.101
0.6333	7.305	14.73	7.096
0.65	7.298	15.23	7.099
0.6667	7.293	15.73	7.096
0.6833	7.286	16.23	7.096
0.7	7.281	16.73	7.096
0.7167	7.277	17.23	7.096
0.7333	7.272	17.73	7.082
0.75	7.267	18.23	7.089
0.7667	7.263	18.73	7.092
0.7833	7.258	19.23	7.087
0.8	7.253	19.73	7.094
0.8167	7.248	20.23	7.087
0.8333	7.246	20.73	7.092
0.85	7.241	21.23	7.087
0.8667	7.237	21.73	7.089
0.8833	7.234	22.23	7.087
0.9	7.23	22.73	7.089
0.9167	7.227	23.23	7.089
0.9333	7.225	23.73	7.087
0.95	7.22	24.23	7.087
0.9667	7.218	24.73	7.087
0.9833	7.216	25.23	7.089
1.	7.213	25.73	7.085
1.017	7.209	26.23	7.087
1.033	7.206	26.73	7.082
1.05	7.204	27.23	7.087
1.067	7.202	27.73	7.082
1.083	7.199	28.23	7.082
1.1	7.197	28.73	7.082
1.117	7.195	29.23	7.082

SOLUTION

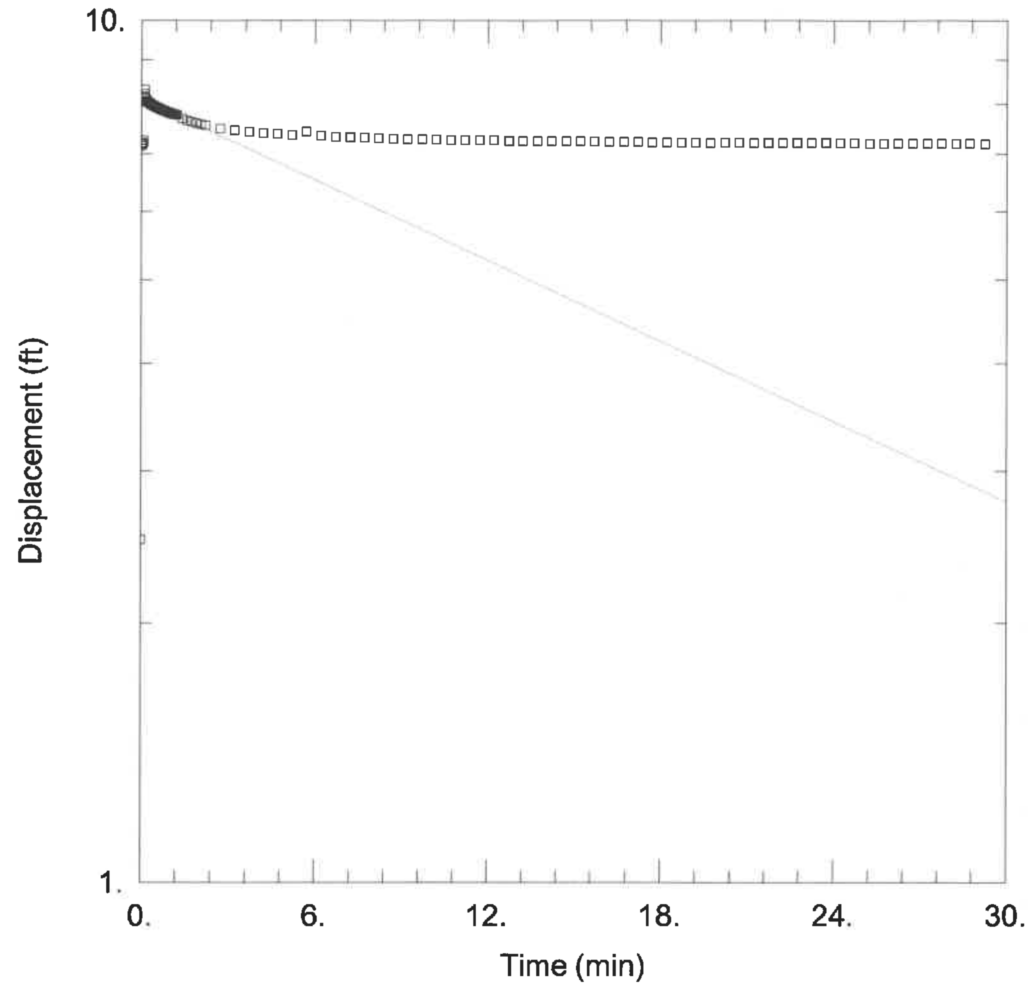
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.741

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	2.5E-5	cm/sec
y0	7.45	ft

T = K*b = 0.005486 cm²/sec



EP04 – FALLING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP04-fh.aqt
Date: 03/12/19 Time: 14:29:20

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP04)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 12.1 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.2 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.3E-5 cm/sec
y0 = 8.1 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP04-fh.aqt
Title: EP04 – Falling Head Test
Date: 03/12/19
Time: 14:29:22

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP04

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 7.2 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 12.1 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	7.151	1.133	7.781
0.03333	7.177	1.15	7.779
0.05	7.193	1.167	7.777
0.06667	7.209	1.183	7.774
0.08333	7.261	1.2	7.77
0.1	8.159	1.217	7.767
0.1167	8.312	1.233	7.765
0.1333	8.218	1.4	7.69
0.15	8.117	1.567	7.657
0.1667	8.035	1.733	7.629
0.1833	8.058	1.9	7.603
0.2	8.068	2.067	7.579
0.2167	8.049	2.233	7.556
0.2333	8.04	2.733	7.492
0.25	8.03	3.233	7.452
0.2667	8.023	3.733	7.424
0.2833	8.016	4.233	7.401
0.3	8.009	4.733	7.38
0.3167	8.002	5.233	7.363
0.3333	7.997	5.733	7.434

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	7.988	6.233	7.349
0.3667	7.983	6.733	7.326
0.3833	7.976	7.233	7.316
0.4	7.972	7.733	7.307
0.4167	7.964	8.233	7.3
0.4333	7.96	8.733	7.293
0.45	7.953	9.233	7.283
0.4667	7.948	9.733	7.276
0.4833	7.943	10.23	7.272
0.5	7.936	10.73	7.269
0.5167	7.932	11.23	7.265
0.5333	7.927	11.73	7.262
0.55	7.92	12.23	7.257
0.5667	7.915	12.73	7.25
0.5833	7.91	13.23	7.248
0.6	7.906	13.73	7.246
0.6167	7.901	14.23	7.239
0.6333	7.896	14.73	7.243
0.65	7.892	15.23	7.239
0.6667	7.887	15.73	7.236
0.6833	7.882	16.23	7.232
0.7	7.878	16.73	7.229
0.7167	7.873	17.23	7.227
0.7333	7.868	17.73	7.222
0.75	7.866	18.23	7.225
0.7667	7.861	18.73	7.222
0.7833	7.857	19.23	7.222
0.8	7.852	19.73	7.218
0.8167	7.849	20.23	7.218
0.8333	7.845	20.73	7.215
0.85	7.84	21.23	7.213
0.8667	7.838	21.73	7.211
0.8833	7.833	22.23	7.208
0.9	7.828	22.73	7.208
0.9167	7.826	23.23	7.211
0.9333	7.821	23.73	7.208
0.95	7.819	24.23	7.204
0.9667	7.817	24.73	7.206
0.9833	7.812	25.23	7.201
1.	7.807	25.73	7.199
1.017	7.805	26.23	7.199
1.033	7.803	26.73	7.197
1.05	7.798	27.23	7.199
1.067	7.795	27.73	7.197
1.083	7.791	28.23	7.194
1.1	7.788	28.73	7.197
1.117	7.786	29.23	7.194

SOLUTION

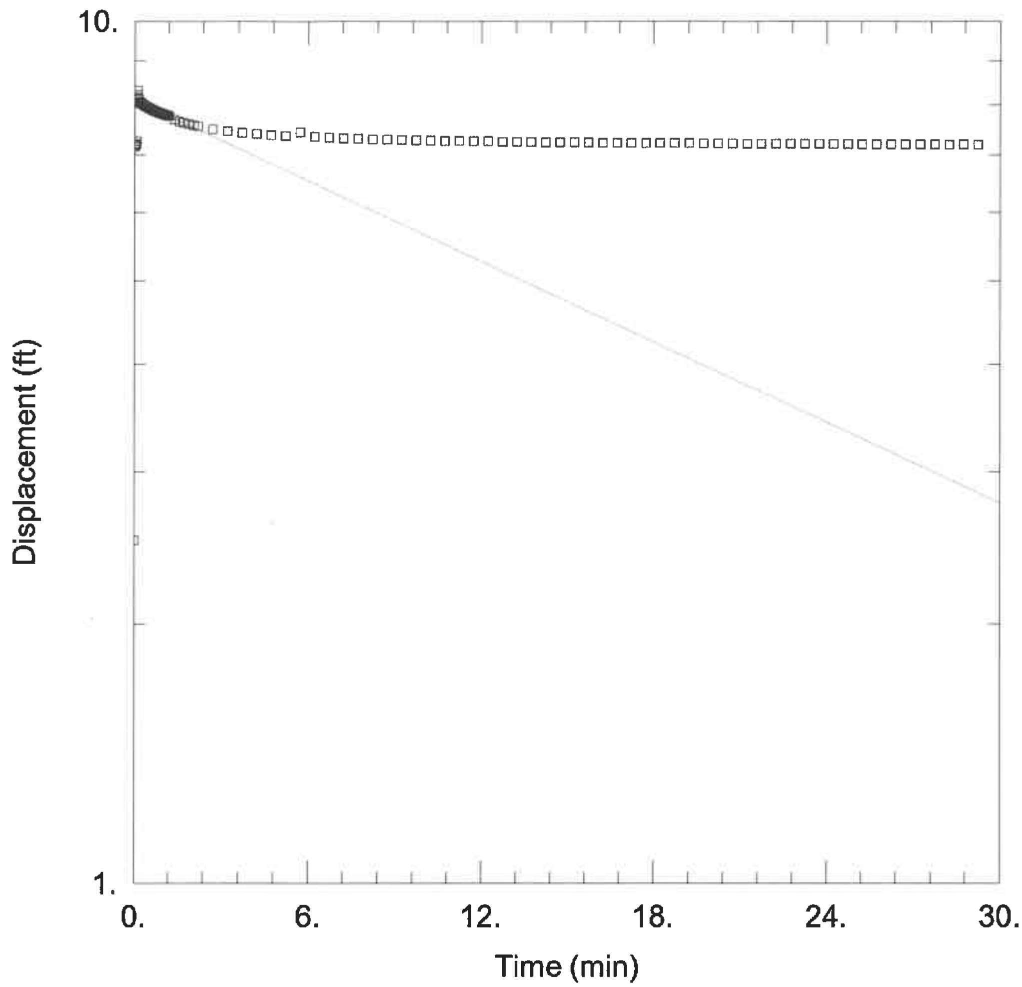
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.759

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	3.3E-5	cm/sec
y0	8.1	ft

$T = K*b = 0.007242\ cm^2/sec$



EP04 – FALLING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP04rfh.aqt
Date: 03/12/19 Time: 14:29:24

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP04)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 12.1 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.2 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.3E-5 cm/sec
y0 = 8.1 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP04rfh.aqt
Title: EP04 – Falling Head Test
Date: 03/12/19
Time: 14:29:26

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP04

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 7.2 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 12.1 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	7.151	1.133	7.781
0.03333	7.177	1.15	7.779
0.05	7.193	1.167	7.777
0.06667	7.209	1.183	7.774
0.08333	7.261	1.2	7.77
0.1	8.159	1.217	7.767
0.1167	8.312	1.233	7.765
0.1333	8.218	1.4	7.69
0.15	8.117	1.567	7.657
0.1667	8.035	1.733	7.629
0.1833	8.058	1.9	7.603
0.2	8.068	2.067	7.579
0.2167	8.049	2.233	7.556
0.2333	8.04	2.733	7.492
0.25	8.03	3.233	7.452
0.2667	8.023	3.733	7.424
0.2833	8.016	4.233	7.401
0.3	8.009	4.733	7.38
0.3167	8.002	5.233	7.363
0.3333	7.997	5.733	7.434

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	7.988	6.233	7.349
0.3667	7.983	6.733	7.326
0.3833	7.976	7.233	7.316
0.4	7.972	7.733	7.307
0.4167	7.964	8.233	7.3
0.4333	7.96	8.733	7.293
0.45	7.953	9.233	7.283
0.4667	7.948	9.733	7.276
0.4833	7.943	10.23	7.272
0.5	7.936	10.73	7.269
0.5167	7.932	11.23	7.265
0.5333	7.927	11.73	7.262
0.55	7.92	12.23	7.257
0.5667	7.915	12.73	7.25
0.5833	7.91	13.23	7.248
0.6	7.906	13.73	7.246
0.6167	7.901	14.23	7.239
0.6333	7.896	14.73	7.243
0.65	7.892	15.23	7.239
0.6667	7.887	15.73	7.236
0.6833	7.882	16.23	7.232
0.7	7.878	16.73	7.229
0.7167	7.873	17.23	7.227
0.7333	7.868	17.73	7.222
0.75	7.866	18.23	7.225
0.7667	7.861	18.73	7.222
0.7833	7.857	19.23	7.222
0.8	7.852	19.73	7.218
0.8167	7.849	20.23	7.218
0.8333	7.845	20.73	7.215
0.85	7.84	21.23	7.213
0.8667	7.838	21.73	7.211
0.8833	7.833	22.23	7.208
0.9	7.828	22.73	7.208
0.9167	7.826	23.23	7.211
0.9333	7.821	23.73	7.208
0.95	7.819	24.23	7.204
0.9667	7.817	24.73	7.206
0.9833	7.812	25.23	7.201
1.	7.807	25.73	7.199
1.017	7.805	26.23	7.199
1.033	7.803	26.73	7.197
1.05	7.798	27.23	7.199
1.067	7.795	27.73	7.197
1.083	7.791	28.23	7.194
1.1	7.788	28.73	7.197
1.117	7.786	29.23	7.194

SOLUTION

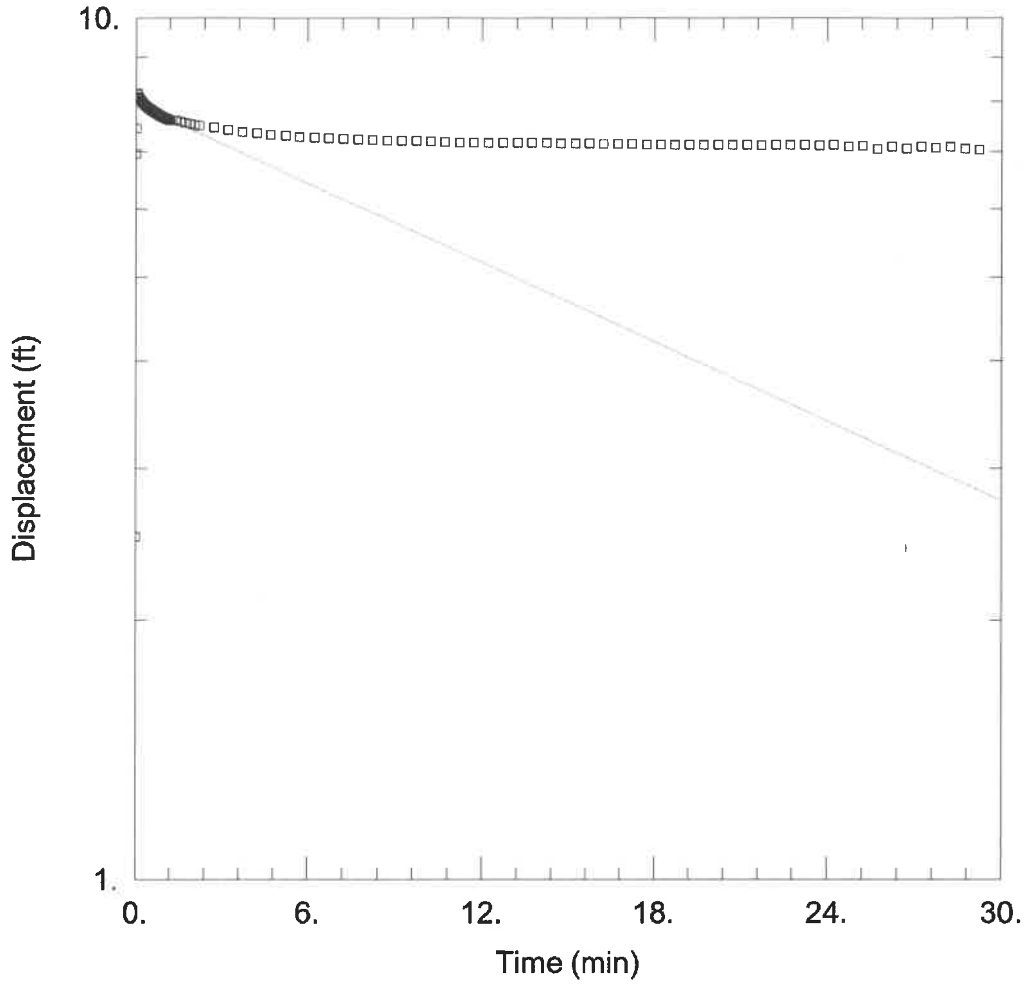
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.759

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	3.3E-5	cm/sec
y0	8.1	ft

$T = K*b = 0.007242 \text{ cm}^2/\text{sec}$



EP04 – RISING HEAD TEST

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP04-rh.aqt
Date: 03/12/19 Time: 14:29:28

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EP04)

Initial Displacement: 2.5 ft
Total Well Penetration Depth: 12.1 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.2 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 3.25E-5 cm/sec y0 = 7.95 ft

Data Set: I:\18jobs\18E0022\Admin\13-Calculations\SlugTests\EP04-rh.aqt
Title: EP04 – Rising Head Test
Date: 03/12/19
Time: 14:29:30

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022
Location: Marion, IL
Test Well: EPB

AQUIFER DATA

Saturated Thickness: 7.2 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP04

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.5 ft
Static Water Column Height: 7.2 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 0.3333 ft
Screen Length: 10. ft
Total Well Penetration Depth: 12.1 ft

No. of Observations: 134

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	6.954	1.133	7.625
0.03333	7.439	1.15	7.62
0.05	8.145	1.167	7.615
0.06667	8.178	1.183	7.61
0.08333	8.098	1.2	7.608
0.1	8.084	1.217	7.603
0.1167	8.077	1.233	7.599
0.1333	8.066	1.4	7.608
0.15	8.056	1.567	7.582
0.1667	8.028	1.733	7.559
0.1833	8.014	1.9	7.536
0.2	8.005	2.067	7.515
0.2167	7.993	2.233	7.496
0.2333	7.981	2.733	7.456
0.25	7.965	3.233	7.411
0.2667	7.955	3.733	7.374
0.2833	7.946	4.233	7.341
0.3	7.936	4.733	7.315
0.3167	7.927	5.233	7.294
0.3333	7.918	5.733	7.273

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.35	7.908	6.233	7.261
0.3667	7.899	6.733	7.247
0.3833	7.892	7.233	7.233
0.4	7.883	7.733	7.222
0.4167	7.875	8.233	7.215
0.4333	7.868	8.733	7.205
0.45	7.859	9.233	7.196
0.4667	7.852	9.733	7.191
0.4833	7.845	10.23	7.186
0.5	7.838	10.73	7.179
0.5167	7.829	11.23	7.17
0.5333	7.821	11.73	7.168
0.55	7.817	12.23	7.163
0.5667	7.807	12.73	7.161
0.5833	7.8	13.23	7.156
0.6	7.796	13.73	7.154
0.6167	7.789	14.23	7.154
0.6333	7.782	14.73	7.147
0.65	7.777	15.23	7.147
0.6667	7.77	15.73	7.142
0.6833	7.765	16.23	7.137
0.7	7.758	16.73	7.135
0.7167	7.753	17.23	7.135
0.7333	7.746	17.73	7.132
0.75	7.742	18.23	7.13
0.7667	7.735	18.73	7.123
0.7833	7.73	19.23	7.123
0.8	7.723	19.73	7.123
0.8167	7.718	20.23	7.121
0.8333	7.711	20.73	7.118
0.85	7.707	21.23	7.116
0.8667	7.702	21.73	7.114
0.8833	7.695	22.23	7.114
0.9	7.69	22.73	7.111
0.9167	7.683	23.23	7.114
0.9333	7.678	23.73	7.109
0.95	7.674	24.23	7.111
0.9667	7.669	24.73	7.095
0.9833	7.664	25.23	7.102
1.	7.66	25.73	7.039
1.017	7.655	26.23	7.09
1.033	7.65	26.73	7.05
1.05	7.646	27.23	7.09
1.067	7.641	27.73	7.069
1.083	7.639	28.23	7.086
1.1	7.634	28.73	7.05
1.117	7.629	29.23	7.031

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.759

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	3.25E-5	cm/sec
y0	7.95	ft

T = K*b = 0.007132 cm^2/sec

AUTOMATIC ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
K	3.944E-6	2.269E-7	+/- 4.488E-7	17.38	cm/sec
y0	7.746	0.0202	+/- 0.03995	383.6	ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

T = K*b = 0.0008656 cm^2/sec

Parameter Correlations

	K	y0
K	1.00	0.59
y0	0.59	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . . . 4.477 ft^2
Variance . . . . 0.03392 ft^2
Std. Deviation . . . . 0.1842 ft
Mean . . . . 6.23E-5 ft
No. of Residuals 134
No. of Estimates 2

Appendix C

Packer Test Results

Bedrock Packer Test Calculations

Packer Test Solution

"Methods and procedures for defining aquifer parameters" (by John Sevee);
in Practical Handbook of Ground-Water Monitoring (ed. David Nielsen)

"Friction Losses in Pipe" (APPENDIX 17.A.);
in Groundwater and Wells (Fletcher G. Driscoll)

Site SIPC Marion Power Plant
Boring EBR
1.4902 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

NOTE:
Zero flow rate

Test #		Depth [Interval midpoint] (feet BGS)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
A	1	160.55	0.600	154.74	10.00	23.07	0.220	177.587	2.002E-05	
	2	160.55	0.700	154.74	10.00	23.07	0.257	177.550	2.336E-05	
	3	160.55	0.600	154.74	10.00	23.07	0.220	177.587	2.002E-05	
	4	160.55	0.800	154.74	10.00	23.07	0.293	177.514	2.670E-05	
	5	160.55	0.600	154.74	20.00	46.13	0.220	200.654	1.772E-05	
	6	160.55	0.700	154.74	20.00	46.13	0.257	200.617	2.067E-05	
	7	160.55	0.500	154.74	20.00	46.13	0.183	200.691	1.476E-05	
	8	160.55	0.600	154.74	20.00	46.13	0.220	200.654	1.772E-05	
	9	160.55	0.400	154.74	30.00	69.20	0.147	223.794	1.059E-05	
	10	160.55	0.300	154.74	30.00	69.20	0.110	223.831	7.941E-06	
	11	160.55	0.450	154.74	30.00	69.20	0.165	223.776	1.191E-05	
	12	160.55	0.030	154.74	30.00	69.20	0.011	223.930	7.937E-07	
	13	160.55	0.150	154.74	20.00	46.13	0.055	200.819	4.425E-06	*Step down*
	14	160.55	-0.150	154.74	20.00	46.13	0.055	200.819	4.425E-06	*Step down*
	15	160.55	0.000	154.74	10.00	23.07	0.000	177.807	3.332E-10	*Step down*
	16	160.55	0.000	154.74	10.00	23.07	0.000	177.807	3.332E-10	*Step down*
B	1	149.50	0.400	143.69	10.00	23.07	0.137	166.620	1.400E-05	
	2	149.50	0.280	143.69	10.00	23.07	0.096	166.661	9.795E-06	
	3	149.50	0.190	143.69	10.00	23.07	0.065	166.692	6.645E-06	
	4	149.50	0.130	143.69	10.00	23.07	0.044	166.713	4.546E-06	
	5	149.50	0.190	143.69	20.00	46.13	0.065	189.759	5.838E-06	
	6	149.50	0.110	143.69	20.00	46.13	0.038	189.786	3.379E-06	
	7	149.50	0.120	143.69	20.00	46.13	0.041	189.783	3.686E-06	
	8	149.50	0.120	143.69	20.00	46.13	0.041	189.783	3.686E-06	
	9	149.50	0.380	143.69	30.00	69.20	0.130	212.761	1.041E-05	
	10	149.50	0.390	143.69	30.00	69.20	0.133	212.758	1.069E-05	
	11	149.50	0.530	143.69	30.00	69.20	0.181	212.710	1.453E-05	
	12	149.50	0.600	143.69	30.00	69.20	0.205	212.686	1.645E-05	
	13	149.50	0.190	143.69	20.00	46.13	0.065	189.759	5.838E-06	*Step down*
	14	149.50	0.270	143.69	20.00	46.13	0.092	189.732	8.297E-06	*Step down*
	15	149.50	-0.800	143.69	10.00	23.07	0.273	166.484	2.802E-05	*Step down*
	16	149.50	0.410	143.69	10.00	23.07	0.140	166.617	1.435E-05	*Step down*
C	1	139.45	0.510	133.64	10.00	23.07	0.162	156.545	1.869E-05	
	2	139.45	0.490	133.64	10.00	23.07	0.156	156.551	1.796E-05	
	3	139.45	0.760	133.64	10.00	23.07	0.242	156.465	2.787E-05	
	4	139.45	0.110	133.64	10.00	23.07	0.035	156.672	4.028E-06	
	5	139.45	0.540	133.64	20.00	46.13	0.172	179.602	1.725E-05	
	6	139.45	0.440	133.64	20.00	46.13	0.140	179.634	1.405E-05	
	7	139.45	0.580	133.64	20.00	46.13	0.185	179.589	1.853E-05	
	8	139.45	0.330	133.64	30.00	69.20	0.105	202.736	9.339E-06	
	9	139.45	0.290	133.64	30.00	69.20	0.092	202.749	8.207E-06	
	10	139.45	0.250	133.64	30.00	69.20	0.080	202.761	7.074E-06	
	11	139.45	0.900	133.64	30.00	69.20	0.287	202.554	2.549E-05	
	12	139.45	0.520	133.64	20.00	46.13	0.166	179.608	1.661E-05	*Step down*
	13	139.45	0.470	133.64	20.00	46.13	0.150	179.624	1.501E-05	*Step down*
	14	139.45	-0.050	133.64	10.00	23.07	0.016	156.691	1.831E-06	*Step down*
	15	139.45	-0.210	133.64	10.00	23.07	0.067	156.640	7.692E-06	*Step down*

Bedrock Packer Test Calculations

Site SIPC Marion Power Plant
Boring EBR

1.4902 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

NOTE:
Zero flow rate

Test #	Depth [Interval midpoint] (feet BGS)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
D 1	128.80	0.640	122.99	10.00	23.07	0.188	145.869	2.471E-05	
2	128.80	0.580	122.99	10.00	23.07	0.171	145.886	2.239E-05	
3	128.80	0.620	122.99	10.00	23.07	0.182	145.875	2.394E-05	
4	128.80	0.620	122.99	10.00	23.07	0.182	145.875	2.394E-05	
5	128.80	0.800	122.99	20.00	46.13	0.235	168.889	2.668E-05	
6	128.80	0.680	122.99	20.00	46.13	0.200	168.924	2.267E-05	
7	128.80	0.260	122.99	20.00	46.13	0.076	169.048	8.662E-06	
8	128.80	0.590	122.99	20.00	46.13	0.174	168.950	1.967E-05	
9	128.80	0.470	122.99	30.00	69.20	0.138	192.053	1.378E-05	
10	128.80	0.660	122.99	30.00	69.20	0.194	191.997	1.936E-05	
11	128.80	0.400	122.99	30.00	69.20	0.118	192.073	1.173E-05	
12	128.80	0.470	122.99	30.00	69.20	0.138	192.053	1.378E-05	
13	128.80	0.430	122.99	20.00	46.13	0.126	168.998	1.433E-05	*Step down*
14	128.80	0.550	122.99	20.00	46.13	0.162	168.962	1.833E-05	*Step down*
15	128.80	-0.060	122.99	10.00	23.07	0.018	146.039	2.314E-06	*Step down*
16	128.80	0.080	122.99	10.00	23.07	0.024	146.033	3.085E-06	*Step down*
E 1	118.50	0.160	112.69	10.00	23.07	0.043	135.714	6.508E-06	
2	118.50	0.010	112.69	10.00	23.07	0.003	135.754	4.066E-07	
3	118.50	0.080	112.69	10.00	23.07	0.022	135.735	3.253E-06	
4	118.50	0.100	112.69	10.00	23.07	0.027	135.730	4.067E-06	
5	118.50	0.080	112.69	20.00	46.13	0.022	158.802	2.781E-06	
6	118.50	0.001	112.69	20.00	46.13	0.000	158.824	3.476E-08	
7	118.50	0.099	112.69	20.00	46.13	0.027	158.797	3.441E-06	
8	118.50	0.070	112.69	20.00	46.13	0.019	158.805	2.433E-06	
9	118.50	0.400	112.69	30.00	69.20	0.108	181.783	1.215E-05	
10	118.50	0.310	112.69	30.00	69.20	0.084	181.807	9.412E-06	
11	118.50	0.350	112.69	30.00	69.20	0.095	181.796	1.063E-05	
12	118.50	0.300	112.69	30.00	69.20	0.081	181.810	9.109E-06	
13	118.50	0.130	112.69	20.00	46.13	0.035	158.789	4.519E-06	*Step down*
14	118.50	0.070	112.69	20.00	46.13	0.019	158.805	2.433E-06	*Step down*
15	118.50	-0.300	112.69	10.00	23.07	0.081	135.676	1.221E-05	*Step down*
16	118.50	-0.850	112.69	10.00	23.07	0.230	135.527	3.462E-05	*Step down*
F 1	108.30	0.580	102.49	10.00	23.07	0.143	125.414	2.497E-05	
2	108.30	0.390	102.49	10.00	23.07	0.096	125.461	1.678E-05	
3	108.30	-0.110	102.49	10.00	23.07	0.027	125.530	4.731E-06	
4	108.30	0.360	102.49	10.00	23.07	0.089	125.468	1.549E-05	
5	108.30	0.540	102.49	20.00	46.13	0.134	148.490	1.963E-05	
6	108.30	0.460	102.49	20.00	46.13	0.114	148.510	1.672E-05	
7	108.30	0.770	102.49	20.00	46.13	0.190	148.434	2.801E-05	
8	108.30	0.470	102.49	20.00	46.13	0.116	148.508	1.709E-05	
9	108.30	0.650	102.49	30.00	69.20	0.161	171.530	2.046E-05	
10	108.30	0.610	102.49	30.00	69.20	0.151	171.540	1.920E-05	
11	108.30	0.620	102.49	30.00	69.20	0.153	171.538	1.951E-05	
12	108.30	1.050	102.49	30.00	69.20	0.260	171.431	3.307E-05	
13	108.30	0.700	102.49	20.00	46.13	0.173	148.451	2.546E-05	*Step down*
14	108.30	0.410	102.49	20.00	46.13	0.101	148.523	1.490E-05	*Step down*
15	108.30	-0.190	102.49	10.00	23.07	0.047	125.510	8.173E-06	*Step down*
16	108.30	-0.510	102.49	10.00	23.07	0.126	125.431	2.195E-05	*Step down*

Bedrock Packer Test Calculations

Site SIPC Marion Power Plant
Boring EBR
1.4902 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

NOTE:
Zero flow rate

Test #	Depth [Interval midpoint] (feet BGS)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
G 1	97.85	0.310	92.04	10.00	23.07	0.069	115.038	1.418E-05	
2	97.85	0.220	92.04	10.00	23.07	0.049	115.058	1.006E-05	
3	97.85	0.610	92.04	10.00	23.07	0.136	114.971	2.792E-05	
4	97.85	0.500	92.04	10.00	23.07	0.112	114.995	2.288E-05	
5	97.85	0.490	92.04	20.00	46.13	0.109	138.065	1.867E-05	
6	97.85	0.480	92.04	20.00	46.13	0.107	138.067	1.829E-05	
7	97.85	0.510	92.04	20.00	46.13	0.114	138.060	1.944E-05	
8	97.85	0.550	92.04	20.00	46.13	0.123	138.051	2.096E-05	
9	97.85	0.690	92.04	30.00	69.20	0.154	161.087	2.254E-05	
10	97.85	0.630	92.04	30.00	69.20	0.141	161.100	2.058E-05	
11	97.85	0.580	92.04	30.00	69.20	0.130	161.111	1.894E-05	
12	97.85	1.220	92.04	30.00	69.20	0.273	160.968	3.988E-05	
13	97.85	0.640	92.04	20.00	46.13	0.143	138.031	2.440E-05	*Step down*
14	97.85	0.300	92.04	20.00	46.13	0.067	138.107	1.143E-05	*Step down*
15	97.85	-0.150	92.04	10.00	23.07	0.034	115.073	6.859E-06	*Step down*
16	97.85	-0.150	92.04	10.00	23.07	0.034	115.073	6.859E-06	*Step down*
H 1	87.70	0.310	81.89	10.00	23.07	0.062	104.895	1.511E-05	
2	87.70	0.240	81.89	10.00	23.07	0.048	104.909	1.170E-05	
3	87.70	0.240	81.89	10.00	23.07	0.048	104.909	1.170E-05	
4	87.70	0.250	81.89	10.00	23.07	0.050	104.907	1.218E-05	
5	87.70	0.280	81.89	20.00	46.13	0.056	127.968	1.119E-05	
6	87.70	0.200	81.89	20.00	46.13	0.040	127.984	7.990E-06	
7	87.70	0.160	81.89	20.00	46.13	0.032	127.992	6.392E-06	
8	87.70	0.320	81.89	20.00	46.13	0.064	127.960	1.279E-05	
9	87.70	0.420	81.89	30.00	69.20	0.084	151.007	1.422E-05	
10	87.70	0.460	81.89	30.00	69.20	0.092	150.999	1.558E-05	
11	87.70	0.420	81.89	30.00	69.20	0.084	151.007	1.422E-05	
12	87.70	0.910	81.89	30.00	69.20	0.182	150.909	3.083E-05	
13	87.70	0.320	81.89	20.00	46.13	0.064	127.960	1.279E-05	*Step down*
14	87.70	0.330	81.89	20.00	46.13	0.066	127.958	1.319E-05	*Step down*
15	87.70	0.020	81.89	10.00	23.07	0.004	104.953	9.743E-07	*Step down*
16	87.70	-0.130	81.89	10.00	23.07	0.026	104.931	6.334E-06	*Step down*
I 1	77.55	0.100	71.74	10.00	23.07	0.018	94.789	5.216E-06	
2	77.55	0.030	71.74	10.00	23.07	0.005	94.802	1.565E-06	
3	77.55	0.010	71.74	10.00	23.07	0.002	94.805	5.215E-07	
4	77.55	0.000	71.74	10.00	23.07	0.000	94.807	0.000E+00	*No take*
5	77.55	0.000	71.74	20.00	46.13	0.000	117.874	4.194E-10	*No take*
6	77.55	0.070	71.74	20.00	46.13	0.012	117.862	2.936E-06	
7	77.55	0.030	71.74	20.00	46.13	0.005	117.869	1.258E-06	
8	77.55	0.110	71.74	20.00	46.13	0.019	117.855	4.615E-06	
9	77.55	0.180	71.74	30.00	69.20	0.032	140.909	6.316E-06	
10	77.55	0.000	71.74	30.00	69.20	0.000	140.941	3.508E-10	*No take*
11	77.55	0.000	71.74	30.00	69.20	0.000	140.941	3.508E-10	*No take*
12	77.55	0.000	71.74	30.00	69.20	0.000	140.941	3.508E-10	*No take*
13	77.55	0.230	71.74	20.00	46.13	0.041	117.833	9.651E-06	*Step down*
14	77.55	0.220	71.74	20.00	46.13	0.039	117.835	9.231E-06	*Step down*
15	77.55	0.040	71.74	10.00	23.07	0.007	94.800	2.086E-06	*Step down*
16	77.55	-0.400	71.74	10.00	23.07	0.071	94.736	2.088E-05	*Step down*

Bedrock Packer Test Calculations

Site SIPC Marion Power Plant
Boring EBR

1.4902 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

NOTE:
Zero flow rate

Test #	Depth [Interval midpoint] (feet BGS)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
J 1	67.20	0.000	61.39	10.00	23.07	0.000	84.457	5.619E-10	
2	67.20	0.010	61.39	10.00	23.07	0.002	84.455	5.619E-07	
3	67.20	-0.070	61.39	10.00	23.07	0.011	84.446	3.934E-06	
4	67.20	0.030	61.39	10.00	23.07	0.005	84.452	1.686E-06	
5	67.20	0.010	61.39	20.00	46.13	0.002	107.522	4.414E-07	
6	67.20	0.190	61.39	20.00	46.13	0.029	107.495	8.388E-06	
7	67.20	0.090	61.39	20.00	46.13	0.014	107.510	3.973E-06	
8	67.20	0.030	61.39	20.00	46.13	0.005	107.519	1.324E-06	
9	67.20	0.070	61.39	30.00	69.20	0.011	130.580	2.544E-06	
10	67.20	0.030	61.39	30.00	69.20	0.005	130.586	1.090E-06	
11	67.20	0.040	61.39	30.00	69.20	0.006	130.585	1.454E-06	
12	67.20	0.060	61.39	30.00	69.20	0.009	130.582	2.181E-06	
13	67.20	-0.040	61.39	20.00	46.13	0.006	107.518	1.765E-06	*Step down*
14	67.20	-0.040	61.39	20.00	46.13	0.006	107.518	1.765E-06	*Step down*
15	67.20	0.020	61.39	10.00	23.07	0.003	84.454	1.124E-06	*Step down*
16	67.20	0.000	61.39	10.00	23.07	0.000	84.457	5.619E-10	*Step down*
K 1	56.70	0.040	50.89	10.00	23.07	0.005	73.952	2.438E-06	
2	56.70	0.010	50.89	10.00	23.07	0.001	73.956	6.094E-07	
3	56.70	-0.060	50.89	10.00	23.07	0.008	73.949	3.656E-06	
4	56.70	0.020	50.89	10.00	23.07	0.003	73.954	1.219E-06	
5	56.70	0.010	50.89	20.00	46.13	0.001	97.023	4.645E-07	
6	56.70	0.000	50.89	20.00	46.13	0.000	97.024	4.645E-10	*No take*
7	56.70	0.000	50.89	20.00	46.13	0.000	97.024	4.645E-10	*No take*
8	56.70	0.000	50.89	20.00	46.13	0.000	97.024	4.645E-10	*No take*
9	56.70	0.370	50.89	30.00	69.20	0.048	120.043	1.389E-05	
10	56.70	0.440	50.89	30.00	69.20	0.057	120.034	1.652E-05	
11	56.70	0.330	50.89	30.00	69.20	0.043	120.048	1.239E-05	
12	56.70	0.510	50.89	30.00	69.20	0.066	120.025	1.915E-05	
13	56.70	0.000	50.89	20.00	46.13	0.000	97.024	4.645E-10	*Step down*
14	56.70	0.030	50.89	20.00	46.13	0.004	97.020	1.393E-06	*Step down*
15	56.70	0.020	50.89	10.00	23.07	0.003	73.954	1.219E-06	*Step down*
16	56.70	0.000	50.89	10.00	23.07	0.000	73.957	6.093E-10	*Step down*
L 1	46.25	0.760	40.44	10.00	23.07	0.080	63.427	5.049E-05	
2	46.25	0.810	40.44	10.00	23.07	0.086	63.421	5.382E-05	
3	46.25	0.750	40.44	10.00	23.07	0.079	63.428	4.983E-05	
4	46.25	0.710	40.44	10.00	23.07	0.075	63.432	4.717E-05	
5	46.25	1.480	40.44	20.00	46.13	0.156	86.418	7.217E-05	
6	46.25	1.290	40.44	20.00	46.13	0.136	86.438	6.289E-05	
7	46.25	1.170	40.44	20.00	46.13	0.124	86.450	5.703E-05	
8	46.25	1.160	40.44	20.00	46.13	0.123	86.451	5.654E-05	
9	46.25	0.770	40.44	10.00	23.07	0.081	63.426	5.116E-05	*Step down*
10	46.25	0.710	40.44	10.00	23.07	0.075	63.432	4.717E-05	*Step down*
M 1	35.75	0.390	29.94	10.00	23.07	0.032	52.975	2.821E-05	
2	35.75	0.540	29.94	10.00	23.07	0.044	52.963	3.907E-05	
3	35.75	0.420	29.94	10.00	23.07	0.034	52.973	3.038E-05	
4	35.75	0.430	29.94	10.00	23.07	0.035	52.972	3.110E-05	
5	35.75	0.580	29.94	20.00	46.13	0.047	76.027	2.923E-05	
6	35.75	0.480	29.94	20.00	46.13	0.039	76.035	2.419E-05	
7	35.75	0.560	29.94	20.00	46.13	0.046	76.028	2.822E-05	
8	35.75	0.550	29.94	20.00	46.13	0.045	76.029	2.772E-05	
9	35.75	0.410	29.94	10.00	23.07	0.033	52.974	2.966E-05	*Step down*
10	35.75	0.470	29.94	10.00	23.07	0.038	52.969	3.400E-05	*Step down*

Bedrock Packer Test Calculations

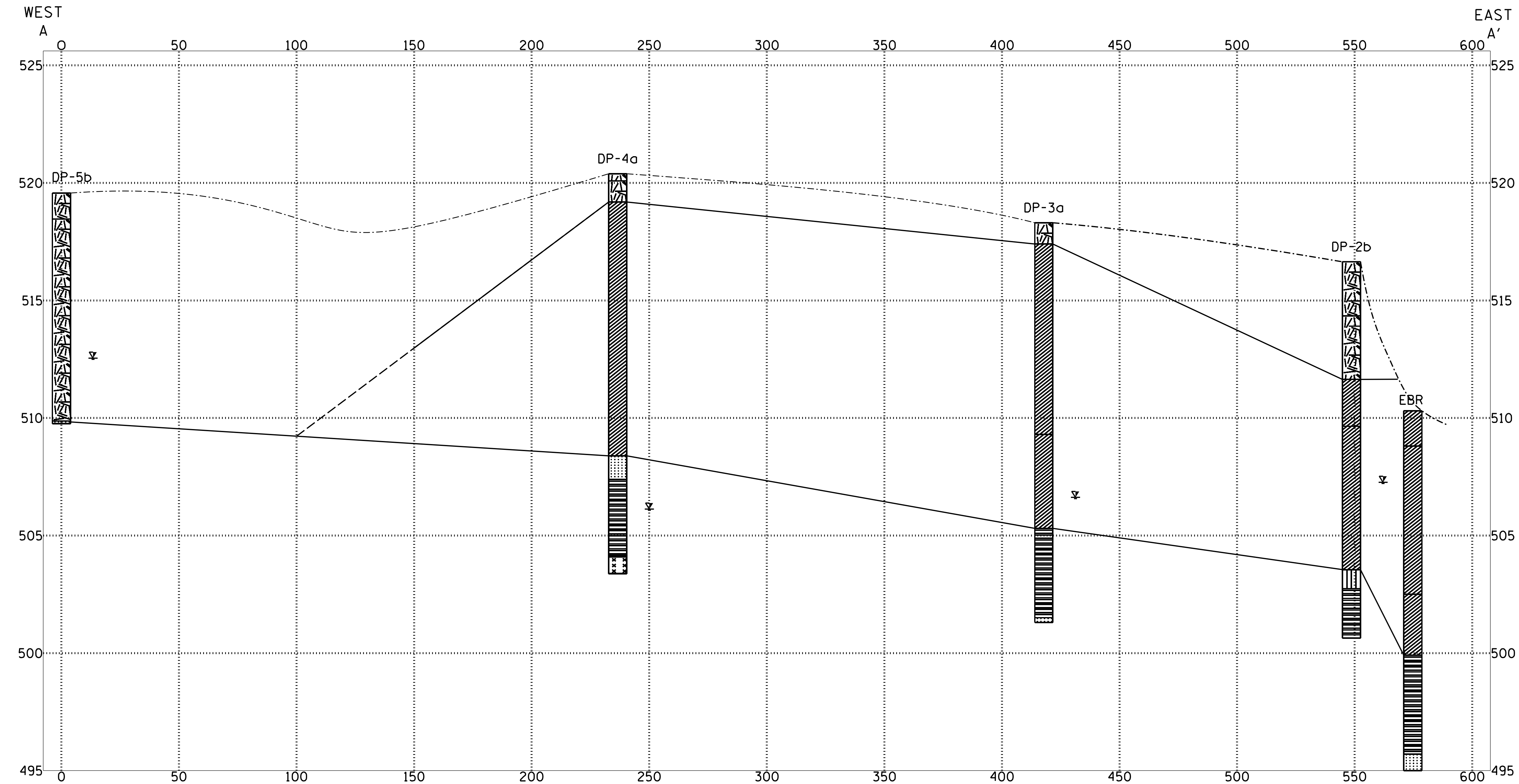
Site SIPC Marion Power Plant
Boring EBR
1.4902 Radius of test hole (in ft.)
8.4700 Length of test zone (in ft.)

NOTE:
Zero flow rate

Test #	Depth [Interval midpoint] (feet BGS)	Constant flow rate Q (in gal/min)	Static Head H_s (in feet)	Guage pressure p (in psi)	Pressure head $H_p = p*2.31$ (in feet)	Friction loss H_f (in feet)	Differential head $H_s + H_p - H_f$ (in feet)	Hydraulic Conductivity K (in cm/sec)	Comments
N 1	26.20	0.180	20.39	10.00	23.07	0.011	43.446	1.386E-05	
2	26.20	0.300	20.39	10.00	23.07	0.018	43.439	2.310E-05	
3	26.20	0.260	20.39	10.00	23.07	0.016	43.441	2.002E-05	
4	26.20	0.160	20.39	10.00	23.07	0.010	43.447	1.232E-05	
5	26.20	0.200	20.39	10.00	23.07	0.012	43.445	1.540E-05	
6	26.20	0.250	20.39	10.00	23.07	0.015	43.442	1.925E-05	
7	26.20	0.250	20.39	10.00	23.07	0.015	43.442	1.925E-05	
8	26.20	0.240	20.39	10.00	23.07	0.014	43.443	1.848E-05	
9	26.20	0.170	20.39	10.00	23.07	0.010	43.447	1.309E-05	

Appendix D

Geologic Cross Sections



EXPLANATION

LITHOLOGY

- FILL
- CLAY
- SILT
- SAND
- SANDSTONE
- SHALE

EX — EXISTING GROUND

PB — POND BOUNDARY

POTENTIOMETRIC SURFACE (27 FEB 2019 - 1 MARCH 2019)

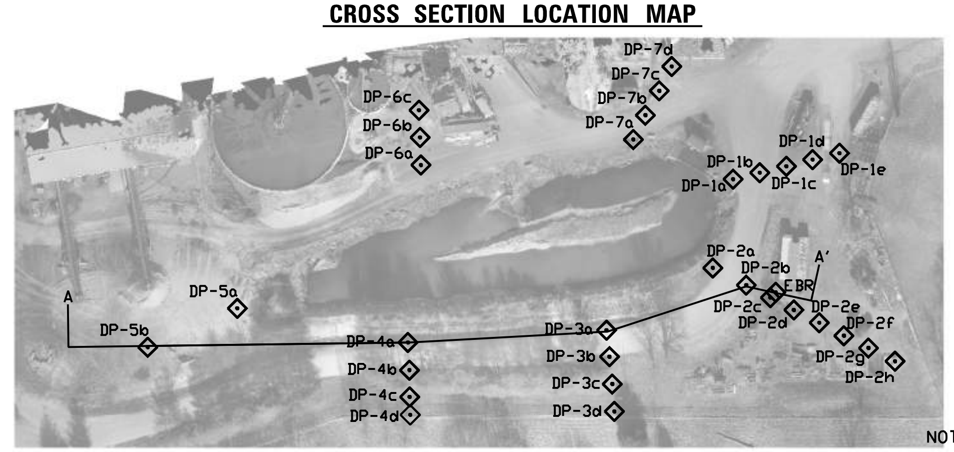
SCALES

VERTICAL ENHANCEMENT = 10X

VERTICAL: 1 IN. = 2.5 FT. 2.5 0 2.5 5

HORIZONTAL: 1 IN. = 25 FT. 25 0 25 50

CROSS SECTION LOCATION MAP



NOT TO SCALE

NOTES:

1. GEOLOGY AT INDIVIDUAL BOREHOLES IS NOT REPRESENTATIVE OF ENTIRE SITE.
2. TOPOGRAPHY MAPPED BY HANSON AERIAL SURVEY DATED 10 JANUARY 2019.
3. GEOLOGIC UNITS ARE INTERPOLATED BETWEEN BORING LOCATIONS, ACTUAL SUBSURFACE CONDITIONS MAY VARY FROM THOSE DEPICTED.
4. LITHOLOGICAL INTERPRETATION ARE GENERALIZED IN CROSS SECTION. ADDITIONAL DETAIL MAY BE INCLUDED ON THE APPROPRIATE FIELD BORING LOGS.
5. GROUNDWATER LEVELS REPRSENT WATER LEVELS TAKEN ON 27 FEBRUARY 2019 TO 1 MARCH 2019

DESIGNED	RWH	03/15/2019
DRAWN	CAD	03/15/2019
REVIEWED	RWH	03/15/2019

HANSON

Hanson Professional Services Inc.

CROSS SECTIONS A–A'

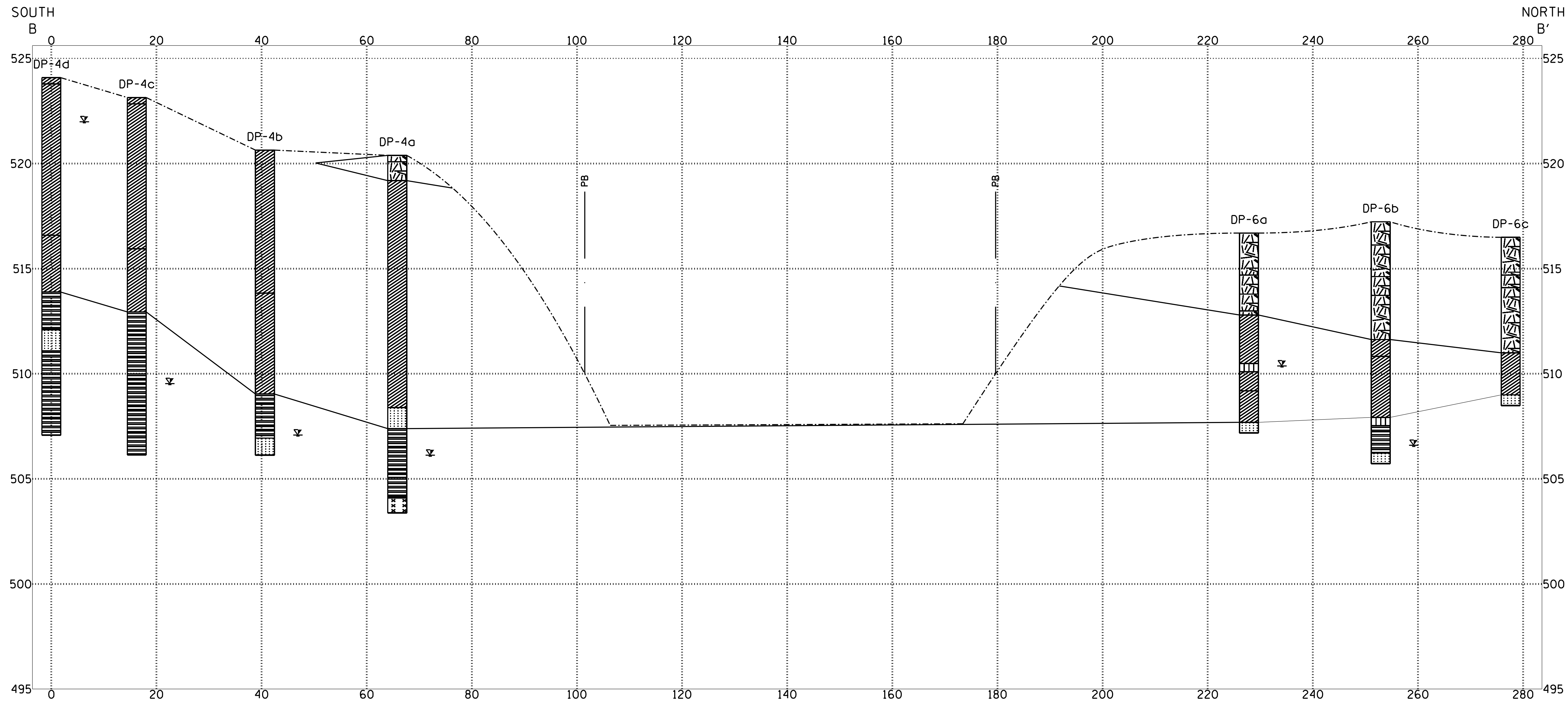
EMERY POND

MARION POWER PLANT

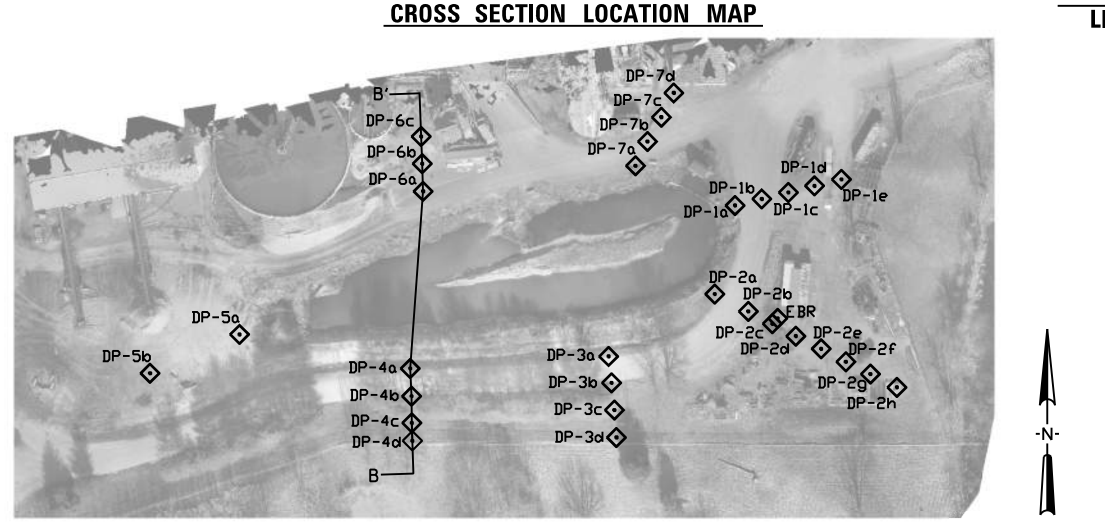
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE D–1



CROSS SECTION LOCATION MAP



EXPLANATION

LITHOLOGY

- FILL
- CLAY
- SILT
- SAND
- SANDSTONE
- SHALE

EX — EXISTING GROUND

PB — POND BOUNDARY

POTENTIOMETRIC SURFACE (27 FEB 2019 - 1 MARCH 2019)

SCALES

VERTICAL ENHANCEMENT = 4X

VERTICAL: 1 IN. = 2.5 FT. (2.5 0 2.5 5)

HORIZONTAL: 1 IN. = 10 FT. (10 0 10 20)

NOTES:

1. GEOLOGY AT INDIVIDUAL BOREHOLES IS NOT REPRESENTATIVE OF ENTIRE SITE.
2. TOPOGRAPHY MAPPED BY HANSON AERIAL SURVEY DATED 10 JANUARY 2019.
3. GEOLOGIC UNITS ARE INTERPOLATED BETWEEN BORING LOCATIONS, ACTUAL SUBSURFACE CONDITIONS MAY VARY FROM THOSE DEPICTED.
4. LITHOLOGICAL INTERPRETATION ARE GENERALIZED IN CROSS SECTION. ADDITIONAL DETAIL MAY BE INCLUDED ON THE FIELD BORING LOGS.
5. GROUNDWATER LEVELS REPRSENT WATER LEVELS TAKEN ON 27 FEBRUARY 2019 TO 1 MARCH 2019

DESIGNED	RWH	03/15/2019
DRAWN	CAD	03/15/2019
REVIEWED	RWH	03/15/2019

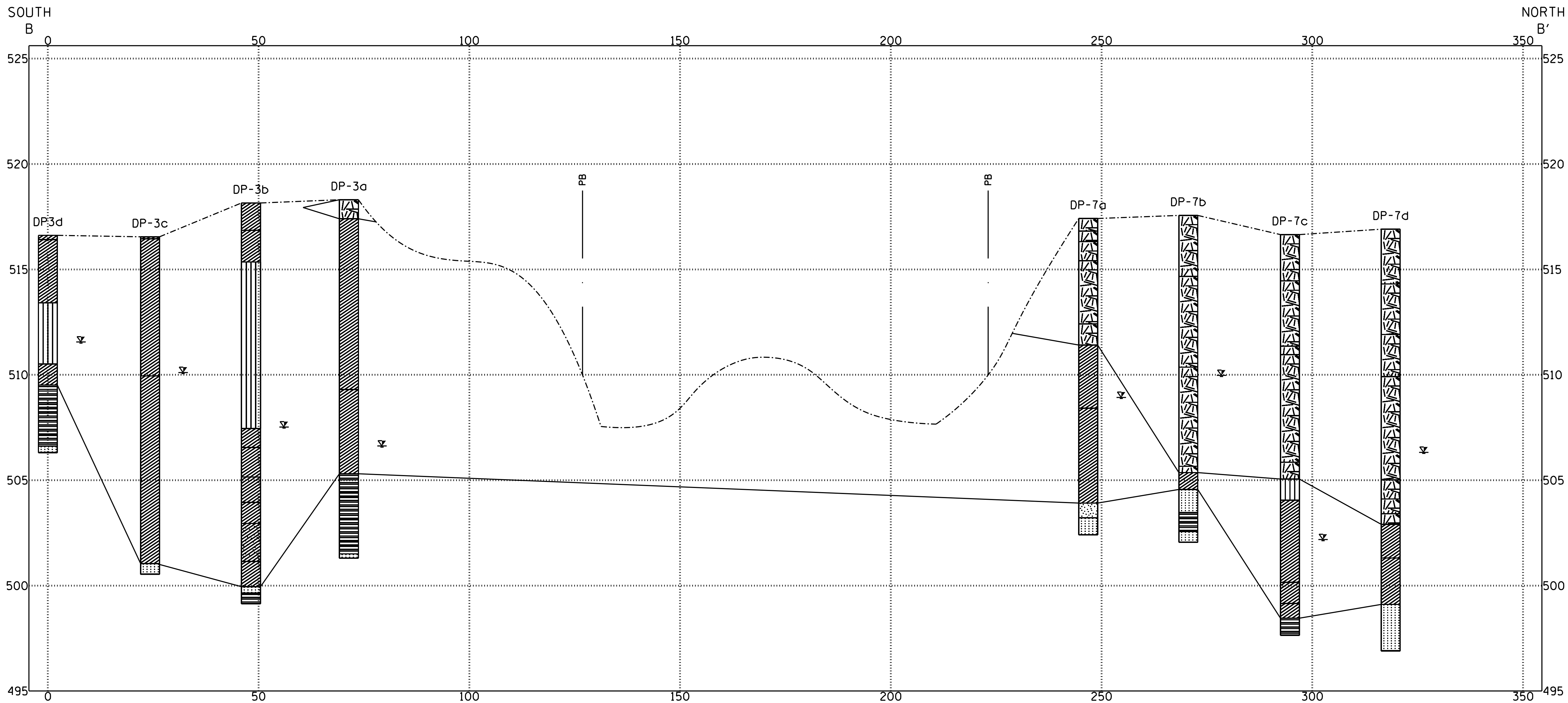
HANSON
Hanson Professional Services Inc.

CROSS SECTIONS B–B'

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE D–2



EXPLANATION

LITHOLOGY

FILL
CLAY
SILT
SAND
SANDSTONE
SHALE

EX — EXISTING GROUND

PB — POND BOUNDARY

POTENTIOMETRIC SURFACE (27 FEB 2019 - 1 MARCH 2019)

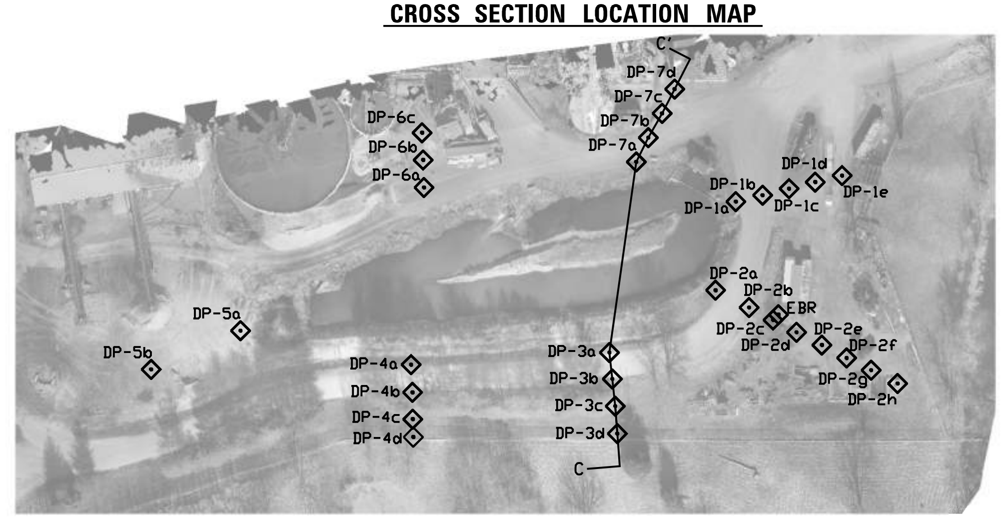
SCALES

VERTICAL ENHANCEMENT = 5X

VERTICAL: 1 IN. = 2.5 FT. 2.5 0 2.5 5

HORIZONTAL: 1 IN. = 12.5 FT. 12.5 0 12.5 25

CROSS SECTION LOCATION MAP



-N-

NOT TO SCALE

NOTES:

1. GEOLOGY AT INDIVIDUAL BOREHOLES IS NOT REPRESENTATIVE OF ENTIRE SITE.
2. TOPOGRAPHY MAPPED BY HANSON AERIAL SURVEY DATED 10 JANUARY 2019.
3. GEOLOGIC UNITS ARE INTERPOLATED BETWEEN BORING LOCATIONS. ACTUAL SUBSURFACE CONDITIONS MAY VARY FROM THOSE DEPICTED.
4. LITHOLOGICAL INTERPRETATION ARE GENERALIZED IN CROSS SECTION. ADDITIONAL DETAIL MAY BE INCLUDED ON THE APPROPRIATE FIELD BORING LOGS.
5. GROUNDWATER LEVELS REPRSENT WATER LEVELS TAKEN ON 27 FEBRUARY 2019 TO 1 MARCH 2019

DESIGNED	RWH	03/15/2019
DRAWN	CAD	03/15/2019
REVIEWED	RWH	03/15/2019

HANSON

Hanson Professional Services Inc.

CROSS SECTIONS C–C'

EMERY POND

MARION POWER PLANT

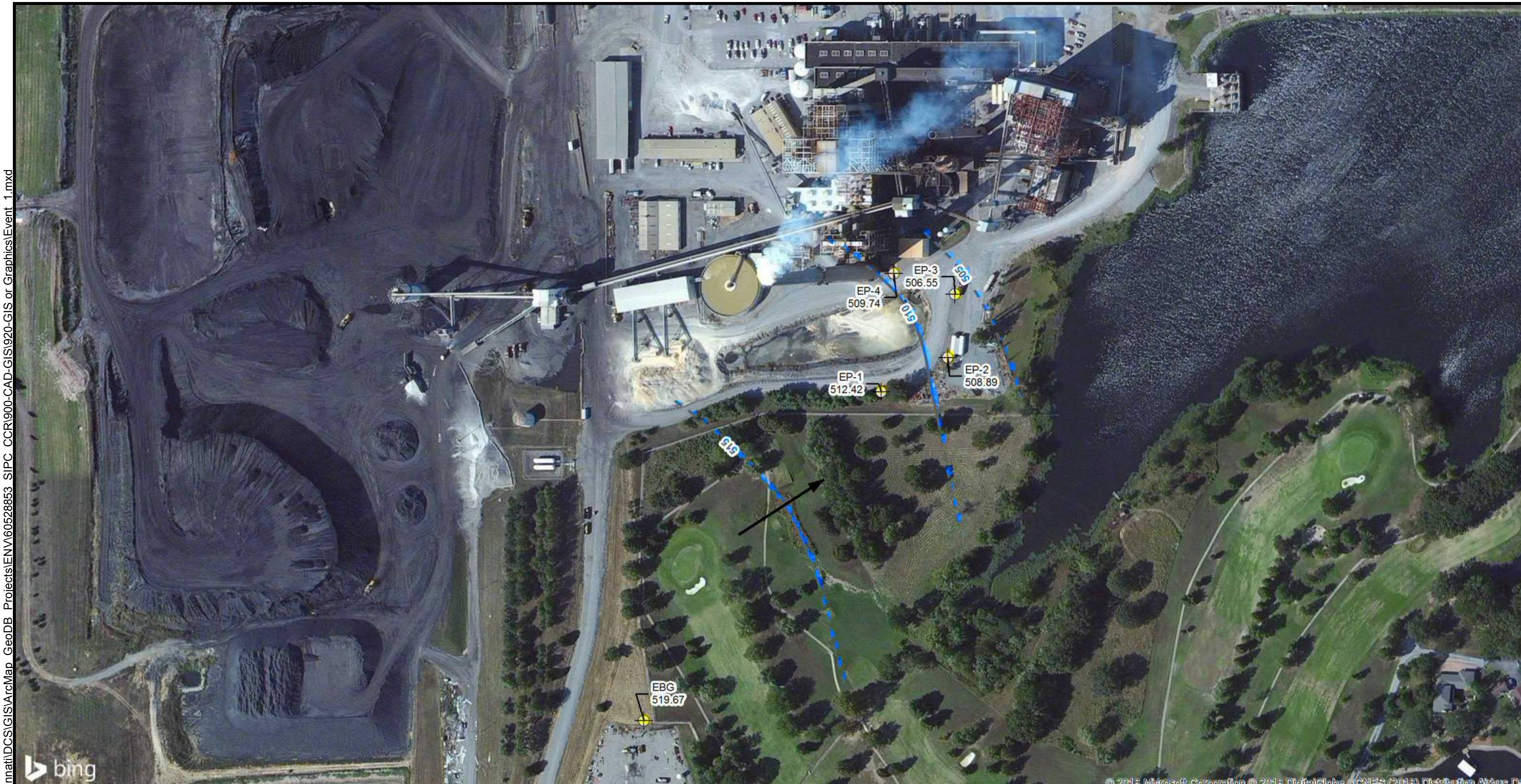
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE D–3

Appendix E

Potentiometric Surface Maps



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Legend

- Groundwater Monitoring Well
- ;
- Solid
- Inferred Direction of Groundwater Flow

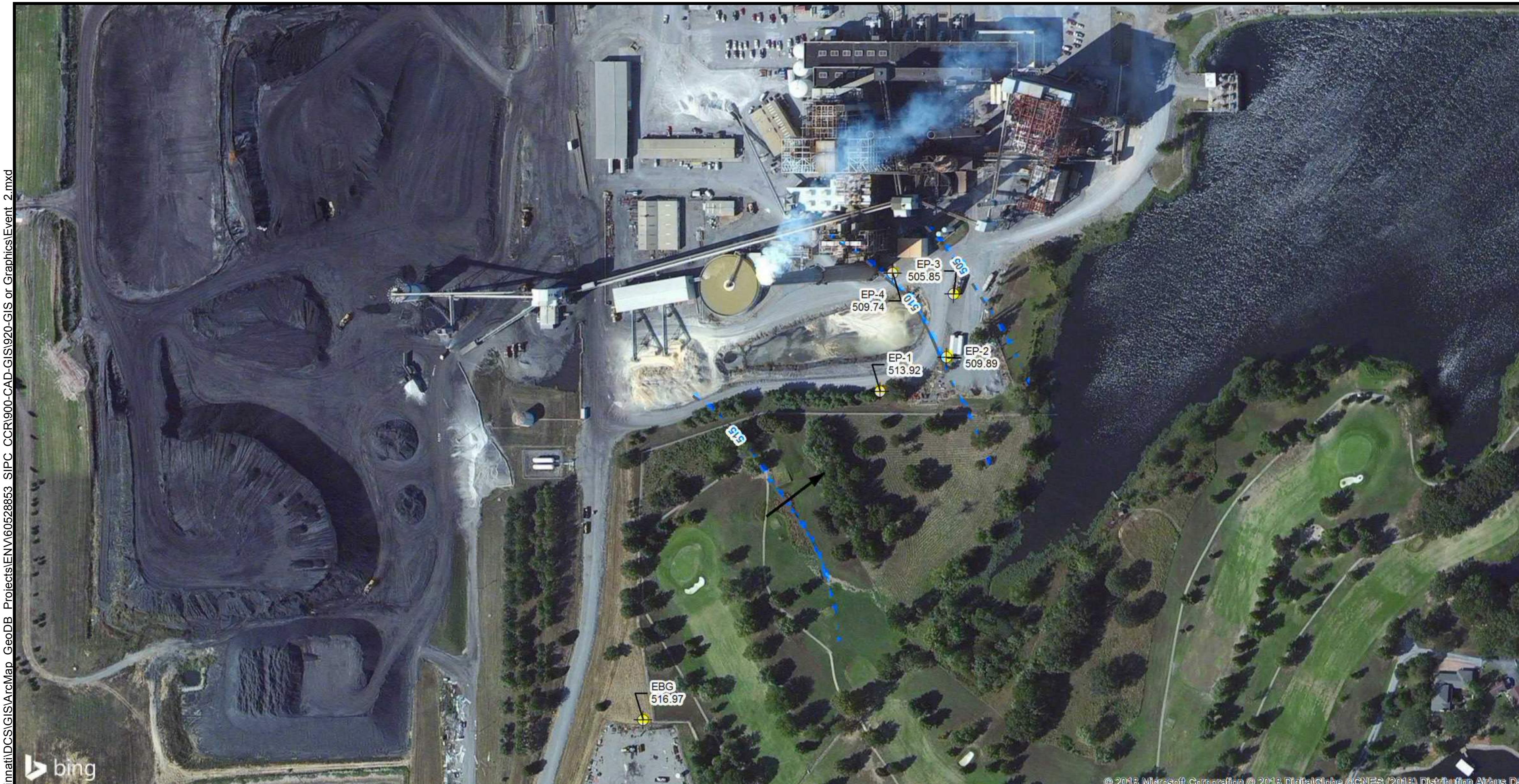
0 200 400
Feet

N

MARION POWER PLANT

APPENDIX B
EVENT 1
EMORY POND POTENTIOMETRIC
SURFACE MAP MARCH 24, 2017

DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	



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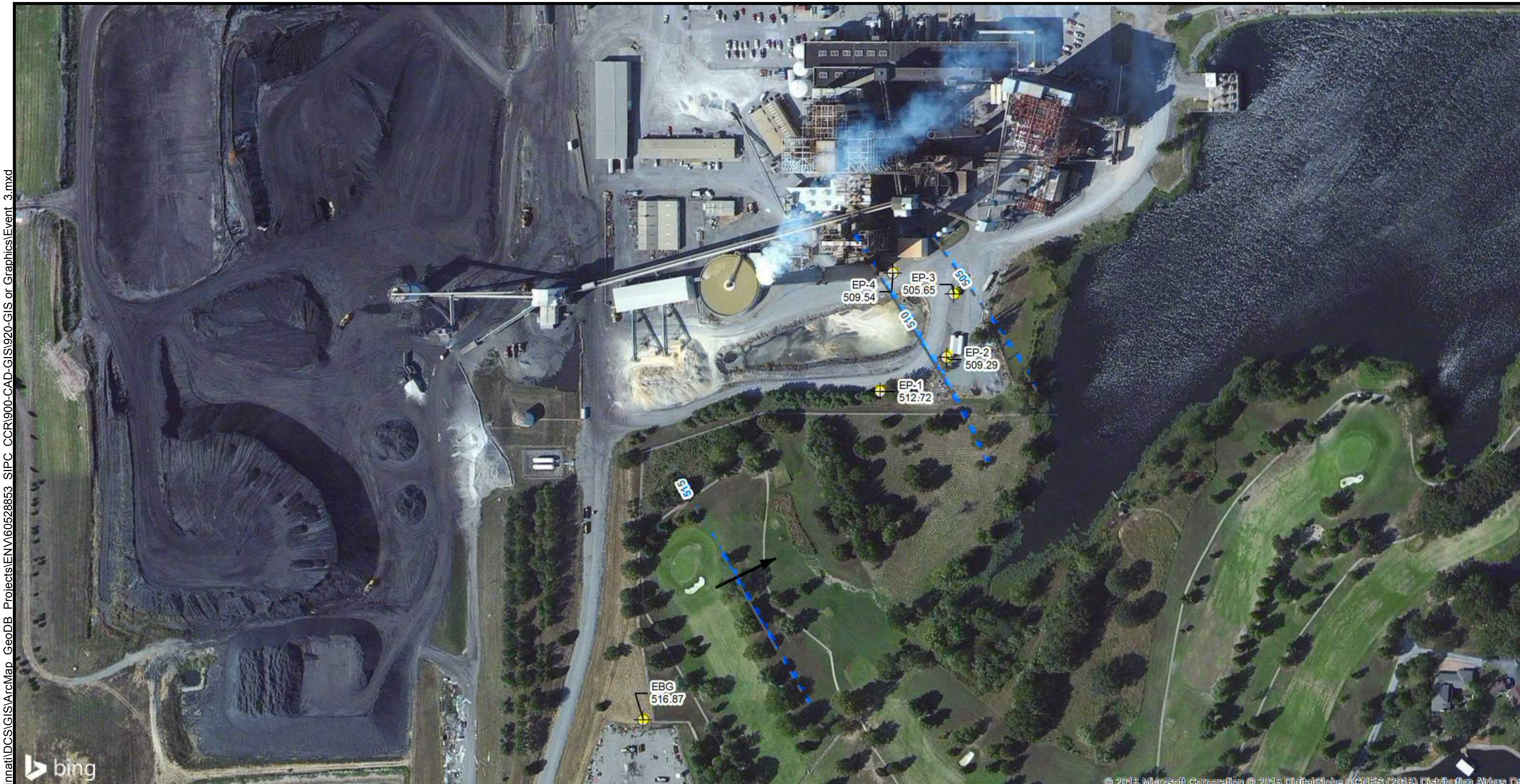
Legend

- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

0 200 400
Feet

N

MARION POWER PLANT	
APPENDIX B EVENT 2 EMORY POND POTENTIOMETRIC SURFACE MAP APRIL 24, 2017	
DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	



Legend

- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

0 200 400

Feet

N

MARION POWER PLANT	
APPENDIX B EVENT 3 EMORY POND POTENTIOMETRIC SURFACE MAP MAY 25, 2017	
DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	

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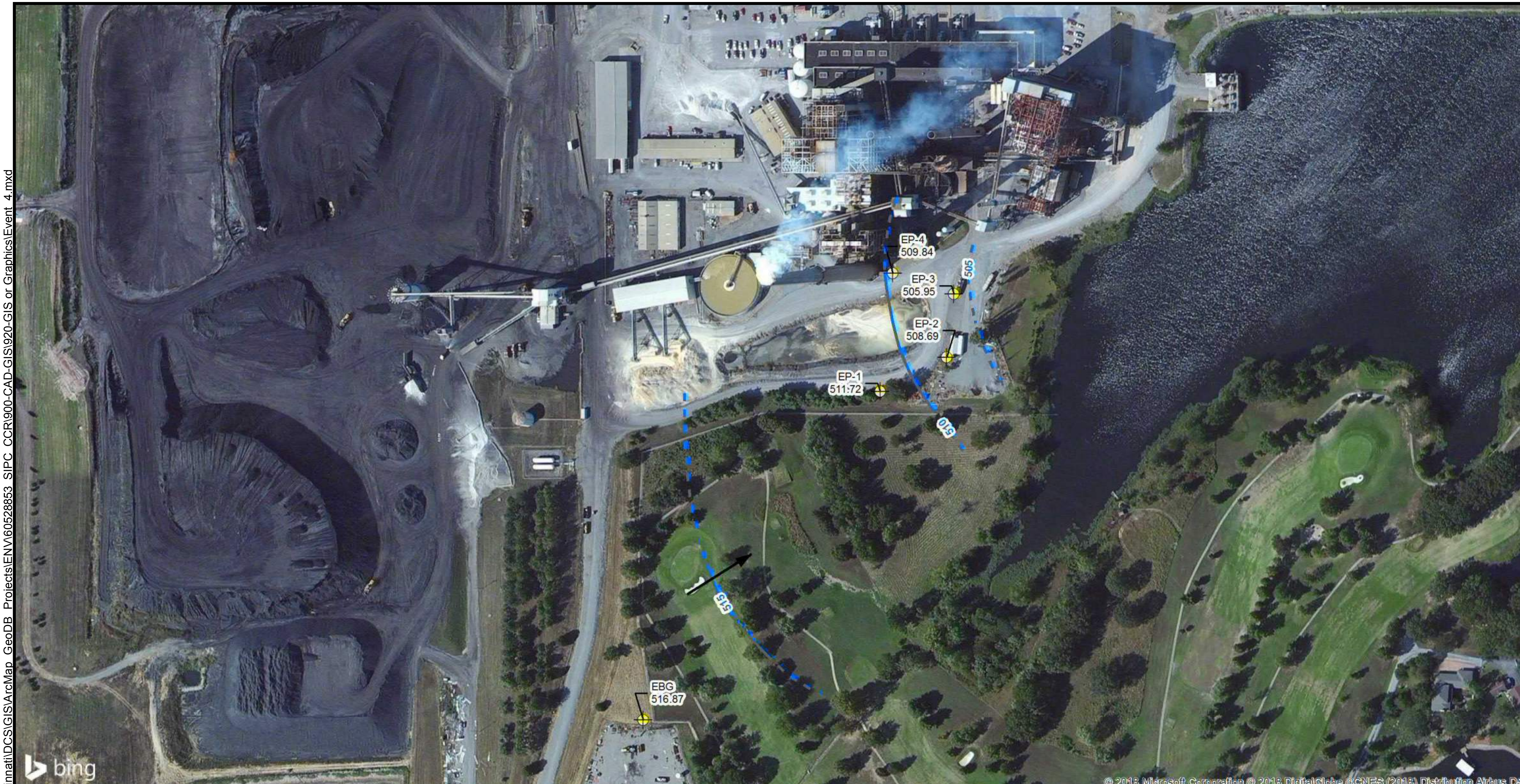

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Legend

- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

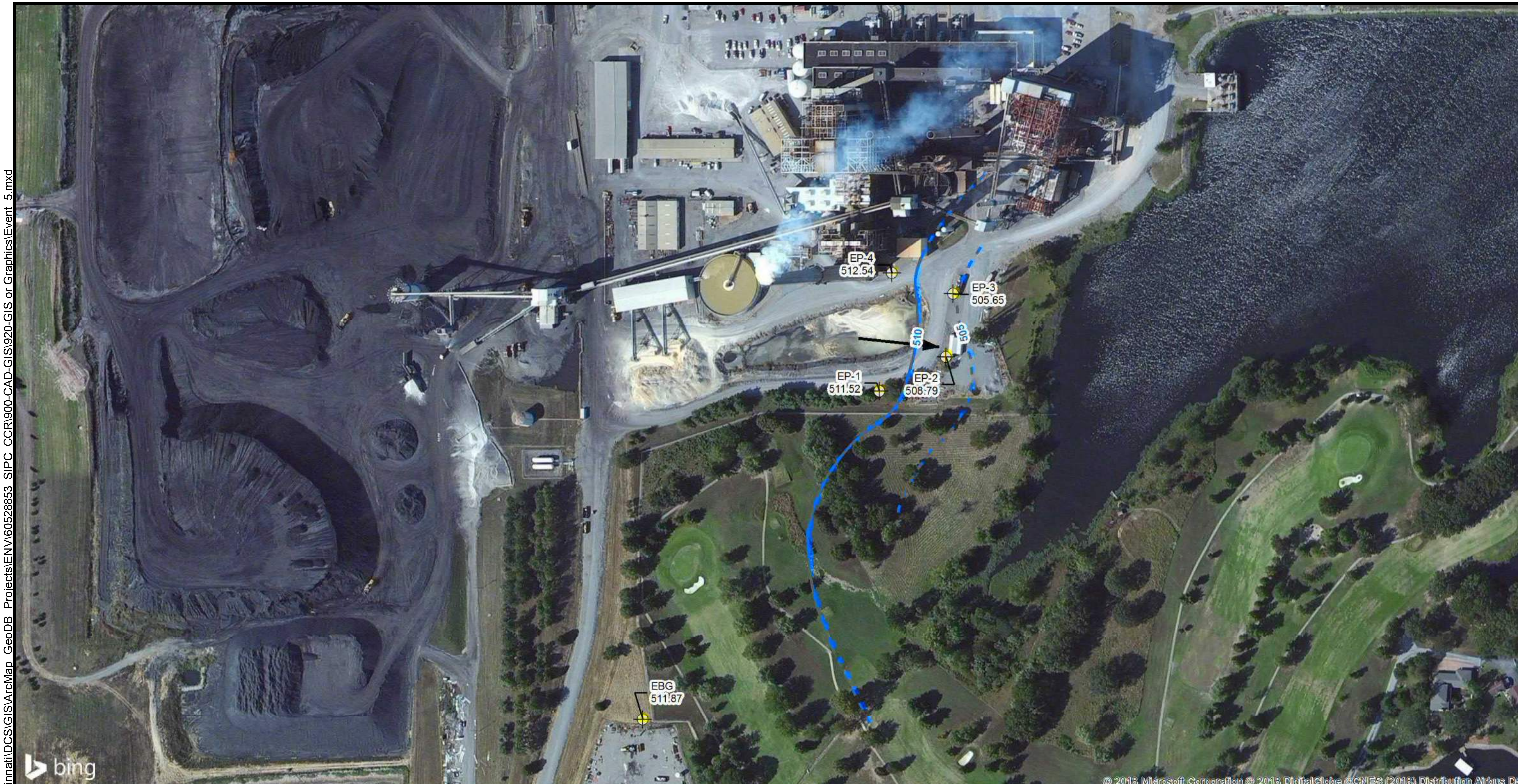
0 200 400
Feet

N

MARION POWER PLANT

APPENDIX B
EVENT 4
EMORY POND POTENTIOMETRIC
SURFACE MAP JUNE 22, 2017

DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	



Document Path: G:\Cincinnati\DCS\GIS\ArcMap_GeoDB_Projects\ENV\60528853_SIPC_CCR\900-CAD-GIS\920-GIS or Graphics\Event_5.mxd

Legend

- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

0 200 400
Feet

N

MARION POWER PLANT

APPENDIX B
EVENT 5
EMORY POND POTENTIOMETRIC
SURFACE MAP JUNE 29, 2017

DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	

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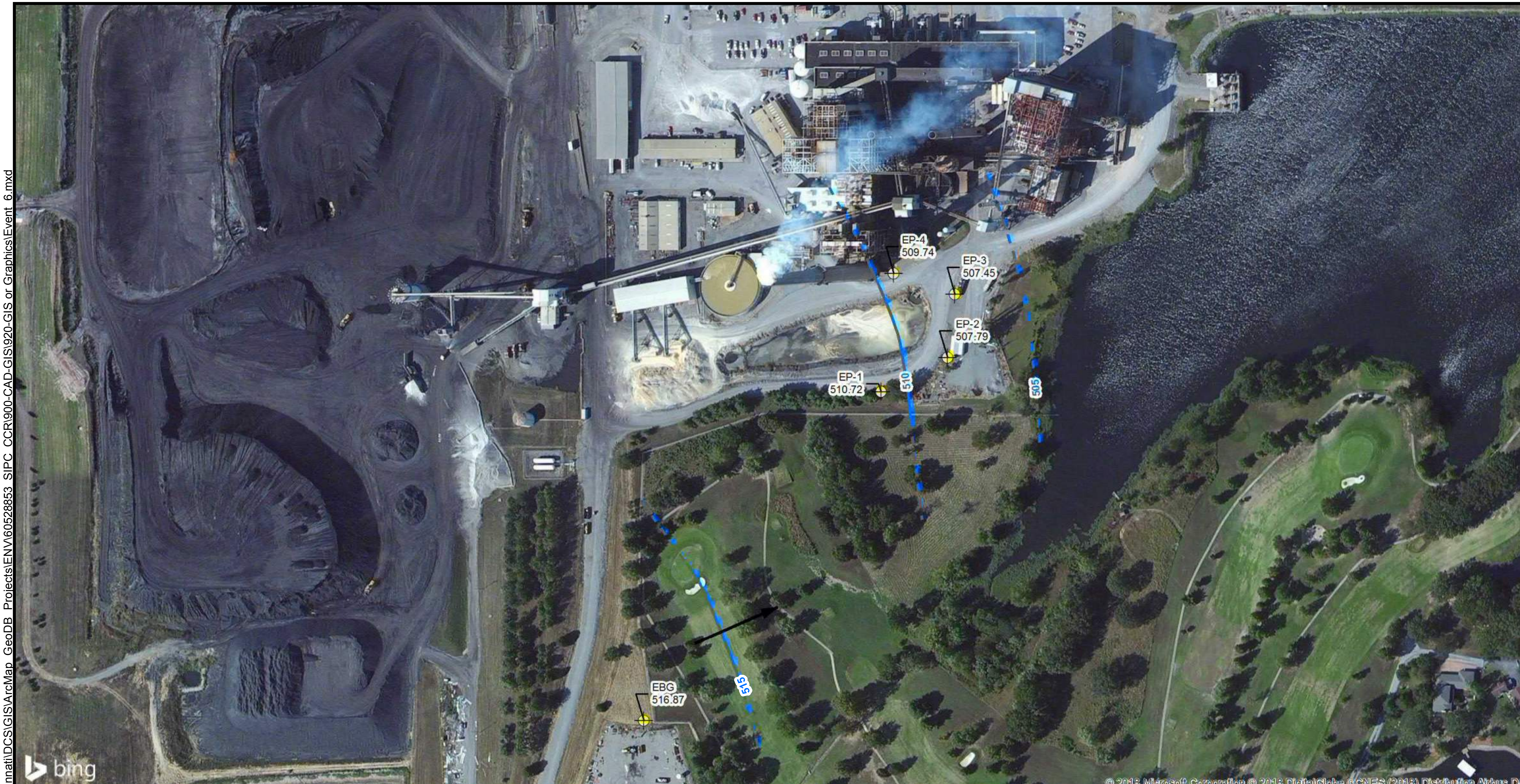


Legend

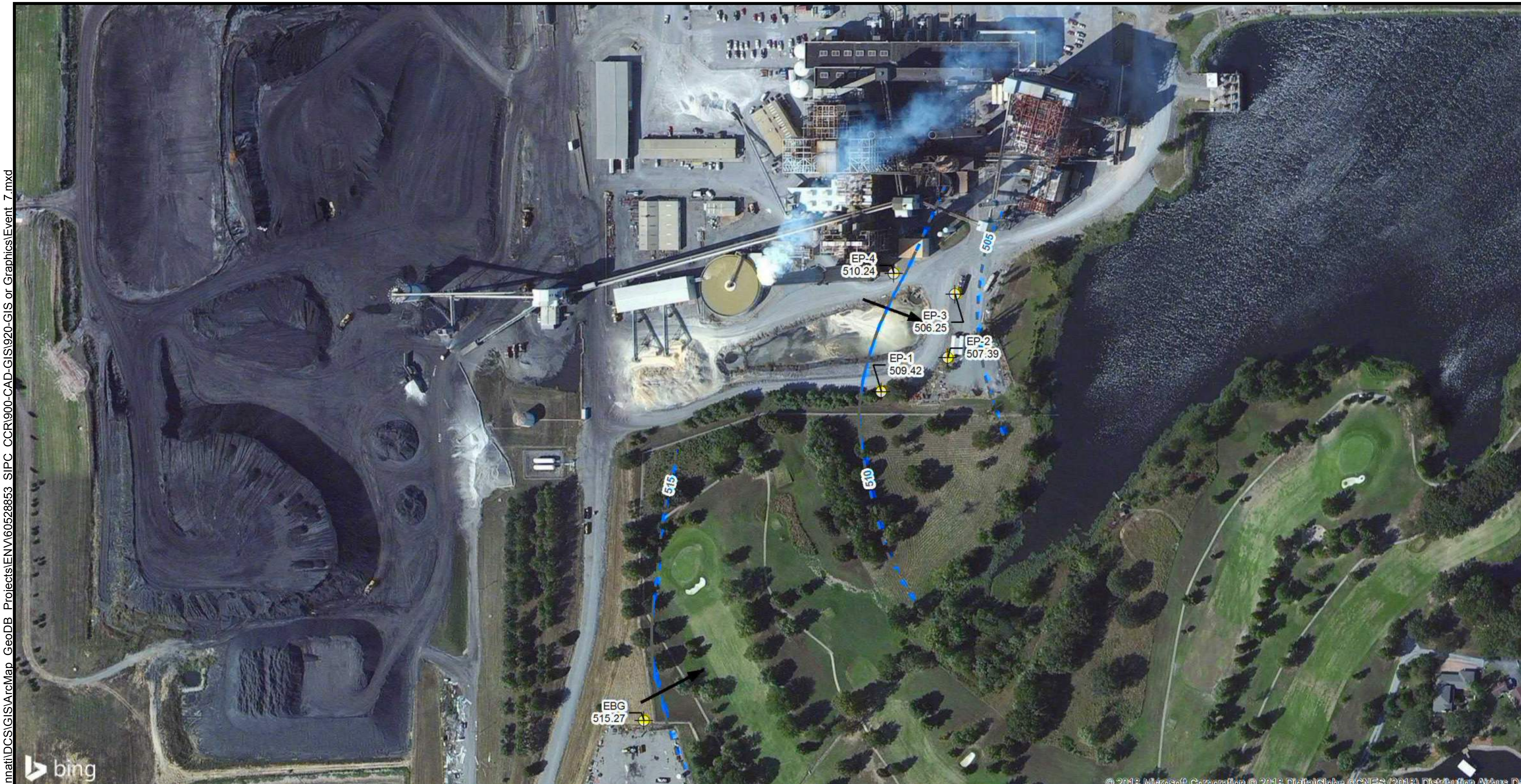
- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

0 200 400

Feet

N

MARION POWER PLANT	
APPENDIX B EVENT 6 EMORY POND POTENTIOMETRIC SURFACE MAP JULY 24, 2017	
DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	



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Legend

- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

0 200 400
Feet

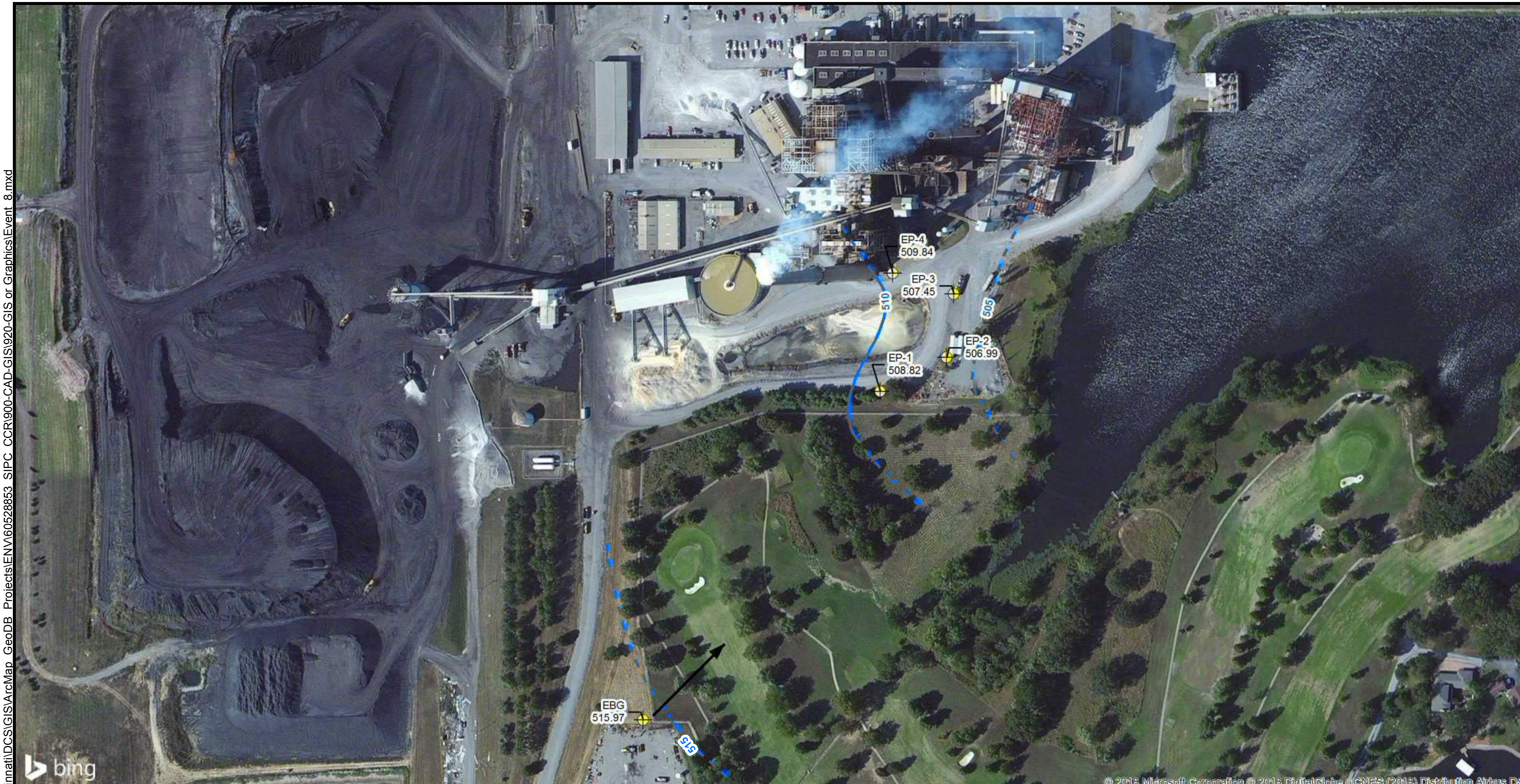
N

MARION POWER PLANT

APPENDIX B
EVENT 7
EMORY POND POTENTIOMETRIC
SURFACE MAP AUGUST 3, 2017

DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	

Document Path: G:\Cincinnati\DCS\GIS\ArcMap_GeoDB_Projects\ENV\60528853_SIPC_CCR\900-CAD-GIS\920-GIS or Graphics\Event_8.mxd



Legend

- Groundwater Monitoring Well
- Groundwater Contour (ft,msl)
- Inferred Groundwater Contour (ft,msl)
- Inferred Direction of Groundwater Flow

0 200 400
Feet

N

MARION POWER PLANT	
APPENDIX B EVENT 8 EMORY POND POTENTIOMETRIC SURFACE MAP AUGUST 31, 2017	
DATE: 1/22/2018	1 inch = 200 feet
CREATED BY: TA	CHECKED BY: DPC
JOB NO. 60535846	

SCALE: 1 in. = 135 ft.

0 ft. 100 ft. 200 ft. 300 ft. 400 ft.

CONTOUR INTERVAL = 1 ft.

N

HANSON

Hanson Professional Services Inc.

POTENTIOMETRIC SURFACE MAP

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0007

FIGURE NO. E-9

I:\19jobs\19E0002\Admin\14-Reports\FIG_B1PZ20180322_20190118.srf

SCALE: 1 in. = 135 ft.

0 ft. 100 ft. 200 ft. 300 ft. 400 ft.

CONTOUR INTERVAL = 1 ft.

HANSON
Hanson Professional Services Inc.

POTENTIOMETRIC SURFACE MAP

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0007 FIGURE NO. E-10

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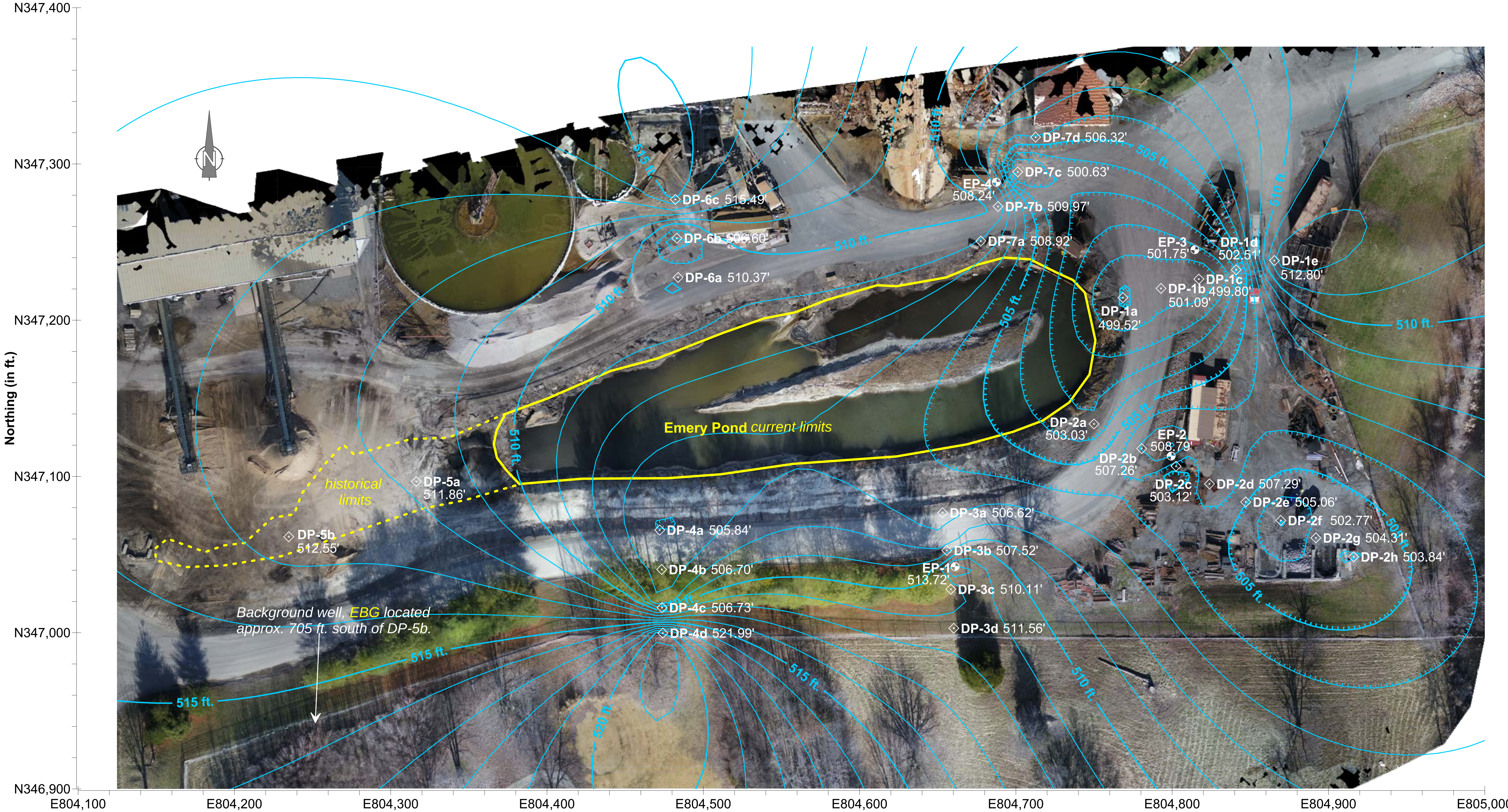

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EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Water levels taken 27 Feb to 1 Mar 2019.

SCALE: 1 inch equals 60 feet

0 ft. 60 ft. 120 ft. 180 ft. 240 ft.

HANSON
Hanson Professional Services Inc.

Potentiometric Surface Map - 1 March 2019

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE NO. E-11

APPENDIX E

Hydrogeologic Investigation Addendum

Emery Pond

Hydrogeologic Investigation Addendum

Marion Power Plant
Southern Illinois Power Cooperative
Marion, Williamson County, Illinois

July 9, 2019

HANSON
Engineering | Planning | Allied Services

Table of Contents

Figures and Tables

Figures

Tables

Abbreviations

B-R – Bouwer and Rice
CFR – Code of Federal Regulations
$cm^3/cm^2/sec$ – cubic centimeters per square centimeters per second (see also cm/s)
cm/sec – centimeters per second (simplification of $cm^3/cm^2/sec$)
(dim) – Dimensionless
EPA – Environmental Protection Agency
ft. – feet
ft^2 – square feet
GPD – Gallons per day
GPM – Gallons per minute
IAC – Illinois Administrative Code
KGS – Kansas Geological Survey

1. Introduction

Southern Illinois Power Cooperative (SIPC) submitted documentation prepared by Hanson Professional Services Inc. (Hanson) to the Illinois Environmental Protection Agency Bureau of Water in response to a Violation Notice (No. 6364 dated July 3, 2018) for groundwater exceedances at the Emery Pond (Site). The Bureau of Water provided review comments in a letter SIPC received on June 6, 2019. This report provides a response to Comment 1 regarding the interpretation of Class I versus Class II groundwater [35 IAC 620.210-220] at the Site.

2. Site Hydrogeology

The site is located in the Shawnee Hills section within the Interior Low Plateaus (physiographic) Province (Leighton et al., 1948). Site geology consists of glacially-derived deposits of the Illinoisan Stage overlying Pennsylvanian Age bedrock. Table 1 list the hydro- and litho-stratigraphic units with their descriptions located within 50 feet of the surface at the Site (Willman et al., 1995 and Berg & Kempton, 1988).

Table 1. Site Geologic/Hydrogeologic Units

Litho-stratigraphic Unit	Hydro-stratigraphic Unit	Lithologic Description
Peoria/Roxana Silt	Unlithified Unit	light yellow-tan to gray, fine sandy silt
Glasford Formation (undifferentiated)		silty/sandy diamictons with thin lenticular bodies of silt, sand, and gravel
Caseyville Formation	Bedrock Unit	primarily sandstone with shales

The Emery Pond appears to have been constructed on the Bedrock Unit, with the current pond footprint being relatively flat (elevation 505 ft. on the east and west sides to 507 ft. in the middle) with rather sharp elevation changes within the historical footprint (502 ft. to 510 ft. as depicted in Figure 11 of the Hydrogeologic Investigation Report (Hanson, 2019a). The original groundwater monitoring wells for the Site are screened to monitor the Unlithified Unit adjacent to the Emery Pond.

The Unlithified Unit only has a few feet (3-5 ft.) of saturated thickness, and Hanson's March 2019 evaluation of the hydraulic conductivity indicated that the Unlithified Unit had hydraulic conductivity values lower than 1×10^{-4} $cm^3/cm^2/sec$ at all four of the detection monitoring wells (EP-1, EP-2, EP-3 and EP-4). The Illinois EPA, relying on the Holcomb Foundation Engineering Company's (Holcomb) earlier interpretation of the slug test data, indicated in Comment 1 that the groundwater at EP-1 and EP-4 should be classified as Class I: Potable Resource Groundwater. During June 2019, Hanson further investigated the Site and installed two new monitoring wells adjacent to existing wells EP-1 and EP-4. With this additional information, Hanson continues to interpret the Unlithified Unit as containing Class II: General Resource Groundwater.

3. New Monitoring Wells

On June 10, 2019, Hanson and Holcomb mobilized to the Site to collect additional soil data and install two new monitoring wells adjacent to EP-1 and EP-4 (see Figure 1). For reference, the Boring Logs with well details for the original (AECOM) and new (Hanson) monitoring wells are located in Appendix A.

EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

SCALE: 1 inch equals 60 feet

0 ft. 60 ft. 120 ft. 180 ft. 240 ft.

HANSON
Hanson Professional Services Inc.

Monitoring Well Location Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE NO. 1

3.1 Monitoring Well EP-1a

Hanson believed that EP-1a was necessary because of the well construction of EP-1, which was drilled 15 feet into the Bedrock Unit. Additionally, the filter pack extends 13 feet above the top of the screen for a total filter pack length of 23 feet. The Illinois Water Well Code [77 IAC 920] limits the filter pack to only 2 feet above the top of the screen [77 IAC 920.170(c)(2)]. This excessive filter pack also cross connects groundwater from the Unlithified Unit with the Bedrock Unit. The grouting requirements of the Water Well Code [77 IAC 920.170(d)] requires that migration of fluids from one zone to another be prevented.

EP-1a was drilled and installed at a depth of approximately 16.5 ft. with a 5-foot screen. The bottom of the well is about 1-foot into the Bedrock Unit, and the filter pack extends about 1.5 ft. above the screen.

3.2 Monitoring Well EP-4a

The well construction of EP-4 does conform to 77 IAC 920.170. The issue at this location was to confirm the lithology found during the installation of EP-4 and to collect soil samples for testing.

EP-4a was drilled and installed at a depth of approximately 17 ft. with a 5-foot screen. The bottom of the well is about 1-foot into the Bedrock Unit, and the filter pack extends about 1.25 ft. above the screen.

4. Hydraulic Conductivity Testing

4.1 Horizontal Hydraulic Conductivity Testing

The day after the well installation, EP-4, EP-4a, and EP-1a were slug tested to obtain hydraulic conductivity values. Table 2 summarizes the results of the various hydraulic conductivity testing (Hanson, 2019b) at the Site. The most recent slug test results are located in Appendix B.

Table 2. Slug Test Results

Well ID	Testing Company	Method	Falling Head ($cm^3/cm^2/sec$)	Rising Head^ ($cm^3/cm^2/sec$)	Average ($cm^3/cm^2/sec$)	Geometric Mean ($cm^3/cm^2/sec$)
EP-1	Holcomb	B-R	2.36×10^{-4}			
EP-1	Hanson	B-R	2.80×10^{-5}	3.45×10^{-5}	3.13×10^{-5}	3.11×10^{-5}
EBR*	Hanson	Packer			1.72×10^{-5}	1.68×10^{-5}
EP-1a	Hanson	KGS	7.60×10^{-5}	7.50×10^{-6}	7.55×10^{-6}	7.55×10^{-6}
EP-4	Holcomb	B-R	2.63×10^{-4}			
EP-4	Hanson	B-R	3.30×10^{-5}	3.25×10^{-5}	3.28×10^{-5}	3.27×10^{-5}
EP-4	Hanson	KGS	1.10×10^{-4}	9.10×10^{-6}	5.96×10^{-5}	3.16×10^{-5}
EP-4a	Hanson	KGS	1.40×10^{-3}	9.40×10^{-4}	1.17×10^{-3}	1.15×10^{-3}

^ Rising head test data for EP-1a failed to record. Result is a second falling head test.
* Depth of EBR Packer Test at 26.2 ft. is equivalent to the depth of the screen (in the sandstone) at EP-1.

Hanson selected the Kansas Geological Survey Model (Hyder et al., 1994) for the slug test analyses. The KGS Model uses curve matching over the entire test dataset and not just the second (transitional) portion of the data curve (referred to as the Double Straight Line Effect) as the Bouwer and Rice (1976 and Bouwer, 1989) Method requires. This match to the entire data curve is less subjective than the straight-line fit to the relevant portion of the data curve of the B-R Method and reduces the variability in results by the analyst, as seen in the hydraulic conductivity values calculated by Holcomb and Hanson using the same datasets for EP-1 and EP-4. Other interpretive issues could arise if the analyst only relies on the original Bouwer and Rice (1976) paper. Bouwer (1989) explains that there were two problems with 1976 paper, 1) it said the fit line should match the first or steepest part of the data curve, resulting in a much higher hydraulic conductivity value, and 2) an equation to estimate the slug test duration had an error that underestimated the time the test should take, that could create an insufficient dataset.

Comparison of different tests methods at EP-1 appear to indicate that Hanson's Bouwer-Rice results were similar to the bedrock packer test (Sevee, 1991) done at boring EBR (results at 26.2 ft. or elevation 484.1 ft. were in the low-10^{-5} range). The packer test is a calculation with no interpretation. The results at EP-1a are more representative of what would be expected of a well screened in the unlithified materials found at the Site. Hydraulic conductivity results at EP-1a were found in the high-10^{-6} range, well below the Class I groundwater requirement of 1×10^{-4} $cm^3/cm^2/sec$. This means that 4 of the 5 monitoring wells had hydraulic conductivity test results of less than 1×10^{-4} $cm^3/cm^2/sec$, as identified in 35 IAC 620.210(a)(4)(B).

4.2 Vertical Hydraulic Conductivity Testing

As part of the new monitoring well installations, thin-wall (Shelby) tube samples were collected at representative depths at each well location. The upper samples (6-8 ft. depth at both locations) were taken to evaluate possible infiltration rates for potential groundwater modeling and the deeper samples (12-14 ft. at EP-1a and 14-16 ft. at EP-4a) were collected to evaluate potential anisotropy in the water bearing zone. Table 3 lists the results of the laboratory testing following ASTM D5084. The complete Holcomb laboratory report is located in Appendix C.

Table 3. Permeameter Test Results

Well ID	Depth (ft.)	Avg. Hydraulic Conductivity ($cm^3/cm^2/sec$)
EP-1a	6.5 – 7.0	6.91×10^{-8}
EP-1a	13.0 – 13.5	1.02×10^{-7}
EP-4a	7.5 – 8.0	5.52×10^{-8}
EP-4a	14.0 – 14.5	no test

The deep sample from EP-4a was unable to be tested. The sample contained several sandstone cobbles, likely placed during the fill process during plant construction. The presence of these sandstone cobbles may be related to why the horizontal hydraulic conductivity values observed during the slug tests at these wells are higher than the values observed during slug testing of the adjacent EP-4.

The vertical hydraulic conductivity results indicate there is anisotropy with respect to groundwater flow within the unlithified materials overlying bedrock. This anisotropy limits vertical recharge of surface water and/or precipitation through these materials. Hanson believes that recharge of the Unlithified Unit occurs in and around the area of the gypsum loadout where more permeable bottom ash is found directly above the Bedrock Unit. This anisotropy may also be related to why several of the extent of contamination study borings were unable to make water.

The observed anisotropy between horizontal and vertical hydraulic conductivity is typically observed in bedded geologic materials. However, anisotropy can also be associated with different flow mechanisms in fine-grained materials (e.g., fractures, piping, etc.) (Ohio EPA, 2006). At 1- to 2-orders of magnitude difference between horizontal and vertical hydraulic conductivities, the Hanson horizontal hydraulic conductivity results should be considered more representative.

5. Simulation of a Pumping Test

Along with slug testing the monitoring wells to evaluate the local hydraulic conductivity, Hanson has also prepared a pump test model to evaluate the criteria of 35 IAC 620.210(a)(4)(A). The pump test model evaluates several site-specific parameters relative to the requirement of sustained pumping of 150 gallons per day from a 12-inch diameter borehole from a thickness of 15 feet or less. Hanson used a finite-difference model created by P-Squared Technologies, Inc. (P^2, 1996) that is based on Rathod and Rushton (1984). Table 4 lists the input parameters for the pump test simulation and Table 5 presents input changes made for sensitivity analyses. Simulation output files are located in Appendix D.

Table 4. Model Input Parameters

Parameter	Value	Model Input	Description
Aquifer horiz. K	3 x 10^{-3} cm/s	0.636 GPD/ft^2	Maximum value from slug tests in geologic materials
Aquifer vert. K	3 x 10^{-5} cm/s	0.00636 GPD/ft^2	Horizontal versus vertical hydraulic conductivity
Base of Aquifer	15 ft.	15 ft.	Values combine to represent site-specific values. Maximum water level measure in wells was approximately 10 ft., with only about 5 ft. of saturated thickness observed during drilling.
Top of Aquifer	10 ft.	10 ft.	
Initial Water Level	5 ft.	5 ft.	
Well Radius	6 in.	0.5 ft.	Per 35 IAC 620.210(a)(4)(A)
Production Rate	150 GPD	0.10417 GPM	Per 35 IAC 620.210(a)(4)(A)
Aquifer Storativity	0.001 (dim)	0.001 (dim)	Default value in model
Artesian Storativity	0.001 (dim)	0.001 (dim)	Default value in model
Aquifer Type	none	Semi-confined	Site-specific interpretation

Table 5. Model Sensitivity Parameters

Parameter	Base-line Value	Sensitivity Value	Change(s)
Aquifer Type	Semi-confined	Unconfined	Nominal (Δh = -0.42 ft.) and simulation terminated at 573 min.
Aquifer Parameter	Anisotropic hK <> vK	Isotropic hK = vK	Nominal (Δh = -0.24 ft.) and simulation terminated at 573 min.
hK and vK	0.636 & 0.00636 GPD/ft^2	2.12* & 0.0212 GPD/ft^2	Well pumped 150 GPD for a full day
Aquifer Thickness	10 ft.	15 ft.	Small (Δh = 1.58 ft.) and simulation terminated at 909 min.

* 2.12 GPD/ft^2 = 1.0 x 10^{-4} cm/s.

The simulations show that for most of the sensitivity changes the model was not particularly sensitive, with simulations terminating for excess drawdown at some time less than 1,440 minutes (1 day). The model was more sensitive to changes in horizontal hydraulic conductivity, with the model pumping 150 gallons in the 1,440 minute (1 day) model period for the hK = 1 x 10^{-4} cm^3/cm^2/sec scenario. Based on the findings of the pump test simulation modeled with site-specific inputs, Hanson confirms that shallow groundwater in the Unlithified Unit at the Site cannot sustain a pumping rate of 150 GPD and therefore is Class II: General Resource Groundwater.

A pump test simulation was also performed to evaluate the Bedrock Unit. Hanson found that from a 12-inch diameter borehole, 15 ft. thick, with a geometric mean hydraulic conductivity of 3.1 x 10^{-5} cm/s (from the interval of 21.5 to 51.5 ft. in boring EBR) the simulation was incapable of sustaining a 150 GPD pumping rate. Therefore, although the groundwater associated with the Bedrock Unit is Class I: Potable Resource Groundwater, the shallower portions of the Bedrock Unit should not be considered an aquifer.

6. Groundwater Classification

Hanson has found that that 4 of the 5 monitoring wells monitoring the Unlithified Unit had hydraulic conductivity test results of less than 1 x 10^{-4} cm^3/cm^2/sec. The exceptions were EP-4 and EP-4a. Both wells had results greater than 1 x 10^{-4} cm^3/cm^2/sec. However, Hanson has found that test results from EP-3, EP-4, and EP-4a are not germane to groundwater classification, since all three wells are screened in man-made or fill materials. The US Geological Survey (USGS) does not consider fill[†] to be a geologic material (see Soller, 2009).

The Illinois Groundwater Quality Rules [35 IAC 620.110] equate the terms aquifer and groundwater with the phrase “saturated geological materials”.

> “Aquifer” means saturated (with groundwater) soils and geologic materials which are sufficiently permeable to readily yield economically useful qualities of water to wells, springs, or streams under ordinary hydraulic gradients [415 ILCS 55/3(b)]
>
> “Groundwater” means underground water which occurs within the saturated zone and geologic materials where the fluid pressure in the pore space is equal to or greater than atmospheric pressure. [415 ILCS 5/3.210]

35 IAC 620.210 goes further and requires that Class I: Potable Resource Groundwater be in a “geologic material” [35 IAC 620.210(a)(4)]. Therefore, based on the hydraulic conductivity results of wells screened in unlithified geologic materials and other wells screened in fill or made land, none of the shallow groundwater at the Emery Pond is Class I: Potable Resource Groundwater as defined in 35 Ill. Adm. Code 620.210(a). Therefore, all groundwater found within the Unlithified Unit at the Site is Class II: General Resource Groundwater.

[†] Other Materials identified by USGS are “rock and sediment (undifferentiated)”, “rock (undifferentiated)”, “made or human-engineered land”, “water or ice”, and “unmapped areas” (Soller, 2009).

7. Conclusion

Hanson has installed two additional monitoring wells to provide a better interpretation of groundwater at the Site. The new wells were installed to 1) provide an evaluation of the Unlithified Unit at the Site (EP-1a) and 2) provide additional hydraulic conductivity data (EP-1a and EP-4a). From this additional information, Hanson reaches the following conclusions:

1. EBG, EP-1, and EP-3 were improperly installed to evaluate groundwater solely from the Unlithified Unit.

2. Hanson's original evaluation of the hydraulic conductivity at EP-1 more closely matches the bedrock packer test data from EBR at an equivalent depth.

3. New hydraulic conductivity data was obtained from EP-1a using a slug test solution method less prone to variation in user analysis (i.e., the line fit used in B-R method versus the curve match in KGS method).

4. The Emery Pond does not lie within the minimum setback zone of a potable water supply well per 35 IAC 620.210(a)(1). The nearest potable water well is at the Lake of Egypt Country Club, over 2,400 feet away from the Emery Pond.

5. The Unlithified Unit does not contain sands and gravels greater than or equal to 5 ft. thick per 35 IAC 620.210(a)(2), and does not contain sandstone greater than or equal to 10 ft. thick or fractured carbonate rock greater than or equal to 15 ft. thick per 35 IAC 620.210(a)(3).

6. EP-3, EP-4, and EP-4a are constructed in "human-engineered land" or fill which cannot contain "groundwater" as defined in 35 IAC 620.110.

7. The hydraulic conductivity results obtained from EP-1a and EP-2, are less than 1×10^{-4} $cm^3/cm^2/sec$, and indicates groundwater at the Site is Class II: General Resource Groundwater per 35 IAC 620.210(a)(4)(B).

8. A pump test simulation, using site-specific input parameters, further confirms that the Unlithified Unit groundwater at the Site should be classified as Class II: General Resource Groundwater per 35 IAC 620.210(a)(4)(A).

9. Based on the definitions of "aquifer" and "groundwater" found at 35 IAC 610.110, an aquifer contains groundwater, but not all strata that contain groundwater are aquifers. The latter describes groundwater found within the Unlithified Unit and the upper Bedrock Unit at the Site (above elevation 450 ft. NVGD), further supporting the conclusion that there is no aquifer as defined by 40 CFR 257.2.

8. Licensed Professional Signature/Seal

The geological work product contained in this document has been prepared under my personal supervision and has been prepared and administered in accordance with the standards of reasonable professional skill and diligence.

Rhonald W. Hasenyager, P.G.
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, IL 62703-2886
(217) 788-2450
Registration No. 196-000246

Seal:

Expires 31 March 2021

Signature: ______________________ Date: 9 July 2019

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Appendix A

Boring Logs with Well Construction Details

Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EP-1

Sheet 1 of 1

Date(s) Drilled and Installed	**2/7/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**31.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**519.72 ft, msl** **517.07 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347042.306 ft** **804661.174 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: % Recovery	USCS Code	MATERIAL DESCRIPTION
	0	NR	Topsoil	Black TOPSOIL, moist
		NR	CL	Brownish tan silty CLAY, moist, medium plasticity (CL)
	5	NR		
510		NR		becomes orangish with trace coarse sand and gravel, with rust colored mottles
	10	NR		becomes very stiff
		NR		becomes medium-stiff, low plasticity
	15	NR	ML	Brownish tan to oragne clayey SILT, trace gravel and rust colored mottles, stiff, non-plastic, moist (ML)
500		NR	SP	Red orange SAND with orange-brown silty clay, moist (SP)
	20	NR	SNDSTN	SANDSTONE, with interbedded limestone and shale
		NR		
	25	NR		
490		NR		
	30	NR		
	35			Boring terminated at 31.0 ft. bgs on 2/7/2017. Monitoring well installed to 31.0 ft. bgs on 2/7/2017. NR = Not Recorded

WELL CONSTRUCTION DETAILS

Riser with protective casing and locking cap
Concrete
Bentonite Chips
Filter Sand
2.0" diameter SCH 40 PVC Riser
2.0" diameter SCH 40 PVC, 0.010" Slotted Screen

AECOM

Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

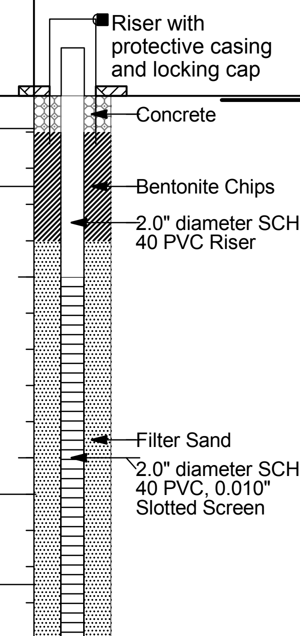
Log of EP-2

Sheet 1 of 1

Date(s) Drilled and Installed	**2/7/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**15.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**513.79 ft, msl** **511.15 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347113.029 ft** **804799.408 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	SAMPLES: Sample Interval	SAMPLES: % Recovery	USCS Code	USCS Graphic Symbol	MATERIAL DESCRIPTION
	0		NR	Fill		Asphalt and GRAVEL (FILL)
510			NR	CL		Brown to tan silty CLAY, medium stiff, moist (CL)
						brown to tan silty CLAY, soft to medium, medium to high plasticity, moist (CL)
	5		NR	CL		medium plasticity, with rust color oxidation, trace sand and gravel
			NR			
	10		NR			
500			NR	ML		Tan clayey SILT, stiff, low plasticity, moist (ML)
			NR	SNDSTN		SANDSTONE
	15					Boring terminated at 15.0 ft. bgs on 2/7/2017. Monitoring well installed to 15.0 ft. bgs on 2/7/2017. NR = Not Recorded
	20					
490						
	25					
	30					
480						
	35					

WELL CONSTRUCTION DETAILS



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AECOM

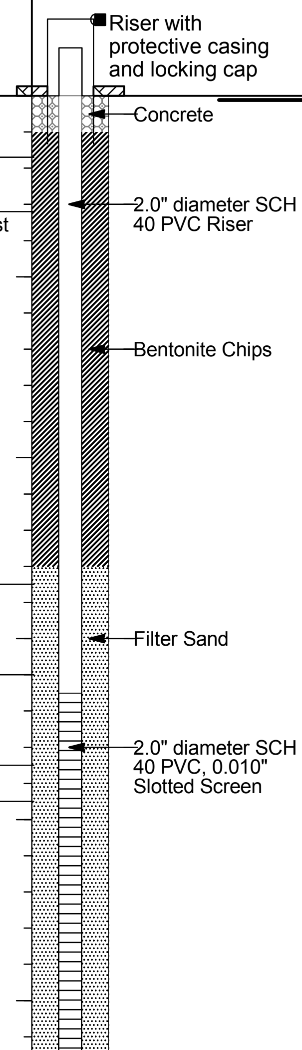
Client: Southern Illinois Power Cooperative
Project Name: SIPC Marion CCR
Project Location: SIPC Marion
Project Number: 60535846

Log of EP-3

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**26.5 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**518.95 ft, msl** **518.95 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**347245.08 ft** **804814.534 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0		NR	Fill	GRAVEL (FILL)
			NR	ML	Brown clayey SILT, moist (ML)
	5		NR	CL	Olive green to gray silty CLAY, trace sand, medium, low to medium plasticity, moist (CL)
510	10		NR		2 inch layer of cinders, clay becomes tan-brown
			NR		becomes loose, moist, brown/gray/tan, with gravel, some sand and cinders
	15		NR	ML	Light gray to tan clayey SILT, stiff, low plasticity, moist (ML)
			NR	ML	Gray SILT, trace clay, stiff, non-plastic, moist (ML)
500			NR	CL	Gray silty CLAY with yellow-gold gypsum, moist to wet (CL)
	20		NR	SNDSTN	SANDSTONE
			NR		
	25		NR		
			NR		
490	30				Boring terminated at 26.5 ft. bgs on 2/8/2017. Monitoring well installed to 26.5 ft. bgs on 2/8/2017. NR = Not Recorded
	35				

WELL CONSTRUCTION DETAILS

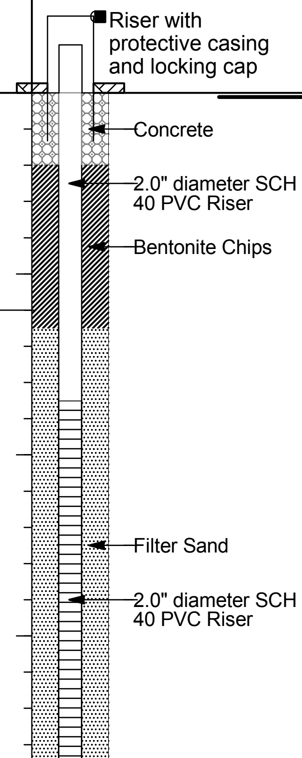


Client: Southern Illinois Power Cooperative	Log of EP-4
Project Name: SIPC Marion CCR	Sheet 1 of 1
Project Location: SIPC Marion	
Project Number: 60535846	

Date(s) Drilled and Installed	2/8/2017	Logged By	Suzanne Dale	Reviewed By	
Drilling Method	Hollow Stem Auger	Drilling Contractor	Holcomb Engineering	Total Depth of Borehole	18.5 feet, bgs
Sampling Method	Split Spoon	Water Level TOIC	Not measured	TOC Elevation / Ground Surface	519.74 ft, msl / 517.07 ft, msl
Size and Type of Well Casing	2-Inch Schedule 40 PVC	Screen Perforation	0.010 - inch	Northing (Plant) / Easting (Plant)	347288.297 ft / 804687.527 ft
Seal or Backfill	Bentonite Chips				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0		NR	Fill	GRAVEL, sand, silt (FILL)
			NR	Fill	old abandoned pipe
	5		NR	Fill	
510			NR	CL	Brown silty CLAY with some gravel, high plasticity, moist to wet (CL)
	10		NR	CL	
			NR	CL	becomes brown-gray, with some layering of black fine sand, high plasticity
	15		NR	CL	becomes wet becomes tan-gray, moist to wet, high plasticity
500			NR	CL	becomes brown/tan/gray, trace fine sand
			NR	Shale	SHALE, gray
	20				Boring terminated at 19.5 ft. bgs on 2/8/2017. Monitoring well installed to 18.5 ft. bgs on 2/8/2017. NR = Not Recorded
	25				
490					
	30				
	35				

WELL CONSTRUCTION DETAILS



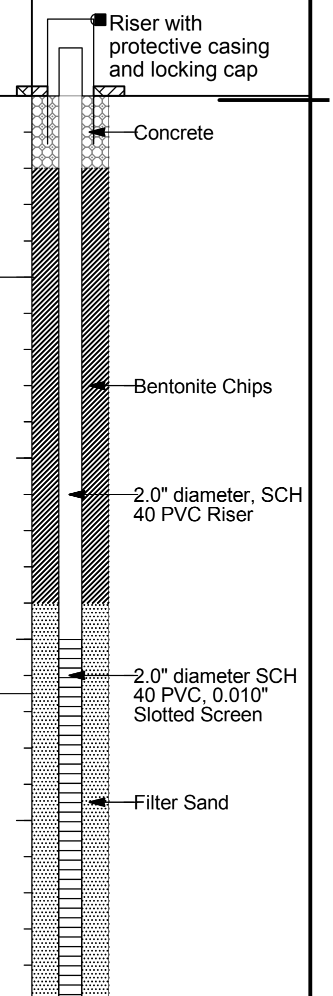
AECOM

Client: Southern Illinois Power Cooperative **Project Name: SIPC Marion CCR** **Project Location: SIPC Marion** **Project Number: 60535846**	**Log of EBG** Sheet 1 of 1

Date(s) Drilled and Installed	**2/8/2017**	Logged By	**Suzanne Dale**	Reviewed By	
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**Holcomb Engineering**	Total Depth of Borehole	**25.0 feet, bgs**
Sampling Method	**Split Spoon**	Water Level TOIC	**Not measured**	TOC Elevation Ground Surface	**524.87 ft, msl** **521.74 ft, msl**
Size and Type of Well Casing	**2-Inch Schedule 40 PVC**	Screen Perforation	**0.010 - inch**	Northing (Plant) Easting (Plant)	**346358.14 ft** **804168.155 ft**
Seal or Backfill	**Bentonite Chips**				

Elevation, feet msl	Depth, feet bgs	Sample Interval	% Recovery	USCS Code	MATERIAL DESCRIPTION
	0	X	NR	ML	Brownish tan, clayey SILT, stiff, non-plastic, moist (ML)
520		X	NR		
	5			CL	Brownish tan silty CLAY, very soft, medium to high plasticity, moist (CL)
		X	NR		becomes low to medium plasticity
	10	X	NR		with black fines
510		X	NR		becomes brown/orange/gray, trace black fines, low plasticity
	15	X	NR		trace rust colored oxidation with red mottling
		X	NR	SHALE	SHALE, gray
	20	X	NR		
500		X	NR		
		X	NR		
	25				Boring terminated at 25.0 ft. bgs on 2/7/2017. Monitoring well installed to 25.0 ft. bgs on 2/7/2017. NR = Not Recorded
	30				
490					
	35				

WELL CONSTRUCTION DETAILS



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AECOM

HANSON

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KEY TO SYMBOLS

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

ASPHALT	ASHPALT
BASALT	BASALT
BLDRCBBL	BOULDERS AND COBBLES
BRECCIA	BRECCIA
CH	HIGH PLASTICITY CLAY
CL	LOW PLASTICITY CLAY
COAL	COAL
CONC.	CONCRETE
FILL	FILL
GC	CLAYEY GRAVEL
GM	SILTY GRAVEL
GPS	SANDY GRAVEL
GP	POORLY GRADED GRAVEL
GW	WELL GRADED GRAVEL
LIMESTONE	
MH	ELASTIC SILT
ML	SILT
OH	HIGH PLASTICITY ORGANIC SILT
OL	LOW PLASTICITY SILT
PT	PEAT
SANDSTONE	
SC	CLAYEY SAND
SHALE	
SILTSTONE	
SM	SILTY SAND
SP	POORLY GRADED SAND
SW	WELL GRADED SAND
TILL	GLACIAL TILL
TOPSOIL	

SAMPLER SYMBOLS

- GRAB / AUGER CUTTINGS HAND AUGER [AUG or HA]
- SPLIT SPOON / SPT [SS]
- SHELBY TUBE [SH]
- ROCK CORE [RC]
- CONTINUOUS OR MACROSAMPLER [CS or DP]
- BLIND DRILL [BD]
- MODOFIED CALIFORNIA SAMPLER [MC]

WELL SYMBOLS

- CONCRETE SURFACE SEAL
- HIGH-SOLIDS BENTONITE GROUT
- BENTONITE CHIP SEAL
- SAND PACK W/SOLID RISER
- SAND PACK W/SCREEN

ABBREVIATIONS

LL	-	Liquid Limit (%)
PL	-	Plastic Limit (%)
woh	-	Weight of Hammer
wor	-	Weight of Rods
MaxGS	-	Maximum Grain Size
<#200	-	Percent Passing No. 200 Sieve
NP	-	Non-Plastic
Qu	-	Unconfined Compressive Strength (tsf)
Qp (P)	-	Pocket Penetrometer
TV	-	Torvane
PID	-	Photoionization Detector
ppm	-	Parts per Million

GROUNDWATER LEVELS

- Level during drilling, or as indicated
- Level after 24 hours, or as indicated
- Level as indicated

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 6/10/2019
Finish: 6/10/2019
WEATHER: Ptly. Cloudy, mild (mid 70's)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model: CME 750X ATV Drill
Drilling Method: 3¼" HSA with SPT

FIELD STAFF: Driller: J Carter
Helper: D Plucker
Eng/Geo: R. Hasenyager

BOREHOLE ID: EP1a
Well ID: EP1a
Surface Elev: 516.58 ft. MSL
Completion: 16.44 ft. BGS
Station: 347,045.80N
804,657.41E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
▽ = 10.50 - during drilling
▼ = Dry - in MW at completion
▼ =

SAMPLE Number	Recov / Total (in) % Recovery	Type	Blows / 6 in N - Value RQD	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) Qp (tsf) Failure Type
1A	21/24 *88%*	SS	*2-2 3-5* N=5	21.9		*2.5*
2A	22/24 *92%*	SS	*1-2 4-7* N=6	21.4		*2.0*
3A	24/24 *100%*	SS	*2-4 5-6* N=9	20.8		
ST4	24/24 *100%*	SH		18.3	112	*3.5*
5A	19/24 *79%*	SS	*2-4 7-6* N=11	22.8		*2.5*
6A	24/24 *100%*	SS	*2-3 5-7* N=8	21.2		*2.0*
ST7	24/24 *100%*	SH		20.3	105	*3.0*
8A	23/23 *100%*	SS	*4-10 21-60/5"* N=31	15.7		
8B				12.7		
	0/6 *0%*	BD				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0 – 1.0	Black (10YR2/1), moist, medium, SILT with few clay and trace sand.	516
1.0 – 10.0	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, few sand, and trace gravel.	514, 512, 510, 508
10.0 – 13.6	Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, medium, CLAY with some silt, few sand, and trace gravel.	506, 504
13.6 – 15.1	Yellowish brown (10YR5/6) with 15% gray (10YR5/1) mottles, moist, stiff, SILT with few clay and trace sand.	502
15.1 – 15.4	Yellowish brown (10YR5/4), moist, loose, very fine- to medium-grained SAND.	
15.4 – 16.1	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt, few sand, and trace gravel.	
16.1 – 16.4	Yellowish brown (10YR5/6), weathered SANDSTONE.	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16. ▽ at 10.5 ft.

End of boring = 16.4 ft.

Borehole Detail | Remarks

NOTE(S): Monitoring well EP1a installed in bore hole.

FIELD BORING LOG

HANSON

CLIENT: Southern Illinois Power Cooperative
Site: Emery Pond
Location: SIPC Marion Power Plant
Project: 18E0022A
DATES: Start: 6/10/2019
Finish: 6/10/2019
WEATHER: Ptly. Sunny, mild (lo 70's)

CONTRACTOR: Holcomb Foundation Engineering Co.
Rig mfg/model: CME 750X ATV Drill
Drilling Method: 3¼" HSA with SPT
FIELD STAFF: Driller: J Carter
Helper: D Plucker
Eng/Geo: R. Hasenyager

BOREHOLE ID: EP4a
Well ID: EP4a
Surface Elev: 517.36 ft. MSL
Completion: 18.00 ft. BGS
Station: 347,283.28N
804,686.50E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Goreville
Township: Southern
Section 26, **Tier** 10S.; **Range** 2E.

WATER LEVEL INFORMATION:
= 14.00 - during drilling
= 14.10 - in MW at completion
=

SAMPLE: Number	SAMPLE: Recov / Total (in) % Recovery	SAMPLE: Type	TESTING: Blows / 6 in N - Value **RQD**	TESTING: Water Content (%)	TESTING: Dry Density (lb/ft^3)	TESTING: Qu (tsf) Qp (tsf) Failure Type
1A	23/24 *96%*	SS	*11-14 38-18* N=52	4.0		
2A	21/24 *88%*	SS	*5-6 10-10* N=16	16.8		*4.5*, *1.5*
3A	19/24 *79%*	SS	*3-3 3-4* N=6	17.5		
ST4	20/24 *83%*	SH		18.4	111	*3.8*
5A	15/24 *63%*	SS	*1-2 2-2* N=4	22.8		*1.5*
6A	20/24 *83%*	SS	*woh-woh 1-1*	23.7		*0.0*
7A	16/24 *67%*	SS	*woh-woh 1-1*	22.4		*0.5*
ST8	9/24 *38%*	SH		18.4		*2.5*
9A	23/24 *96%*	SS	*4-5 4-10* N=9	14.2		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
0–2	Gray (10YR6/1), moist, very hard, GRAVEL with few sand and little silt [FILL]	516	
2–4	Yellowish brown (10YR5/6), moist, stiff, CLAY with some silt, few sand, and trace gravel. [FILL]	514	
4–10.8	Yellowish brown (10YR5/6), moist, medium,CLAY with some silt, few sand, and trace gravel. [FILL]	512, 510, 508	
10.8–16.2	Dark gray (10YR4/1), moist, soft, CLAY with some silt few sand, and trace gravel, bottom ash, and sandstone cobbles. [FILL]	506, 504, 502	
16.2–16.5	Yellowish brown (10YR5/8), weathered SANDSTONE.		
16.5–18	Light gray (10YR6/1), SHALE.	500	

End of boring = 18.0 ft.

NOTE(S): Monitoring well EP4a installed in bore hole.

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Williamson Well #: EP1a

Site Name: Emery Pond Borehole #: EP1a

State Plane Coordinate: X 804,657.4 Y 347,045.8 (or) Latitude: 37° 37' 7.867" Longitude: -88° 57' 11.832"

Surveyed By: ______ IL Registration #: ______

Drilling Contractor: Holcomb Foundation Engineering Co. Driller: J Carter

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: 6/10/2019 Date Finished: 6/10/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 6/14/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 15 min.

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

Installation Method: ______

Setting Time: ______

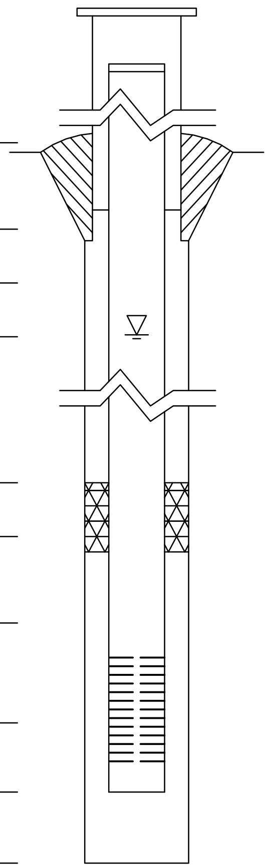
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
520.52	-3.94	Top of Protective Casing
520.02	-3.44	Top of Riser Pipe
516.58	0.00	Ground Surface
514.08	2.50	Top of Annular Sealant
512.17	4.41	Static Water Level (After Completion) 6/11/2019
n/a	n/a	Top of Seal
506.76	9.82	Top of Sand Pack
505.28	11.30	Top of Screen
500.62	15.96	Bottom of Screen
500.14	16.44	Bottom of Well
500.14	16.44	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	14.74
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	4.66
Total Length of Casing	(feet)	19.88
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Williamson Well #: EP4a

Site Name: Emery Pond Borehole #: EP4a

State Plane Coordinate: X 804,686.5 Y 347,283.3 (or) Latitude: 37° 37' 5.518" Longitude: -88° 57' 12.174"

Surveyed By: ______ IL Registration #: ______

Drilling Contractor: Holcomb Foundation Engineering Co. Driller: J Carter

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: 6/10/2019 Date Finished: 6/10/2019

Report Form Completed By: Rhonald W. Hasenyager Date: 6/14/2019

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Bentonite chips

Installation Method: Gravity

Setting Time: 15 min.

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

Installation Method: ______

Setting Time: ______

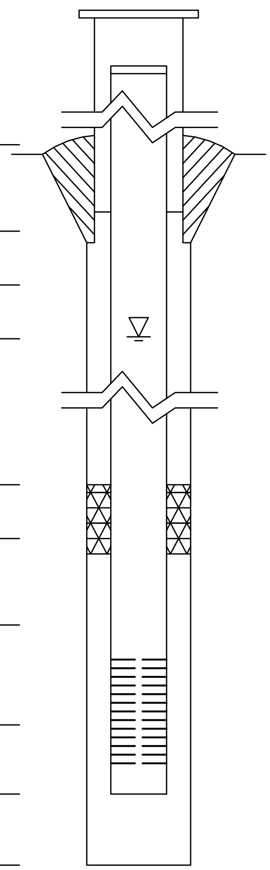
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
519.50	-2.14	Top of Protective Casing
518.93	-1.57	Top of Riser Pipe
517.36	0.00	Ground Surface
514.86	2.50	Top of Annular Sealant
511.62	5.74	Static Water Level (After Completion) 6/11/2019
n/a	n/a	Top of Seal
506.41	10.95	Top of Sand Pack
505.14	12.22	Top of Screen
500.48	16.88	Bottom of Screen
500.00	17.36	Bottom of Well
499.36	18.00	Bottom of Borehole

* Referenced to a National Geodetic Datum

CASING MEASUREMENTS

Diameter of Borehole	(inches)	8.0
ID of Riser Pipe	(inches)	2.0
Protective Casing Length	(feet)	5.0
Riser Pipe Length	(feet)	13.79
Bottom of Screen to End Cap	(feet)	0.48
Screen Length (1st slot to last slot)	(feet)	4.66
Total Length of Casing	(feet)	18.93
Screen Slot Size **	(inches)	0.010

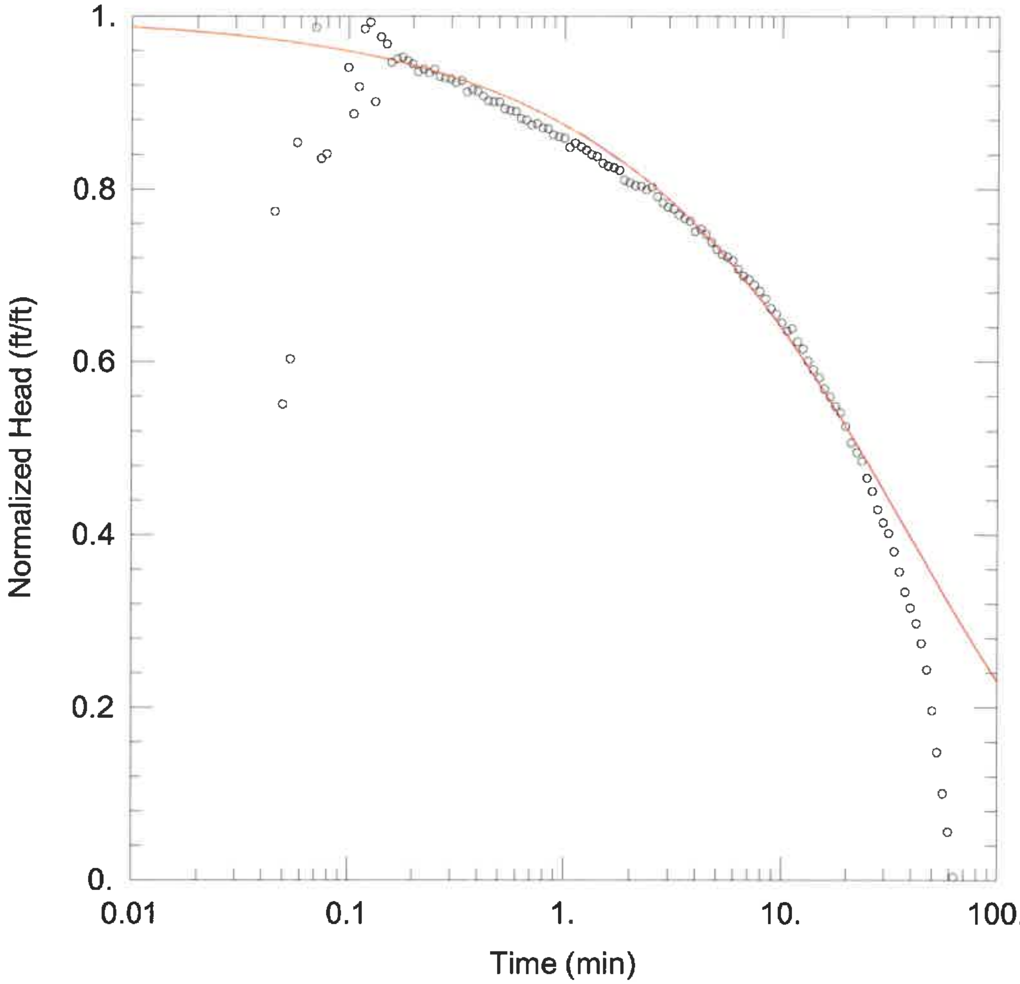
**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

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

Appendix B

Slug Test Results



EP-1A FALLING HEAD TEST

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP1a-fh.aqt
Date: 06/14/19 Time: 13:15:15

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Well: EP1a
Test Date: 11 June 2019

AQUIFER DATA

Saturated Thickness: 11.31 ft

WELL DATA (EP-1a)

Initial Displacement: 0.99 ft
Total Well Penetration Depth: 15.97 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 11.31 ft
Screen Length: 4.66 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 7.6E-6 cm/sec
Kz/Kr = 1.

Ss = 0.07 ft^{-1}

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP1a-fh.aqt
Title: EP-1a Falling Head Test
Date: 06/14/19
Time: 13:01:10

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Date: 11 June 2019
Test Well: EP1a

AQUIFER DATA

Saturated Thickness: 11.31 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP-1a

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.99 ft
Static Water Column Height: 11.31 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 1. ft
Screen Length: 4.66 ft
Total Well Penetration Depth: 15.97 ft

No. of Observations: 132

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.02083	1.619	1.5	0.821
0.025	1.531	1.58	0.818
0.02917	1.283	1.68	0.816
0.03333	1.145	1.78	0.813
0.0375	1.181	1.88	0.802
0.04167	1.262	1.99	0.799
0.04583	0.766	2.11	0.796
0.05	0.545	2.24	0.795
0.05417	0.597	2.37	0.791
0.05833	0.845	2.51	0.794
0.0625	1.024	2.66	0.783
0.06667	1.054	2.82	0.776
0.07083	0.977	2.98	0.771
0.075	0.827	3.16	0.769
0.07917	0.832	3.35	0.762
0.08333	1.061	3.55	0.758
0.0875	1.134	3.76	0.755
0.09167	1.102	3.98	0.743
0.09583	1.025	4.22	0.746

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.1	0.931	4.47	0.74
0.106	0.878	4.73	0.731
0.112	0.909	5.01	0.723
0.119	0.975	5.31	0.717
0.126	0.983	5.62	0.714
0.133	0.892	5.96	0.71
0.141	0.966	6.31	0.7
0.15	0.958	6.68	0.692
0.158	0.937	7.08	0.688
0.168	0.941	7.5	0.682
0.178	0.943	7.94	0.675
0.188	0.939	8.41	0.666
0.199	0.935	8.91	0.655
0.211	0.926	9.44	0.649
0.224	0.929	10.	0.639
0.237	0.925	10.6	0.629
0.251	0.929	11.2	0.632
0.266	0.921	11.9	0.617
0.282	0.919	12.6	0.609
0.298	0.918	13.3	0.595
0.316	0.914	14.1	0.585
0.335	0.916	15.	0.576
0.355	0.903	15.8	0.563
0.376	0.906	16.8	0.554
0.398	0.904	17.8	0.543
0.422	0.898	18.8	0.536
0.447	0.893	19.9	0.52
0.473	0.892	21.1	0.501
0.501	0.892	22.4	0.49
0.531	0.884	23.7	0.48
0.562	0.882	25.1	0.46
0.596	0.881	26.6	0.445
0.631	0.873	28.2	0.424
0.668	0.871	29.8	0.409
0.708	0.865	31.6	0.397
0.75	0.867	33.5	0.376
0.794	0.862	35.5	0.353
0.841	0.861	37.6	0.33
0.891	0.854	39.8	0.312
0.944	0.852	42.2	0.294
1.	0.85	44.7	0.271
1.06	0.839	47.3	0.241
1.12	0.844	50.1	0.194
1.193	0.84	53.1	0.146
1.26	0.836	56.2	0.099
1.33	0.831	59.6	0.055
1.41	0.829	63.1	0.003

SOLUTION

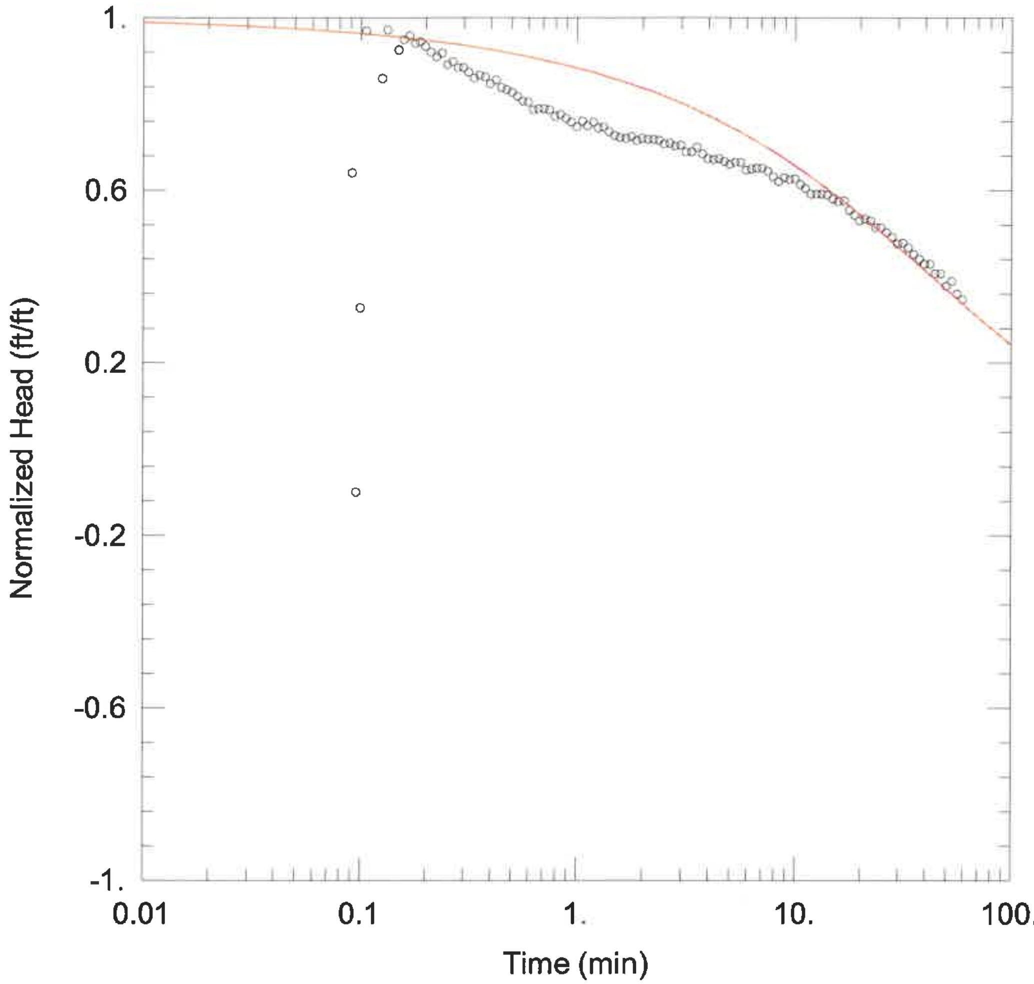
Slug Test
Aquifer Model: Confined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	9.5E-6	cm/sec
Ss	0.05	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.003275 cm^2/sec



EP-1A FALLING HEAD TEST 2

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP1a-fh2.aqt
Date: 06/14/19 Time: 13:15:17

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Well: EP1a
Test Date: 11 June 2019

AQUIFER DATA

Saturated Thickness: 11.31 ft

WELL DATA (EP-1a)

Initial Displacement: 0.45 ft
Total Well Penetration Depth: 15.97 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 11.31 ft
Screen Length: 4.66 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined

Kr = 7.5E-6 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.06 ft^{-1}

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP1a-fh2.aqt
Title: EP-1a Falling Head Test 2
Date: 06/14/19
Time: 13:01:16

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Date: 11 June 2019
Test Well: EP1a

AQUIFER DATA

Saturated Thickness: 11.31 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP-1a

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.45 ft
Static Water Column Height: 11.31 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 1. ft
Screen Length: 4.66 ft
Total Well Penetration Depth: 15.97 ft

No. of Observations: 123

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.05417	0.809	1.88	0.322
0.05833	2.237	1.99	0.324
0.0625	1.448	2.114	0.323
0.06667	0.771	2.24	0.323
0.07083	1.122	2.37	0.322
0.075	1.815	2.51	0.318
0.07917	1.743	2.66	0.319
0.08333	1.254	2.82	0.316
0.0875	0.664	2.98	0.317
0.09167	0.288	3.16	0.31
0.09583	-0.045	3.35	0.31
0.1	0.147	3.55	0.315
0.106	0.436	3.76	0.308
0.112	0.59	3.98	0.303
0.119	0.452	4.22	0.302
0.126	0.386	4.47	0.303
0.133	0.437	4.73	0.3
0.141	0.455	5.01	0.297
0.15	0.416	5.31	0.299

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.158	0.427	5.62	0.299
0.168	0.431	5.96	0.291
0.178	0.423	6.31	0.292
0.188	0.425	6.68	0.293
0.199	0.42	7.08	0.293
0.211	0.414	7.5	0.29
0.224	0.409	7.94	0.284
0.237	0.413	8.41	0.279
0.251	0.401	8.91	0.283
0.266	0.404	9.44	0.281
0.282	0.398	10.	0.282
0.298	0.398	10.6	0.276
0.316	0.393	11.2	0.272
0.335	0.387	11.9	0.266
0.355	0.39	12.6	0.266
0.376	0.388	13.3	0.266
0.398	0.381	14.1	0.265
0.422	0.385	15.	0.261
0.4485	0.377	15.8	0.258
0.473	0.375	16.8	0.259
0.501	0.372	17.8	0.249
0.531	0.368	18.8	0.244
0.562	0.363	19.9	0.238
0.596	0.362	21.1	0.24
0.631	0.354	22.4	0.238
0.668	0.355	23.7	0.231
0.708	0.355	25.1	0.231
0.75	0.354	26.6	0.226
0.794	0.347	28.2	0.221
0.841	0.349	29.8	0.214
0.891	0.345	31.6	0.215
0.9445	0.341	33.5	0.21
1.	0.336	35.5	0.203
1.06	0.342	37.6	0.198
1.12	0.337	39.8	0.193
1.195	0.341	42.2	0.193
1.26	0.335	44.7	0.183
1.33	0.336	47.3	0.183
1.41	0.331	50.1	0.17
1.5	0.327	53.1	0.175
1.58	0.325	56.2	0.162
1.68	0.324	59.6	0.156
1.78	0.326		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: KGS Model

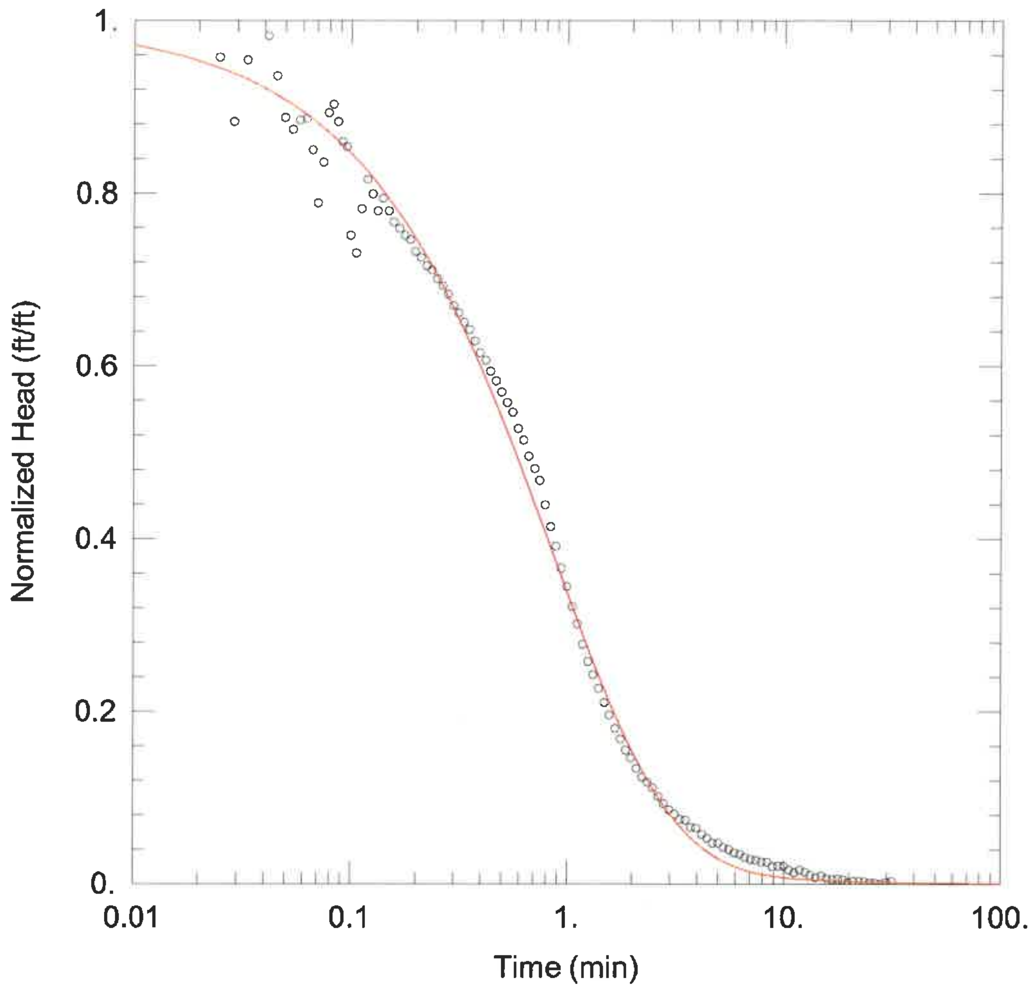
VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate

Kr	7.5E-6	cm/sec
Ss	0.06	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.002585 cm^2/sec



EP-4A FALLING HEAD TEST

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4a-fh.aqt
Date: 06/14/19 Time: 13:15:20

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Well: EP1a
Test Date: 11 June 2019

AQUIFER DATA

Saturated Thickness: 11.91 ft

WELL DATA (EP-4a)

Initial Displacement: 2.45 ft
Total Well Penetration Depth: 16.57 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 11.91 ft
Screen Length: 4.66 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.0014 cm/sec
Kz/Kr = 1.

Ss = 0.0005 ft^{-1}

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4a-fh.aqt
Title: EP-4a Falling Head Test
Date: 06/14/19
Time: 13:01:21

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Date: 11 June 2019
Test Well: EP1a

AQUIFER DATA

Saturated Thickness: 11.91 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP-4a

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.45 ft
Static Water Column Height: 11.91 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 1. ft
Screen Length: 4.66 ft
Total Well Penetration Depth: 16.57 ft

No. of Observations: 121

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.01667	2.858	1.06	0.786
0.02083	2.766	1.12	0.737
0.025	2.344	1.19	0.679
0.02917	2.162	1.26	0.63
0.03333	2.337	1.33	0.593
0.0375	2.452	1.41	0.554
0.04167	2.406	1.5	0.514
0.04583	2.292	1.58	0.479
0.05	2.174	1.68	0.441
0.05417	2.14	1.78	0.411
0.05833	2.167	1.88	0.379
0.0625	2.171	1.99	0.357
0.06667	2.082	2.11	0.327
0.07083	1.932	2.24	0.303
0.075	2.048	2.37	0.288
0.07917	2.187	2.51	0.273
0.08333	2.211	2.66	0.248
0.0875	2.162	2.82	0.227
0.09167	2.106	2.98	0.21

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.09583	2.092	3.16	0.198
0.1	1.84	3.35	0.183
0.106	1.79	3.55	0.181
0.112	1.915	3.76	0.16
0.119	1.999	3.98	0.158
0.126	1.957	4.22	0.14
0.133	1.909	4.47	0.129
0.141	1.945	4.73	0.116
0.15	1.909	5.01	0.116
0.158	1.878	5.31	0.103
0.168	1.86	5.62	0.098
0.178	1.84	5.96	0.088
0.188	1.828	6.31	0.084
0.199	1.794	6.68	0.075
0.211	1.777	7.08	0.069
0.224	1.754	7.5	0.067
0.237	1.742	7.94	0.062
0.251	1.717	8.41	0.061
0.266	1.697	8.91	0.049
0.282	1.674	9.44	0.05
0.298	1.641	10.	0.05
0.316	1.62	10.6	0.039
0.335	1.594	11.2	0.031
0.355	1.573	11.9	0.039
0.376	1.54	12.6	0.033
0.398	1.507	13.3	0.024
0.422	1.486	14.1	0.018
0.447	1.453	15.	0.022
0.473	1.426	15.8	0.015
0.501	1.394	16.8	0.012
0.531	1.364	17.8	0.013
0.562	1.337	18.8	0.011
0.596	1.291	19.9	0.003
0.631	1.258	21.1	0.008
0.668	1.213	22.4	0.007
0.7111	1.177	23.7	0.006
0.75	1.144	25.1	0.003
0.7944	1.075	26.6	0.002
0.841	1.013	28.2	0.
0.891	0.958	29.8	0.004
0.944	0.895	31.6	0.007
1.	0.843		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: KGS Model

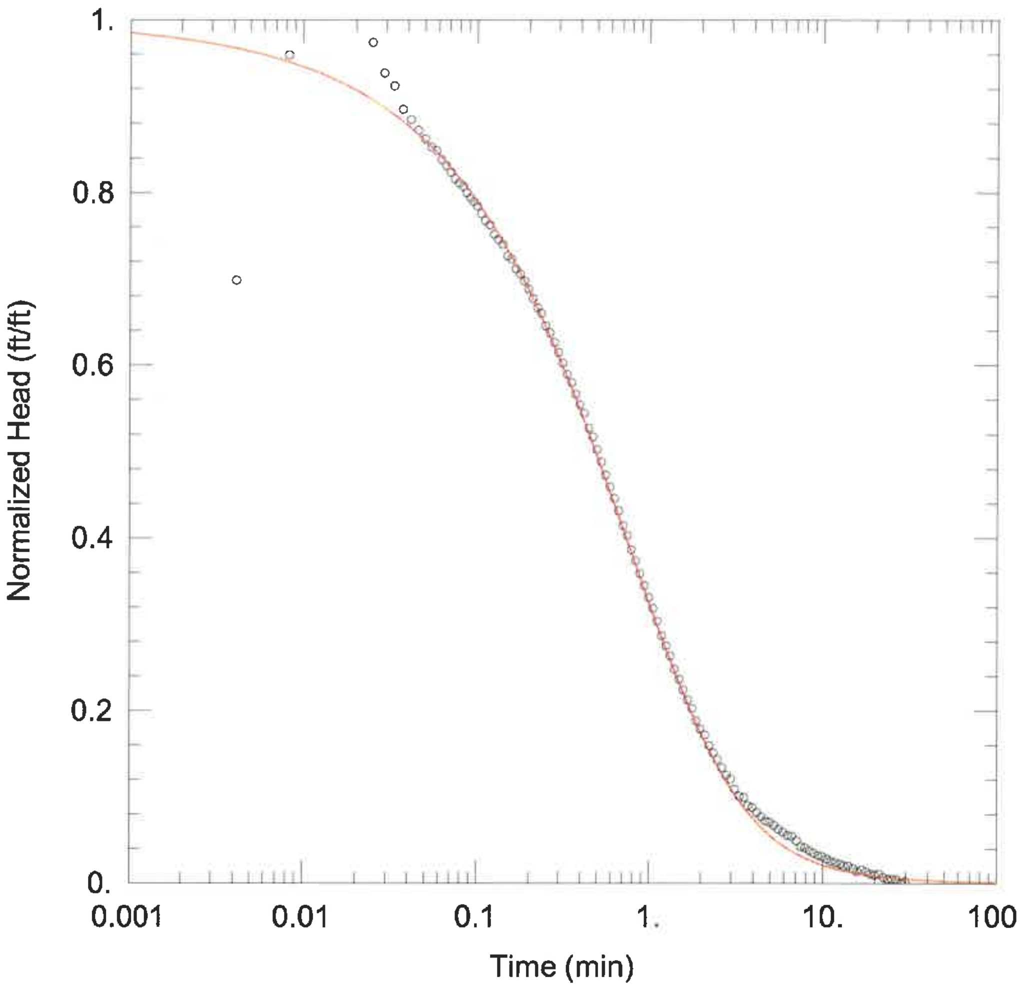
VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	0.0014	cm/sec

Ss	0.0005	ft^{-1}
Kz/Kr	1.	

$T = K*b = 0.5082\ cm^2/sec$



EP-4A RISING HEAD TEST

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4a-rh.aqt
Date: 06/14/19 Time: 13:15:23

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Well: EP1a
Test Date: 11 June 2019

AQUIFER DATA

Saturated Thickness: 11.91 ft

WELL DATA (EP-4a)

Initial Displacement: 2.08 ft
Total Well Penetration Depth: 16.57 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 11.91 ft
Screen Length: 4.66 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.00094 cm/sec
Ss = 0.007 ft^{-1}
Kz/Kr = 1.

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4a-rh.aqt
Title: EP-4a Rising Head Test
Date: 06/14/19
Time: 13:01:27

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Date: 11 June 2019
Test Well: EP1a

AQUIFER DATA

Saturated Thickness: 11.91 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP-4a

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.08 ft
Static Water Column Height: 11.91 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 1. ft
Screen Length: 4.66 ft
Total Well Penetration Depth: 16.57 ft

No. of Observations: 123

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.004167	1.452	0.944	0.717
0.008333	1.994	1.	0.688
0.01352	2.373	1.06	0.662
0.01667	2.255	1.12	0.631
0.02083	2.081	1.19	0.597
0.025	2.024	1.26	0.572
0.02917	1.951	1.33	0.547
0.03333	1.92	1.41	0.516
0.0375	1.864	1.5	0.491
0.04167	1.839	1.58	0.466
0.04583	1.814	1.68	0.442
0.05	1.793	1.78	0.421
0.05417	1.774	1.88	0.391
0.05833	1.765	1.99	0.371
0.0625	1.743	2.11	0.357
0.06667	1.728	2.24	0.332
0.07083	1.713	2.37	0.314
0.075	1.697	2.51	0.298
0.07917	1.687	2.66	0.278

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.08333	1.679	2.82	0.259
0.0875	1.663	2.98	0.251
0.09167	1.651	3.16	0.227
0.09583	1.641	3.35	0.209
0.1	1.631	3.55	0.206
0.106	1.613	3.76	0.187
0.112	1.596	3.98	0.182
0.119	1.586	4.22	0.17
0.126	1.563	4.47	0.16
0.133	1.551	4.73	0.15
0.141	1.539	5.01	0.147
0.15	1.511	5.31	0.139
0.158	1.504	5.62	0.13
0.168	1.48	5.96	0.123
0.178	1.468	6.31	0.115
0.188	1.451	6.68	0.113
0.199	1.431	7.08	0.102
0.211	1.409	7.5	0.088
0.224	1.387	7.94	0.085
0.237	1.373	8.41	0.078
0.251	1.343	8.91	0.073
0.266	1.326	9.44	0.067
0.282	1.303	10.	0.064
0.298	1.279	10.6	0.058
0.316	1.253	11.2	0.053
0.335	1.226	11.9	0.05
0.355	1.206	12.6	0.046
0.376	1.178	13.3	0.042
0.398	1.153	14.1	0.042
0.422	1.132	15.	0.035
0.447	1.097	15.8	0.028
0.473	1.076	16.8	0.032
0.501	1.045	17.8	0.027
0.531	1.015	18.8	0.022
0.562	0.983	19.9	0.02
0.596	0.955	21.1	0.022
0.631	0.927	22.4	0.014
0.668	0.897	23.7	0.01
0.7095	0.862	25.1	0.01
0.75	0.838	26.6	0.009
0.794	0.803	28.2	0.
0.841	0.777	29.8	0.004
0.891	0.746		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate

Kr	0.00094	cm/sec
Ss	0.007	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.3412 cm²/sec

AUTOMATIC ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
Kr	0.0009353	6.228E-5	+/- 0.0001233	15.02	cm/sec
Ss	0.00671	0.001498	+/- 0.002967	4.478	ft^{-1}
Kz/Kr	0.5	not estimated			

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

T = K*b = 0.3395 cm²/sec

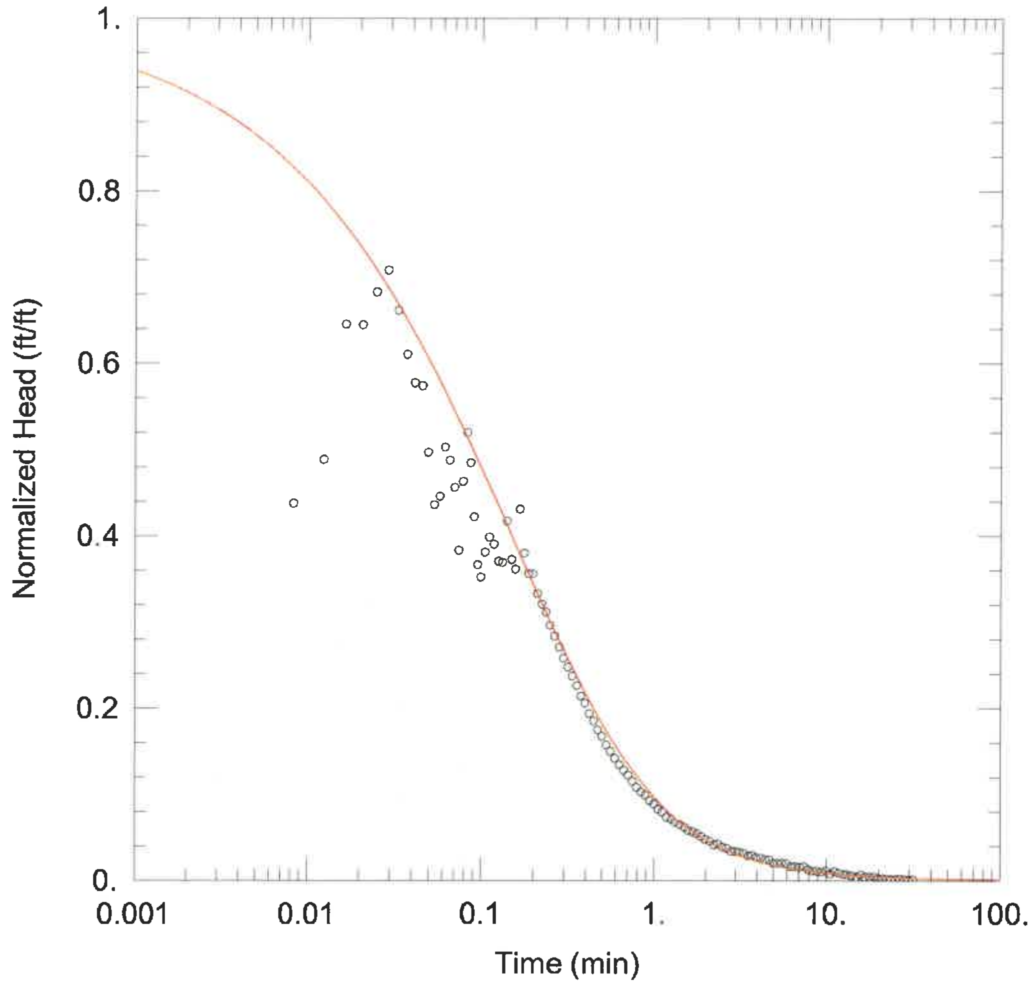
Parameter Correlations

	Kr	Ss
Kr	1.00	-0.94
Ss	-0.94	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . . . 0.6775 ft^2
Variance . . . . 0.005599 ft^2
Std. Deviation . . . . 0.07483 ft
Mean . . . . 0.005425 ft
No. of Residuals 123
No. of Estimates 2



EP-4 FALLING HEAD TEST

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4-fh.aqt
Date: 06/24/19 Time: 07:59:14

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Well: EP4
Test Date: 11 June 2019

AQUIFER DATA

Saturated Thickness: 12.72 ft

WELL DATA (EP-4)

Initial Displacement: 3.4 ft
Total Well Penetration Depth: 22.42 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 12.72 ft
Screen Length: 9.7 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 0.0011 cm/sec
Kz/Kr = 1.
Ss = 0.025 ft^{-1}

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4-fh.aqt
Title: EP-4 Falling Head Test
Date: 06/24/19
Time: 07:51:17

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Date: 11 June 2019
Test Well: EP4

AQUIFER DATA

Saturated Thickness: 12.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP-4

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.4 ft
Static Water Column Height: 12.72 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 1. ft
Screen Length: 9.7 ft
Total Well Penetration Depth: 22.42 ft

No. of Observations: 123

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.00835	1.486	1.	0.302
0.01252	1.66	1.06	0.281
0.01668	2.193	1.12	0.27
0.02085	2.191	1.19	0.25
0.02502	2.32	1.26	0.243
0.02918	2.406	1.33	0.23
0.03335	2.249	1.41	0.221
0.03752	2.075	1.5	0.21
0.04168	1.961	1.58	0.197
0.04585	1.95	1.68	0.192
0.05002	1.688	1.78	0.185
0.05418	1.481	1.88	0.173
0.05835	1.514	1.99	0.162
0.06252	1.708	2.11	0.154
0.06668	1.657	2.24	0.141
0.07085	1.549	2.37	0.144
0.07502	1.302	2.51	0.132
0.07918	1.574	2.66	0.127
0.08335	1.766	2.82	0.115

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
0.08752	1.646	2.98	0.114
0.09168	1.434	3.16	0.112
0.09585	1.245	3.35	0.106
0.1	1.196	3.55	0.098
0.106	1.294	3.76	0.099
0.112	1.353	3.98	0.09
0.119	1.325	4.22	0.089
0.126	1.259	4.47	0.083
0.133	1.254	4.73	0.081
0.141	1.417	5.01	0.069
0.15	1.265	5.31	0.068
0.158	1.227	5.62	0.069
0.168	1.464	5.96	0.066
0.178	1.292	6.31	0.055
0.188	1.21	6.68	0.055
0.199	1.21	7.08	0.052
0.211	1.132	7.5	0.055
0.224	1.09	7.94	0.043
0.237	1.058	8.41	0.039
0.251	1.007	8.91	0.037
0.266	0.964	9.44	0.033
0.282	0.92	10.	0.039
0.298	0.877	10.6	0.026
0.316	0.842	11.2	0.036
0.335	0.807	11.9	0.03
0.355	0.769	12.6	0.025
0.376	0.727	13.3	0.023
0.398	0.7	14.1	0.019
0.422	0.658	15.	0.015
0.447	0.629	15.8	0.022
0.473	0.594	16.8	0.015
0.501	0.569	17.8	0.014
0.531	0.535	18.8	0.015
0.562	0.509	19.9	0.008
0.596	0.482	21.1	0.008
0.631	0.457	22.4	0.007
0.668	0.435	23.7	0.004
0.708	0.415	25.1	0.004
0.75	0.391	26.6	0.007
0.794	0.367	28.2	0.004
0.841	0.348	29.8	0.002
0.891	0.337	31.6	0.005
0.944	0.316		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: KGS Model

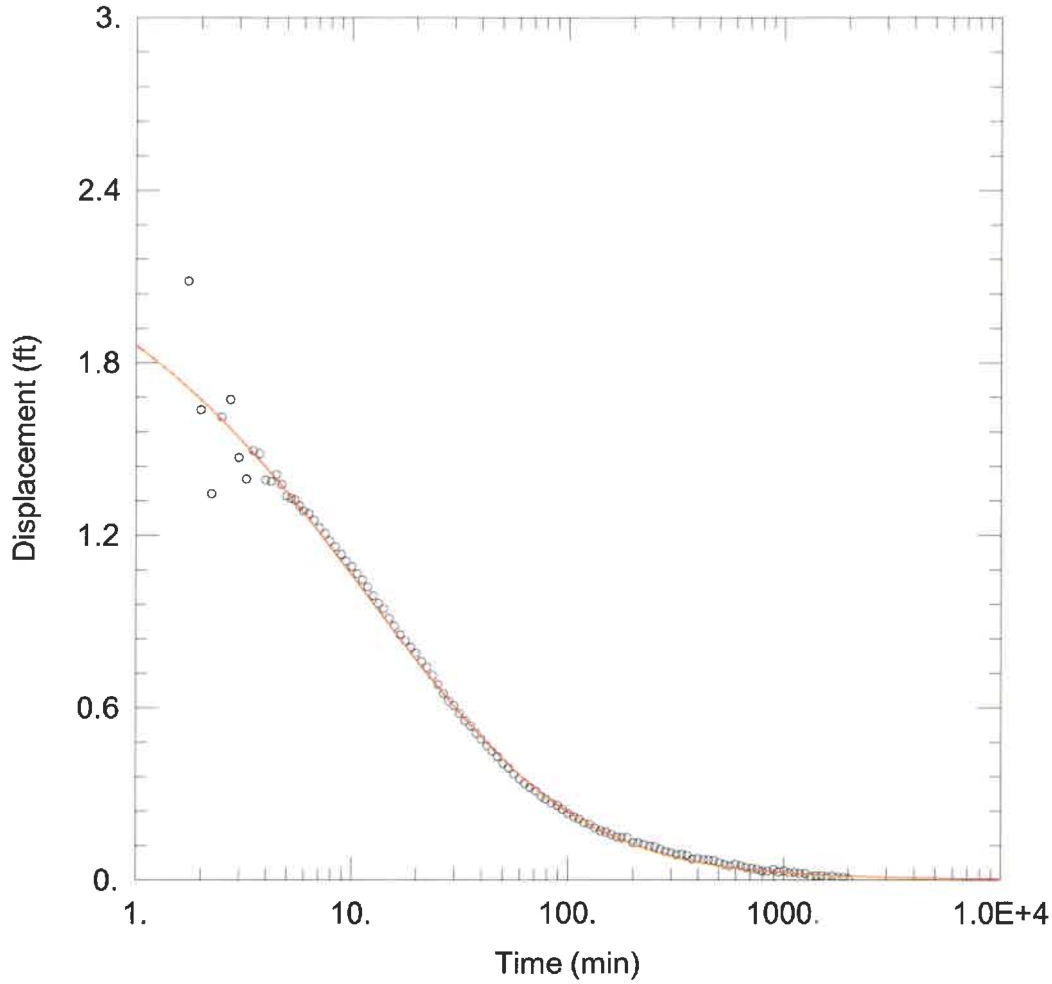
VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate

Kr	0.0011	cm/sec
Ss	0.025	ft^{-1}
Kz/Kr	1.	

T = K*b = 0.4265 cm²/sec



EP-4 RISING HEAD TEST

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4-rh.aqt
Date: 06/24/19 Time: 07:59:20

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Well: EP4
Test Date: 11 June 2019

AQUIFER DATA

Saturated Thickness: 12.72 ft

WELL DATA (EP-4)

Initial Displacement: 2.4 ft
Total Well Penetration Depth: 22.42 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 12.72 ft
Screen Length: 9.7 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 9.1E-6 cm/sec
Kz/Kr = 1.

Ss = 0.05 ft^{-1}

Data Set: I:\18jobs\18E0022A\Admin\13-Calculations\SlugTests\EP4-rh.aqt
Title: EP-4 Rising Head Test
Date: 06/24/19
Time: 07:51:20

PROJECT INFORMATION

Client: Southern Illinois Power Coop.
Project: 18E0022a
Location: Marion, IL
Test Date: 11 June 2019
Test Well: EP4

AQUIFER DATA

Saturated Thickness: 12.72 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: EP-4

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.4 ft
Static Water Column Height: 12.72 ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft
Well Skin Radius: 1. ft
Screen Length: 9.7 ft
Total Well Penetration Depth: 22.42 ft

No. of Observations: 119

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
1.75	2.083	71.4	0.31
2.	1.635	75.6	0.291
2.25	1.343	79.8	0.281
2.5	1.611	84.6	0.267
2.75	1.671	90.	0.258
3.	1.468	94.8	0.245
3.25	1.395	100.8	0.231
3.5	1.494	106.8	0.219
3.75	1.483	112.8	0.212
4.	1.392	119.4	0.198
4.25	1.386	126.6	0.194
4.5	1.409	134.4	0.181
4.75	1.376	142.2	0.171
5.	1.335	150.6	0.166
5.25	1.327	159.6	0.157
5.5	1.322	169.2	0.15
5.75	1.302	178.8	0.146
6.	1.283	189.6	0.146
6.36	1.274	201.	0.13

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
6.72	1.251	213.	0.128
7.14	1.225	225.6	0.123
7.56	1.205	238.8	0.117
7.98	1.179	253.2	0.115
8.46	1.16	268.2	0.106
9.	1.133	283.8	0.098
9.48	1.108	300.6	0.094
10.08	1.089	318.6	0.087
10.68	1.065	337.2	0.088
11.28	1.044	357.6	0.086
11.94	1.018	378.6	0.072
12.66	0.988	400.8	0.074
13.44	0.962	424.8	0.07
14.22	0.943	450.	0.069
15.06	0.91	476.4	0.067
15.96	0.883	504.6	0.059
16.92	0.853	534.6	0.053
17.88	0.832	566.4	0.048
18.96	0.809	600.	0.054
20.1	0.788	636.	0.048
21.3	0.76	672.	0.043
22.56	0.739	714.	0.04
23.88	0.711	756.	0.037
25.32	0.679	798.	0.031
26.82	0.648	846.	0.03
28.38	0.623	900.	0.036
30.06	0.606	948.	0.027
31.86	0.58	1008.	0.032
33.72	0.554	1068.	0.024
35.76	0.535	1128.	0.026
37.86	0.511	1194.	0.022
40.08	0.49	1266.	0.022
42.48	0.467	1344.	0.011
45.	0.447	1422.	0.014
47.64	0.43	1506.	0.014
50.46	0.405	1596.	0.009
53.46	0.39	1692.	0.013
56.64	0.368	1788.	0.008
60.	0.351	1896.	0.007
63.6	0.335	2010.	0.004
67.2	0.322		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: KGS Model

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
Kr	9.1E-6	cm/sec
Ss	0.05	ft^{-1}

Kz/Kr 1.

T = K*b = 0.003528 cm^2/sec

Appendix C

Holcomb Lab Test Results

LABORATORY TESTS
MARION POWER STATION- EMERY POND
WILLIAMSON COUNTY, ILLINOIS

Prepared for:

Hanson Professional Services, Inc
1525 South Sixth Street
Springfield, Illinois 62703

Prepared by:

HFE
Holcomb Foundation Engineering
Carbondale, Illinois
618-529-5262

June 27, 2019

HFE File Number: H-19093

Subcontract Agreement No S-18E0022A/HFE 2

TABLE OF CONTENTS

Holcomb Foundation Engineering Co., Inc.

SOILS • BITUMINOUS • CONCRETE • ENGINEERING AND TESTING

393 Wood Road
Carbondale, IL 62901

PHONE 618-529-5262
TOLL FREE 800-333-1740
FAX 618-457-8991

June 27, 2019

Hanson Professional Services, LLC
7625 North University Street, Suite 200
Peoria, IL 61614

Attention: Mr. Rhonald Hasenyager

Re: Laboratory Tests
Marion Power Station – Emery Pond
Williamson County, Illinois
HFE File H-19093
Subcontract Agreement No S-18E0022A/HFE2

Dear Sir:

We have completed the soil borings and laboratory tests for the above referenced project Enclosed is the Laboratory Test Data. If you should have any questions or require additional information, please feel free to contact us at your convenience.

Sincerely,

HOLCOMB FOUNDATION ENGINEERING INC.

Timothy J. Holcomb, P.E.

MOISTURE CONTENT WORKSHEET

Project: Marion Power Station
Project No.: H-19093 6/26/2019

Boring	Sample	Wet Wt.	Pan	Dry Wt.	Mc. (%)
EP-1	1	165.7	34.4	142.1	21.9
EP-1	2	150.2	26	128.3	21.4
EP-1	3	168.8	35.1	145.8	20.8
EP-1	4	733.3	92.9	634.1	18.3
EP-1	5	190.5	28.6	160.4	22.8
EP-1	6	165	26.3	140.7	21.2
EP-1	7	511.9	75.5	438.2	20.3
EP-1	8A	174.2	26.6	154.2	15.7
EP-1	8B	152.1	25	137.8	12.7
EP-4	1	104.1	28.8	101.2	4.0
EP-4	2	130.4	29.7	115.9	16.8
EP-4	3	128.2	25.3	112.9	17.5
EP-4	5	151.1	21.5	127	22.8
EP-4	6	169.4	21.3	141	23.7
EP-4	7	168.3	27.5	142.5	22.4
EP-4	8	442.4	73.3	385	18.4
EP-4	9	146.7	31.6	132.4	14.2

Marion Power Station

Emery Pond

Permeability Tests

// Holcomb Foundation Engineering Co., Inc.

SOILS • BITUMINOUS • CONCRETE • ENGINEERING AND TESTING

393 Wood Road
Carbondale, IL 62901

PHONE 618-529-5262
TOLL FREE 800-333-1740
FAX 618-457-8991

Permeability Tests Results

Marion Power Plant

Marion, Illinois

HFE File: H-19093
Date: 6/25/19

Location	Moisture Content (%) Before Test	Moisture Content (%) After Test	Dry Unit Weight (PCF)	Permeability (Cm./Sec.)
EP-1A (6-8')	18.3	19.1	111.7	7 x 10-8
EP-1A (12-14')	20.3	20.6	105.1	1 x 10-7
EP-4A (6-8')	18.4	17.4	111.2	5 x 10-8

Permeability Tests performed in accordance with ASTM D-5084

HOLCOMB FOUNDATION ENGINEERING CO.
393 WOOD ROAD
CARBONDALE ILLINOIS

PERMEABILITY TEST RESULTS

Project	Marion Power Plant	Boring/Sample	EP-1A
		Depth	13-13.5'
Project #	H-19093	Classification	Brown Silty Clay
Date	6/25/2019	Diameter	2.865
		Length	5.577 Inch
Area	41.59169		

In Place Mc		After Test Mc		Unit Weight (PCF)	
Wet Wt.	511.9	Wet Wt.	1274.6	Sample Wt	1192.4
Pan	75.5	Pan	82.5		
Dry Wt.	438.2	Dry Wt.	1070.6	Wet UW=	126.5
Mc (%)	20.3	Mc (%)	20.6	Dry UW=	105.1

Time(hrs)	Time(min)	Quantity In (cc	Out Flow (cc	Head (psi)	Permeability (cm/sec)
15	38	0.40	24.90		
31	40	5.50	22.20	2	2.14E-07
55	51	9.70	18.30	2	1.56E-07
64	41	11.10	16.80	2	1.47E-07
78	41	13.30	14.60	2	1.38E-07
102	26	16.00	12.00	2	1.21E-07
127	3	18.80	9.50	2	1.11E-07
151	10	21.00	7.30	2	1.02E-07
175	8	23.00	5.40	2	9.54E-08
7	30	0.50	24.20		
31	55	4.00	20.80	2	9.65E-08
55	53	8.00	16.50	2	1.04E-07
79	1	11.50	13.00	2	1.04E-07
		Average Permeability			1.02E-07

PERMEABILITY TEST RESULTS

Project	Marion Power Plant	Boring/Sample	EP-1A
		Depth	6.5-7'
Project #	H-19093	Classification	Brown Silty Clay
Date	6/25/2019	Diameter	2.828
		Length	5.58 Inch
Area	40.52436		

In Place Mc		After Test Mc		Unit Weight (PCF)	
Wet Wt.	733.3	Wet Wt.	1302.1	Sample Wt	1214.5
Pan	92.9	Pan	80.6		
Dry Wt.	634.1	Dry Wt.	1106.5	Wet UW=	132.1
Mc (%)	18.3	Mc (%)	19.1	Dry UW=	111.7

Time(hrs)	Time(min)	Quantity In (cc	Out Flow (cc	Head (psi)	Permeability (cm/sec)
15	24	0.10	24.90		
31	40	11.50	13.80	2	4.84E-07
39	3	13.30	12.20	2	3.86E-07
15	4	0.10	24.80		
31	51	7.80	17.40	2	3.17E-07
40	41	9.50	15.60	2	2.54E-07
54	42	10.20	15.00	2	1.76E-07
14	52	1.70	24.00		
30	26	7.40	18.20	2	2.53E-07
55	3	8.90	17.00	2	1.24E-07
79	11	10.10	15.80	2	9.03E-08
103	8	10.90	15.00	2	7.20E-08
127	55	11.90	12.10	2	6.24E-08
151	52	16.50	9.10	2	7.47E-08
175	2	17.30	8.10	2	6.73E-08
		Average Permeability			6.91E-08

HOLCOMB FOUNDATION ENGINEERING CO.
393 WOOD ROAD
CARBONDALE ILLINOIS

PERMEABILITY TEST RESULTS

Project	Marion Power Plant	Boring/Sample	EP-4A		
Project #	H-19093	Depth	7.5-8'		
		Classification	Brown Silty Clay w/ small pebbles & sand		
Date	6/25/2019	Diameter	2.825 Inch	Area	40.43842
		Length	5.575 Inch		

In Place Mc		After Test Mc		Unit Weight (PCF)	
Wet Wt.	442.4	Wet Wt.	1293.1	Sample Wt	1206.8
Pan	73.3	Pan	91.4		
Dry Wt.	385	Dry Wt.	1115.4	Wet UW=	131.7
Mc (%)	18.4	Mc (%)	17.4	Dry UW=	111.2

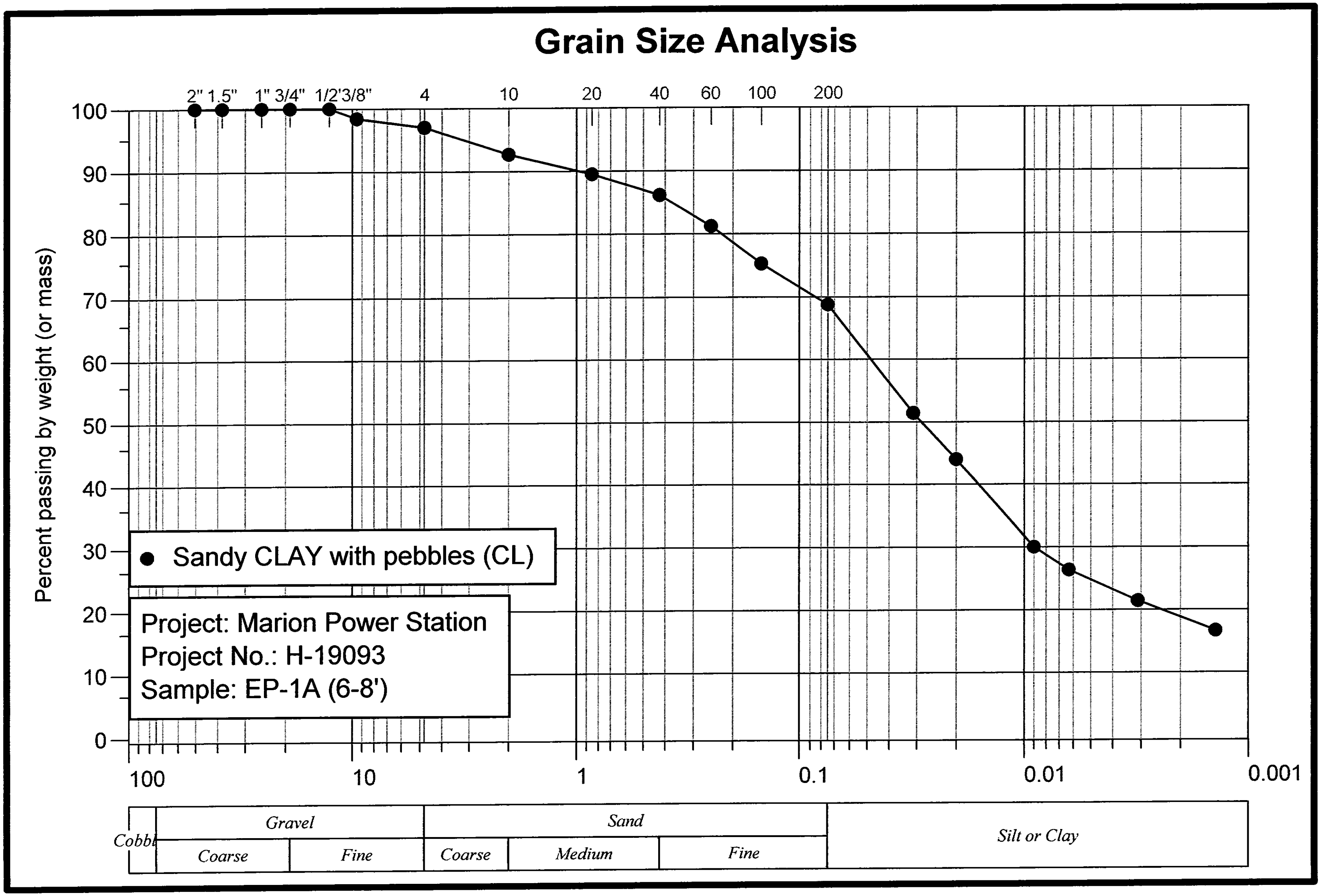
Time(hrs)	Time(min)	Quantity (cc)	Flow (cc)	Head (psi)	Permeability (cm/sec)
8	7	0.20	24.60		
30	27	2.90	23.70	2	8.36E-08
55	3	4.90	22.30	2	6.93E-08
79	15	6.60	20.80	2	6.23E-08
103	8	8.30	19.40	2	5.90E-08
127	54	9.80	18.00	2	5.55E-08
151	52	11.40	16.40	2	5.39E-08
175	1	12.90	14.90	2	5.26E-08

Average Permeability 5.52E-08

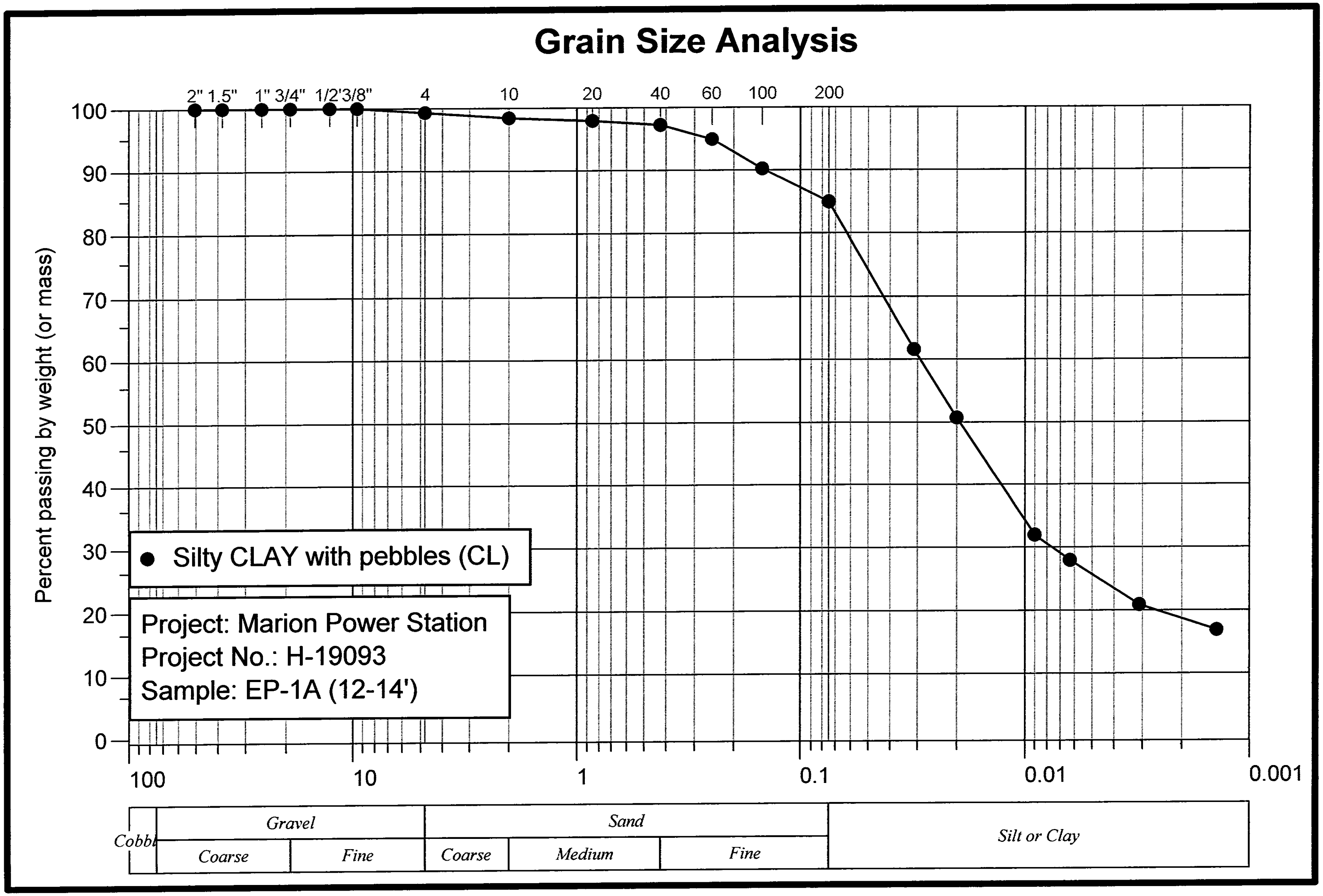
Marion Power Station

Emery Pond

Grain Size Analyses

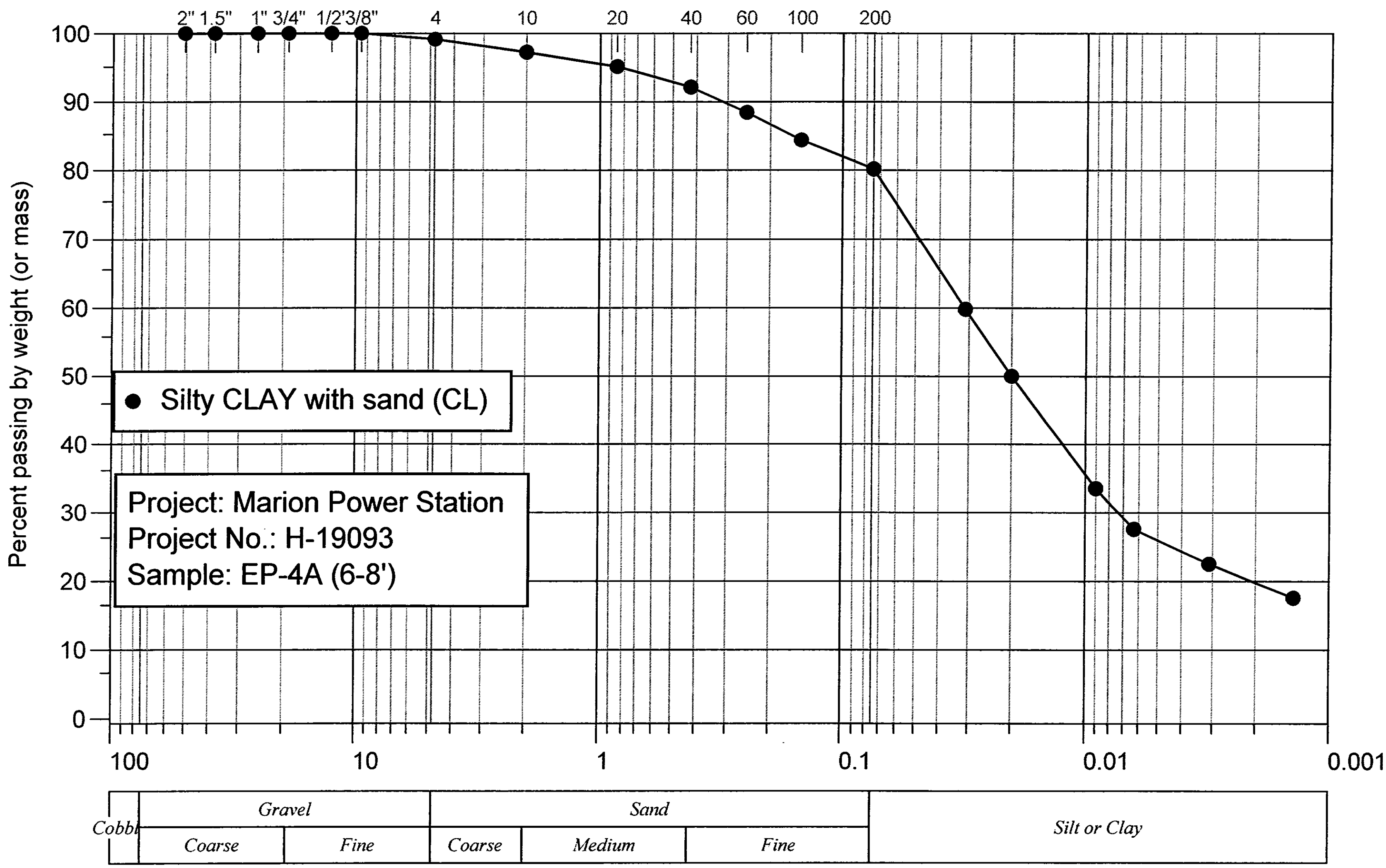


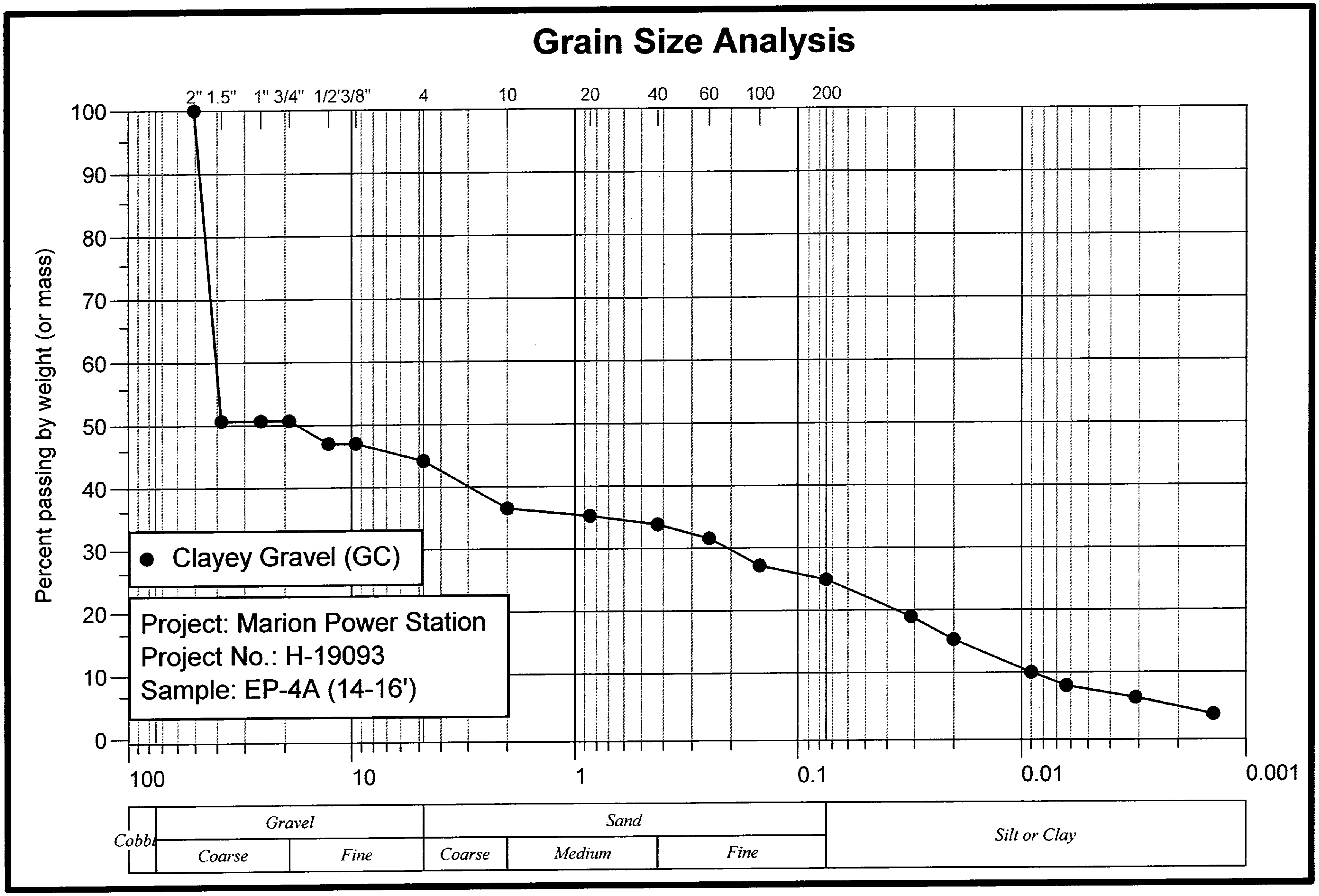
Grain Size Analysis
2" 1.5" 1" 3/4" 1/2'3/8" 4 10 20 40 60 100 200
Percent passing by weight (or mass)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
Sandy CLAY with pebbles (CL)
Project: Marion Power Station
Project No.: H-19093
Sample: EP-1A (6-8')
Cobbl
Gravel
Coarse
Fine
Sand
Coarse
Medium
Fine
Silt or Clay



Grain Size Analysis
2" 1.5" 1" 3/4" 1/2'3/8" 4 10 20 40 60 100 200
Percent passing by weight (or mass)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
Silty CLAY with pebbles (CL)
Project: Marion Power Station
Project No.: H-19093
Sample: EP-1A (12-14')
Cobbl
Gravel
Coarse
Fine
Sand
Coarse
Medium
Fine
Silt or Clay

Grain Size Analysis




Grain Size Analysis
2" 1.5" 1" 3/4" 1/2'3/8" 4 10 20 40 60 100 200
Percent passing by weight (or mass)
100 90 80 70 60 50 40 30 20 10 0
100 10 1 0.1 0.01 0.001
● Clayey Gravel (GC)
Project: Marion Power Station
Project No.: H-19093
Sample: EP-4A (14-16')
Cobbl
Gravel
Coarse
Fine
Sand
Coarse
Medium
Fine
Silt or Clay

Grain Size Analysis and Hydrometer Worksheet

Project:	Marion Power Station	Client:	
Project No.:	H-19093	Date:	6/19/2019
Boring/Depth:	**EP-1A 6-8'**	Total Weight:	239.70

Grain Size

Sieve	mm	Wt. Retained	% Passing	Adj. % Passing
2"	50.800	0.000	0.0	100.0
1.5"	38.100	0.000	0.0	100.0
1"	25.400	0.000	0.0	100.0
3/4"	19.050	0.000	0.0	100.0
1/2"	12.700	0.000	0.0	100.0
3/8"	9.530	3.800	1.6	98.4
#4	4.760	7.200	3.0	97.0
#10	2.000	17.800	7.4	92.6
#20	0.850		96.7	89.5
#40	0.425		93.1	86.2
#60	0.250		87.7	81.2
#100	0.149		81.3	75.3
#200	0.075		74.5	68.9
.031mm			55.8	51.7
.020mm			47.8	44.3
.009mm			32.8	30.4
.0063mm			28.8	26.7
.0031mm			23.6	21.8
.0014mm			18.6	17.2

Hydrometer

Grain Size	*	% Passing	*	Hydrometer	*	Temperature	*	Wt. Ret.
#10	*	100.0	*	X	*	X	*	0
#20	*	96.7	*	X	*	X	*	1.66
#40	*	93.1	*	X	*	X	*	3.46
#60	*	87.7	*	X	*	X	*	6.14
#100	*	81.3	*	X	*	X	*	9.35
#200	*	74.5	*	X	*	X	*	12.76
	*		*		*		*	
0.031	*	55.8	*	34	*	72	*	X
0.020	*	47.8	*	30	*	72	*	X
0.009	*	32.8	*	22	*	74	*	X
0.0063	*	28.8	*	20	*	74	*	X
0.0031	*	23.6	*	17	*	76	*	X
0.0014	*	18.6	*	14.5	*	76	*	X

Grain Size Analysis and Hydrometer Worksheet

Project:	Marion Power Station	Client:	
Project No.:	H-19093	Date:	6/19/2019
Boring/Depth:	**EP-1A 12-14'**	Total Weight:	196.80

Grain Size

Sieve	mm	Wt. Retained	% Passing	Adj. % Passing
2"	50.800	0.000	0.0	100.0
1.5"	38.100	0.000	0.0	100.0
1"	25.400	0.000	0.0	100.0
3/4"	19.050	0.000	0.0	100.0
1/2"	12.700	0.000	0.0	100.0
3/8"	9.530	0.000	0.0	100.0
#4	4.760	1.400	0.7	99.3
#10	2.000	3.100	1.6	98.4
#20	0.850		99.5	97.9
#40	0.425		98.6	97.1
#60	0.250		96.4	94.9
#100	0.149		91.6	90.2
#200	0.075		86.4	85.0
.031mm			62.8	61.8
.020mm			51.8	51.0
.009mm			32.8	32.3
.0063mm			28.8	28.3
.0031mm			21.6	21.3
.0014mm			17.6	17.3

Hydrometer

Grain Size	*	% Passing	*	Hydrometer	*	Temperature	*	Wt. Ret.
#10	*	100.0	*	X	*	X	*	0
#20	*	99.5	*	X	*	X	*	0.25
#40	*	98.6	*	X	*	X	*	0.69
#60	*	96.4	*	X	*	X	*	1.78
#100	*	91.6	*	X	*	X	*	4.19
#200	*	86.4	*	X	*	X	*	6.81
	*		*		*		*	
0.031	*	62.8	*	37.5	*	72	*	X
0.020	*	51.8	*	32	*	72	*	X
0.009	*	32.8	*	22	*	74	*	X
0.0063	*	28.8	*	20	*	74	*	X
0.0031	*	21.6	*	16	*	76	*	X
0.0014	*	17.6	*	14	*	76	*	X

Grain Size Analysis and Hydrometer Worksheet

Project:	Marion Power Station	Client:	
Project No.:	H-19093	Date:	6/19/2019
Boring/Depth:	**EP-4A 7.5-8'**	Total Weight:	168.00

Grain Size

Sieve	mm	Wt. Retained	% Passing	Adj. % Passing
2"	50.800	0.000	0.0	100.0
1.5"	38.100	0.000	0.0	100.0
1"	25.400	0.000	0.0	100.0
3/4"	19.050	0.000	0.0	100.0
1/2"	12.700	0.000	0.0	100.0
3/8"	9.530	0.000	0.0	100.0
#4	4.760	1.700	1.0	99.0
#10	2.000	4.780	2.8	97.2
#20	0.850		97.8	95.1
#40	0.425		94.8	92.1
#60	0.250		90.9	88.4
#100	0.149		86.9	84.4
#200	0.075		82.7	80.3
.031mm			61.8	60.0
.020mm			51.8	50.3
.009mm			34.8	33.8
.0063mm			28.8	28.0
.0031mm			23.6	22.9
.0014mm			18.6	18.1

Hydrometer

Grain Size	*	% Passing	*	Hydrometer	*	Temperature	*	Wt. Ret.
#10	*	100.0	*	X	*	X	*	0
#20	*	97.8	*	X	*	X	*	1.08
#40	*	94.8	*	X	*	X	*	2.62
#60	*	90.9	*	X	*	X	*	4.53
#100	*	86.9	*	X	*	X	*	6.54
#200	*	82.7	*	X	*	X	*	8.66
	*		*		*		*	
0.031	*	61.8	*	37	*	72	*	X
0.020	*	51.8	*	32	*	72	*	X
0.009	*	34.8	*	23	*	74	*	X
0.0063	*	28.8	*	20	*	74	*	X
0.0031	*	23.6	*	17	*	76	*	X
0.0014	*	18.6	*	14.5	*	76	*	X

Grain Size Analysis and Hydrometer Worksheet

Project:	Marion Power Station	Client:	
Project No.:	H-19093	Date:	6/19/2019
Boring/Depth:	**EP-4A 14-16'**	Total Weight:	169.80

Grain Size

Sieve	mm	Wt. Retained	% Passing	Adj. % Passing
2"	50.800	0.000	0.0	100.0
1.5"	38.100	83.200	49.0	51.0
1"	25.400	83.200	49.0	51.0
3/4"	19.050	83.200	49.0	51.0
1/2"	12.700	89.400	52.7	47.3
3/8"	9.530	89.400	52.7	47.3
#4	4.760	94.200	55.5	44.5
#10	2.000	107.200	63.1	36.9
#20	0.850		96.6	35.6
#40	0.425		92.8	34.2
#60	0.250		86.5	31.9
#100	0.149		75.1	27.7
#200	0.075		68.8	25.3
.031mm			52.8	19.5
.020mm			42.8	15.8
.009mm			28.8	10.6
.0063mm			22.8	8.4
.0031mm			17.6	6.5
.0014mm			10.6	3.9

Hydrometer

Grain Size	*	% Passing	*	Hydrometer	*	Temperature	*	Wt. Ret.
#10	*	100.0	*	X	*	X	*	0
#20	*	96.6	*	X	*	X	*	1.68
#40	*	92.8	*	X	*	X	*	3.62
#60	*	86.5	*	X	*	X	*	6.73
#100	*	75.1	*	X	*	X	*	12.46
#200	*	68.8	*	X	*	X	*	15.62
	*		*		*		*	
0.031	*	52.8	*	32.5	*	72	*	X
0.020	*	42.8	*	27.5	*	72	*	X
0.009	*	28.8	*	20	*	74	*	X
0.0063	*	22.8	*	17	*	74	*	X
0.0031	*	17.6	*	14	*	76	*	X
0.0014	*	10.6	*	10.5	*	76	*	X

GENERAL NOTES

SAMPLE INDENTIFICATION

The Unified Classification System is used to indentify the soil unless othwerwise noted.

RELATIVE DENSITY & CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	BLOWS PER FOOT
Very Loose	0-4
Loose	5-10
Firm	11-30
Dense	31-50
Very Dense	Over 50

TERM (COHESIVE SOILS)	QU (tsf)
Very Soft	0.00- 0.25
Soft	0.25-0.50
Firm	0.50-1.00
Stiff	1.00-2.00
Very Stiff	2.00-4.00
Hard	4.00+

DRILLING & SAMPLING SYMBOLS

ss:	Split Spoon-	1 3/8" I.D., 2" O.D.
st:	Shelby Tube-	2.80" I.D., 3" O.D.
au:	Auger Samples	
cs:	Continuous Sampling	2.0" I.D

SOIL PROPERTY SYMBOLS

●	Unconfined Compressive Strength, Qu (tsf)
+	Penetrometer Value, (tsf)
	Plastic Limit (%)
o	Water Content (%)
	Liquid Limit (%)
X	Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2" O.D. Split Spoon

PARTICLE SIZE

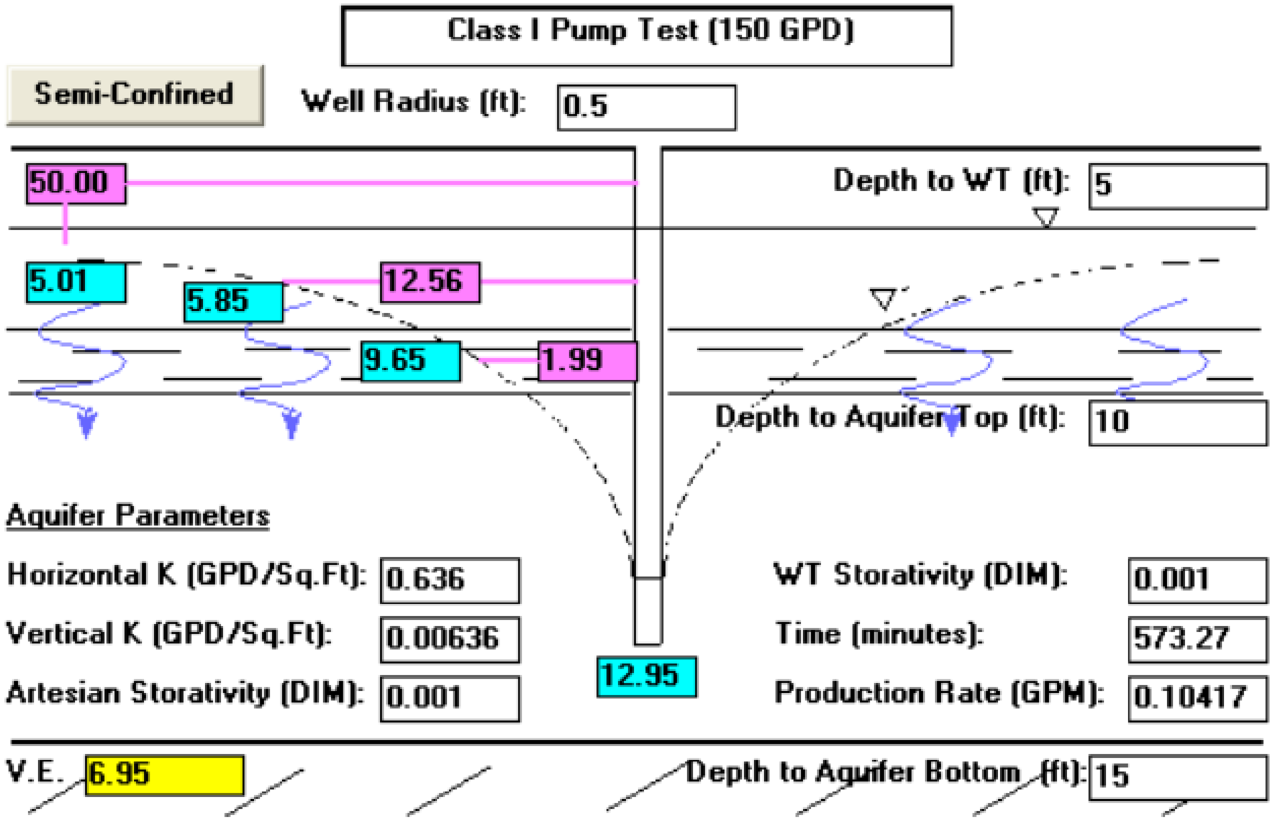
Boulders	8in +	Medium Sand	0.6mm to 0.2mm
Cobbles	8in to 3in	Fine Sand	0.2mm to 0.74 mm
Gravel	3in. to 5mm	Silt	0.074mm to 0.0005mm
Coarse Sand	5mm to 0.6mm	Clay	Less Than 0.005mm

UNIFIED SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		GRAVELS WITH FINES	GM	Silty gravels, gravels-sand silt mixtures
			GC	Clayey gravels, gravel-sand clay mixtures
		CLEAN SANDS	SW	Well-graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LOW PLASTICITY		SC	Clayey sands, clay-sand mixtures
			ML	Inoganic silts of clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity
	SILTS AND CLAYS HIGH PLASTICITY		OL	Organic silts and organic silty clays of low plasticity
			MH	Inorganic clays of high plasticity
			CH	Organic clays of high plasticity
HIGHLY ORGANIC SOILS			OH	Organic clays of medium to high plasticity
			PT	Peat, humus, swamp soils with high organic contents

Appendix D

Pump Test Simulation



D-1. Base-line Model

```
Model  : SIMULATION OF 1 OR 2-LAYER AQUIFER SYSTEM, UNIFORM PROPERTIES, WELL
         STORAGE CAPACITY, DELAYED GRAVITY YIELD, LEAKAGE, DEWATERING, RADIAL FLOW
         TO PRODUCTION WELL,FINITE-DIFFERENCE APPROXIMATION FOR PUMPING TEST DESIGN

Program based in part on program presented by Rushton, K.R. and S.C.Redshaw. 1979.
Seepage and groundwater flow-numerical analysis by analog and digital methods. John
Wiley & Sons, Ltd. New York, and Rathod,K.S and Rushton, K.R. 1984. Numerical
method of pumping test analysis using microcomputers.  GROUND WATER. Vol.22, No.5.

SIMULATION SOFTWARE BY:
   P-Squared Technologies, Inc.
   P.O. Box 22668
   KNOXVILLE, TN 37933
   (423) 691-3668
   May, 1996

DATA BASE FOR SEMI-CONFINED AQUIFER TYPE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT)=0.64
AQUITARD VERT. HYDR. COND. (GPD/SQ FT)=0.0064
AQUIFER THICKNESS (FT)=10.00
AQUITARD THICKNESS (FT)=5.00
ARTESIAN AQUIFER STORATIVITY (DIM)=0.0010
WATER TABLE STORATIVITY (DIM)=0.0010
PRODUCTION WELL EFFECTIVE RADIUS (FT)=0.500
TOP OF AQUIFER DEPTH (FT)=10.00
BASE OF AQUIFER DEPTH (FT)=15.00
INITIAL WATER LEVEL DEPTH (FT)=5.00
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM)= .10417

TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

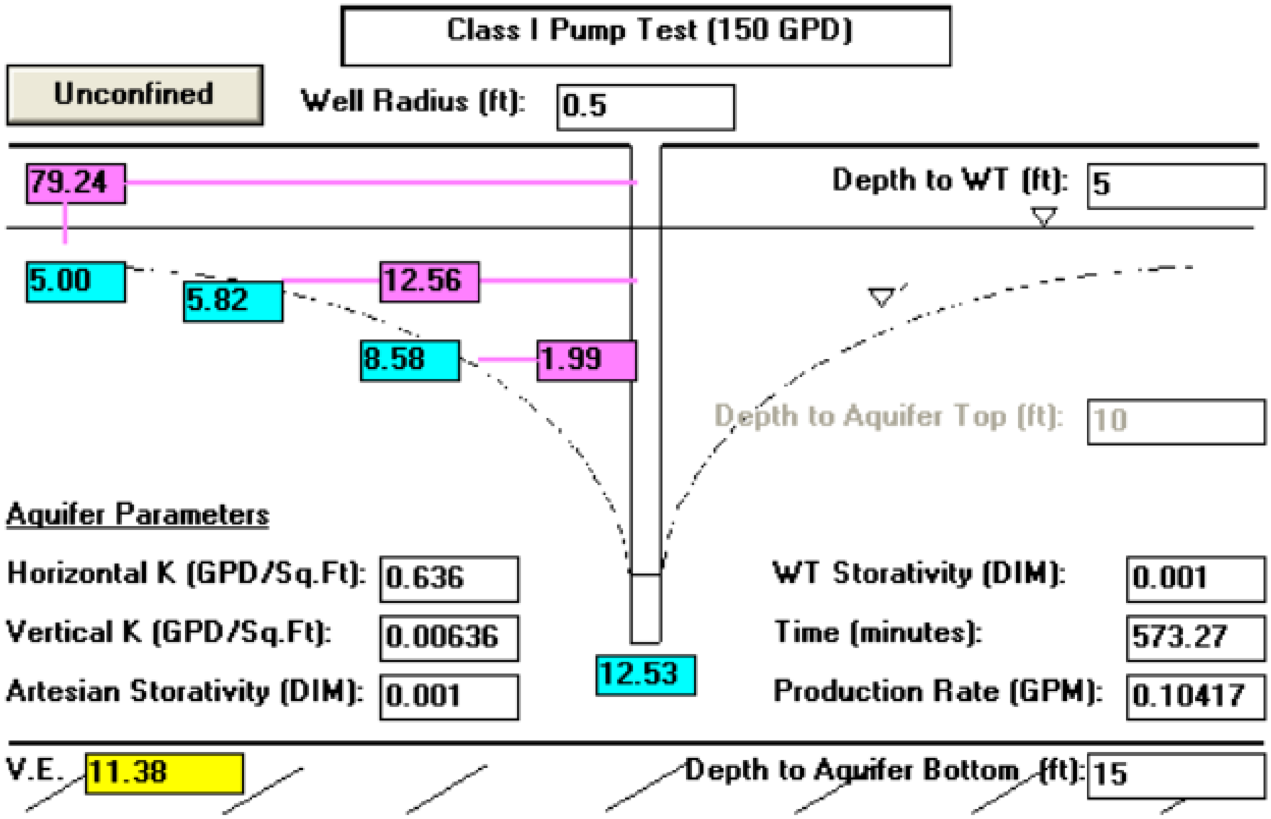
                              SELECTED DISTANCES (FT)

  TIME          0.50      79.24      199.05      500.00      1255.94     3154.79  (MIN)
     0.14       5.00       5.00        5.00        5.00        5.00        5.00
     0.23       5.00       5.00        5.00        5.00        5.00        5.00
     0.36       5.01       5.00        5.00        5.00        5.00        5.00
     0.57       5.01       5.00        5.00        5.00        5.00        5.00
     0.91       5.02       5.00        5.00        5.00        5.00        5.00
     1.44       5.03       5.00        5.00        5.00        5.00        5.00
     2.28       5.04       5.00        5.00        5.00        5.00        5.00
     3.62       5.06       5.00        5.00        5.00        5.00        5.00
     5.73       5.10       5.00        5.00        5.00        5.00        5.00
     9.09       5.16       5.00        5.00        5.00        5.00        5.00
    14.40       5.25       5.00        5.00        5.00        5.00        5.00
    22.82       5.40       5.00        5.00        5.00        5.00        5.00
    36.17       5.62       5.00        5.00        5.00        5.00        5.00
    57.33       5.98       5.00        5.00        5.00        5.00        5.00
    90.86       6.52       5.00        5.00        5.00        5.00        5.00
   144.00       7.35       5.00        5.00        5.00        5.00        5.00
   228.22       8.59       5.00        5.00        5.00        5.00        5.00
   361.71      10.40       5.00        5.00        5.00        5.00        5.00
   573.27      12.95       5.00        5.00        5.00        5.00        5.00
EXCESSIVE DRAWDOWN

DURATION OF MODELING SIMULATION IN MINUTES = 1440.00

DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD
```

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)
2	0.50	12.95
3	0.79	11.85
4	1.26	10.74
5	1.99	9.65
6	3.15	8.58
7	5.00	7.56
8	7.92	6.63
9	12.56	5.85
10	19.91	5.33
11	31.55	5.07
12	50.00	5.01



D-2. Unconfined Aquifer Sensitivity

```
Model  : SIMULATION OF 1 OR 2-LAYER AQUIFER SYSTEM, UNIFORM PROPERTIES, WELL
         STORAGE CAPACITY, DELAYED GRAVITY YIELD, LEAKAGE, DEWATERING, RADIAL FLOW
         TO PRODUCTION WELL,FINITE-DIFFERENCE APPROXIMATION FOR PUMPING TEST DESIGN

Program based in part on program presented by Rushton, K.R. and S.C.Redshaw. 1979.
Seepage and groundwater flow-numerical analysis by analog and digital methods. John
Wiley & Sons, Ltd. New York, and Rathod,K.S and Rushton, K.R. 1984. Numerical
method of pumping test analysis using microcomputers.  GROUND WATER. Vol.22, No.5.

SIMULATION SOFTWARE BY:
   P-Squared Technologies, Inc.
   P.O. Box 22668
   KNOXVILLE, TN 37933
   (423) 691-3668
   May, 1996

DATA BASE FOR SEMI-CONFINED AQUIFER TYPE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT)=0.64
AQUIFER VERT. HYDR. COND. (GPD/SQ FT)=0.006
AQUIFER THICKNESS (FT)=10.00
ARTESIAN AQUIFER STORATIVITY (DIM)=0.0010
WATER TABLE STORATIVITY (DIM)=0.0010
PRODUCTION WELL EFFECTIVE RADIUS (FT)=0.500
TOP OF AQUIFER DEPTH (FT)=5.00
BASE OF AQUIFER DEPTH (FT)=15.00
INITIAL WATER LEVEL DEPTH (FT)=5.00
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM)= .10417

TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

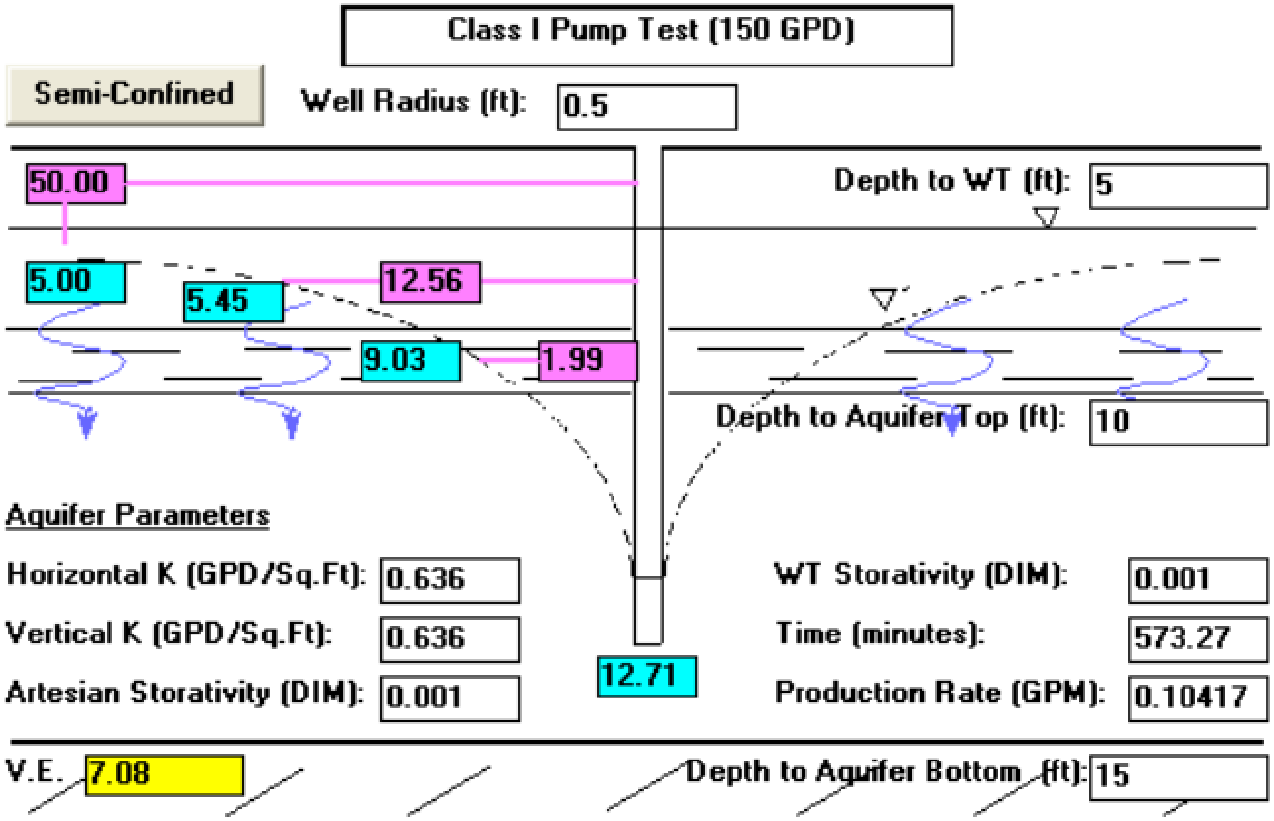
                               SELECTED DISTANCES (FT)

  TIME          0.50      79.24     199.05     500.00    1255.94    3154.79  (MIN)
     0.14       5.00       5.00       5.00       5.00       5.00       5.00
     0.23       5.00       5.00       5.00       5.00       5.00       5.00
     0.36       5.01       5.00       5.00       5.00       5.00       5.00
     0.57       5.01       5.00       5.00       5.00       5.00       5.00
     0.91       5.02       5.00       5.00       5.00       5.00       5.00
     1.44       5.03       5.00       5.00       5.00       5.00       5.00
     2.28       5.04       5.00       5.00       5.00       5.00       5.00
     3.62       5.06       5.00       5.00       5.00       5.00       5.00
     5.73       5.10       5.00       5.00       5.00       5.00       5.00
     9.09       5.16       5.00       5.00       5.00       5.00       5.00
    14.40       5.25       5.00       5.00       5.00       5.00       5.00
    22.82       5.39       5.00       5.00       5.00       5.00       5.00
    36.17       5.61       5.00       5.00       5.00       5.00       5.00
    57.33       5.95       5.00       5.00       5.00       5.00       5.00
    90.86       6.47       5.00       5.00       5.00       5.00       5.00
   144.00       7.24       5.00       5.00       5.00       5.00       5.00
   228.22       8.38       5.00       5.00       5.00       5.00       5.00
   361.71      10.05       5.00       5.00       5.00       5.00       5.00
   573.27      12.53       5.00       5.00       5.00       5.00       5.00
EXCESSIVE DRAWDOWN

DURATION OF MODELING SIMULATION IN MINUTES = 1440.00


DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD
```

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)
2	0.50	12.53
3	0.79	10.77
4	1.26	9.56
5	1.99	8.58
6	3.15	7.74
7	5.00	7.00
8	7.92	6.36
9	12.56	5.82
10	19.91	5.40
11	31.55	5.14
12	50.00	5.03
13	79.24	5.00



D-3. Isotropic Aquifer Sensitivity

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Model  : SIMULATION OF 1 OR 2-LAYER AQUIFER SYSTEM, UNIFORM PROPERTIES, WELL
         STORAGE CAPACITY, DELAYED GRAVITY YIELD, LEAKAGE, DEWATERING, RADIAL FLOW
         TO PRODUCTION WELL,FINITE-DIFFERENCE APPROXIMATION FOR PUMPING TEST DESIGN

Program based in part on program presented by Rushton, K.R. and S.C.Redshaw. 1979.
Seepage and groundwater flow-numerical analysis by analog and digital methods. John
Wiley & Sons, Ltd. New York, and Rathod,K.S and Rushton, K.R. 1984. Numerical
method of pumping test analysis using microcomputers.  GROUND WATER. Vol.22, No.5.

SIMULATION SOFTWARE BY:
   P-Squared Technologies, Inc.
   P.O. Box 22668
   KNOXVILLE, TN 37933
   (423) 691-3668
   May, 1996

DATA BASE FOR SEMI-CONFINED AQUIFER TYPE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT)=0.64
AQUITARD VERT. HYDR. COND. (GPD/SQ FT)=0.6360
AQUIFER THICKNESS (FT)=10.00
AQUITARD THICKNESS (FT)=5.00
ARTESIAN AQUIFER STORATIVITY (DIM)=0.0010
WATER TABLE STORATIVITY (DIM)=0.0010
PRODUCTION WELL EFFECTIVE RADIUS (FT)=0.500
TOP OF AQUIFER DEPTH (FT)=10.00
BASE OF AQUIFER DEPTH (FT)=15.00
INITIAL WATER LEVEL DEPTH (FT)=5.00
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM)= .10417

TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

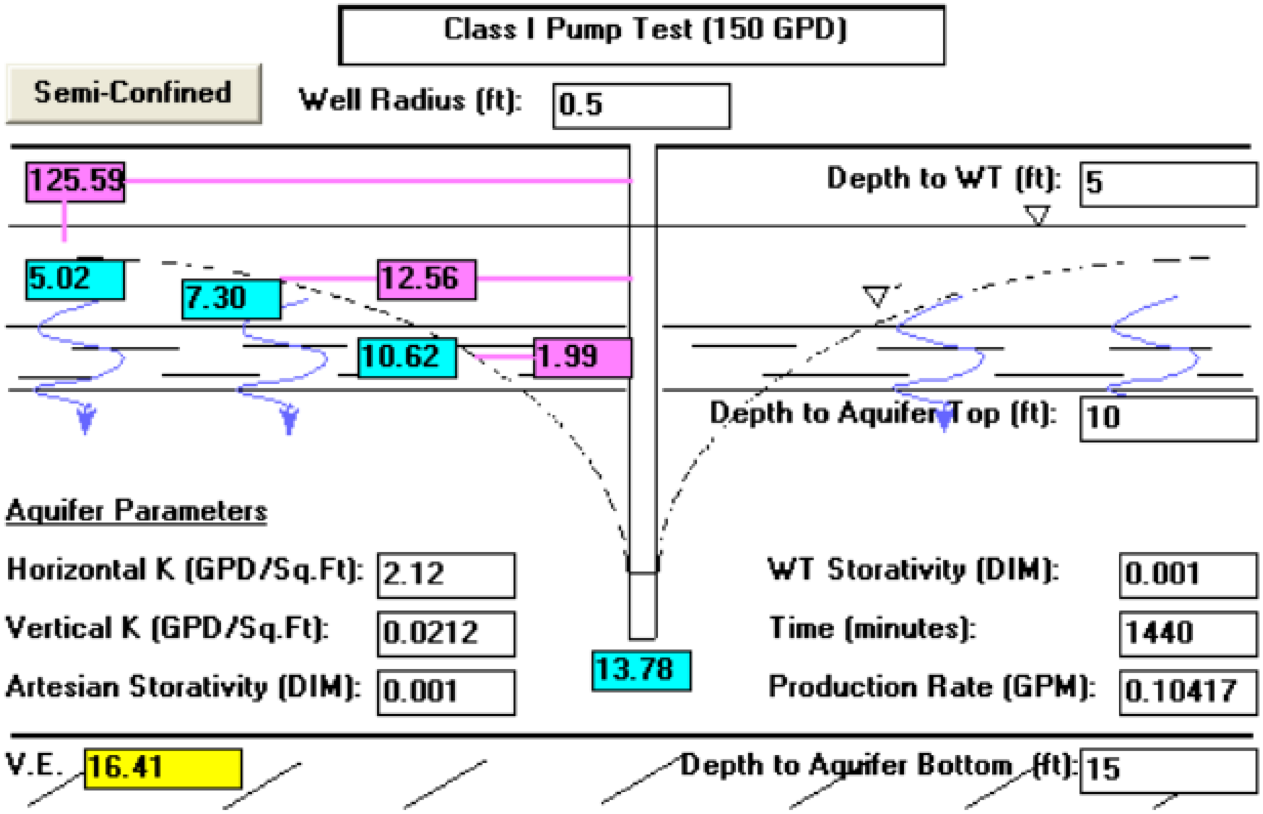
                              SELECTED DISTANCES (FT)

  TIME          0.50      79.24     199.05     500.00    1255.94    3154.79  (MIN)
     0.14       5.00       5.00       5.00       5.00       5.00       5.00
     0.23       5.00       5.00       5.00       5.00       5.00       5.00
     0.36       5.01       5.00       5.00       5.00       5.00       5.00
     0.57       5.01       5.00       5.00       5.00       5.00       5.00
     0.91       5.02       5.00       5.00       5.00       5.00       5.00
     1.44       5.03       5.00       5.00       5.00       5.00       5.00
     2.28       5.04       5.00       5.00       5.00       5.00       5.00
     3.62       5.06       5.00       5.00       5.00       5.00       5.00
     5.73       5.10       5.00       5.00       5.00       5.00       5.00
     9.09       5.16       5.00       5.00       5.00       5.00       5.00
    14.40       5.25       5.00       5.00       5.00       5.00       5.00
    22.82       5.40       5.00       5.00       5.00       5.00       5.00
    36.17       5.62       5.00       5.00       5.00       5.00       5.00
    57.33       5.98       5.00       5.00       5.00       5.00       5.00
    90.86       6.52       5.00       5.00       5.00       5.00       5.00
   144.00       7.34       5.00       5.00       5.00       5.00       5.00
   228.22       8.56       5.00       5.00       5.00       5.00       5.00
   361.71      10.32       5.00       5.00       5.00       5.00       5.00
   573.27      12.71       5.00       5.00       5.00       5.00       5.00
EXCESSIVE DRAWDOWN

DURATION OF MODELING SIMULATION IN MINUTES = 1440.00

DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD
```

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)
2	0.50	12.71
3	0.79	11.46
4	1.26	10.23
5	1.99	9.03
6	3.15	7.89
7	5.00	6.87
8	7.92	6.03
9	12.56	5.45
10	19.91	5.13
11	31.55	5.02
12	50.00	5.00



D-4. Hydraulic Conductivity at 1 x 10^{-4} cm/s Sensitivity

Model : SIMULATION OF 1 OR 2-LAYER AQUIFER SYSTEM, UNIFORM PROPERTIES, WELL STORAGE CAPACITY, DELAYED GRAVITY YIELD, LEAKAGE, DEWATERING, RADIAL FLOW TO PRODUCTION WELL,FINITE-DIFFERENCE APPROXIMATION FOR PUMPING TEST DESIGN

Program based in part on program presented by Rushton, K.R. and S.C.Redshaw. 1979. Seepage and groundwater flow-numerical analysis by analog and digital methods. John Wiley & Sons, Ltd. New York, and Rathod,K.S and Rushton, K.R. 1984. Numerical method of pumping test analysis using microcomputers. GROUND WATER. Vol.22, No.5.

SIMULATION SOFTWARE BY:
P-Squared Technologies, Inc.
P.O. Box 22668
KNOXVILLE, TN 37933
(423) 691-3668
May, 1996

DATA BASE FOR SEMI-CONFINED AQUIFER TYPE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT)=2.12
AQUITARD VERT. HYDR. COND. (GPD/SQ FT)=0.0212
AQUIFER THICKNESS (FT)=10.00
AQUITARD THICKNESS (FT)=5.00
ARTESIAN AQUIFER STORATIVITY (DIM)=0.0010
WATER TABLE STORATIVITY (DIM)=0.0010
PRODUCTION WELL EFFECTIVE RADIUS (FT)=0.500
TOP OF AQUIFER DEPTH (FT)=10.00
BASE OF AQUIFER DEPTH (FT)=15.00
INITIAL WATER LEVEL DEPTH (FT)=5.00
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM)= .10417

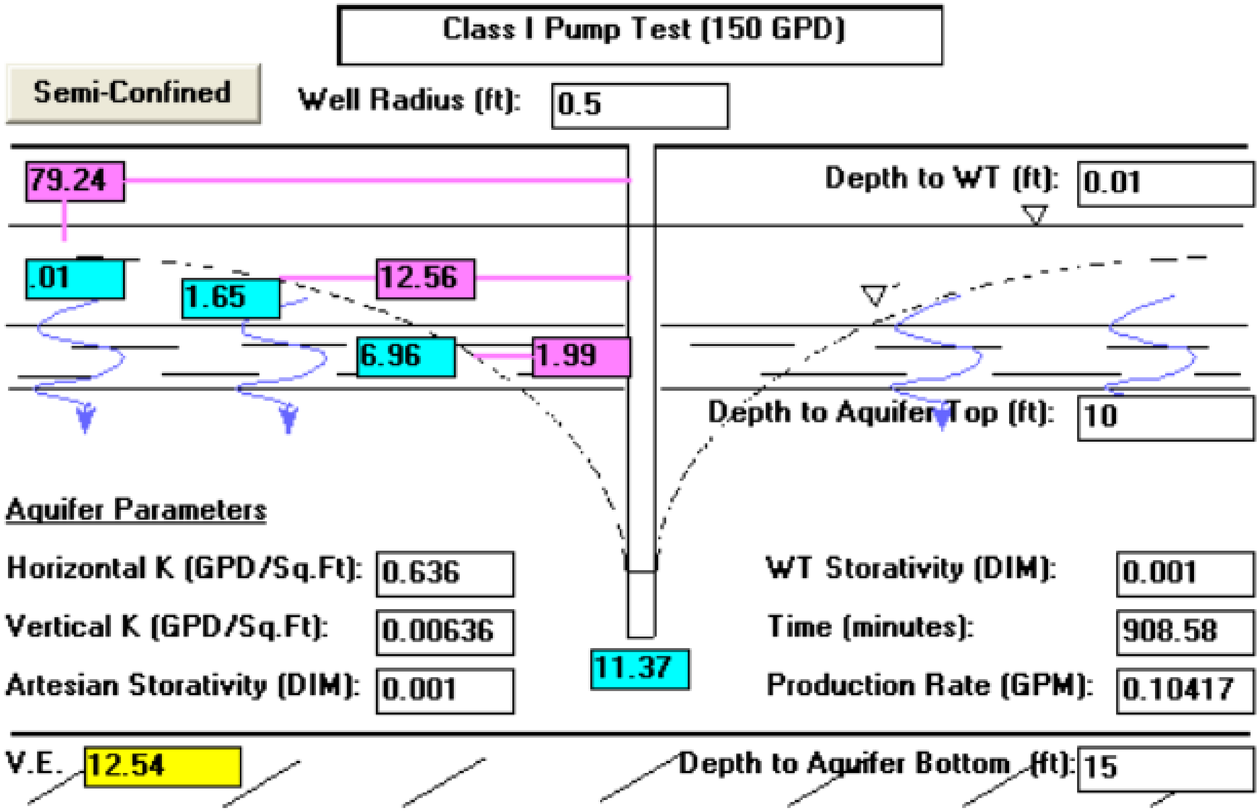
TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

	SELECTED DISTANCES (FT)					
TIME (MIN)	0.50	79.24	199.05	500.00	1255.94	3154.79
0.14	5.00	5.00	5.00	5.00	5.00	5.00
0.23	5.00	5.00	5.00	5.00	5.00	5.00
0.36	5.01	5.00	5.00	5.00	5.00	5.00
0.57	5.01	5.00	5.00	5.00	5.00	5.00
0.91	5.02	5.00	5.00	5.00	5.00	5.00
1.44	5.03	5.00	5.00	5.00	5.00	5.00
2.28	5.04	5.00	5.00	5.00	5.00	5.00
3.62	5.06	5.00	5.00	5.00	5.00	5.00
5.73	5.10	5.00	5.00	5.00	5.00	5.00
9.09	5.16	5.00	5.00	5.00	5.00	5.00
14.40	5.25	5.00	5.00	5.00	5.00	5.00
22.82	5.38	5.00	5.00	5.00	5.00	5.00
36.17	5.60	5.00	5.00	5.00	5.00	5.00
57.33	5.92	5.00	5.00	5.00	5.00	5.00
90.86	6.39	5.00	5.00	5.00	5.00	5.00
144.00	7.06	5.00	5.00	5.00	5.00	5.00
228.22	7.98	5.00	5.00	5.00	5.00	5.00
361.71	9.16	5.00	5.00	5.00	5.00	5.00
573.27	10.56	5.01	5.00	5.00	5.00	5.00
908.58	12.06	5.04	5.00	5.00	5.00	5.00
1440.00	13.78	5.11	5.00	5.00	5.00	5.00

DURATION OF MODELING SIMULATION IN MINUTES = 1440.00

DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)
2	0.50	13.78
3	0.79	12.51
4	1.26	11.48
5	1.99	10.62
6	3.15	9.78
7	5.00	8.94
8	7.92	8.11
9	12.56	7.30
10	19.91	6.55
11	31.55	5.89
12	50.00	5.39
13	79.24	5.11
14	125.59	5.02



D-5. Aquifer Thickness at 15 ft. Sensitivity

```
Model  : SIMULATION OF 1 OR 2-LAYER AQUIFER SYSTEM, UNIFORM PROPERTIES, WELL
         STORAGE CAPACITY, DELAYED GRAVITY YIELD, LEAKAGE, DEWATERING, RADIAL FLOW
         TO PRODUCTION WELL,FINITE-DIFFERENCE APPROXIMATION FOR PUMPING TEST DESIGN

Program based in part on program presented by Rushton, K.R. and S.C.Redshaw. 1979.
Seepage and groundwater flow-numerical analysis by analog and digital methods. John
Wiley & Sons, Ltd. New York, and Rathod,K.S and Rushton, K.R. 1984. Numerical
method of pumping test analysis using microcomputers.  GROUND WATER. Vol.22, No.5.

SIMULATION SOFTWARE BY:
   P-Squared Technologies, Inc.
   P.O. Box 22668
   KNOXVILLE, TN 37933
   (423) 691-3668
   May, 1996

DATA BASE FOR SEMI-CONFINED AQUIFER TYPE:

AQUIFER HORIZ. HYDR. COND. (GPD/SQ FT)=0.64
AQUITARD VERT. HYDR. COND. (GPD/SQ FT)=0.0064
AQUIFER THICKNESS (FT)=14.00
AQUITARD THICKNESS (FT)=5.00
ARTESIAN AQUIFER STORATIVITY (DIM)=0.0010
WATER TABLE STORATIVITY (DIM)=0.0010
PRODUCTION WELL EFFECTIVE RADIUS (FT)=0.500
TOP OF AQUIFER DEPTH (FT)=10.00
BASE OF AQUIFER DEPTH (FT)=15.00
INITIAL WATER LEVEL DEPTH (FT)=0.01
INFINITE AQUIFER SYSTEM

COMPUTATION RESULTS:

PRODUCTION WELL DISCHARGE RATE (GPM)= .10417

TIME-DRAWDOWN OR WATER LEVEL VALUES (FT)

                              SELECTED DISTANCES (FT)

  TIME          0.50      79.24     199.05     500.00    1255.94    3154.79  (MIN)
     0.14       0.01       0.01       0.01       0.01       0.01       0.01
     0.23       0.01       0.01       0.01       0.01       0.01       0.01
     0.36       0.02       0.01       0.01       0.01       0.01       0.01
     0.57       0.02       0.01       0.01       0.01       0.01       0.01
     0.91       0.03       0.01       0.01       0.01       0.01       0.01
     1.44       0.04       0.01       0.01       0.01       0.01       0.01
     2.28       0.05       0.01       0.01       0.01       0.01       0.01
     3.62       0.07       0.01       0.01       0.01       0.01       0.01
     5.73       0.11       0.01       0.01       0.01       0.01       0.01
     9.09       0.17       0.01       0.01       0.01       0.01       0.01
    14.40       0.26       0.01       0.01       0.01       0.01       0.01
    22.82       0.41       0.01       0.01       0.01       0.01       0.01
    36.17       0.63       0.01       0.01       0.01       0.01       0.01
    57.33       0.99       0.01       0.01       0.01       0.01       0.01
    90.86       1.53       0.01       0.01       0.01       0.01       0.01
   144.00       2.36       0.01       0.01       0.01       0.01       0.01
   228.22       3.60       0.01       0.01       0.01       0.01       0.01
   361.71       5.41       0.01       0.01       0.01       0.01       0.01
   573.27       7.96       0.01       0.01       0.01       0.01       0.01
   908.58      11.37       0.01       0.01       0.01       0.01       0.01
EXCESSIVE DRAWDOWN

DURATION OF MODELING SIMULATION IN MINUTES = 1440.00
```

DISTANCE-DRAWDOWN OR WATER LEVEL VALUES AT END OF PUMPING PERIOD

NODE NO	RADIUS(FT)	DRAWDOWN OR WATER LEVEL (FT)
2	0.50	11.37
3	0.79	9.89
4	1.26	8.42
5	1.99	6.96
6	3.15	5.52
7	5.00	4.12
8	7.92	2.80
9	12.56	1.65
10	19.91	0.76
11	31.55	0.24
12	50.00	0.05
13	79.24	0.01

APPENDIX F

Groundwater Analytical Results

	Well ID	EBG	EBG	EBG	EBG	EBG	EBG	EBG	EBG	EBG
	Sample Data	3/23/2017	4/3/2017	5/25/2017	6/22/2017	6/29/2017	7/24/2017	8/1/2017	8/31/2017	3/22/2018
	Sample Purpose	Background	Background	Background	Background	Background	Background	Background	Background	Detection Monitoring
ANALYTE	Unit									
CCR Appendix III										
Boron	mg/L	0.12	0.079	0.1	0.071	0.073	0.079	0.074	0.056	0.033
Calcium	mg/L	23	10	30	23	32	37	35	35	14
Chloride	mg/L	55	11	84	68	79	27	86	82	12
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	0.64	<0.5	<0.5	0.53
pH	SU	6.5	6.8	6.41	6.45	6.53	6.59	6.66	6.26	6.35
Sulfate	mg/L	64	54	42	57	50	61	45	44	63
Total Dissolved Solids (TDS)	mg/L	480	400	440	470	280	420	380	470	300
CCR Appendix IV										
Antimony	mg/L	0.00057	0.00085 J	<0.005	0.00069 J	0.0014 J	<0.005	0.00022 J	<0.005	
Arsenic	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Barium	mg/L	0.13	0.029	0.17	0.049	0.086	0.19	0.18	0.16	
Beryllium	mg/L	0.00033 J	<0.0002	<0.005	<0.0002	<0.0002	<0.005	<0.0002	<0.005	
Cadmium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Chromium	mg/L	0.0062	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Cobalt	mg/L	0.008	0.00016 J	0.014	0.00015 J	0.0014 J	0.0093	0.0038 J	0.0073	
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	0.64	<0.5	<0.5	0.53
Lead	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Lithium	mg/L	0.046 J	0.0074 J	<0.1	0.028 J	0.059 J	<0.1	0.082 J	<0.1	
Mercury	mg/L		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Molybdenum	mg/L	0.0034 J	0.0043 J	<0.005	0.0017 J	0.0016 J	<0.005	0.0024 J	<0.005	
Radium 226	pCi/L	0.878	<0.223	0.805	<0.262	<0.245	0.43	0.28	0.77	
Radium 228	pCi/L	1.06	<0.496	0.555	<0.0695	<0.371	0.98	1.24	2.22	
Radium, 226/228 Combined	pCi/L	1.938	<0.496	1.36	<0.262	<0.371	1.41	1.52	2.99	
Selenium	mg/L	0.0019 J	<0.0005	<0.005	0.0036 J	0.0019 J	<0.005	0.0028 J	0.007	
Thallium	mg/L	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

Well ID		EBG	EBG	EBG	EBG	EBG	EBG	EBG	EBG
Sample Data		8/27/2018	1/11/2019	6/27/2019	1/30/2020	6/22/2020	1/21/2021	5/31/2021	8/30/2021
Sample Purpose		Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Corrective Action Monitoring	Corrective Action Monitoring
ANALYTE	Unit								
CCR Appendix III									
Boron	mg/L	0.035	0.041	<0.08	<0.5	0.022	<0.5	<0.02	0.01 J
Calcium	mg/L	15	13	15.2	12	13	15	13.3	12.1
Chloride	mg/L	16	12	18	7.2	12	13	22	17
Fluoride	mg/L	0.55	0.5	<0.5	0.56	<0.5	0.46	0.6	0.58
pH	SU	6.57	6.85	6.21	6.54	6.5	6.57	6.61	6.58
Sulfate	mg/L	72	75	77	87	81	78	85	83
Total Dissolved Solids (TDS)	mg/L	360	370	470	280	500	320	344	340
CCR Appendix IV									
Antimony	mg/L	<0.012		<0.0016		<0.001		<0.001	<0.001
Arsenic	mg/L	<0.3		<0.002		0.0011		<0.001	<0.001
Barium	mg/L	0.091		<0.2		0.068		0.0505	0.0469
Beryllium	mg/L	<0.008	0.00038 J	<0.00015		<0.001		<0.001	<0.001
Cadmium	mg/L	<0.01		<0.00054		<0.002		<0.001	<0.001
Chromium	mg/L	<0.01	<0.01	<0.014		0.0042		<0.0015	0.0011 J
Cobalt	mg/L	<0.01	0.0038	<0.01		0.0017		<0.001	0.0003 J
Fluoride	mg/L	0.55	0.5	<0.5	0.56	<0.5	0.46	0.6	0.58
Lead	mg/L	<0.01	<0.01	<0.0062		<0.0075		<0.001	<0.001
Lithium	mg/L	<0.1 J		<0.08		<0.1 J		0.0207	0.0164
Mercury	mg/L	<0.0002		<0.0002		<0.0002		<0.0002	<0.0002
Molybdenum	mg/L	<0.005		<0.01		<0.003		0.0145	0.0014 J
Radium 226	pCi/L	0.933		0.703		0.468			<0.21
Radium 228	pCi/L	0.447		0.911		0.514			1.02
Radium, 226/228 Combined	pCi/L	1.38		1.61		0.983			<1.23
Selenium	mg/L	<0.002	0.00079 J	<0.001		<0.001		<0.001	<0.001
Thallium	mg/L	<0.05	<0.05	<0.00094		<0.05		<0.002	0.0054

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

Well ID		EP-1	EP-1	EP-1	EP-1	EP-1	EP-1	EP-1	EP-1	EP-1
Sample Data		3/23/2017	4/3/2017	5/25/2017	6/22/2017	6/29/2017	7/24/2017	8/1/2017	8/31/2017	3/22/2018
Sample Purpose		Background	Background	Background	Background	Background	Background	Background	Background	Detection Monitoring
ANALYTE	Unit									
CCR Appendix III										
Boron	mg/L	0.13	0.21	0.28	0.26	0.32	0.21	0.23	0.17	0.38
Calcium	mg/L	220	280	310	310	310	270	250	240	330
Chloride	mg/L	54	54	48	50	50	51	48	48	60
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH	SU	6.94	6.89	6.55	6.52	6.64	6.57	6.82	6.79	6.25
Sulfate	mg/L	820	910	850	850	440	540	520	440	510
Total Dissolved Solids (TDS)	mg/L	2000	2300	2300	2300	2200	2200	2100	2100	2400
CCR Appendix IV										
Antimony	mg/L	0.00043 J	<0.0002	<0.005	0.00057 J	0.00095 J	<0.005	<0.0002	<0.005	
Arsenic	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Barium	mg/L	0.045	0.04	0.041	0.032	0.033	0.029	0.028	0.026	
Beryllium	mg/L	<0.0002	<0.0002	<0.005	<0.0002	<0.0002	<0.005	<0.0002	<0.005	
Cadmium	mg/L	<0.005	0.006	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Chromium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Cobalt	mg/L	0.0017 J	0.00079 J	<0.005	0.00081 J	0.00057 J	<0.005	0.00074 J	<0.005	
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Lithium	mg/L	0.024 J	0.028 J	<0.1	0.032 J	0.029 J	<0.1	0.024 J	<0.1	
Mercury	mg/L		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Molybdenum	mg/L	0.0028 J	0.0016 J	<0.005	0.00077 J	0.0018 J	<0.005	0.0019 J	<0.005	
Radium 226	pCi/L	0.603	0.341	0.37	0.313	<0.139	0.16	0.38	0.24	
Radium 228	pCi/L	<0.0552	0.55	<0.609	0.496	<0.0387	<0.27	1.04	1.15	
Radium, 226/228 Combined	pCi/L	0.603	0.891	0.37	0.809	<0.139	0.16	1.42	1.39	
Selenium	mg/L	0.0012 J	0.0014 J	<0.005	0.005 J	0.0025 J	<0.005	0.0011 J	<0.005	
Thallium	mg/L	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

Well ID		EP-1	EP-1	EP-1	EP-1	EP-1	EP-1	EP-1	EP-1
Sample Data		8/27/2018	1/11/2019	6/27/2019	1/30/2020	6/22/2020	1/21/2021	5/31/2021	8/30/2021
Sample Purpose		Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Corrective Action Monitoring	Corrective Action Monitoring
ANALYTE	Unit								
CCR Appendix III									
Boron	mg/L	0.92	0.75	1.12	1.1	0.92	1	0.816	0.931
Calcium	mg/L	410	410	444	540	470	460	478	483
Chloride	mg/L	63	70	55	52	34	39	44	48
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.22	0.19
pH	SU	6.36	6.33	6.2	7.39	6.15	6.29	6.18	6.12
Sulfate	mg/L	1000	1600	1500	1700	1400	1400	1450	1640
Total Dissolved Solids (TDS)	mg/L	2700	2800	550	2700	2700	2500	2500	2520
CCR Appendix IV									
Antimony	mg/L	<0.012		<0.0016		<0.005		<0.001	0.0005 J
Arsenic	mg/L	<0.3		<0.002		<0.005		<0.001	0.0005 J
Barium	mg/L	0.023		<0.2		0.019		0.0216	0.02
Beryllium	mg/L	<0.008	<0.005	<0.00015		<0.005		<0.001	<0.001
Cadmium	mg/L	<0.01		<0.00054		<0.002 J		<0.001	<0.001
Chromium	mg/L	<0.01	<0.01	<0.014		<0.003		<0.002	0.0019
Cobalt	mg/L	<0.01	0.00056 J	<0.01		<0.005		0.0012	0.001 J
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.22	0.19
Lead	mg/L	<0.01	<0.01	<0.0062		<0.0075		<0.001	<0.001
Lithium	mg/L	<0.1 J		<0.08		<0.1 J		0.0141	0.0127
Mercury	mg/L	<0.0002		<0.0002		<0.0002		<0.0002	<0.0002
Molybdenum	mg/L	<0.005		<0.01		<0.005		<0.0015	<0.0015
Radium 226	pCi/L	0.453		0.619		0.42			<0.04
Radium 228	pCi/L	0.992		0.0905		0.405			1.78
Radium, 226/228 Combined	pCi/L	1.445		0.71		0.825			<1.82
Selenium	mg/L	<0.002	<0.0028	<0.001		<0.005		0.0015	0.0014
Thallium	mg/L	<0.05	<0.05	<0.00094		<0.05		<0.002	0.0042

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

Well ID		EP-2	EP-2	EP-2	EP-2	EP-2	EP-2	EP-2	EP-2	EP-2
Sample Data		3/23/2017	4/3/2017	5/25/2017	6/22/2017	6/29/2017	7/24/2017	8/1/2017	8/31/2017	3/22/2018
Sample Purpose		Background	Background	Background	Background	Background	Background	Background	Background	Detection Monitoring
ANALYTE	Unit									
CCR Appendix III										
Boron	mg/L	0.22	0.19	0.2	0.23	0.29	0.26	0.31	0.23	0.24
Calcium	mg/L	190	170	200	200	470	200	190	180	230
Chloride	mg/L	42	39	36	37	36	36	36	36	30
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH	SU	6.18	6.39	6.31	6.1	5.75	5.86	5.88	6.33	6.27
Sulfate	mg/L	860	660	780	780	470	430	770	340	420
Total Dissolved Solids (TDS)	mg/L	1800	1800	1900	1800	1900	1800	1800	1800	1700
CCR Appendix IV										
Antimony	mg/L	0.00029 J	<0.0002	<0.005	0.0004 J	0.00073 J	<0.005	<0.0002	<0.005	
Arsenic	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Barium	mg/L	0.039	0.035	0.038	0.03	0.029	0.025	0.025	0.025	
Beryllium	mg/L	<0.0002	<0.0002	<0.005	<0.0002	<0.0002	<0.005	<0.0002	<0.005	
Cadmium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Chromium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Cobalt	mg/L	0.052	0.029	0.023	0.016	0.0087	<0.005	0.00086 J	<0.005	
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Lithium	mg/L	0.018 J	0.015 J	<0.1	0.020 J	0.025 J	<0.1	0.021 J	<0.1	
Mercury	mg/L		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Molybdenum	mg/L	0.0015 J	0.0017 J	<0.005	0.0003 J	0.00055 J	<0.005	0.00082 J	<0.005	
Radium 226	pCi/L	<0.187	0.338	<0.177	0.197	1.9	0.08	0.14	0.08	
Radium 228	pCi/L	0.853	<0.0622	<0.126	<0.127	<0.458	0.4	1.35	0.64	
Radium, 226/228 Combined	pCi/L	0.853	0.338	<0.177	0.197	1.9	0.48	1.49	0.72	
Selenium	mg/L	0.0038 J	0.0027 J	<0.005	0.0074	0.0061	0.0054	0.0046 J	<0.005	
Thallium	mg/L	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

	Well ID	EP-2	EP-2	EP-2	EP-2	EP-2	EP-2	EP-2	EP-2
	Sample Data	8/27/2018	1/11/2019	6/27/2019	1/30/2020	6/22/2020	1/21/2021	5/31/2021	8/30/2021
	Sample Purpose	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Corrective Action Monitoring	Corrective Action Monitoring
ANALYTE	Unit								
CCR Appendix III									
Boron	mg/L	0.2	0.37	0.274	0.56	0.47	0.49 J	0.544	0.499
Calcium	mg/L	190	280	236	430	360	340	372	363
Chloride	mg/L	35	25	29	13	19	28	29	34
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	0.28	0.62	0.40
pH	SU	6.28	6.62	6.18	6.46	5.81	6.37	5.74	5.91
Sulfate	mg/L	740	1100	1100	1100	1200	1300	1370	1590
Total Dissolved Solids (TDS)	mg/L	1800	1900	400	1900	2200	2300	2120	2370
CCR Appendix IV									
Antimony	mg/L	<0.012		<0.0016		<0.001		<0.001	<0.0010
Arsenic	mg/L	<0.3		<0.002		<0.001		<0.001	0.0005 J
Barium	mg/L	0.018		<0.2		0.019		0.0146	0.0198
Beryllium	mg/L	<0.008	<0.005	<0.0016		<0.001		0.0011	0.0003 J
Cadmium	mg/L	<0.01		<0.00054		<0.002 J		0.0015	0.0016
Chromium	mg/L		<0.01	<0.014		<0.003		<0.0015	<0.0015
Cobalt	mg/L	<0.01	0.0007 J	<0.01		<0.001		0.0017	0.0052
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	0.28	0.62	0.40
Lead	mg/L	<0.01	<0.01	<0.0062		<0.0075		<0.001	0.0007 J
Lithium	mg/L	<0.1 J		<0.08		<0.1 J		0.0206	0.0148
Mercury	mg/L	<0.0002		<0.0002		<0.0002		<0.0002	<0.00020
Molybdenum	mg/L	<0.005		<0.01		<0.001		<0.0015	<0.0015
Radium 226	pCi/L	0		<0.149		0.0467			<0.02
Radium 228	pCi/L	0.443		0.553		0.176			2.51
Radium, 226/228 Combined	pCi/L	0.443		0.553		0.222			2.53
Selenium	mg/L	<0.002	0.0055	<0.001		0.0031		<0.001	<0.0010
Thallium	mg/L	<0.05	<0.05	<0.00094		<0.05		<0.002	0.0090

Notes:
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mg/L= miligram per liter
pCi/L= picocurries per liter
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"J" indicates the result is estimated

	Well ID	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3
	Sample Data	3/23/2017	4/3/2017	5/25/2017	6/22/2017	6/29/2017	7/24/2017	8/1/2017	8/31/2017	3/22/2018
	Sample Purpose	Background	Background	Background	Background	Background	Background	Background	Background	Detection Monitoring
ANALYTE	Unit									
CCR Appendix III										
Boron	mg/L	0.11	0.089	0.081	0.057	0.085	0.083	0.09	0.09	0.078
Calcium	mg/L	34	29	45	93	30	32	34	33	34
Chloride	mg/L	100	120	140	220	66	110	120	110	110
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH	SU	5.99	5.96	6.03	6.08	6.01	5.96	6.02	6.13	6.1
Sulfate	mg/L	120	180	190	300	73	130	140	110	110
Total Dissolved Solids (TDS)	mg/L	680	820	1400	560	570	720	630	1000	700
CCR Appendix IV										
Antimony	mg/L	0.00022 J	<0.0002	<0.005	0.00026 J	0.00091 J	<0.005	<0.0002	<0.005	
Arsenic	mg/L	<0.005	0.0088	0.0076	0.0061	<0.005	0.0093	0.0062	0.0069	
Barium	mg/L	0.072	0.059	0.059	0.061	0.065	0.064	0.057	0.058	
Beryllium	mg/L	<0.0002	<0.0002	<0.005	<0.0002	<0.0002	<0.005	<0.0002	<0.005	
Cadmium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Chromium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Cobalt	mg/L	0.11	0.12	0.091	0.037	0.11	0.12	0.1	0.11	
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	mg/L	<0.005	0.0056	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Lithium	mg/L	<0.003	0.0095 J	<0.1	0.12	0.012 J	<0.1	0.028 J	<0.1	
Mercury	mg/L		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Molybdenum	mg/L	0.00037 J	0.00045 J	<0.005	<0.0002	<0.0002	<0.005	0.00047 J	<0.005	
Radium 226	pCi/L	1.64	0.715	1	0.366	0.317	0.19	0.43	0.41	
Radium 228	pCi/L	<0.438	1.92	<0.633	0.42	<0.397	0.77	2.42	0.77	
Radium, 226/228 Combined	pCi/L	1.64	2.635	1	0.786	0.317	0.96	2.88	1.18	
Selenium	mg/L	0.013	0.011	0.016	0.028	0.013	0.016	0.012	0.022	
Thallium	mg/L	<0.025	<0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	

Notes:
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"J" indicates the result is estimated

	Well ID	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3	EP-3
	Sample Data	8/27/2018	1/11/2019	6/27/2019	1/30/2020	6/22/2020	1/21/2021	5/31/2021	8/30/2021
	Sample Purpose	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Corrective Action Monitoring	Corrective Action Monitoring
ANALYTE	Unit								
CCR Appendix III									
Boron	mg/L	0.082	0.033	<0.08	<0.5	0.024	<0.25	0.0556	0.0750
Calcium	mg/L	38	94	76.3	40	80	66	40.6	35.5
Chloride	mg/L	140	240	150	140	330	230	127	129
Fluoride	mg/L	<0.5	<0.5	<25	<0.5	<0.5	0.35	0.22	0.17
pH	SU	6.1	6.11	5.98	6.31	6.01	6.24	6.13	6.07
Sulfate	mg/L	150	340	160	190	410	300	148	114
Total Dissolved Solids (TDS)	mg/L	690	750	580	750	960	1500	692	672
CCR Appendix IV									
Antimony	mg/L	<0.012		<0.0016		<0.001		<0.001	<0.0010
Arsenic	mg/L	<0.3		0.0057	0.0067	0.0059	<0.1	0.0075	0.0076
Barium	mg/L	0.064		<0.2		0.041		0.0819	0.101
Beryllium	mg/L	<0.008	0.00033 J	<0.00015		<0.001		<0.001	<0.0010
Cadmium	mg/L	<0.01		<0.00054		<0.002		<0.001	<0.0010
Chromium	mg/L	<0.01	<0.01	<0.014		<0.003		<0.0015	<0.0015
Cobalt	mg/L	0.088	0.044	0.032	0.087	0.047	0.031	0.0912	0.0882
Fluoride	mg/L	<0.5	<0.5	<25	<0.5	<0.5	0.35	0.22	0.17
Lead	mg/L	<0.01	<0.01	<0.0062		<0.0075 J		<0.001	<0.0010
Lithium	mg/L	<0.1 J		0.119		0.12		0.0314	0.0169
Mercury	mg/L	<0.0002		<0.0002		<0.0002		<0.0002	<0.00020
Molybdenum	mg/L	<0.005		<0.01		<0.001		<0.0015	<0.0015
Radium 226	pCi/L	0.679		0.0839		0.513			<0.27
Radium 228	pCi/L	0.717		0.477		0.304			<0.5
Radium, 226/228 Combined	pCi/L	1.396		0.561		0.817			<0.77
Selenium	mg/L	<0.002	<0.0028	<0.001		<0.001		<0.001	<0.0010
Thallium	mg/L	<0.05	<0.05	<0.00094		<0.05		<0.002	0.0019 J

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

	Well ID	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4
	Sample Data	3/23/2017	4/3/2017	5/25/2017	6/22/2017	6/29/2017	7/24/2017	8/1/2017	8/31/2017	3/22/2018
	Sample Purpose	Background	Background	Background	Background	Background	Background	Background	Background	Detection Monitoring
ANALYTE	Unit									
CCR Appendix III										
Boron	mg/L	14	23	14	11	13	11	14	11	13
Calcium	mg/L	190	170	170	150	190	160	150	150	200
Chloride	mg/L	460	290	380	430	250	180	210	210	200
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH	SU	5.51	5.88	5.77	5.8	5.81	5.8	5.8	5.85	6.04
Sulfate	mg/L	620	530	660	730	410	290	330	340	320
Total Dissolved Solids (TDS)	mg/L	2300	2300	2400	2000	2100	2300	2200	2300	2100
CCR Appendix IV										
Antimony	mg/L	0.00028 J	<0.0002	<0.005	0.00033 J	0.00051 J	<0.005	<0.0002	<0.005	
Arsenic	mg/L	0.035	0.039	0.037	0.053	0.044	0.044	0.035	0.049	
Barium	mg/L	0.035	0.026	0.028	0.029	0.037	0.026	0.031	0.023	
Beryllium	mg/L	<0.0002	<0.0002	<0.005	<0.0002	<0.0002	<0.005	<0.0002	<0.005	
Cadmium	mg/L	<0.005	0.0052	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Chromium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Cobalt	mg/L	0.39	0.41	0.41	0.44	0.34	0.41	0.42	0.38	
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	mg/L	0.009	0.013	0.011	0.017	<0.01	0.011	0.012	0.012	
Lithium	mg/L	0.0044 J	0.0062 J	<0.1	0.0047 J	0.0063 J	<0.1	0.0053 J	<0.1	
Mercury	mg/L		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Molybdenum	mg/L	0.00092 J	0.0011 J	<0.005	<0.0002	0.00058 J	<0.005	0.001 J	<0.005	
Radium 226	pCi/L	1.1	1.17	<0.0457	0.18	<0.219	0.3	0.15	0.33	
Radium 228	pCi/L	<0.442	<0.353	0.864	0.897	<0.490	0.44	0.96	2.14	
Radium, 226/228 Combined	pCi/L	1.1	1.17	0.864	1.077	<0.490	0.74	1.11	2.47	
Selenium	mg/L	0.13	0.12	0.13	0.2	0.13	0.13	0.11	0.16	
Thallium	mg/L	<0.025	0.065	0.092	0.094	0.058	<0.05	0.075	0.075	

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pCi/L= picocurries per liter
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"J" indicates the result is estimated

ANALYTE	Unit	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4
	Well ID	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4	EP-4
	Sample Data	8/27/2018	1/11/2019	6/27/2019	1/30/2020	6/22/2020	1/21/2021	5/31/2021	8/30/2021
	Sample Purpose	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Corrective Action Monitoring	Corrective Action Monitoring
CCR Appendix III									
Boron	mg/L	11	15	11.5	11	9.9	10	11.9	11.8
Calcium	mg/L	150	140	159	170	150	140	179	162
Chloride	mg/L	310	420	440	370	380	390	484	446
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.1	0.09 J
pH	SU	5.85	6.07	5.86	5.94	5.79	5.91	5.79	5.70
Sulfate	mg/L	520	750	710	630	610	580	670	565
Total Dissolved Solids (TDS)	mg/L	1900	2000	130	2000	2500	1900	1860	1750
CCR Appendix IV									
Antimony	mg/L	<0.012		<0.0016		<0.001		<0.001	<0.0010
Arsenic	mg/L	<0.3		0.026 J	0.019	0.014	<0.1	0.0075	0.0073
Barium	mg/L	0.023		<0.2		0.027		0.0248	0.0270
Beryllium	mg/L		<0.0055	<0.0015		<0.005		<0.001	<0.0010
Cadmium	mg/L	<0.01		<0.00054		<0.002		<0.001	<0.0010
Chromium	mg/L	0.011	<0.01	<0.014		<0.003 J		<0.0015	<0.0015
Cobalt	mg/L	0.31	0.41	0.28	0.26	0.33	0.32	0.287	0.326
Fluoride	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.1	0.09 J
Lead	mg/L	0.015	<0.01	<0.0062		0.018	<0.05	<0.001	<0.0010
Lithium	mg/L	<0.1 J		<0.08		<0.1 J		<0.003	0.0023 J
Mercury	mg/L	<0.0002		<0.0002		<0.0002		<0.0002	<0.00020
Molybdenum	mg/L	<0.005		<0.01		<0.001		<0.0015	<0.0015
Radium 226	pCi/L	0.262		0.77		0.163			<0.11
Radium 228	pCi/L	0.79		0.929		0.41			<0.14
Radium, 226/228 Combined	pCi/L	1.052		1.7		0.573			<0.25
Selenium	mg/L	0.021	<0.0028	<0.001		0.0012		<0.001	<0.0010
Thallium	mg/L	0.14	0.18	<0.00094		<0.05 J		<0.002	0.0012 J

Notes:
SU= Standard Units
mg/L= miligram per liter
pCi/L= picocurries per liter
"<" indicates the result was not detected, the laboratory reporting limit is provided
"J" indicates the result is estimated

Prepared by: DPJ
Checked by: DFSC
Reviewed by: MAH

APPENDIX G

Corrective Action and Selected Remedy Plan

Emery Pond

Corrective Action and Selected Remedy Plan, Including GMZ Petition

Marion Power Plant
Southern Illinois Power Cooperative
Marion, Williamson County, Illinois

March 29, 2019
revised March 30, 2021

HANSON
Engineering | Planning | Allied Services

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Figures and Tables

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Abbreviations

BGS – below ground surface
CAP – Correction Action Plan
CCR – Coal Combustion Residuals
CFR – Code of Federal Regulations
COC – Contaminant of Concern
EPA – Environmental Protection Agency
GMZ – Groundwater Management Zone
GPS – groundwater protection standard [after 40 CFR 257.95(h)]
IAC – Illinois Administrative Code
NELAP – National Environmental Laboratory Accreditation Program
mg/L – milligram per liter
SSL – statistically significant level
ug/L – micrograms per liter

1. Introduction

Marion Power Plant (Plant) is owned and operated by the Southern Illinois Power Cooperative (SIPC). The Emery Pond is a coal combustion residuals (CCR) impoundment at the Plant and has functioned from the late-1980's to the present as a storm water storage structure for drainage from the adjacent Plant area, including the more recent Gypsum Loadout Area. The Emery Pond and adjacent Gypsum Loadout Area are referred to in this Plan as the Site.

This Plan outlines the selection of a remedy to address the 35 IAC Part 620 exceedances due to the Site alleged in Illinois EPA's Violation Notice No. 6364 issued on July 3, 2018, and any additional detected Part 620 exceedances attributable to the Site, as further described below. The selected remedy for impacted groundwater is also consistent with the federal CCR rule, including 40 CFR 257.97 and 40 CFR 257.98. The remedy selected in this plan includes both active remedial actions, including the removal of CCR from the Site, and a request for a groundwater management zone (GMZ) for a limited time to allow the active corrective action to achieve relevant Part 620 groundwater quality standards. As discussed further below, the impacted groundwater has not measurably impacted nearby surface waters, specifically Lake of Egypt, and no such impact is expected during the requested GMZ period.

Figure 1 shows the Site location on a USGS Topographic Map and Figure 2 depicts the Emery Pond and other features/units at the Site.

2. Groundwater Impacts

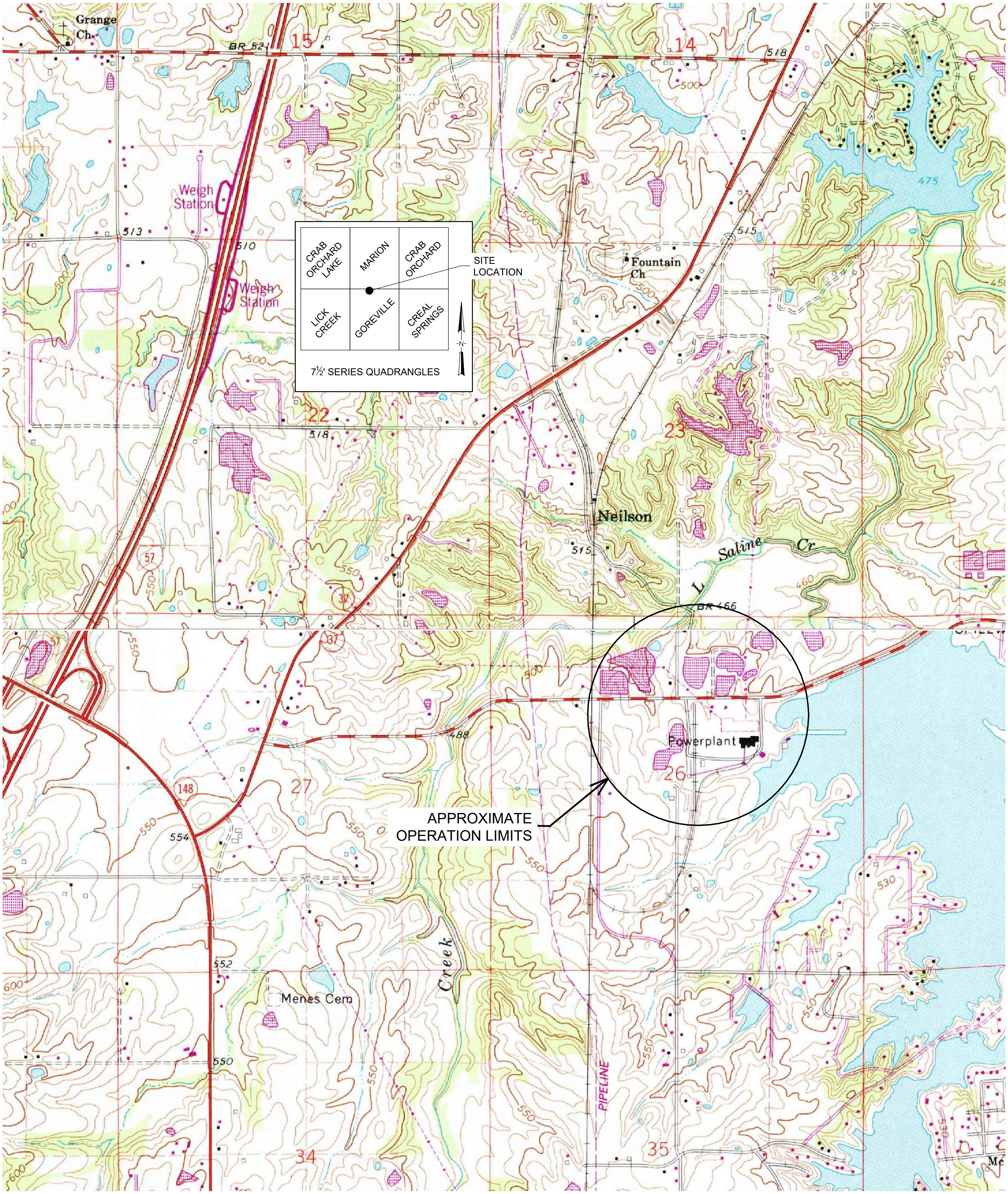
2.1 Site Hydrogeology

The site is located in the Shawnee Hills Section within the Interior Low Plateaus (physiographic) Province (Leighton et al., 1948). Site geology consists of glacially derived deposits of the Illinoisan Stage overlying Pennsylvanian Age bedrock. Table 1 list the hydro- and litho-stratigraphic units with their descriptions located within 50 feet of the surface at the Site (Willman et al, 1995 and Berg & Kempton, 1988).

Table 1. Site Geologic/Hydrogeologic Units

Litho-stratigraphic Unit	Hydro-stratigraphic Unit	Lithologic Description
Peoria/Roxana Silt	Unlithified Unit	light yellow tan to gray, fine sandy silt
Glasford Formation (undifferentiated)		silty/sandy diamictons with thin lenticular bodies of silt, sand, and gravel
Caseyville Formation	Bedrock Unit	primarily sandstone with shales

The current groundwater monitoring wells for the Site are all screened at the Unlithified/Bedrock Units interface. This zone has relatively low hydraulic conductivity (< 1×10^{-4} cm/s) and only a few feet (5-10 ft.) of saturated thickness. Because of this low hydraulic conductivity, groundwater in the Unlithified Unit and upper portion of the Bedrock Unit (approximately the upper 11 ft.) is classified as Class II: General Resource Groundwater. At the request of Illinois EPA, compliance will be evaluated against the Class I: Potable Resource Groundwater standards. Groundwater in the rest of the explored Bedrock Unit is Class I: Potable Resource Groundwater.



SCALE

2,000 0 2,000 4,000

1 inch = 2,000 feet Contour interval = 10 feet

Approximate Site Location: n½ of Section 26; T10S., R2E.

SITE LOCATION MAP

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 1

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I:\18JOBS\18E0022A\ADMIN\14-REPORTS\HYDROGEO\FIG_1SITEMAP_20190314.DWG

EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

SCALE: 1 inch equals 60 feet

0 ft. 60 ft. 120 ft. 180 ft. 240 ft.

HANSON Hanson Professional Services Inc.	Site Features Map
	EMERY POND MARION POWER PLANT WILLIAMSON CO., ILLINOIS
	HANSON NO. 18E0022A FIGURE NO. 2

The following reasons are used for these classifications:

The Unlithified Unit is classified as Class II groundwater because:

1. The Unit does not contain a sand, gravel, or sand & gravel deposit greater than 5 ft. thick, and
2. The slug test results (see Hanson, 2019a and 2019b) are less than 1 x 10^{-4} cm/s.

The upper (approximately 11 ft.) of the Bedrock Unit is classified as Class II groundwater because:

1. The Unit contains less than 10 ft. of sandstone,
2. The Unit contains less than 15 ft. of fractured carbonate rock, and
3. The packer test results (see Hanson, 2019a) are less than 1 x 10^{-4} cm/s.

The lower Bedrock Unit is classified as Class I groundwater because:

1. The Unit has two continuous segments of sandstone that exceed 10 ft. in thickness,
2. Although the packer test results (see Hanson, 2019a) are less than 1 x 10^{-4} cm/s.

Although groundwater is present in the Unlithified and upper/lower Bedrock Units, there is no groundwater use associated with any of the operations at the Marion Power Plant. Additionally, given existing groundwater data and because SIPC owns the property immediately surrounding the Marion Power Plant and Lake of Egypt, there is no off-site migration of groundwater. The nearest water well is located at the Lake of Egypt County Club, approximately 2,500 feet south southeast from Emery Pond and is screened from 65-90 feet below ground surface. This water well is also located on SIPC property.

For the purposes of the Emery Pond corrective action and closure work, SIPC has agreed to monitor and conduct corrective action for the purpose of achieving compliance with Class I groundwater quality standards.

2.2 Groundwater Monitoring History

Five monitoring wells were installed to meet the monitoring requirements of the US EPA's CCR Rule, background well EBG and downgradient wells EP-1, EP-2, EP-3, and EP-4 (see Figure 2). Groundwater monitoring at the Site has been ongoing since evaluation of background water quality began in 2017, consistent with 40 CFR 257.90. SIPC conducted detection monitoring in compliance with the CCR Rule (40 CFR 257.94). The results of detection monitoring triggered assessment monitoring (40 CFR 257.95) in 2018 for Appendix IV constituents.

The Illinois EPA issued Violation Notice No. 6364 on July 3, 2018. This notice alleged the exceedances of the Class I: Potable Use Groundwater Standards (35 IAC 620.410) summarized in Table 2. As identified in the Hydrogeologic Investigation Report (Hanson, 2019a) and Hydrogeologic Investigation Addendum (Hanson, 2019b), groundwater at the Site has been classified as Class II: General Resource Groundwater (35 IAC 620.240) in the Unlithified Unit and the upper (approx. 11 ft.) of the Bedrock Unit.

Table 2. Exceedances of the Class I: Potable Resource GW Standards

Parameter	Class I Std.	Units	EP-1	EP-2	EP-3	EP-4
Arsenic	0.010	mg/L				X
Boron	2.0	mg/L				X
Cadmium	0.005	mg/L	X			X
Chloride	200	mg/L			X	
Lead	0.0075	mg/L				X
pH	6.5 – 9.0	SU		X	X	X
Selenium	0.050	mg/L				X
Sulfate	400	mg/L	X	X		X
TDS	1,200	mg/L	X	X	X	
Thallium	0.002	mg/L				X

An extent of contamination study was performed in February 2019. The isopleth maps showing the results of that study are in Appendix C. Seven (7) linear sets of borings were drilled (direct push method) in a radial pattern around the Site at approximately 25 ft. intervals outward from the Emery Pond (see Figure 2). Groundwater samples were collected at each boring and analyzed for total analytes of the Class I inorganic parameter list. During sample collection, several borings were found to be either dry or were unable to produce sufficient volume of water for sampling. These borings were: DP1a, DP1b, DP2a, DP4a, DP4b, DP4c, and DP6b. An additional map, showing the location of each direct push boring, its bottom elevation, and the top of bedrock elevation (assumed to be the bottom of Emery Pond) is also included in Appendix C.

Appendix A contains the tabulated groundwater data and Appendix B and Appendix C contain the graphical groundwater data for the COCs identified and discussed below. While Hanson contends that the groundwater relevant to the Site is Class II under Part 620, it recognizes Illinois EPA's allegations of Class I standards. Accordingly, the below evaluations of Site water quality compare groundwater investigation results to both the Class I and Class II Part 620 groundwater standards and/or the Site Groundwater Protection Standards (GPS) under the federal CCR rule [40 CFR 257.95(h)], as applicable. Parameters with only one exceedance at a well are treated as a false positive result or not a confirmed exceedance[†] (e.g., Chromium, Lithium, etc.) assuming a 95% confidence limit and observable data trends.

2.2.1 Part 257, Appendix III Parameters

2.2.1a Boron

Boron (CAS# 7440-42-8) concentrations exceeded the 35 IAC 620.410 Class I and Class II Standard (2.0 mg/L) at EP-4 since the well was first sampled. Boron has exceeded the Site's background water quality at EP-1, EP-2, and EP-4. Boron had a high concentration in the Emery Pond water sample (72 mg/L). The Boron Concentration Map (in Appendix C) shows the pattern of elevated Boron concentrations at the Site. Note that high concentrations were observed in Line 6 (DP6a and DP6c) in Line 7 (DP7c), in EP-4, and Line 1 (DP1c and DP1e). Migration of Boron does not appear to be to the south of the Emery Pond.

[†] The alternative source demonstration in 40 CFR 257.94(e)(2) allows for the evaluation of natural variation in groundwater quality. Should a re-sample show the previous result was not statistically significant, then that result is a false positive or not a confirmed exceedance.

2.2.1b Calcium

Calcium (CAS# 7440-70-2) does not have a 35 IAC 620 Class I or Class II Standard. However, Calcium has exceeded the Site's background water quality at EP-1, EP-2, and EP-4. The Calcium Concentration Map (in Appendix C) shows the pattern of elevated Calcium concentrations at the Site. Emery Pond water had a Calcium concentration of 899 mg/L, while the gypsum leachate extract had a concentration of 629 mg/L. Calcium concentrations along the south-side of the Emery Pond are generally lower than the pond water or gypsum (in the low- to mid-hundreds). Along the north-side of the pond, concentrations are much higher (exceeding the pond and gypsum concentrations), with an extreme value at DP1e of 16,700 mg/L.

2.2.1c Chloride

Chloride (CAS# 7782-50-5) concentrations exceeded the 35 IAC 620 Class I and Class II groundwater standard (200 mg/L) at EP-4. Chloride has exceeded the Site's background water quality at EP-4 and intermittently at EP-3. The Chloride Concentration Map (in Appendix C) shows the pattern of elevated Chloride concentrations at the Site. Emery Pond had a Chloride concentration of 2190 mg/L. The isopleth map shows high concentrations at DP5a, DP5b, DP6a, DP7c, and EP4. Again, the south side of the Emery Pond generally has concentrations below the Class I and Class II Standards.

2.2.1d pH

pH (CAS# 13967-14-1) has concentrations below the 35 IAC 620 Class I and Class II (lower) groundwater standard (6.5 SU) at EP-4, EP-3, and intermittently at EP-2. pH falls below the Site's lower background water quality limit at EP-4, EP-3, and intermittently at EP-2. The pH Concentration Map (in Appendix C) shows the pattern of pH concentrations at the Site. The pH Isopleth Map shows the historic area of the Emery Pond with pH levels above both the upper-Class II Standard and the upper GPS at DP5a and DP5b. Conversely, pH levels below the lower Class II Standard and lower background water quality limit are found at EP-3, EP-4, DP2g, and DP2h. The Emery Pond had a pH concentration of 7.77 SU.

2.2.1e Sulfate

Sulfate (CAS# 14996-02-2) concentrations have consistently exceeded the 35 IAC 620 Class I and Class II groundwater standard (400 mg/L) at EP-1, EP-2, and EP-4. Sulfate has exceeded the Site's background water quality limit at all four downgradient monitoring wells and upgradient well, EBG for the past two rounds. The Emery Pond had a concentration of 2,000 mg/L and the gypsum leachate had a concentration of 1,350 mg/L. The Sulfate Concentration Map (in Appendix C) shows the pattern of elevated Sulfate concentrations at the Site. Several exploration lines have concentrations that are higher at further distances from the Emery Pond than those closer (see Line 1, Line 3, and Line 6).

2.2.1f Total Dissolved Solids (TDS)

TDS (CAS# 10-05-2) concentrations have consistently exceeded the 35 IAC 620 Class I and Class II groundwater standard (1,200 mg/L) at EP-1, EP-2, and EP-4 and intermittently at EP-3. TDS has also exceeded the Site's background water quality limit at all four downgradient monitoring wells. The TDS Concentration Map (in Appendix C) shows the pattern of elevated TDS concentrations at the Site. This isopleth map displays a similar pattern as Sulfate, whereby some exploration lines have higher concentrations at distance from the Emery Pond. TDS concentrations in the Emery Pond were 6,540 mg/L and the gypsum leachate was 2,140 mg/L.

2.2.2 Part 257, Appendix IV Parameters

2.2.2a Arsenic

Arsenic (CAS# 7440-38-2) concentrations have not exceeded the 35 IAC 620.420 Class II Standard (0.2 mg/L) but did exceed and Class I Standard (0.01 mg/L) at EP-4. Arsenic has exceeded the Site's GPS at EP-3 and EP-4. The Arsenic concentration in the Emery Pond water sample was only 0.0025 mg/L and the gypsum leachate was <0.01 mg/L. The Arsenic Concentration Map (in Appendix C) shows the pattern of elevated Arsenic concentrations at the Site.

2.2.2b Lead

Lead (CAS# 7439-92-1) concentrations have not exceeded the 35 IAC 620 Class II Standard (0.1 mg/L) at any of the monitoring wells but did exceed the Class I Standard at EP-4. Lead has intermittently had concentrations above the Site's GPS of 0.015 mg/L (twice since the end of 2016, but these were not confirmed exceedances that would establish an SSL of the GPS). The Lead concentration in the Emery Pond water sample was only 0.0026 mg/L and the gypsum leachate was <0.0075 mg/L. The Lead Concentration Map (in Appendix C) shows the elevated Lead concentrations around EP-4.

2.2.2c Selenium

Selenium (CAS# 7782-49-2) concentrations exceeded the 35 IAC 620 Class I and Class II Standard (0.05 mg/L) at EP-4 since the well was first sampled. Selenium has also been detected during the background monitoring period above the Site's GPS but has not been observed at an SSL above the GPS at EP-3 and EP-4. The Selenium concentration in the Emery Pond water sample was only 0.082 mg/L and the gypsum leachate was <0.0462 mg/L. The Selenium Concentration Map (in Appendix C) shows the pattern of elevated Selenium concentrations around the Site.

2.2.2d Cobalt

Cobalt (CAS# 7440-48-4) concentrations have not exceeded the 35 IAC 620 Class I or Class II groundwater standards (1.0 mg/L). However, Cobalt has exceeded the Site's GPS at EP-2, EP-3, and EP-4. The Cobalt Concentration Map (in Appendix C) shows the pattern of elevated Cobalt concentrations at the Site. Note that there are two extent borings with high Cobalt, DP1e and DP6a. Both have concentrations above the Emery Pond water and gypsum leachate, 0.145 mg/L and <0.005 mg/L, respectively. No obvious source for these exceedances exists and there is also no apparent connection between the two borings.

2.2.2e Cadmium

Cadmium (CAS# 7440-43-9) concentrations have not exceeded the 35 IAC 620.410 Class II: General Resource groundwater standard (0.05 mg/L), but Cadmium has been reported above the GPS (0.005 mg/L) once (not a confirmed exceedance that would establish an SSL above the GPS). Note that there are two extent borings with high Cadmium, DP1e and DP6a. Both have concentrations above the Emery Pond water and gypsum leachate, 0.019 mg/L and <0.002 mg/L, respectively. No obvious source for these Class II exceedances exists and there is also no apparent connection between the two borings.

2.2.2f Thallium

Thallium (CAS# 7440-28-0) concentrations may have exceeded the 35 IAC 620 Class I and Class II: groundwater standard (0.002 and 0.02 mg/L, respectively) at all the monitoring wells, because the laboratory performing the analyses had a reporting limit of 0.050 mg/L. However, Thallium has had been detected during the background monitoring period above the Site's GPS but has not been observed at an SSL above the GPS. The Thallium Concentration Map (in Appendix C) shows the pattern of elevated Thallium concentrations at the Site. Note that both the Emery Pond and gypsum leachate have concentrations at or below 0.002 mg/L. Therefore, it is unlikely that the Thallium exceedances are related to a release from the Site.

2.2.3 Other 35 IAC 620 Exceedances

The February 2019 investigation identified three other parameters that exceeded the Class I and Class II groundwater standards – Iron, Manganese, and Zinc.

2.2.3a Iron

Iron (CAS# 7439-89-6) concentrations were observed above the Class I and Class II groundwater standard (5.0 mg/L) during the extent investigation. Iron exceedances were observed at all the extent borings plus EP-3 and EP-4. The background monitoring well, EBG, had an Iron concentration that almost reached the Class II Standard (EBG Iron = 4.4 mg/L), but the Emery Pond and gypsum leachate samples had Iron concentrations of 0.899 and 0.0719 mg/L. This implies that Iron is naturally occurring at these elevated concentrations, likely related to the residual iron in the bedrock and RedOx conditions at the Site.

2.2.3b Manganese

Manganese (CAS# 7439-96-5) concentrations were observed above the Class I and Class II groundwater standards (0.150 mg/L and 10.0 mg/L, respectively) during the extent investigation. Manganese exceedances were observed at many of the extent borings plus EP-4. The Emery Pond and gypsum leachate samples had Manganese concentrations of 4.56 and 0.0444 mg/L, respectively. This implies that Manganese, like Iron, at these observed concentrations are naturally occurring, and not related to a release at the Site.

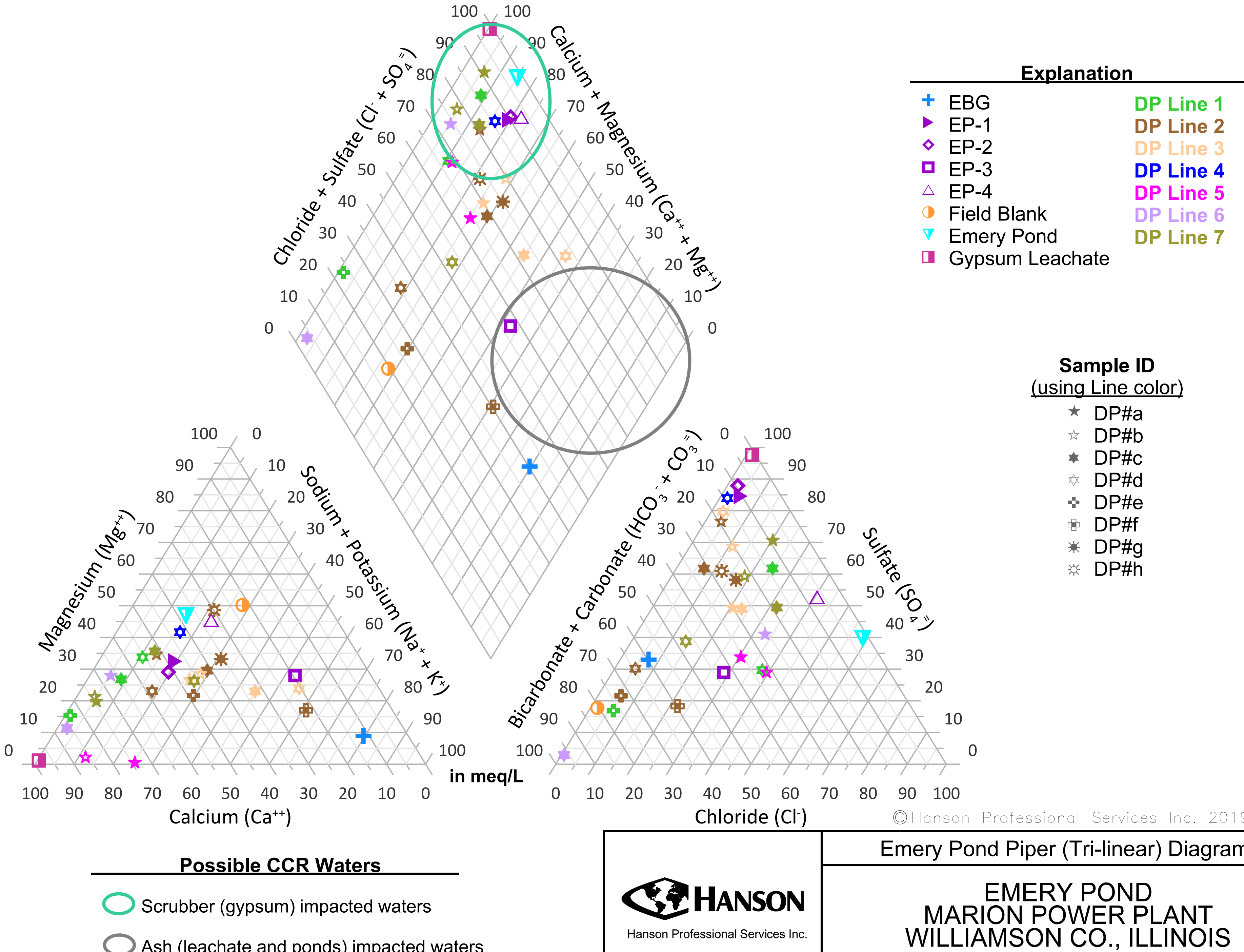
2.2.3c Zinc

Zinc (CAS# 7439-66-6) concentrations were observed above the Class II General Resource groundwater standard (5.0 mg/L) during the extent investigation. Zinc exceedances were observed at three extent borings, DP1e, DP7a, and DP7b. The Emery Pond and gypsum leachate samples had Zinc concentrations of 0.215 and <0.01 mg/L, respectively. The low source water concentrations indicate that these exceedances are not related to a release at the Site.

2.3 Major Cation and Anion Geochemistry

Figure 3 presents the major cation and anion data from the Emery Pond monitoring wells, investigation borings, and potential source water samples. Also shown are ellipses representing possible CCR source waters. Many of the sample results lie in the area identified as Calcium-Chloride type waters. Note that the gypsum leachate sample lies at the apex of this area and is further delineated by the possible scrubber (gypsum) impacted water ellipse. Three of the five monitoring wells also lie in this area (EP-1, EP-2, and EP-4).

The other two monitoring wells (EP-3 and upgradient well, EBG), lie within or near the other CCR source water ellipse. This area to the right of the diamond is identified as Sodium-Chloride type waters and is more indicative of ash impacted waters (either ash leachate or pond water). The investigation borings identified between the two ellipses are likely indicative of mixing of water types from the background waters to the impacted waters. The conclusion drawn from the cation/anion geochemistry is that gypsum is impacting the Emery Pond monitoring system.



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Emery Pond Piper (Tri-linear) Diagram

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE 3

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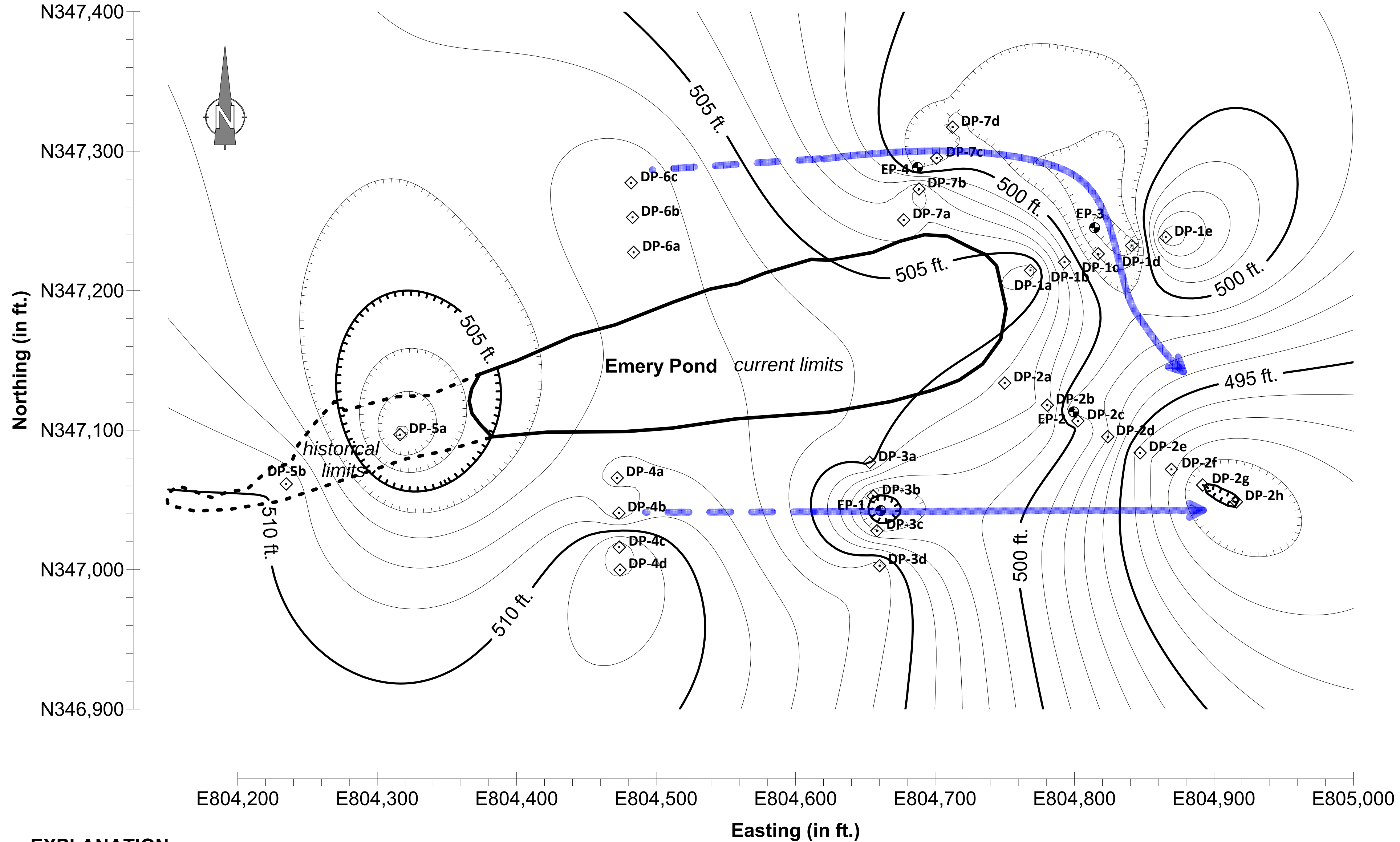


EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

HANSON
Hanson Professional Services Inc.

Preferential Flow Paths (Bedrock Surface)

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE 4

2.4 Groundwater Monitoring Observations

Several overall trends can be observed in the graphs and maps found in Appendix B and Appendix C, including:

1. Several investigation borings have higher concentrations at points further from the Emery Pond than those borings that are closer (e.g., Boron at DP1e and DP7c and Sulfate at DP3b and DP6c). Hanson believes that groundwater flow is controlled by the bedrock topography and the amount and type of fill materials that appear to have been used along the north and east side of the Emery Pond (see Figure 4 for flow paths).
2. Increasing concentration trends can be observed in several wells for many COCs. The most notable is Sulfate, which has had three consecutive increases in concentration over the past four sampling events. Even EBG has seen concentration increases, although to a lesser degree.

   Note that the Groundwater Protection Evaluation model also shows increasing concentrations prior to the implementation of clean closure. In fact, the model shows concentrations continuing to increase for 2-3 years after CCR removal activities are complete, but then reduces over time.
3. pH levels vary dramatically across the Site, from over 10 SU in the bottom ash fill beneath the Gypsum Loadout Area to just above 6 SU at select points east of the Emery Pond. Hanson is unsure of the mechanism that is buffering the pH levels from one side of the Site to the other.

3. Assessment of Corrective Measures

3.1 Corrective Measures Alternatives

An Assessment of Corrective Measures (ACM) is required by 40 CFR 257.96. This requires an evaluation of the available options to mitigating groundwater impacts at the Site. An evaluation addressing the requirements of 257.96 and 257.97 as applied to remedy options is discussed in this Section and Sections 4 and 5, and is summarized in Table 4, Table 5, and Table 6. This evaluation also supports the selected remedy as an adequate and appropriate remedy to address any Part 620 exceedances due to the Site, including those alleged in Illinois EPA’s 2018 Violation Notice.

The assessment of corrective measures must include an analysis of the effectiveness of potential corrective measures in meeting the requirements and objectives of the remedy as described under § 257.97, including at least the following:

- The 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;
- The time required to begin and complete the remedy;
- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

Corrective Measures under review are the following techniques:

Do nothing	Close in Place	Clean Close	Barrier Wall	
Monitored Natural Attenuation		Pump and Treat	Pump Station	Retrofit

The next subsection will discuss each of these alternatives.

3.1.1 Do Nothing

Performing no further action at Emery Pond is a potential corrective measure. It takes no time to implement or complete. However, it does nothing to reduce impacts, control exposure, or limit residual contamination. It also opens the owner to additional scrutiny by Federal and State regulators as well as third-party intervention.

This remedy is not protective of human health, nor does it provide a clear path to attaining the GPS or controlling releases. The CCR is not removed or managed. Because of this, there is an exposure potential.

3.1.2 Close in Place

Leaving the CCR in place and providing an isolating cover system is one of the more commonly used remedy alternatives, especially for larger impoundments. This requires construction of a final cover system that restricts the amount of water infiltration into the CCR and thereby limits the amount of leachate generated. Implementation requires a specialty contractor for the placement and welding of a geosynthetic liner and a regular dirt contractor for placement of the recompacted soil liner and vegetative soil later. The time required to install the cover system varies by the size of the project. For Emery Pond, installation would take between 6-8 weeks. This project would require a new construction permit from Illinois EPA Bureau of Water, which would add 90+ days to the schedule. A construction permit under the proposed Part 845 regulations is not needed if completed prior to July 2021. A down side to close in place is loss, or at least reduction, of storm water storage, which is the primary future function of the new Storm Water Basin.

This potential corrective measure is limited in effectiveness because the potential future groundwater contact with the CCR could prevent attaining the GPS.

3.1.3 Clean Close

Removal of CCR from the Emery Pond is perhaps the most effective and efficient corrective measure for this small pond. The small size of Emery Pond makes this remedy more cost effective, practical, and efficient than at larger ponds, where transposition and disposal of huge amounts of CCR may take months or more, be impractical and create additional concerns and risks. Clean closure will remove CCR and thus any future impact to groundwater. Excavation of bottom sediments in Emery Pond and the removal of the Gypsum Loadout Area and CCR beneath the loadout area will have an immediate benefit to the Site groundwater. CCR will be transported offsite to a solid waste disposal facility in accordance with the proposed Part 845 regulations. Implementation of the plan and removal of CCR should be limited to a 4- to 6-week timeframe. At this time, no additional permitting should be needed (a water pollution control permit has already been received for the work, no additional NPDES permitting should be required, as discussed below, and a construction permit under the proposed Part 845 regulations is not needed, if closure is completed prior to July 2021), but there will be disposal fees associated with disposal of the CCR in a State permitted facility.

3.1.4 Barrier Wall

Barrier walls have been used for some time to protect groundwater from contaminated sources that are too large or too dangerous to economically remove. The most common type of barrier wall is a bentonite slurry wall, where an excavation is made, and a high-solids bentonite slurry is pumped into the excavation. The excavation is extended as bentonite slurry is added. There are some problems with barrier wall systems. First, they can be expensive to construct, with prices in the millions of dollars for even fractions of mile long walls. Secondly, the precipitation that lands within the confines of the wall must be managed to not overtop the barrier or cause additional releases of contaminants to the environment. Overtopping would be a concern for a slurry wall here because it would likely be adjacent to Lake of Egypt and raise the potential for exposure to the contaminants of concern in the lake. Third, a barrier wall likely provides the most return when CCR is left in place and where the CCR could continue to cause groundwater impacts. In that case, the barrier wall may mitigate such impacts. However, when the source CCR is removed, which would occur with the clean close option, a barrier wall provides far less benefit, especially if there is no identified groundwater receptor at risk. This is true for Emery Pond, as discussed in this report. Evidence indicates that even without a slurry wall, current groundwater is not impacting the surface waters of Lake of Egypt (see Section 6.3).

Another issue with constructing a slurry wall around Emery Pond are the underground utilities and foundations associated with the power plant. Utilities (electrical, water, sewer, fuel, etc.) would almost certainly have to be relocated or terminated before construction of the wall could begin with potential interruption to plant operations. Furthermore, excavations adjacent to a large existing structure (i.e., Unit 4 smoke stack) could cause foundation instability. Additional geotechnical investigations would need to be done to establish safe excavation practices prior to any slurry wall construction. Excluding any additional investigations or utility relocations, Hanson estimates an 8- to 12-week installation timeline for slurry wall construction, assuming it could be constructed at this location.

3.1.5 Pump and Treat

As with barrier walls, pump and treat systems have been implemented as a corrective action for decades. Either vertical well points or horizontal trenches can be used to collect groundwater. Although treatment for metals can be straightforward, treating anion contamination can be time consuming and expensive. For example, chloride and sulfate treatment must be done with reverse osmosis (RO). RO uses a semi-permeable membrane to remove many of the dissolved solids in groundwater. This process is slow, expensive, and still generates a waste water stream that could require additional treatment or disposal.

Although horizontal trenches may be more efficient, as noted above, subsurface conditions or utilities may prevent installation of a trench system. The use of well points to collect groundwater also has limits, especially in low hydraulic conductivity soils. The low hydraulic conductivity causes rapid drawdown at the well points with reduced zones of capture. Permitting for this system would require modifying the Site's NPDES permit to allow discharge of the collected groundwater or any treated groundwater. As is true for barrier walls, pump and treat systems typically provide far less benefit when CCR is removed, especially when there are no identified at-risk groundwater receptors. Time for installation could range from 4- to 8-weeks, depending on the system used.

3.1.6 Pump Station

Since the new Stormwater Basin's purpose was to manage storm water, the closure of Emery Pond causes the need to replace that storm water collection function. A pump station is a potential alternative to a new storm water detention basin. This measure must be implemented with either the clean close or close in place options. The pump station could conceptually replace a detention basin with a cistern or sump. The smaller storm water collection volume would require that a larger pump, sized for the appropriate precipitation event (or storm) be used to control flow and prevent storm water discharges directly to Lake of Egypt. With the larger capacity pump, a larger discharge pipe may also be required to get storm water routed through the NPDES discharge system. Storm water would then continue to be discharged via the pond system to NPDES Outfall 002. This option would require a change to the currently planned and permitted construction of the new Stormwater Basin, causing substantial additional delay in the work and no meaningful corrective action benefit. The benefits and limitations of the clean close and close in place options have been previously discussed.

3.1.7 Retrofit

A retrofit of the Emery Pond to a CCR compliant impoundment was also considered. A retrofit would include excavating the CCR present in Emery Pond and the FGD load out area and decontaminating the area, which would remove CCR and its likelihood to impact groundwater. The composite liner system would protect groundwater from future CCR impacts and the impoundment could continue to provide storm water detention. Additionally, a final cover system would need to be placed at the Gypsum Loadout Area after removal of the bed ash found there. This system would take more time than just lining or covering Emery Pond, likely 8- to 10-weeks. Removal of CCR would also require proper transportation and disposal at a State permitted facility. A Bureau of Water construction permit would also be needed and may require an Illinois Department of Natural Resources dam permit. However, because Unit 4 shut down in October 2020, a new CCR surface impoundment is no longer needed.

3.1.8 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) can work as a corrective measure for both organic and inorganic parameters. “Attenuation processes include ions, 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” (US EPA, 2015b). As noted by US EPA (2012), MNA works best when the source of contamination has been removed. Natural processes will, over time, remove or attenuate the small amounts of contaminants left in the soil and groundwater.

One or more of the MNA processes will be involved with the return to Class I groundwater standard for the inorganic constituents that show exceedances of Class I standards and Federal CCR rule standards. Dilution and dispersion were incorporated into the contaminant transport model used to assess Emery Pond (Hanson, 2020a), but none of the current site investigations or the contaminant transport modeling have looked at any of the “reactive” attenuation processes (e.g., sorption, chemical reaction, etc.) that could enhance clean up times. Further, that modeling shows that attaining the Part 257 GPS for Arsenic and Cobalt (the only two Appendix IV parameters with SSLs above the GPS) occurs much quicker. Table 3 lists the time to compliance at each of the downgradient monitoring wells. Note that Cobalt, at the various compliance points does not have exceedances after clean closure is achieved. MNA is an effective process here when paired with active source removal principally due to the small size of Emery Pond and the short duration of the CCR exposure (beginning 2007/08 with the construction of the Gypsum Loadout Area).

Table 3. Time to Reach Compliance at Monitoring Locations

Well ID	Arsenic SSL (time in years)	Arsenic Class I (time in years)	Cobalt SSL (time in years)	Cobalt Class I (time in years)
EP-1	8	2	n/a	n/a
EP-2	10	8	n/a	n/a
EP-3	n/a	n/a	n/a	n/a
EP-4	1	n/a	n/a	n/a

4. Evaluation of Potential Remedies

From the list of remedial option presented in the previous section, several of the more viable alternatives will be discussed here and in the next Section. Based on 40 CFR 257.97, remedies must:

- Be protective of human health and the environment;
- Attain the groundwater protection standard as specified pursuant to § 257.95(h);
- Control the source(s) of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems;
- Comply with standards for management of wastes as specified in § 257.98(d).

Based on the Site hydrogeology, effectiveness, identified risks, and constructability of the closure alternative, SIPC selected three options to further evaluate as part of the Groundwater Protection Evaluation: Closure by Removal with backfill, Closure by Removal with Composite Liner System, Closure by Removal with Composite Liner System and Perimeter Drain, and MNA. All these options meet the needs of the selection criteria for the following reasons:

- Protective of human health and the environment – removal of the CCR removes any probability of future releases from the source of contamination above the GPS. A barrier wall or additional pump and treat system is not warranted because this remedy removes the source, thus eliminating any future releases to be treated by a barrier wall or pump and treat system, and there are no identified at-risk groundwater receptors. Further a barrier wall or pump and treat system would require considerably more time to obtain approval and then construct and would substantially raise costs without any material demonstrated benefit.
- Attain the groundwater standards – Over time, with source removal and monitored natural attenuation, groundwater concentrations are predicted to timely return to below Site background concentrations, Federal GPS (40 CFR 257.95(h)), and the Illinois Class I groundwater standards (35 IAC 620.410) based on model results. Indeed, that modeling predicts that GPS for the exceeded Part 257 constituents should be achieved within 7 years, as mentioned above.
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible – Clean closure removes the physical CCR material within the limits of Emery Pond, including the Gypsum Loadout Area.
- Comply with standards for management of wastes per 257.98(d) – Wastes removed as part of the clean closure will be managed, transported, and disposed of pursuant to RCRA requirements.

5. Corrective Action and Selected Remedy

This Corrective Action and Selected Remedy is submitted to address the groundwater exceedances identified in Section 2, above. Hanson (2020b) proposes to mitigate any groundwater impacts due to the Emery Pond CCR impoundment and adjacent Gypsum Loadout Area by using multiple alternatives from the Table 4 assessed options. These alternatives are consistent with the federal CCR rule and should lead to timely compliance with the Illinois Part 620 groundwater quality standards and the Part 257 GPS.

5.1 Selected Remedy

SIPC proposes to close Emery Pond and the adjacent Gypsum Loadout Area by removal, construct a CCR-compliant composite liner system in the footprint of the existing Emery Pond to continue the storm water management function, construct a perimeter drain at the toe of the liner system to protect the liner from external hydrostatic pressure with the additional benefit of recovering contaminated groundwater, continue to monitor the natural attenuation of contaminants in groundwater, and establish a Groundwater Management Zone (GMZ) pursuant to 35 IAC 620.250(a)(2) to address any Part 620 exceedances due to the Site, including those alleged in Illinois EPA's 2018 Violation Notice.

5.1.1 CCR Removal

Hanson (2020b) proposes to remove the CCR from the current footprint of the Emery Pond and any additional CCR located at and beneath the Gypsum Loadout Area to visually clean levels. Clean closure (removal of any CCR materials) will be visually confirmed and certified by a Professional Engineer prior to continued construction activities. The CCR removal is expected to remove the source of the observed groundwater impacts at the Site, allowing groundwater to improve while the requested GMZ is in effect.

5.1.2 Construction of a CCR Rule Compliant Liner

After removal of the CCR from the current footprint of Emery Pond, a new storm water basin will be constructed within the footprint of the former Emery Pond, which will include a CCR Rule compliant composite liner system and a perimeter drainage system located beneath the outside toe of the liner system (Hanson, 2020b). The liner system is not required by the federal CCR rule because regulated CCR is not expected to be discharged to the new basin following CCR removal from the existing pond. However, the liner will be added as a conservative, protective measure at significant expense, and it should eliminate any discharges to groundwater from the new basin.

5.1.3 Perimeter Drain System

Additionally, the installation of the perimeter toe drain around the base of the basin liner system provides protection from hydraulic (hydrostatic) pressures to the liner system and further affords for collection of groundwater in the vicinity of the new basin. The collected groundwater would be discharged to the new basin and routed to NPDES Outfall 002, which is currently permitted to discharge the types of constituents that would be present in the groundwater. Section 3.9 of the Closure Plan (submitted with this Plan) contains a complete description of the perimeter toe drain and IEPA has issued SIPC a construction permit for the work, which suggests that no additional NPDES permitting is required. However, a confirming question with supporting information concerning NPDES permitting is currently pending with Bureau of Water.

5.1.4 Monitored Natural Attenuation

MNA (dilution and dispersion) will be used to aid in returning groundwater to below the Illinois Class I standards and Federal CCR rule standards. With the removal of the CCR at Emery Pond, MNA functions as a finishing or polishing step in the timely return of groundwater compliance.

5.2 Long- and Short-Term Effectiveness, Protectiveness, and Certainty

The selected remedy provides the best combination of corrective measures to address the long- and short-term effectiveness, protectiveness, and certainty of reaching and maintaining the GPS and Class I groundwater standards.

5.2.1 Magnitude of Reduction of Existing Risks

Removal of the CCR from the Emery Pond and vicinity is the best alternative for reducing risk by allowing the material to be disposed of in a permitted landfill facility that meets the current Illinois landfill rules (35 IAC 810-815). Further protections are included due to the facility's composite liner, leachate collection, and final cover requirement. The added benefit of the perimeter drain will also lower risk with the removal of a currently impacted groundwater.

5.2.2 Magnitude of Residual Risks, Likelihood of Further CCR Releases

As noted in Section 5.2.1, removal prevents further CCR releases from Emery Pond.

5.2.3 Type and Degree of Long-Term Management Required

Long term management of the selected remedy should be nominal. There are operation and management (O & M) needs, including perimeter drain pump maintenance and/or replacement and protection of the geomembrane component of the composite liner system.

However, the O & M costs associated with a close in place and treatment solution would be much greater. Operating a Pump and Treat system or managing precipitation falling within a slurry wall (this water could pick up contamination from contact with the in place CCR) would require further management, create additional risks and concerns (as discussed above) and cost much more than simply removing the CCR and allowing natural attenuation to aid with cleanup.

Groundwater monitoring wells will need to be maintained and repaired/replaced, as needed.

5.2.4 Short-term Risks to the Community or the Environment During Implementation

Potential short-term risks to the removal of the CCR include fugitive dust from storage and loading the dry CCR for transport and the actual transport of the CCR to the permitted disposal facility. Fugitive dust controls will follow the requirements of 40 CFR 257.80 and the proposed 35 IAC 845.500.

Loading CCR for transport will only occur within the Site boundaries, limiting community exposure. Transportation of the CCR will follow the requirements of the proposed 35 IAC 845.740.

5.2.5 Time Until Full Protection is Achieved

Hanson's Groundwater Protection Evaluation indicates that all GPS and Class I groundwater standards will be reached in approximately 27 years, and some will take less time. Further meeting the Part 257 GPS for arsenic and cobalt (only two parameters with an established SSL of the GPS) is predicted to occur much quicker, with arsenic modeled to reach the GPS in approximately 7 years and cobalt never causing a GPS compliance issue at the nearest potential groundwater receptor, the edge of Lake of Egypt.

5.2.6 Potential for Exposure of Human and Environmental Receptors to Remaining CCR

With clean closure there will be no remaining wastes. Groundwater is not used by the Plant, but nominal amounts of groundwater will be collected (estimated to be approximately 600 gallons per day) by the perimeter drain system and discharged to the Storm Water Basin and eventually NPDES Outfall 002. CCR transported to the permitted disposal facility will be entombed and eventually covered with a composite liner system preventing future exposure. The permitted off-site landfill's leachate collection system will restrict potential migration of contaminants to groundwater.

5.2.7 Long-Term Reliability of the Engineering and Institutional Controls

Long-term reliability of the selected remedy is excellent provided routine O & M is performed. Clean closure of the Emery Pond removes continued impacts to groundwater by CCR. Groundwater, as modeled, should return to compliance with Class I standards three years before the end of the 30-year post-closure care period, and compliance with the Part 257 GPS much faster than that.

5.2.8 Potential Need for Replacement of the Remedy

The primary remedy is the removal of CCR from the Emery Pond. Although there are other components to the selected remedy that could need replacement, they are primarily present to continue the use of the impoundment for storm water management, and do not present an exposure potential to CCR. Proper O & M will also defer the need for replacement of parts of the selected remedy.

5.3 Source Control Effectiveness

The selected remedy for Emery Pond does not rely on a source control as the primary mitigation method. New releases of CCR around Emery Pond, with the closure of Unit 4, are unlikely.

5.3.1 The Extent to Which Containment Practices Will Reduce Further Releases

As previously noted, there will be no CCR containment associated with the selected remedy.

5.3.2 Extent to Which Treatment Technologies May be Used

Although there is some groundwater collection associated with the selected remedy, discharge of those waters is controlled by the Site NPDES permit. The only additional treatment technology used is natural attenuation, in conjunction with source removal.

5.4 Implementing Selected Remedy

This section looks at the ease and operational reliability of implementation of the remedy and includes consideration of regulatory requirements and necessary resource for implementation.

5.4.1 Degree of Difficulty Associated with Constructing the Technology

CCR excavation and construction of the perimeter drain and composite liner system are common construction activities. The installation of the geomembrane does require a specialized contractor, but primarily for the equipment needed to make water-tight connections between the geomembrane panels and the remaining water control structures needed for storm water management.

The small size of the Emery Pond also reduces the difficulty and time needed for the closure activity and any risks or concerns that might otherwise be associated with CCR removal, transport, and off-site disposal.

5.4.2 Expected Operational Reliability of Technologies

Composite liner systems have been used at municipal solid waste landfills for over 30 years. With proper construction techniques and third-party construction quality assurance inspections, the selected remedy should perform reliably for as long as the Plant will need to control storm water. Of course, this would include any required O & M to maintain pumps and repair any damages.

Table 4. Corrective Measures Options

Potential Remedies	Pros	Cons	Human Health	Attain GPS	Control Release	Material Removal	Manage RCRA Wastes
Do nothing	• Inexpensive	• Liability	No	No	No	No	n/a
Close in Place	• 40 CFR 257 compliant	• Loss of storm water storage	Somewhat	No	Some	No	Yes
Clean close	• 40 CFR 257 compliant	• Loss of storm water storage	Protective	Yes	Yes	Yes	Yes
Barrier wall	• Containment of COCs	• Still an unlined CCR impoundment • Working around buried utilities	Protective	Yes	Yes	No	n/a
Pump and Treat	• Removal of COCs	• Still an unlined CCR impoundment • Low hydraulic conductivity causes narrow capture zones at wells	Protective	Unk	Unk	No	n/a
Pump Station	• No dam or dam permit • Smaller footprint	• Increased O & M • Additional measures to control CCR	Protective	Yes	Unk	n/a	Yes
Retrofit	• 40 CFR 257 compliant Removes COC source	• Pond unusable during construction • Requires CCR removal • Requires dam permit • New compliant unit no longer needed with shutdown of Unit 4	Protective	Yes	Yes	Yes	Yes

Table 5. Long and Short-term Effectiveness of Options

Potential Remedies	Reduce Existing Risk	Residual Risk	Long-term Management			Short-term Risk	Completion Date	Potential Receptor Exposure	Long-term Reliability	Need to Replace
			Monitoring	Operation	Maintenance					
Do nothing	No	No	No	n/a	n/a	High	Immediately	High	Low	Likely
Close in Place	Somewhat	No	Some	n/a	Yes	Moderate	Fall 2020	Low	Moderate	Possibly
Clean close	Protective	Yes	Yes	Yes	Yes	Low	Fall 2020	Low	Low	Unlikely
Barrier wall	Protective	Yes	Yes	n/a	n/a	Moderate	Fall 2019	Low	Moderate	Possibly
Pump and Treat	Protective	Unk	Unk	n/a	n/a	Moderate	Fall 2019	Moderate	Moderate	Possibly
Pump Station	Protective	Yes	Unk	n/a	Yes	Low	Fall 2020	Low	Low	Unlikely
Retrofit	Protective	Yes	Yes	Yes	Yes	Low	Fall 2020	Low	Low	Unlikely

Table 6. Implementation of Options

Potential Remedies	Construction Difficulties	Operational Reliability	Permits & Approvals	Specialty Equip./Eng.	Availability Treatment, Disposal, & Storage
Do nothing	None	n/a	None	None	None
Close in Place	Nothing major	Good	None	None	None
Clean close	Nothing major	Good	None	None	Need disposal site
Barrier wall	Excavation & buried utilities	Good	None	Specialty Contractor	Unknown fill
Pump and Treat	Drilling & well installation	Good	NPDES	Drilling & Pumps	GW discharges
Pump Station	Drilled shafts	Good	Water Treatment permit	Drilling Contractor	Just like pond
Retrofit	Clean close existing pond	Good	Water Treatment & Dam permits	Geosynthetics	None

5.4.3 Need to Coordinate and Obtain Necessary Approvals / Permits from Other Agencies

SIPC has been working with Bureau of Water to obtain the needed Water Treatment Device permit (35 IAC 309, Subpart B) and any NPDES permitting (35 IAC 309, Subpart A) that might be required for the selected remedy. The construction permit for the water treatment device was issued by Bureau of Water on October 16, 2020. Pursuant to submissions that have been made to Illinois EPA, the proposed remedy adds no new wastewater constituents to the currently permitted discharge and should not adversely impact any receiving water. Indeed, with the recent closure of Unit 4, all CCR from the facility will be managed dry and waste water discharges associated with the Site and facility will decrease. Accordingly, the proposed action should be covered under the facility's current NPDES permit, as suggested by the issued construction permit. Illinois EPA has not informed SIPC that this position is incorrect, and SIPC must proceed with the proposed action immediately to achieve timely closure under the federal CCR rule.

Additionally, the Illinois Department of Natural Resources dam permit re-classified the Emery Pond Dam as a Class III dam on December 16, 2020.

5.4.4 Availability of Necessary Equipment and Specialists

Excavation and recompacted soil placement are common earth work activities done by many contractors with the needed earthmoving equipment and trained operators. Drainage systems, like the perimeter drain, are also common construction activities. The water-tight placement of the geomembrane is the only specialty task associated with the selected remedy. Although specialized, there are several trained installation companies. Many of these installers are associated with the geomembrane manufacturing companies.

5.5 Groundwater Monitoring Plan

Groundwater monitoring will continue at the Site. Groundwater monitoring proposed with respect to the Part 620 groundwater standards is detailed in Hanson's (2020c) Groundwater Monitoring Plan that accompanies this Plan. Additionally, assessment monitoring in accordance with 40 CFR 257 will continue. Thus, future monitoring will include both monitoring required by the federal CCR rule, which may be implemented by an Illinois rule once adopted and monitoring proposed to address Part 620 groundwater standard compliance.

5.5.1 Timetable

Active corrective action activities were proposed to coincide with the closure of Unit 4 in fall 2020. See Hanson's (2020b) Closure Plan for details. That timetable has been delayed given the need to work with Illinois EPA to obtain approval of these and related plans and reports with Illinois EPA. However, some work has begun, and the remainder must proceed in the very near future to timely close Emery Pond under the federal CCR rule.

Illinois EPA has requested that SIPC address permitting with respect to certain elements of the selected remedy described above. A 35 IAC 302, Subpart B construction permit for the work, including the new, non-CCR Storm Water Basin (that replaces Emery Pond) was issued by Illinois EPA Bureau of Water on October 16, 2020. In addition, SIPC earlier submitted a permit modification for its current NPDES permit. However, in light of the subsequent closure of Unit 4, and attendant reductions in wastewater discharges, and because the remedial action for this small pond would not cause the discharge of any new or different constituents and would not adversely impact any receiving water, SIPC believes that the proposed remedial action is covered under its current NPDES permit, which is also supported by the terms of the issued construction permit. SIPC has been waiting for months for Illinois EPA to provide a further clarifying response, and SIPC respectfully asks once again for Illinois EPA's immediate concurrence that no further NPDES permit action is needed so that SIPC may timely complete closure of Emery Pond.

In addition to the proposed active remedies, SIPC is also requesting a GMZ and proposing future groundwater monitoring, including to assess the ameliorative impacts of CCR source removal with dispersive and diffusive flux of COCs over time. The duration and scope of the requested GMZ is described in Section 6, below.

6. Application for a Groundwater Management Zone (GMZ)

6.1 Technical Support Documentation

A previously submitted Hydrogeologic Investigation Report (Hanson, 2019a) and Hydrogeologic Investigation Addendum (Hanson, 2019b), as well as an updated Closure Plan (Hanson, 2020b), Groundwater Monitoring Plan (Hanson, 2020c), and Groundwater Protection Evaluation (Hanson, 2020a) submitted with this Plan, support this Plan and GMZ Application. These documents provide descriptions of the site geology, hydrogeology, closure methods, and groundwater monitoring.

6.2 Groundwater Management Zone

As part of this Plan, SIPC requests establishment of a Groundwater Management Zone (GMZ) pursuant to 35 IAC Part 620. As provided in 35 IAC 620.250(a)(2), a GMZ may be established for sites at which the owner or operator undertakes “an adequate corrective action in a timely and appropriate manner and provides a written confirmation to the Agency.” A GMZ is defined as "a three-dimensional region containing groundwater being managed to mitigate impairment caused by the release of contaminants from a site.” SIPC plans to undertake in the very near future, corrective actions, including CCR removal from the Site and installation of a liner in the new basin, as well as prospective groundwater monitoring to assess the ameliorative impacts of CCR source removal and dispersive and diffusive flux of COCs over time. This corrective action is both timely, considering the ongoing negotiations between Illinois EPA and SIPC in connection with the earlier issued violation notice and federal CCR rule requirements, and adequate to address any groundwater impacts to the Site. Further, as described below, recent investigations confirm that any groundwater impacts are not causing any measurable impact to nearby surface waters.

The horizontal extent of the proposed GMZ is depicted in the Plat found in Appendix D, and contains approximately 7.5 acres. The GMZ does not extend beyond the Plant boundaries. A description of the platted area is also found in Appendix D. Vertically, the GMZ is bounded by the ground surface down to the bottom of the upper (weathered) portion of the Bedrock Unit. Hanson has identified this depth as approximately 21.5 ft. BGS at bedrock boring, EBR, or an approximate elevation of 489 ft. The parameters to be covered by the GMZ include the following: Arsenic, Boron, Calcium, Chloride, pH, Sulfate, Selenium, Total Dissolved Solids, Cobalt, Thallium, Iron, Lead, Manganese, and Zinc. Pursuant to the modeling referenced below, the GMZ's expected duration is 27 years.

The Notice of Adequate Corrective Action forms are included in Appendix E.

Table 7. Lake of Egypt Sample Analytical Results

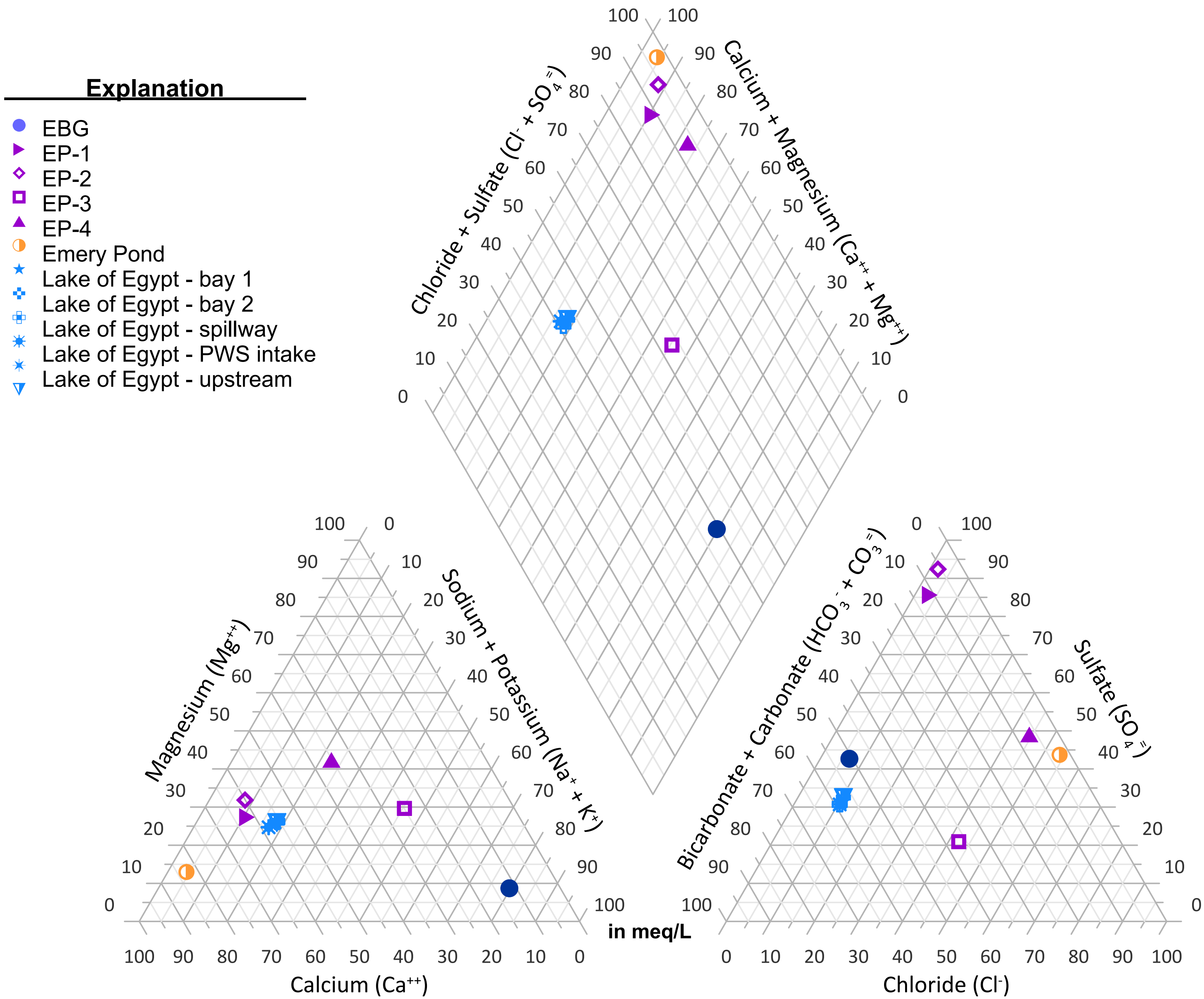
PARAMETER NAME	UNITS	LE-b1	LE-b2	LE-d	LE-in	LE-u
pH (field)	SU	7.09	7.25	7.07	6.57	7.19
Specific Conductivity	µS/cm	139.4	137.1	144.2	173.5	136.2
Temperature	°C	28.2	28.6	28.7	26.7	28.
Dissolved Oxygen	mg/L	5.06	6.21	6.22	4.71	5.65
Oxidation/Reduction Potential	mV	+171.4	+184.7	+172.5	+231.4	+186.7
Turbidity	NTU	3.53	2.88	2.55	4.45	2.54
Arsenic, total	µg/L	<25.	<25.	<25.	<25.	<25.
Barium, total	µg/L	2.52	2.65	2.27	2.34	2.51
Bicarbonate, total	mg/L	38.	38.	39.	39.	38.
Boron, total	µg/L	<20.	<20.	<20.	<20.	<20.
Cadmium, total	µg/L	<1.	<1.	<1.	<1.	<1.
Calcium, total	mg/L	14.1	14.1	13.7	15.4	14.1
Carbonate, total	mg/L	0.	0.	0.	0.	0.
Chloride, total	mg/L	<4.	4.	<4.	<4.	<4.
Chromium, total	µg/L	<5.	<5.	<5.	<5.	<5.
Cobalt, total	µg/L	<5.	<5.	<5.	<5.	<5.
Copper, total	µg/L	<5.	<5.	<5.	<5.	5.6
Fluoride, total	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Iron, total	mg/L	0.077	0.076	0.056	0.099	0.057
Lead, total	µg/L	<1.	<1.	<1.	<1.	<1.
Magnesium, total	mg/L	3.97	3.98	3.92	3.96	3.97
Manganese, total	µg/L	395.	423.	236.	250.	371.
Mercury, total	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel, total	µg/L	<5.	<5.	<5.	<5.	<5.
Nitrogen, Ammonia, total	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrogen, Nitrate, total	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen, Nitrite, total	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus, total (as P)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium, total	mg/L	1.96	2.	1.94	1.94	2.
Selenium, total	µg/L	<1.	<1.	<1.	<1.	<1.
Silver, total	µg/L	<1.	<1.	<1.	<1.	<1.
Sodium, total	mg/L	4.11	4.16	4.03	4.03	4.13
Sulfate, total	mg/L	16.	17.	16.	16.	17.
Thallium, total	µg/L	<2.	<2.	<2.	<2.	<2.
Total Dissolved Solids	mg/L	60.	56.	44.	56.	46.
Total Suspended Solids	mg/L	<6.	<6.	<6.	<6.	<6.
Zinc, total	µg/L	<10.	<10.	<10.	<10.	<10.

I:\18jobs\18E0022A\Admin\14-Reports\CAP\FIG_5LakeSampleMap_20200717.srf

Revised 7/17/2020 – added Bay Mixing Area and label to figure.

HANSON Hanson Professional Services Inc.	LAKE OF EGYPT SAMPLE LOCATION MAP
	EMERY POND – MARION POWER PLANT SOUTHERN ILLINOIS POWER COOPERATIVE MARION, WILLIAMSON COUNTY, ILLINOIS
	HANSON NO. 18E0022B FIGURE 5

FIGURE 6. June 2020 Piper (Tri-linear) Diagram



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6.3 Environmental Impact of Proposed Corrective Action

Implementation of this Plan and establishment of the GMZ will have a positive environmental impact. The removal of existing CCR materials and installation of a new CCR Rule compliant liner in the new storm water basin will reduce the impact from the COCs at the Site. The GMZ will remain in place until the groundwater meets applicable Part 620 water quality standards, as established through proposed monitoring.

The Groundwater Protection Evaluation (Hanson, 2020a) submitted herewith, assesses groundwater flow and contaminant transport utilizing the USGS MODFLOW groundwater flow model (McDonald and Harbaugh, 1988) and MT3D contaminant transport model (Zheng, 1990) incorporated into the pre- and post-processor software, Processing Modflow X (Simcore, 2020), to evaluate some of the corrective measures options for Emery Pond and determine the time needed for contaminant concentrations to fall below Class I: Potable Resource groundwater standards (35 IAC 620.410). After selecting the CCR removal with Liner and Drain scenario as the appropriate remedy, each of the contaminants of concern were modeled using a worst-case source concentration (maximum observed concentration from various potential sources). Based on these evaluations, it was found that total Boron took the longest to achieve Class I compliance, with concentrations at a compliance point located adjacent to Lake of Egypt returning to below Class I limits at 27 years. Meeting the Part 257 GPS for Arsenic and Cobalt occurs much quicker. Table 3 lists the time to compliance at each of the downgradient monitoring wells.

Section 5 of the Groundwater Protection Evaluation (Hanson, 2020a) used calculated surface water concentrations, based on mass flux discharges from groundwater to the General Head Boundary (representing Lake of Egypt), to show no predicted surface water standard exceedances due to any groundwater impacts from the Site.

To substantiate this prediction, samples were collected in June 2020 from Lake of Egypt and analyzed for the COCs. Results are presented in Table 7 and sample locations are shown on Figure 6. Analytical results showed no appreciable differences in analyte concentrations between the five lake samples taken adjacent to Emery Pond and other more distant locations. The Piper diagram (Figure 6) also shows the lake samples clustered with no apparent groundwater mixing trends. In addition, no surface water quality standard exceedances were observed.

Illinois EPA has questioned if plant operations and the number of operating units could influence surface water quality. To limit how the calculated results could be interpreted, Hanson (2020a) chose to limit the mixing zone used in the surface water mixing calculations. The bay mixing area shown in Figure 5 does not reach the cooling water intake structure, and therefore groundwater/surface water interactions, based on the calculations in the Groundwater Protection Evaluation, should not be influenced by plant operations.

6.4 Corrective Action Completion Report

Upon meeting the Corrective Action Completion requirements described in 35 IAC 845.680(c) a Corrective Action Completion Report and Certification, meeting the requirements of 35 IAC 845.680(e) will be prepared and submitted to Illinois EPA.

7. Conclusion

Hanson has reviewed the available groundwater data at the Marion Power Plant's Emery Pond and has found concentrations of Arsenic, Boron, Calcium, Chloride, Lead, pH, Sulfate, Thallium, and TDS, above the Class I: Potable Resource Groundwater Standards (35 IAC 620.410) and Class II: General Use Groundwater Standards (35 IAC 620.420). Only assessment monitoring for Cobalt and Arsenic yielded SSLs of GPS exceedances. Hanson also found concentrations of Iron, Manganese, and Zinc that were above the Class I and Class II Standards, but the exceedances do not appear attributable to the Site. Hanson believes that groundwater concentrations of Arsenic, Boron, Calcium, Chloride, Cobalt, Lead, pH, Sulfate, Thallium, and TDS, found above the Class I or Class II Standards are the result of pond and contact water migration from the Site.

This Plan proposes to address and mitigate the release of contaminants and resulting groundwater impacts by clean closing the Emery Pond and Gypsum Loadout Area. A new Storm Water Basin will be constructed within the footprint of the current Emery Pond and the Gypsum Loadout Area will be filled with clean earthen materials that meet the requirements of the applicable state and/or federal regulation. By removing the sources of the groundwater impacts, the concentration of contaminants will be reduced over time, as indicated by Hanson's (2020a) contaminant transport modeling. Time for all COC concentration levels to drop below Class I: Potable Resource limits is approximately 27 years after closure by removal. Meeting the GPS for Arsenic and Cobalt (SSL of GPS) occurs much quicker, with Arsenic modeled to reach the GPS in approximately 7 years and Cobalt never modeled to cause a GPS compliance issue at the modeled compliance point adjacent to Lake of Egypt.

Groundwater monitoring, as required by the CCR Rule will continue after clean closure. Additional groundwater monitoring proposed as part of this Corrective Action and request for a GMZ, is detailed in Hanson's (2020c) Groundwater Monitoring Plan. Prospective groundwater monitoring will assess the expected ameliorative impacts of the corrective actions proposed in this Plan.

8. Licensed Professional Signature/Seal

The geological work product contained in this document has been prepared under my personal supervision and has been prepared and administered in accordance with the standards of reasonable professional skill and diligence.

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Expires 31 March 2023

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Date: 30 March 2021

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Appendix A

Tabulated Groundwater Monitoring Results

TABLE A-1. Analytical Data for Emery Pond (2017-2018)

			Appendix III Constituents														Appendix IV Constituents															
Analyte Name			Boron		Calcium		Chloride		Fluoride		pH		Sulfate		TDS		Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Cobalt		Fluoride	
Units			mg/L		mg/L		mg/L		mg/L		S.U.		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
Downgradient Wells	EP-01	03/23/17	0.13		220.		54.		0.5	U	6.94		820.		2000.		0.0004	J	0.005	U	0.045		0.0002	U	0.005	U	0.005	U	0.0017	J	0.5	U
		04/24/17	0.21		280.		54.		0.5	U	6.89		910.		2300.	H1	0.0002	U	0.005	U	0.04		0.0002	U	0.006		0.005	U	0.0008	J	0.5	U
		05/25/17	0.28		310.		48.		0.5	U	6.55		850.		2300.		0.005	U	0.005	U	0.041		0.005	U	0.01	U	0.01	U	0.005	U	0.5	U
		06/22/17	0.26		310.		50.		0.5	U	6.52		850.		2300.		0.0006	J	0.005	U	0.032		0.0002	U	0.01	U	0.01	U	0.0008	J	0.5	U
		06/29/17	0.32		310.		50.		0.5	U	6.64		440.		2200.		0.001	J	0.005	U	0.033		0.0002	U	0.01	U	0.01	U	0.0006	J	0.5	U
		07/24/17	0.21		270.		51.		0.5	U	6.57		540.		2200.		0.005	U	0.005	U	0.029		0.005	U	0.01	U	0.01	U	0.005	U	0.5	U
		08/01/17	0.23		250.		48.		0.5	U	6.82		520.		2100.		0.0002	U	0.005	U	0.028		0.0002	U	0.01	U	0.01	U	0.0007	J	0.5	U
		08/31/17	0.17		240.		48.		0.5	U	6.79		440.		2100.		0.005	U	0.005	U	0.026		0.005	U	0.01	U	0.01	U	0.005	U	0.5	U
		03/22/18	0.38		330.		60.		0.5	U	6.25		510.		2400.																	
		08/27/18	0.92		410.		63.		0.5	U	6.36		1000.		2700.		0.012	U	0.3	U	0.023	U	0.008	U	0.01	U	0.01	U	0.01	U	0.05	U
	EP-02	03/23/17	0.22		190.		42.		0.5	U	6.18		860.		1800.		0.0003	J	0.005	U	0.039		0.0002	U	0.005	U	0.005	U	0.052		0.5	U
		04/24/17	0.19		170.		39.		0.5	U	6.39		660.		1800.	H1	0.0002	U	0.005	U	0.035		0.0002	U	0.005	U	0.005	U	0.029		0.5	U
		05/25/17	0.2		200.		36.		0.5	U	6.31		780.		1900.		0.005	U	0.005	U	0.038		0.005	U	0.01	U	0.01	U	0.023		0.5	U
		06/22/17	0.23		200.		37.		0.5	U	6.1		780.		1800.		0.0004	J	0.005	U	0.03		0.0002	U	0.01	U	0.01	U	0.016		0.5	U
		06/29/17	0.29		470.		36.		0.5	U	5.75		470.		1900.		0.0007	J	0.005	U	0.029		0.0002	U	0.01	U	0.01	U	0.0087		0.5	U
		07/24/17	0.26		200.		36.		0.5	U	5.86		430.		1800.		0.005	U	0.005	U	0.025		0.005	U	0.01	U	0.01	U	0.005	U	0.5	U
		08/01/17	0.31		190.		36.		0.5	U	5.88		770.		1800.		0.0002	U	0.005	U	0.025		0.0002	U	0.01	U	0.01	U	0.0009	J	0.5	U
		08/31/17	0.23		180.		36.		0.5	U	6.33		340.		1800.		0.005	U	0.005	U	0.025		0.005	U	0.01	U	0.01	U	0.005	U	0.5	U
		03/22/18	0.24		230.		30.		0.5	U	6.27		420.		1700.																	
		08/27/18	0.2		190.		35.		0.5	U	6.28		740.		1800.		0.012	U	0.3	U	0.018		0.008	U	0.01	U	0.01	U	0.01	U	0.5	U
	EP-03	03/23/17	0.11		34.		100.		0.5	U	5.99		120.		680.		0.0002	J	0.005	U	0.072		0.0002	U	0.005	U	0.005	U	0.11		0.5	U
		04/24/17	0.089		29.		120.		0.5	U	5.96		180.		820.	H1	0.0002	U	0.0088		0.059		0.0002	U	0.005	U	0.005	U	0.12		0.5	U
		05/25/17	0.081		45.		140.		0.5	U	6.03		190.		1400.		0.005	U	0.0076		0.059		0.005	U	0.01	U	0.01	U	0.091		0.5	U
		06/22/17	0.057		93.		220.		0.5	U	6.08		300.		560.		0.0003	J	0.0061		0.061		0.0002	U	0.01	U	0.01	U	0.037		0.5	U
		06/29/17	0.085		30.		66.		0.5	U	6.01		73.		570.		0.0009	J	0.005	U	0.065		0.0002	U	0.01	U	0.01	U	0.11		0.5	U
		07/24/17	0.083		32.		110.		0.5	U	5.96		130.		720.		0.005	U	0.0093		0.064		0.005	U	0.01	U	0.01	U	0.12		0.5	U
		08/01/17	0.09		34.		120.		0.5	U	6.02		140.		630.		0.0002	U	0.0062		0.057		0.0002	U	0.01	U	0.01	U	0.1		0.5	U
		08/31/17	0.09		33.		110.		0.5	U	6.13		110.		1000.		0.005	U	0.0069		0.058		0.005	U	0.01	U	0.01	U	0.11		0.5	U
		03/22/18	0.078		34.		110.		0.5	U	6.1		110.		700.																	
		08/27/18	0.082		38.		140.		0.5	U	6.1		150.		690.		0.012	U	0.3	U	0.064		0.008	U	0.01	U	0.01	U	0.088		0.5	U
	EP-04	03/23/17	15.	D	190.		460.		0.5	U	5.51		620.		2300.		0.0003	J	0.035		0.035		0.0002	U	0.005	U	0.005	U	0.39		0.5	U
		04/24/17	23.	D	170.		290.		0.5	U	5.88		530.		2300.	H1	0.0002	U	0.039		0.026		0.0002	U	0.0052		0.005	U	0.41		0.5	U
		05/25/17	14.	D	170.		380.		0.5	U	5.77		660.		2400.		0.005	U	0.037		0.028		0.005	U	0.01	U	0.01	U	0.41		0.5	U
		06/22/17	11.	D	150.		430.		0.5	U	5.8		730.		2000.		0.0003	J	0.053		0.029		0.0002	U	0.01	U	0.01	U	0.44		0.5	U
		06/29/17	13.	D	190.		250.		0.5	U	5.81		410.		2100.		0.0005	J	0.044		0.037		0.0002	U	0.01	U	0.01	U	0.34		0.5	U
		07/24/17	11.	D	160.		180.		0.5	U	5.8		290.		2300.		0.005	U	0.044		0.026		0.005	U	0.01	U	0.01	U	0.41		0.5	U
		08/01/17	14.	D	150.		210.		0.5	U	5.8		330.		2200.		0.0002	U	0.035		0.031		0.0002	U	0.01	U	0.01	U	0.42		0.5	U
		08/31/17	11.	D	150.		210.		0.5	U	5.85		340.		2300.		0.005	U	0.049		0.023		0.005	U	0.01	U	0.01	U	0.38		0.5	U
		03/22/18	13.		200.		200.		0.5	U	6.04		320.		2100.																	
		08/27/18	11.		150.		310.		0.5	U	5.85		520.		1900.		0.012	U	0.3	U	0.023		0.008	U	0.01	U	0.011		0.31		0.5	U
Upgradient Wells	EBG	03/23/17	0.12		23.		55.		0.5	U	6.5		64.		480.		0.0006	J	0.005	U	0.13		0.0003	J	0.005	U	0.006	U	0.008		0.5	U
		04/24/17	0.079		10.		11.		0.5	U	6.8		54.		400.	H1	0.0009	J	0.005	U	0.029		0.0002	U	0.005	U	0.005	U	0.0002	J	0.5	U
		05/25/17	0.1		30.		84.		0.5	U	6.41		42.		440.		0.005	U	0.005	U	0.17		0.005	U	0.01	U	0.01	U	0.014		0.5	U
		06/22/17	0.071		23.		68.		0.5	U	6.45		57.		470.		0.0007	J	0.005	U	0.049		0.0002	U	0.01	U	0.01	U	0.0002	J	0.5	U
		06/29/17	0.073		32.		79.		0.5	U	6.53		50.		280.		0.0014	J	0.005	U	0.086		0.0002	U	0.01	U	0.01	U	0.0014	J	0.5	U
		07/24/17	0.079		37.		27.	M2	0.64	M1	6.59		61.	M2	420.		0.005	U	0.005	U	0.19		0.005	U	0.01	U	0.01	U	0.0093		0.64	M1
		08/01/17	0.074		35.	M3	86.		0.5	U	6.66		45.		380.		0.0002	J	0.005	U	0.18		0.0002	U	0.01	U	0.01	U	0.0038	J	0.5	U
		08/31/17	0.056		35.		82.		0.5	U	6.26		44.		470.		0.005	U	0.005	U	0.16		0.005	U	0.01	U	0.01	U	0.0073		0.5	U
		03/22/18	0.033		14.		12.		0.53		6.35		63.		300.																	
		08/27/18	0.035		15.		16.		0.55		6.57		72.		360.		0.012	U	0.3	U	0.091		0.008	U	0.01	U	0.01	U	0.01	U	0.5	U
GPS Upper Limit			**0.1216**		**46.304**		**118.631**		**0.64**		**6.94**		**68.6063**		**550.253**		**0.005**		**0.005**		**0.2491**		**0.005**		**0.01**		**0.01**		**0.0191**		**0.64**	
GPS Lower Limit											**6.11**																					

TABLE A-1. Analytical Data for Emery Pond (2017-2018)

Appendix IV Constituents																								
Lead		Lithium		Mercury		Molybdenum		Selenium		Thallium		Radium 226* (pCi/L)			Radium 228* (pCi/L)			Radium 226+228 (pCi/L)						
mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		Result	Uncertainty		Result	Uncertainty		Result	Uncertainty					
0.005	U	0.024	J	0.0002	U	0.0028	J	0.0012	J	0.025	U	0.603	±0.277		0.0552	±0.431	U	0.6582	±0.708	U				
0.005	U	0.028	J	0.0002	U	0.0016	J	0.0014	J	0.025	U	0.223	±0.196		0.496	±0.298		0.719	±0.494					
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.025	U	0.805	±0.22		0.555	±0.448		1.36	±0.668					
0.01	U	0.032	J	0.0002	U	0.0008	J	0.005	J	0.05	U	0.313	±0.176		0.496	±0.245		0.809	±0.421					
0.01	U	0.029	J	0.0002	U	0.0018	J	0.0025	J	0.05	U	0.139	±0.129		0.0387	±0.323	U	0.1777	±0.452	U				
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.05	U	0.16			-0.27			-0.11						
0.01	U	0.024	J	0.0002	U	0.0019	J	0.0011	J	0.05	U	0.38			1.04			1.42						
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.05	U	0.24			1.15			1.39						
0.01	U	0.1	U	0.0002	U	0.005	U	0.002	U	0.05	U	0.453	±0.384		0.992	±0.899		1.445	±1.283					
0.005	U	0.018	J	0.0002	U	0.0015	J	0.0038	J	0.025	U	0.187	±0.259	U	0.853	±0.396		1.04	±0.655					
0.005	U	0.015	J	0.0002	U	0.0017	J	0.0027	J	0.025	U	0.341	±0.194		0.55	±0.298		0.891	±0.492					
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.05	U	0.37	±0.15		0.609	±0.224		0.979	±0.374					
0.01	U	0.02	JU	0.0002	U	0.0003	J	0.0074		0.05	U	0.197	±0.142		-0.127	±0.359	U	0.07	±0.501	U				
0.01	U	0.025	J	0.0002	U	0.0006	J	0.0061		0.05	U	1.9	±0.416		0.458	±0.303		2.358	±0.719					
0.01	U	0.1	U	0.0002	U	0.005	U	0.0054		0.05	U	0.08			0.4			0.48						
0.01	U	0.021	J	0.0002	U	0.0008	J	0.0046	J	0.05	U	0.14			1.35			1.49						
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.05	U	0.08			0.64			0.72						
0.01	U	0.1	U	0.0002	U	0.005	U	0.002	U	0.05	U	0.	±0.3	U	0.443	±0.322		0.443	±0.622	U				
0.005	U	0.003	U	0.0002	U	0.0004	J	0.013		0.025	U	1.64	±0.517		0.438	±0.471	U	2.078	±0.988					
0.0056	U	0.0095	J	0.0002	U	0.0005	J	0.011		0.025	U	0.338	±0.285		0.0622	±0.587	U	0.4002	±0.872	U				
0.01	U	0.1	U	0.0002	U	0.005	U	0.016		0.05	U	0.177	±0.327	U	0.126	±0.485	U	0.303	±0.812	U				
0.01	U	0.12		0.0002	U	0.0002	U	0.028		0.05	U	0.355	±0.178		0.42	±0.259		0.775	±0.437					
0.01	U	0.012	J	0.0002	U	0.0002	U	0.013		0.05	U	0.317	±0.178		0.397	±0.364		0.714	±0.542					
0.01	U	0.1	U	0.0002	U	0.005	U	0.016		0.05	U	0.19			0.77			0.96						
0.01	U	0.028	j	0.0002	U	0.0005	J	0.012		0.05	U	0.46			2.42			2.88						
0.01	U	0.1	U	0.0002	U	0.005	U	0.022		0.05	U	0.41			0.77			1.18						
0.01	U	0.1	U	0.0002	U	0.005	U	0.002	U	0.05	U	0.679	±0.682	U	0.717	±0.403		1.396	±1.085					
0.009		0.0044	J	0.0002	U	0.0009	J	0.13		0.025	U	1.1	±0.489		0.442	±0.442		1.542	±0.931					
0.013		0.0062	J	0.0002	U	0.0011	J	0.12		0.065		0.715	±0.399		1.92	±0.406		2.635	±0.805					
0.011		0.1	U	0.0002	U	0.005	U	0.13		0.092		1.	±0.142		0.633	±0.36		1.633	±0.502					
0.017		0.0047	J	0.0002	U	0.0002	U	0.2		0.094		0.18	±0.13		0.897	±0.354		1.077	±0.484					
0.01	U	0.0063	J	0.0002	U	0.0006	J	0.13		0.058		0.219	±0.172		0.49	±0.32		0.709	±0.492					
0.011		0.1	U	0.0002	U	0.005	U	0.13		0.3		0.3			0.44			0.74						
0.012		0.0053	J	0.0002	U	0.001	J	0.11		0.075		0.15			0.96			1.11						
0.012		0.1	U	0.0002	U	0.005	U	0.16		0.075		0.33			2.14			2.47						
0.015		0.1	U	0.0002	U	0.005	U	0.021		0.14		0.262	±0.364	U	0.79	±0.384		1.052	±0.748					
0.005	U	0.0046	J	0.0002	U	0.0034	J	0.0019	J	0.025	U	0.878	±0.42		1.06	±0.33		1.938	±0.75					
0.005	U	0.0074	J	0.0002	U	0.0043	J	0.0005	U	0.025	U	1.17	±0.205		0.353	±0.416	U	1.523	±0.621					
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.05	U	0.0457	±0.278	U	0.864	±0.289		0.9097	±0.567					
0.01	U	0.028	J	0.0002	U	0.0017	J	0.0036	J	0.05	U	0.262	±0.189		0.0695	±0.21	U	0.3315	±0.399	U				
0.01	U	0.059	J	0.0002	U	0.0016	J	0.0019	J	0.05	U	0.245	±0.199		0.371	±0.289		0.616	±0.488					
0.01	U	0.1	U	0.0002	U	0.005	U	0.005	U	0.05	U	0.43			0.98			1.41						
0.01	U	0.082	J	0.0002	U	0.0024	J	0.0028	J	0.05	U	0.28			1.24			1.52						
0.01	U	0.1	U	0.0002	U	0.005	U	0.007		0.05	U	0.77			2.22			2.99						
0.01	U	0.1	U	0.0002	U	0.005	U	0.002	U	0.05	U	0.933	±0.543		0.447	±0.378		1.38	±0.921					
0.01		**0.1**		**0.0002**		**0.005**		**0.007**		**0.05**		**1.2076**			**2.7454**			**4.0038**						

Statistically significant increase (SSI) over baseline sampling using well specific and parameter specific statistical limits.

TDS = Total Dissolved Solids
NA = Not Analyzed
mg/L = milligrams per liter
S.U. = Standard Units
pCi/L = picoCurie/liter
D = Dilution
J = The analyte was positively identified, but the quantitation was 'below The RL.
U = analyte analyzed for but not detected
* = "U" flag for radionuclides is not detected above the minimum detectable concentration which differs from similar flag for aqueous results.
M1 = Matrix Spike recovery outside Control Limits due to sample matrix interference; biased high.
M2 = Matrix Spike recovery outside Control Limits due to sample Matrix interference; biased low
M3 = Analyte in the parent sample for the Matrix Spike was >4x the concentration of the spike solution which renders the spike amount insignificant. Matrix spike recoveries do not impact the quality of the parent sample data for this analyte.
H1 = Sample received outside of holding time for these analyses.

TABLE A-2. Extent of Contamination Study Results (2019)

PARAMETER NAME	UNITS	Class II Std	No. of Exceedances	EBG	EP-3	DP1a	DP1b	DP1c	DP1d	DP1e	EP-2	DP2a	DP2b	DP2c	DP2d	DP2e
Conductivity	µmhos/cm							3420.	1560.	4080.			3230.	2560.	1750.	1760.
pH	SU	6.5 - 9.0	9	6.85	6.11			6.28	6.16	7.74	6.62		6.92	7.06	6.61	6.94
Temperature	°C			8.9	17.2			11.8	8.9	5.6	13.5		13.3	12.8	13.3	12.2
Alkalinity, Bicarbonate, total	mg/L			160.	400.			350.	410.	9500.	140.		440.	470.	1300.	1620.
Alkalinity, Carbonate, total	mg/L			<5.	<5.			0.	0.	0.	<5.		0.	0.	0.	0.
Antimony, total	mg/L	0.024	0	<0.001	<0.001			<0.002	0.001	0.0008	<0.001		0.0011	<0.004	0.0008	0.001
Arsenic, total	mg/L	0.2	5	<0.0012	0.0068			0.163	0.28	0.0884	<0.001		0.0325	0.0941	0.012	0.0546
Barium, total	mg/L	2.	11	0.064	0.036			5.5	5.86	2.05	<0.01		0.316	2.9	0.276	0.78
Beryllium, total	mg/L	0.5	0	<0.0004	<0.001			0.0265	0.0345	0.0258	<0.001		0.0027	0.0245	0.001	0.0049
Boron, total	mg/L	2.	10	0.041	<0.1			5.16	0.404	7.29	0.35		0.157	<0.04	0.0627	0.013
Cadmium, total	mg/L	0.05	3	<0.01	<0.01			0.0032	0.0125	0.545	<0.01		0.0012	0.0012	0.0016	0.0007
Calcium, total	mg/L			13.	62.			892.	433.	16700.	280.		480.	343.	271.	285.
Chloride, total	mg/L	200.	14	12.	160.			368.	281.	454.	25.		54.	62.	62.	77.
Chromium, total	mg/L	1.	4	<0.01	<0.01			0.785	1.11	<0.015	<0.01		0.0839	0.606	0.0232	0.168
Cobalt, total	mg/L	1.	2	<0.0038	0.063			0.56	0.668	1.1	0.0005		0.131	0.225	0.0927	0.0806
Copper, total	mg/L	0.65	6	<0.0045	0.0012			0.552	0.936	2.32	0.0007		0.0541	0.341	0.0269	0.0714
Cyanide, total	mg/L	0.6	0	<0.005	<0.005			<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005
Fluoride, total	mg/L	4.	1	<0.5	<0.5			0.23	0.1	1.02	<0.5		0.49	0.3	0.49	0.26
Iron, total	mg/L	5.	25	4.4	57.			946.	1370.	592.	0.15		81.6	583.	24.3	177.
Lead, total	mg/L	0.1	15	<0.01	<0.01			0.632	0.949	3.28	<0.01		0.053	0.29	0.0239	0.0979
Magnesium, total	mg/L			6.1	54.			224.	159.	1860.	96.		195.	149.	64.6	77.
Manganese, total	mg/L	10.	16	0.65	8.			26.7	53.4	71.	0.064		12.3	10.3	6.83	6.02
Mercury, total	mg/L	0.01	2	<0.0002	<0.0002			0.0012	0.0015	0.0184	<0.0002		0.0001	0.0009	<0.0002	0.0001
Nickel, total	mg/L	2.	2	<0.0049	0.016			0.617	0.747	2.04	0.0061		0.201	0.367	0.115	0.115
Nitrogen, Nitrate, total	mg/L	100.	0	0.68	<0.11			0.084	0.052	0.551	1.		0.154	0.065	0.036	0.039
Potassium, total	mg/L			6.2	3.3			25.1	37.6	75.7	4.5		7.92	17.6	3.86	8.59
Selenium, total	mg/L	0.05	5	<0.0068	0.0007			<0.04	<0.004	<0.02	0.006		0.0012	<0.01	0.0006	<0.001
Silver, total	mg/L		0	<0.001	<0.001			<0.014	<0.014	<0.035	<0.001		<0.007	<0.014	<0.007	<0.007
Sodium, total	mg/L			100.	190.			122.	73.	262.	120.		142.	269.	95.6	195.
Sulfate, total	mg/L	400.	21	74.	220.			1250.	296.	1640.	1100.		1370.	732.	478.	379.
Thallium, total	mg/L	0.02	3	<0.05	<0.05			0.0049	0.0062	0.0441	<0.05		<0.002	<0.008	<0.002	0.001
Total Dissolved Solids (TDS)	mg/L	1200.	22	350.	1300.			2590.	1040.	3400.	1900.		2810.	1880.	1260.	1160.
Vanadium, total	mg/L	0.1	20	<0.0079	0.0012			1.1	1.52	<0.01	0.0011		0.111	0.822	0.0398	0.211
Zinc, total	mg/L	5.	3	<0.021	0.011			1.52	2.45	27.3	0.0049		0.298	0.882	0.195	0.214

CCR (Appendix III or IV) parameter =	*Lead, total*
Upgradient monitoring well =	**EBG**
Downgradient monitoring well =	**EP-3**
Extent investigation boring =	**DP2c**
Concentration exceeds Class II Std. =	65.
Insuficient water to sample =	

Some CCR parameters (Lithium, Molybdenum, & Radium 226/228) do not have Class II GW Standards

TABLE A-2. Extent of Contamination Study Results (2019)

PARAMETER NAME	UNITS	Class II Std	No. of Exceedances	DP2f	DP2g	DP2h	EP-1	DP3a	DP3b	DP3c	DP3d	DP4a	DP4b	DP4c	DP4d	DP5a
Conductivity	µmhos/cm			1630.	869.	733.		1980.	3320.	3060.	672.				512.	8540.
pH	SU	6.5 - 9.0	9	7.06	6.41	6.03	6.33	7.23	7.11	7.21	7.38				7.07	12.5
Temperature	°C			12.8	12.5	12.2	13.9	10.7	12.1	12.9	10.7				8.8	13.8
Alkalinity, Bicarbonate, total	mg/L			690.	120.	120.	240.	560.	480.	470.	70.				50.	n/a
Alkalinity, Carbonate, total	mg/L			0.	0.	0.	<5.	0.	0.	0.	0.				0.	840.
Antimony, total	mg/L	0.024	0	0.0009	0.0049	<0.004	<0.005	<0.002	<0.004	0.0008	0.0006				0.0009	0.0027
Arsenic, total	mg/L	0.2	5	0.11	0.07	0.0681	<0.005	0.0989	0.0882	0.0281	0.0355				0.043	0.0214
Barium, total	mg/L	2.	11	4.87	1.68	3.41	<0.01	2.2	2.83	0.641	0.589				0.91	0.288
Beryllium, total	mg/L	0.5	0	0.006	0.0082	0.0207	<0.005	0.0128	0.018	0.0023	0.0036				0.0043	0.003
Boron, total	mg/L	2.	10	<0.02	0.014	<0.04	0.73	0.054	<0.04	<0.02	<0.02				0.0324	0.854
Cadmium, total	mg/L	0.05	3	0.0024	<0.002	0.0025	<0.01	0.0019	0.0023	0.0008	<0.002				0.0005	0.0031
Calcium, total	mg/L			97.1	96.9	86.1	390.	376.	446.	209.	34.2				67.2	1360.
Chloride, total	mg/L	200.	14	148.	48.	31.	70.	224.	150.	226.	7.				4.	848.
Chromium, total	mg/L	1.	4	0.155	0.274	0.574	<0.01	0.395	0.473	0.0754	0.138				0.108	0.0345
Cobalt, total	mg/L	1.	2	0.127	0.321	0.466	0.0004	0.136	0.225	0.0454	0.0594				0.0587	0.0089
Copper, total	mg/L	0.65	6	0.0901	0.208	0.604	0.0009	0.246	0.31	0.0369	0.0657				0.0982	0.0455
Cyanide, total	mg/L	0.6	0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005				<0.005	<0.005
Fluoride, total	mg/L	4.	1	0.38	0.44	0.14	<0.5	0.58	0.32	0.23	0.18				0.18	0.05
Iron, total	mg/L	5.	25	253.	329.	546.	0.44	389.	519.	84.7	122.				128.	18.
Lead, total	mg/L	0.1	15	0.0956	0.157	0.414	<0.01	0.183	0.289	0.037	0.0593				0.0621	0.0676
Magnesium, total	mg/L			45.2	54.4	85.2	160.	129.	177.	90.3	24.2				40.3	5.16
Manganese, total	mg/L	10.	16	37.7	23.8	33.8	0.035	8.44	13.7	4.38	1.79				2.61	0.312
Mercury, total	mg/L	0.01	2	0.0001	0.0006	0.0017	<0.0002	0.0007	0.0008	0.0001	0.0002				0.0002	0.0007
Nickel, total	mg/L	2.	2	0.225	0.236	0.449	0.0066	0.329	0.404	0.0728	0.0931				0.127	0.0415
Nitrogen, Nitrate, total	mg/L	100.	0	0.035	0.023	0.059	<0.11	0.112	0.079	0.068	1.1				0.113	0.341
Potassium, total	mg/L			5.93	18.9	17.6	4.6	11.6	15.2	4.95	4.5				6.13	545.
Selenium, total	mg/L	0.05	5	<0.001	<0.001	0.0027	<0.005	<0.01	<0.01	0.0023	0.0083				<0.001	0.0762
Silver, total	mg/L		0	<0.007	<0.007	<0.007	<0.001	<0.007	<0.007	<0.007	<0.007				<0.007	<0.007
Sodium, total	mg/L			303.	85.4	61.1	180.	234.	322.	331.	104.				26.3	211.
Sulfate, total	mg/L	400.	21	167.	222.	213.	1600.	724.	1270.	651.	254.				234.	1270.
Thallium, total	mg/L	0.02	3	0.0015	0.0013	0.0057	<0.05	0.0021	0.0033	<0.002	<0.002				0.0017	0.0023
Total Dissolved Solids (TDS)	mg/L	1200.	22	1030.	555.	500.	2800.	1230.	2520.	2140.	470.				365.	4520.
Vanadium, total	mg/L	0.1	20	0.31	0.397	0.727	<0.025	0.415	0.602	0.0902	0.166				0.175	0.178
Zinc, total	mg/L	5.	3	0.26	0.504	1.18	<0.01	0.682	0.896	0.117	0.195				0.503	0.196

CCR (Appendix III or IV) parameter =	*Lead, total*
Upgradient monitoring well =	**EBG**
Downgradient monitoring well =	**EP-3**
Extent investigation boring =	**DP2c**
Concentration exceeds Class II Std. =	65.
Insuficient water to sample =	

Some CCR parameters (Lithium, Molybdenum, & Radium 226/228) do not have Class II GW Standards

TABLE A-2. Extent of Contamination Study Results (2019)

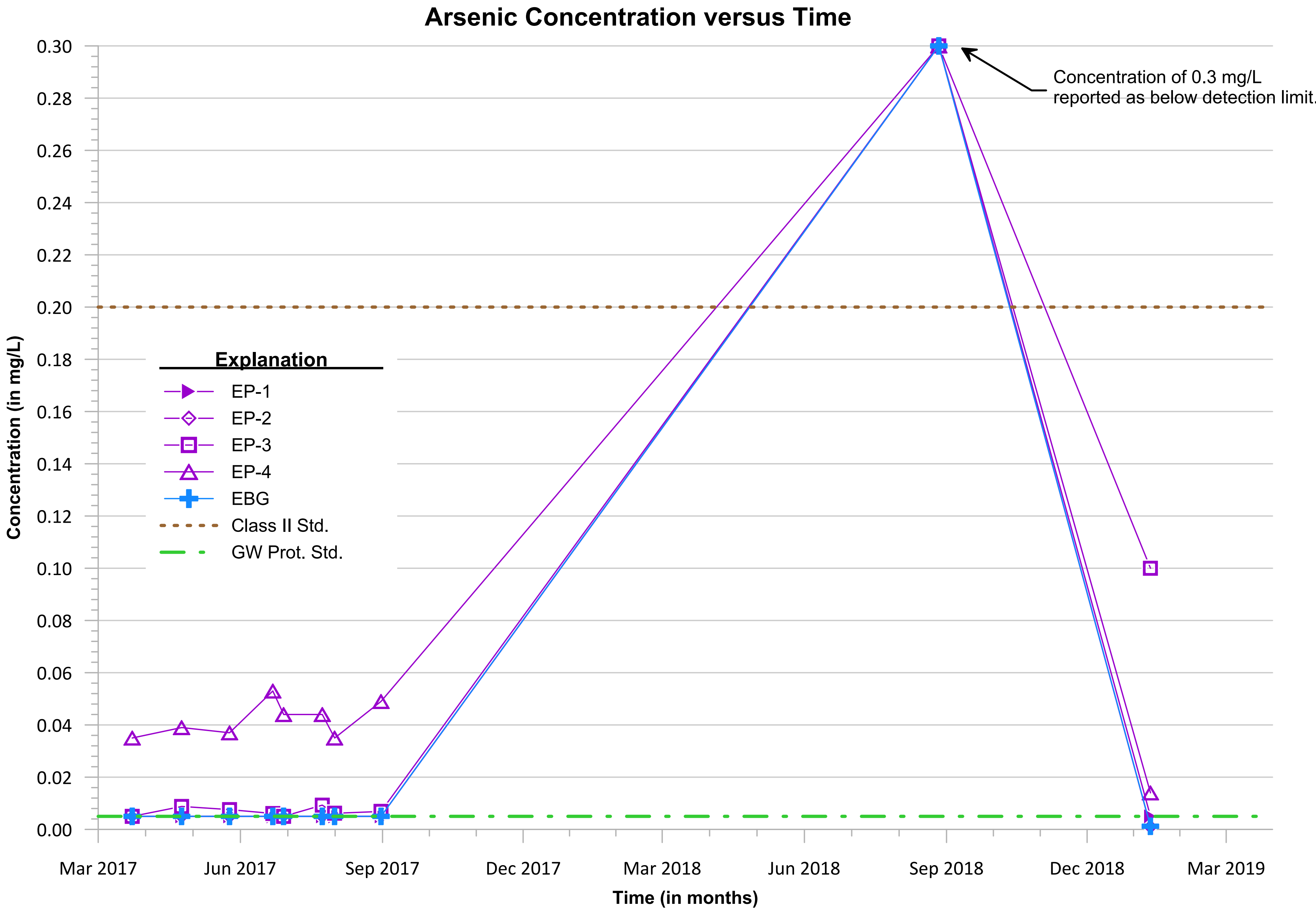
PARAMETER NAME	UNITS	Class II Std	No. of Exceedances	DP5b	DP6a	DP6b	DP6c	EP-4	DP7a	DP7b	DP7c	DP7d	Emery Pond	Gypsum
Conductivity	µmhos/cm			6020.	5160.		3380.		4000.	3580.	3210.	2470.	9630.	
pH	SU	6.5 - 9.0	9	10.6	6.48		7.11	6.07	6.51	6.61	6.44	6.66	7.77	
Temperature	°C			9.9	6.3		5.8	16.	9.7	7.6	9.8	8.9	17.3	
Alkalinity, Bicarbonate, total	mg/L			1260.	1320.		72700.	110.	294.	750.	500.	754.	100.	16.
Alkalinity, Carbonate, total	mg/L			200.	0.		0.	<5.	0.	0.	0.	0.	0.	0.
Antimony, total	mg/L	0.024	0	0.0096	<0.01		0.0018	<0.005	<0.004	<0.01	<0.002	<0.01	0.0007	<0.001
Arsenic, total	mg/L	0.2	5	0.181	0.359		0.188	0.014	1.1	1.64	0.339	0.14	0.0025	<0.01
Barium, total	mg/L	2.	11	1.32	3.22		1.48	0.024	1.49	1.59	2.84	2.46	0.121	0.0111
Beryllium, total	mg/L	0.5	0	0.019	0.083		0.0091	<0.005	0.037	0.06	0.0171	0.0226	<0.0005	<0.0005
Boron, total	mg/L	2.	10	4.88	14.		8.09	12.	3.38	3.38	6.9	0.06	72.7	0.498
Cadmium, total	mg/L	0.05	3	0.018	0.127		0.0147	<0.01	0.0565	0.044	0.0053	0.0005	0.019	<0.002
Calcium, total	mg/L			2820.	1850.		6180.	140.	2000.	2870.	505.	331.	899.	629.
Chloride, total	mg/L	200.	14	1210.	980.		309.	420.	380.	371.	495.	129.	2190.	15.
Chromium, total	mg/L	1.	4	0.328	1.52		0.702	<0.01	1.39	1.95	0.457	0.681	0.0075	0.0149
Cobalt, total	mg/L	1.	2	0.0895	3.87		0.173	0.39	0.421	0.658	0.547	0.281	0.0149	<0.005
Copper, total	mg/L	0.65	6	0.325	1.43		1.1	0.0016	2.12	3.27	0.48	0.292	0.0077	<0.005
Cyanide, total	mg/L	0.6	0	<0.005	<0.005		<0.025	<0.005	<0.005	0.003	0.004	<0.005	0.183	<0.005
Fluoride, total	mg/L	4.	1	0.15	0.21		2.26	<0.5	1.26	0.3	0.14	0.43	17.1	1.67
Iron, total	mg/L	5.	25	177.	1780.		332.	230.	1570.	2660.	824.	780.	0.899	0.0719
Lead, total	mg/L	0.1	15	0.527	1.87		0.375	<0.01	2.47	5.17	0.583	0.319	0.0026	<0.0075
Magnesium, total	mg/L			42.1	470.		495.	120.	322.	499.	211.	114.	673.	4.45
Manganese, total	mg/L	10.	16	2.85	112.		11.8	77.	30.7	53.4	45.1	12.3	4.56	0.0444
Mercury, total	mg/L	0.01	2	0.0129	0.0078		0.0014	<0.0002	0.0099	0.0069	0.0006	0.0005	0.0004	<0.0002
Nickel, total	mg/L	2.	2	0.348	2.23		0.513	0.056	1.45	1.45	0.476	0.39	0.118	0.01
Nitrogen, Nitrate, total	mg/L	100.	0	0.235	0.336		0.334	<0.11	0.122	0.033	0.185	<0.05	4.86	<0.05
Potassium, total	mg/L			488.	61.5		20.4	2.7	51.9	66.2	18.	15.	8.66	0.11
Selenium, total	mg/L	0.05	5	0.137	0.0288		0.0347	<0.005	0.407	0.304	<0.002	0.0083	0.082	0.0462
Silver, total	mg/L		0	<0.007	<0.07		<0.035	<0.001	<0.014	<0.035	<0.014	<0.007	<0.007	<0.007
Sodium, total	mg/L			158.	136.		189.	110.	149.	169.	134.	218.	408.	2.68
Sulfate, total	mg/L	400.	21	1200.	1640.		1680.	740.	1790.	1590.	1040.	485.	2000.	1350.
Thallium, total	mg/L	0.02	3	0.0089	0.0251		0.0032	0.097	0.0059	<0.02	0.0044	<0.004	0.002	<0.002
Total Dissolved Solids (TDS)	mg/L	1200.	22	4080.	3700.		3220.	2000.	3240.	2900.	2450.	1640.	6540.	2140.
Vanadium, total	mg/L	0.1	20	1.01	2.47		0.508	<0.025	1.59	2.34	0.761	0.659	0.0161	<0.01
Zinc, total	mg/L	5.	3	1.69	4.88		2.79	0.02	6.06	7.75	1.72	0.913	0.215	<0.01

CCR (Appendix III or IV) parameter =	*Lead, total*
Upgradient monitoring well =	**EBG**
Downgradient monitoring well =	**EP-3**
Extent investigation boring =	**DP2c**
Concentration exceeds Class II Std. =	65.
Insuficient water to sample =	

Some CCR parameters (Lithium, Molybdenum, & Radium 226/228) do not have Class II GW Standards

Appendix B

Graphical Groundwater Monitoring Results



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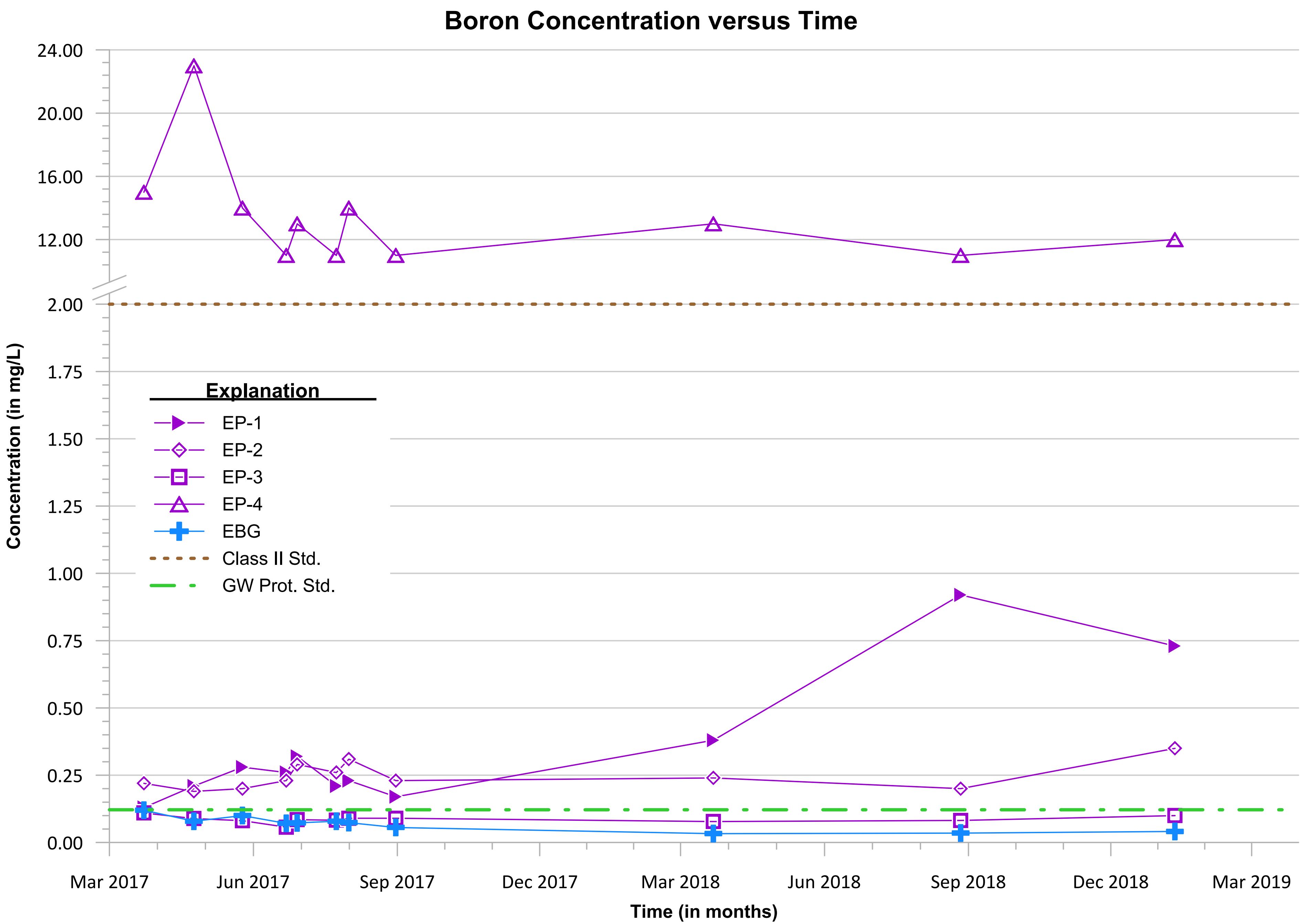

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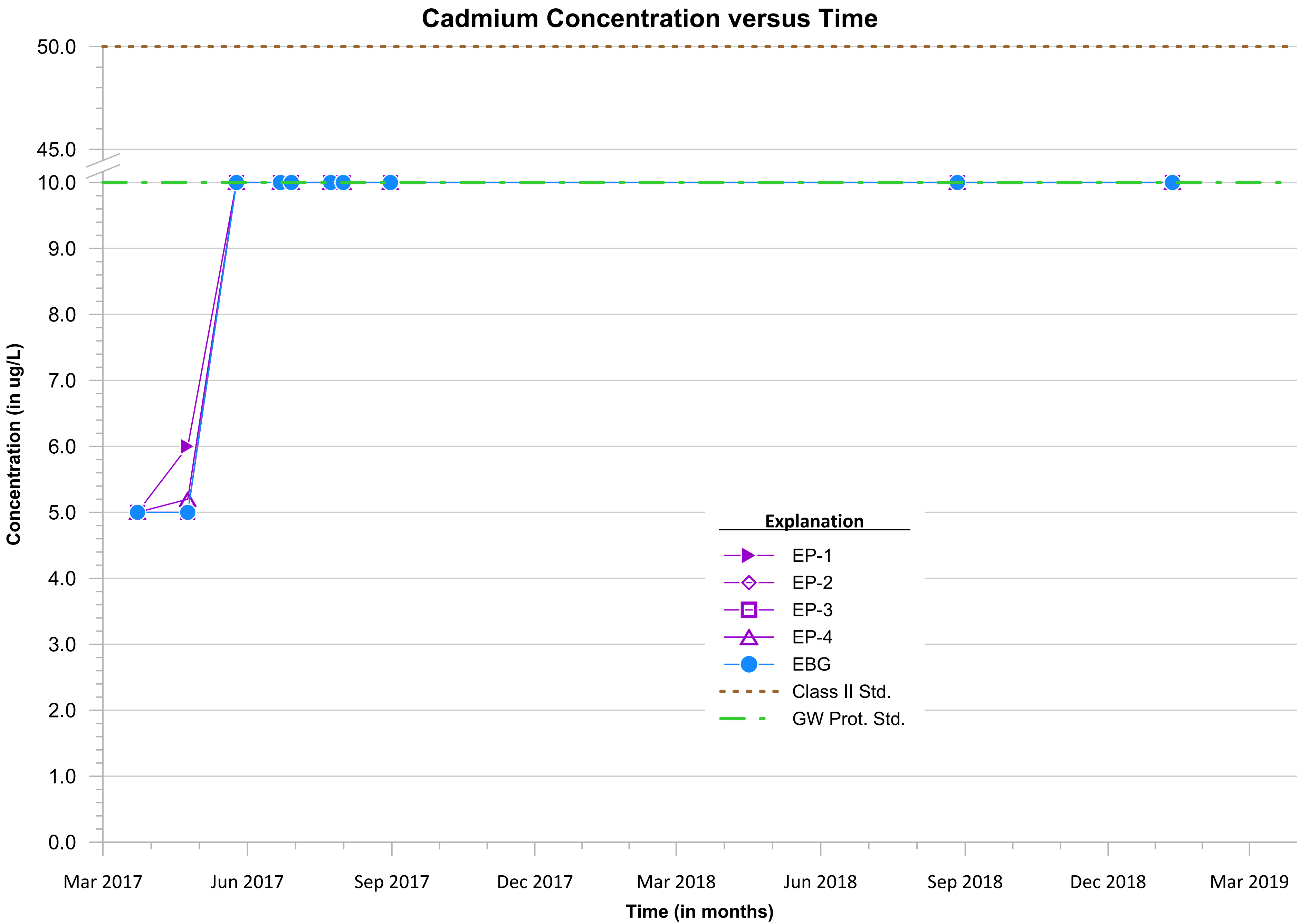

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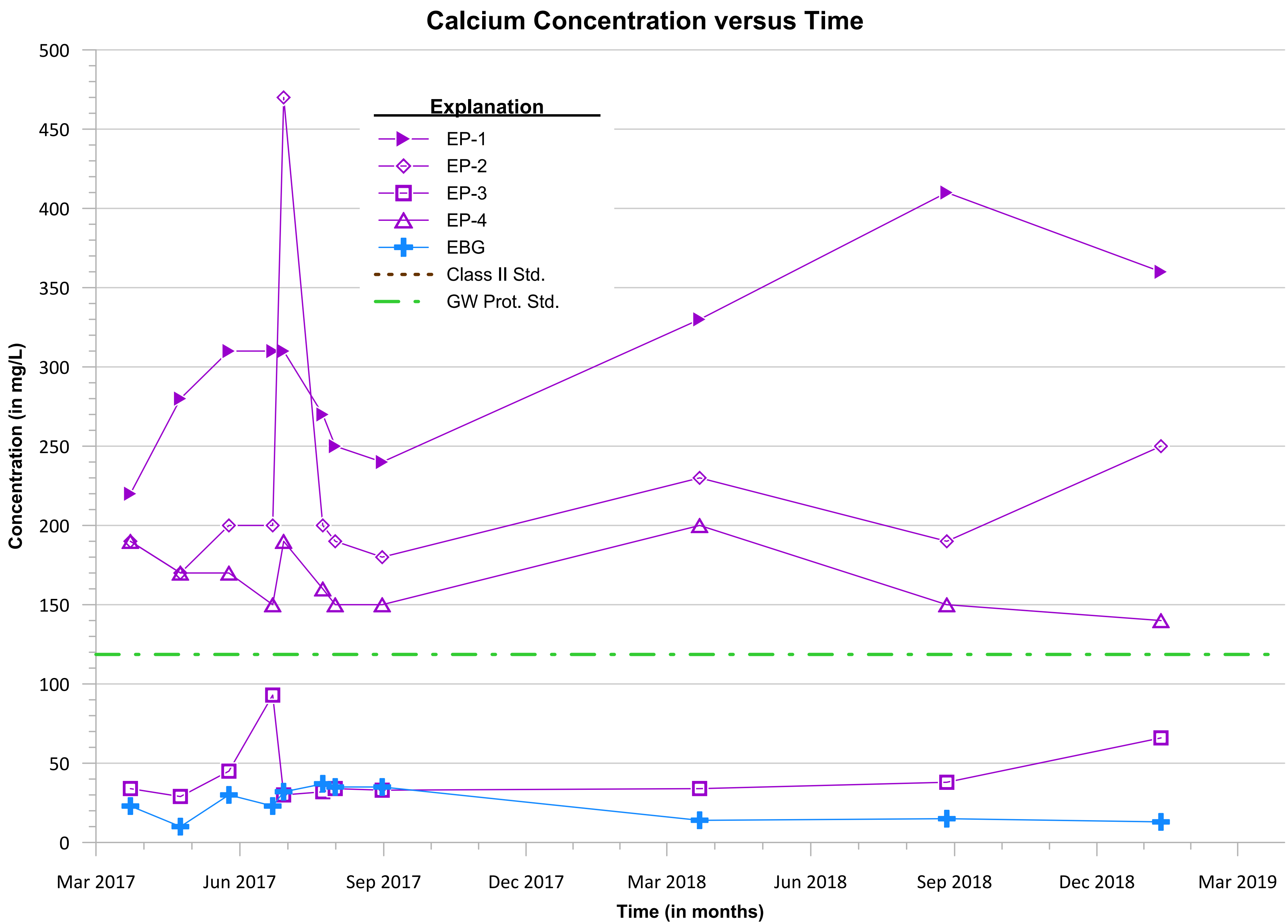

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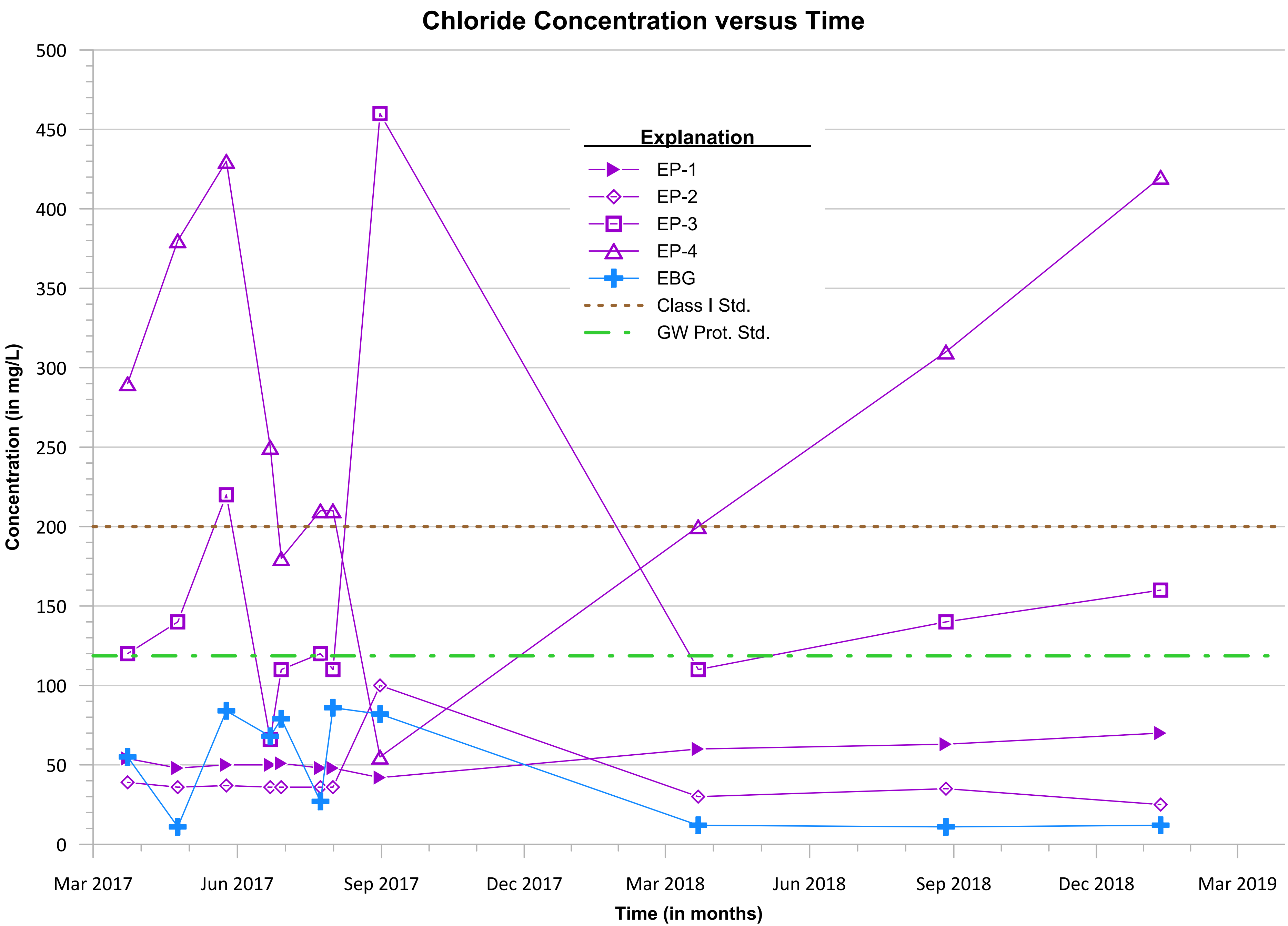

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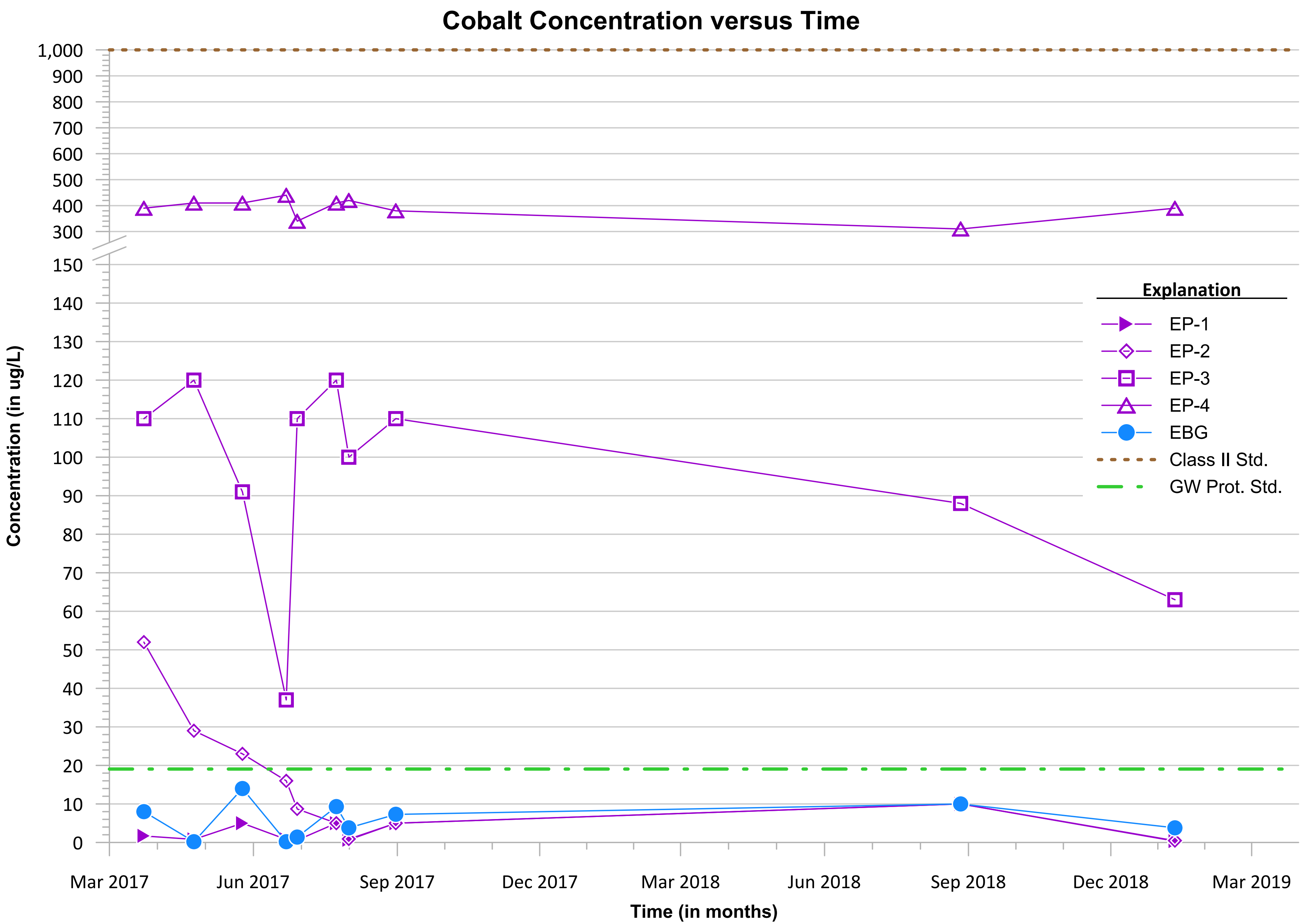

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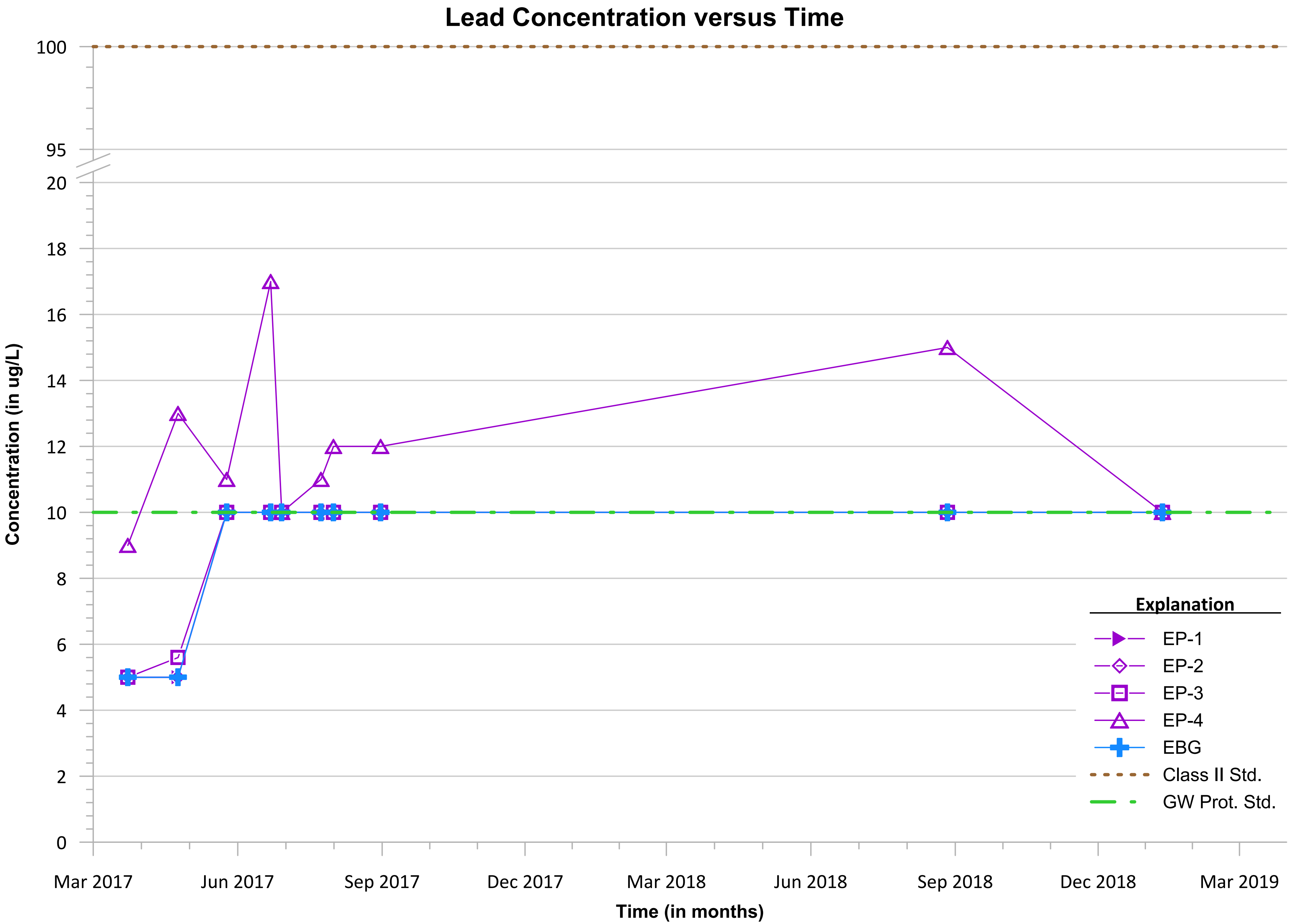

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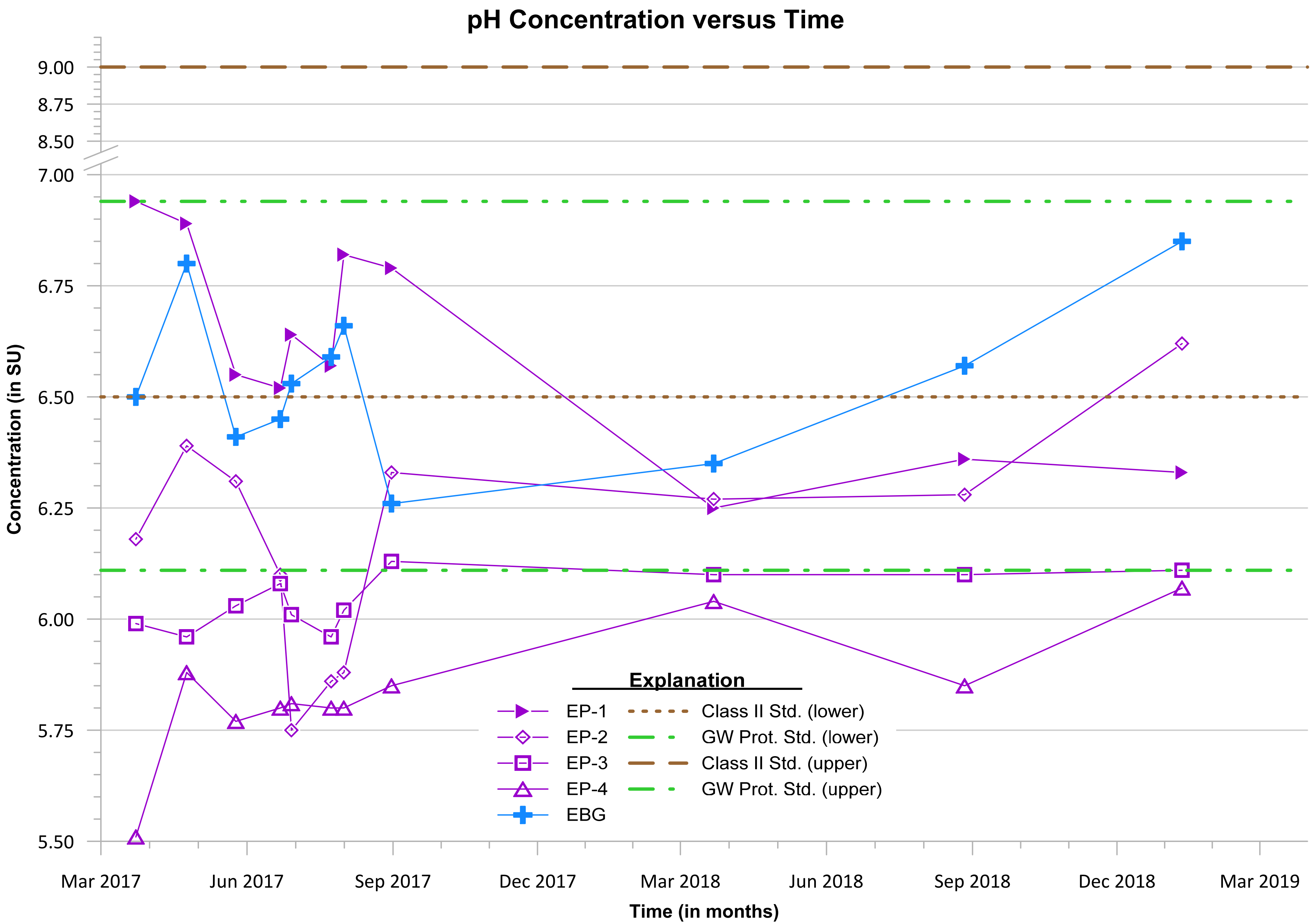

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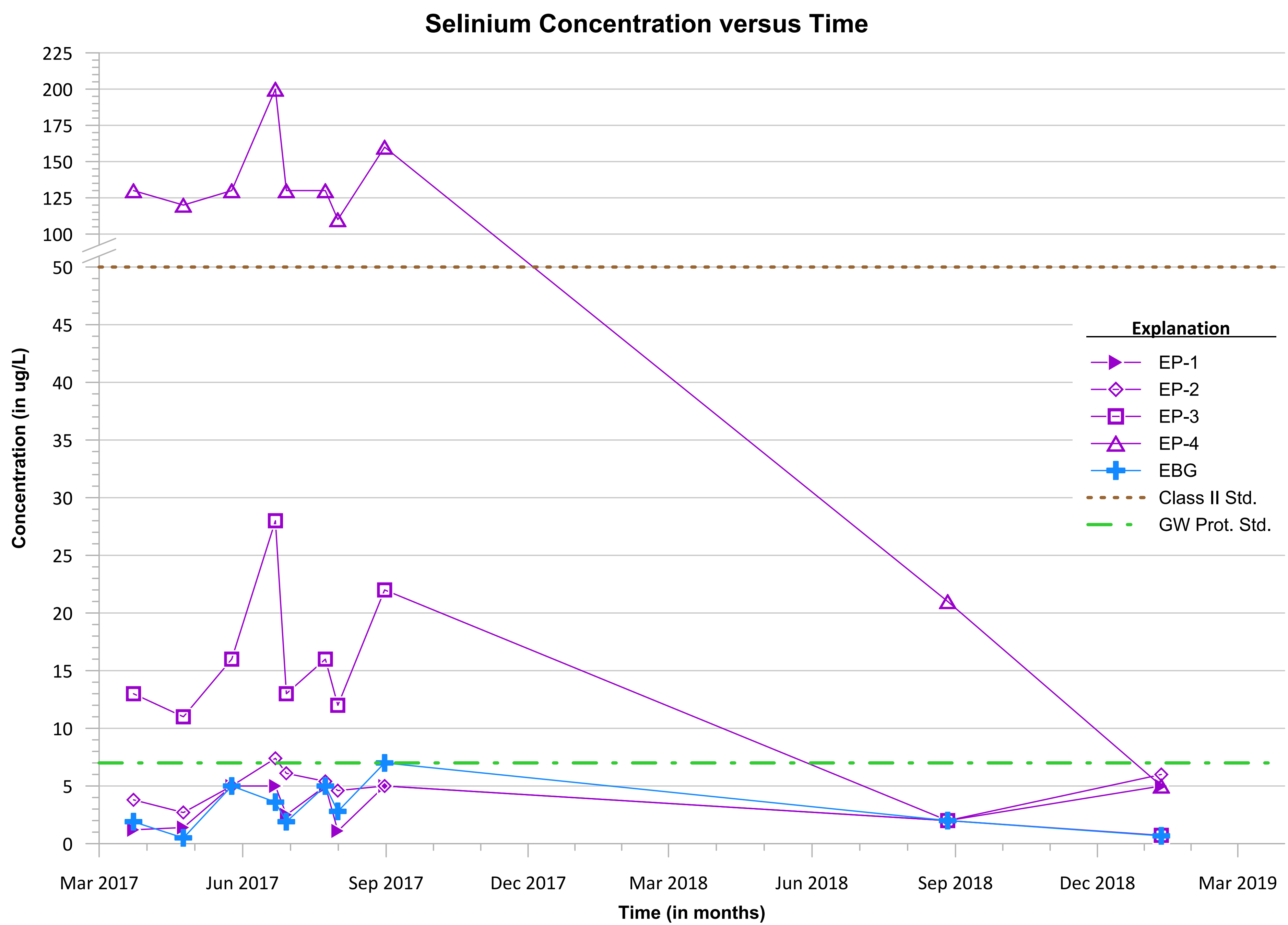

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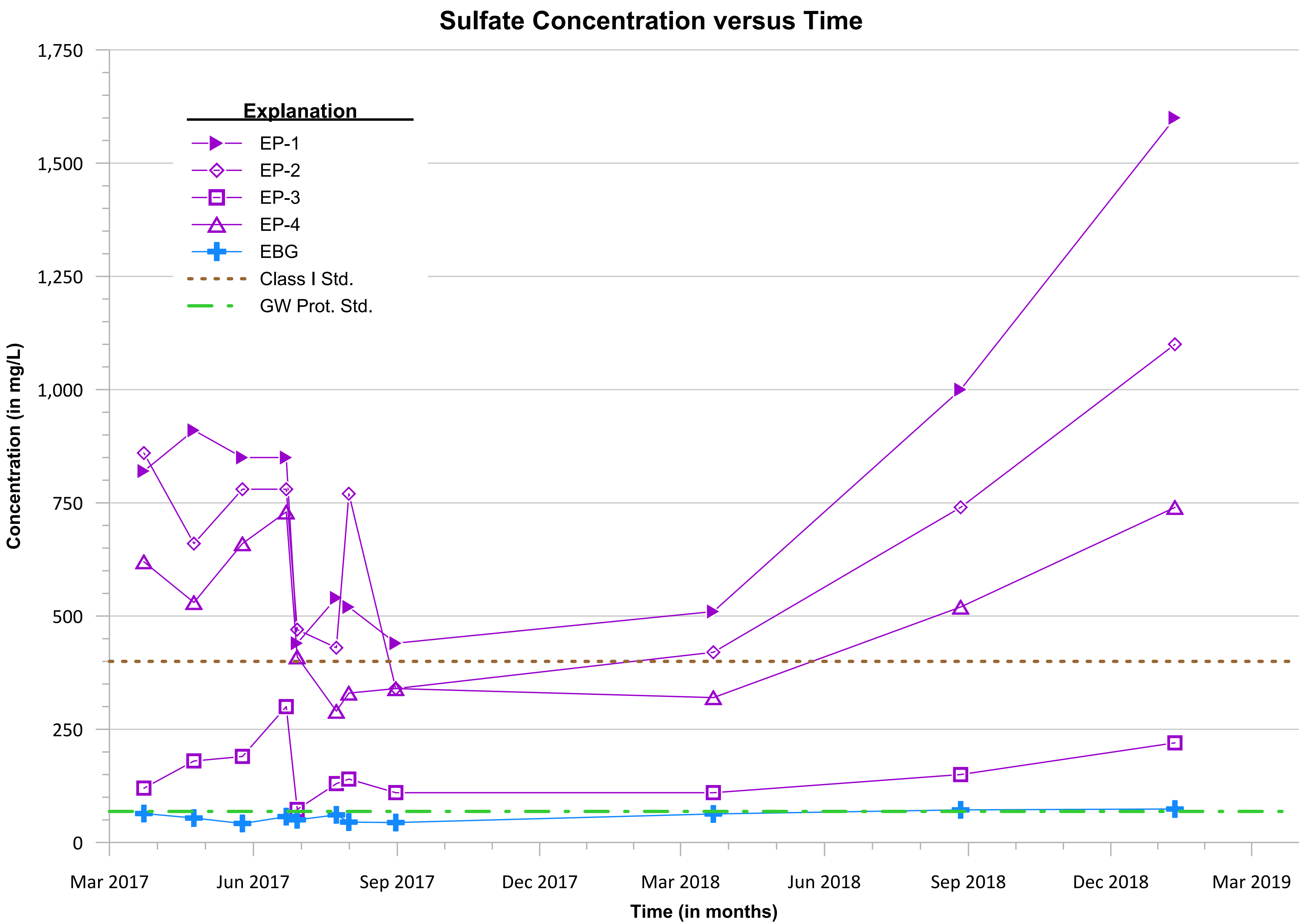

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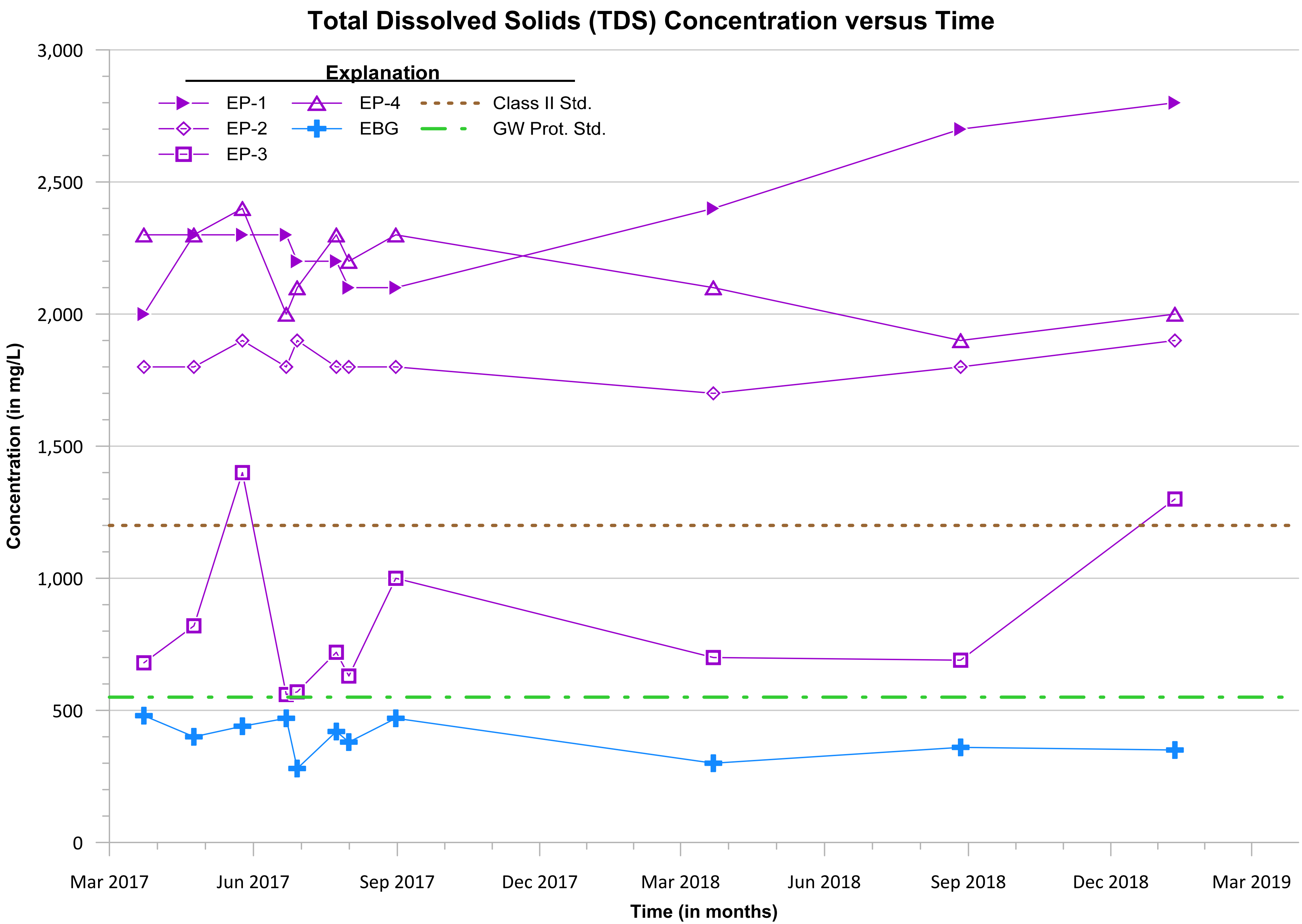

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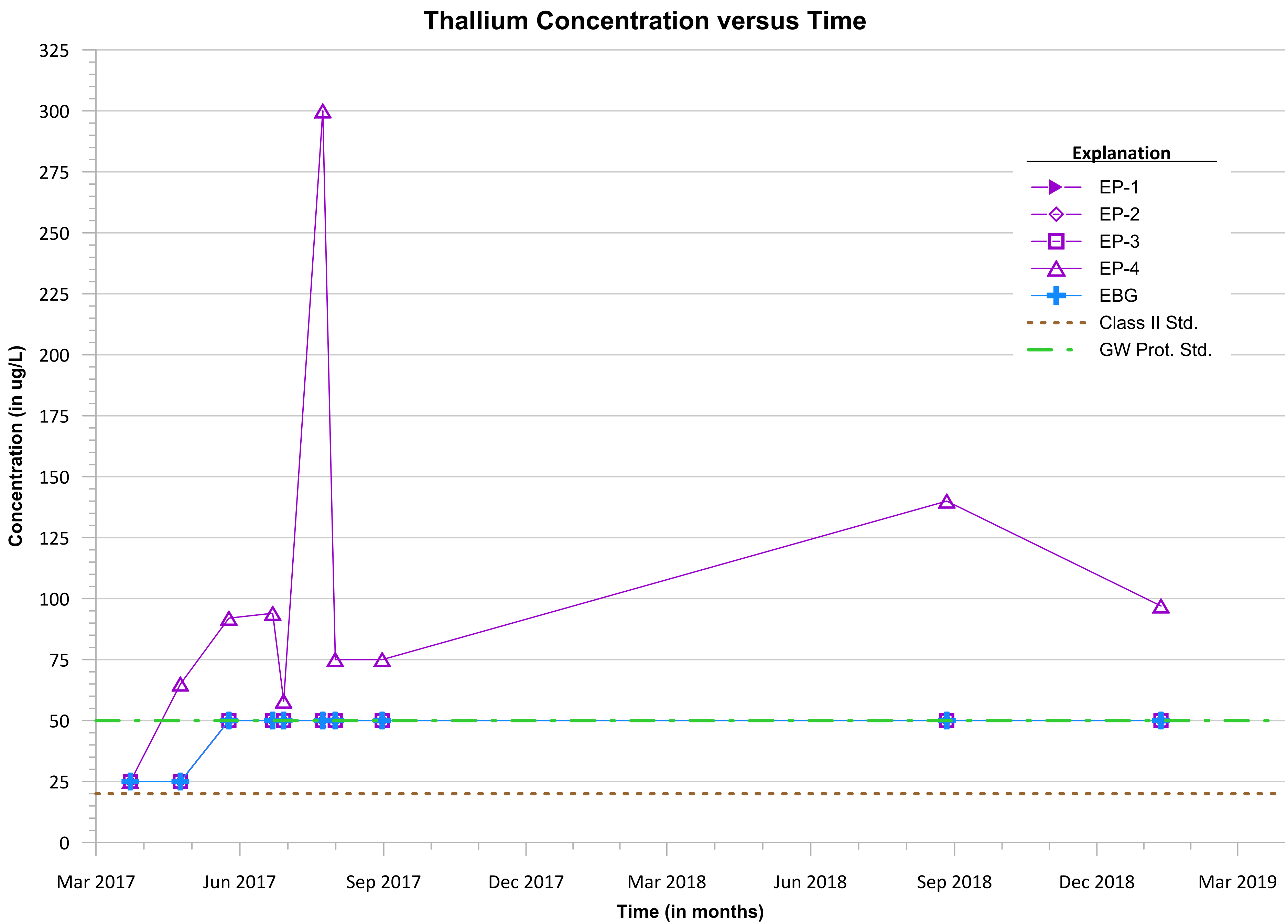

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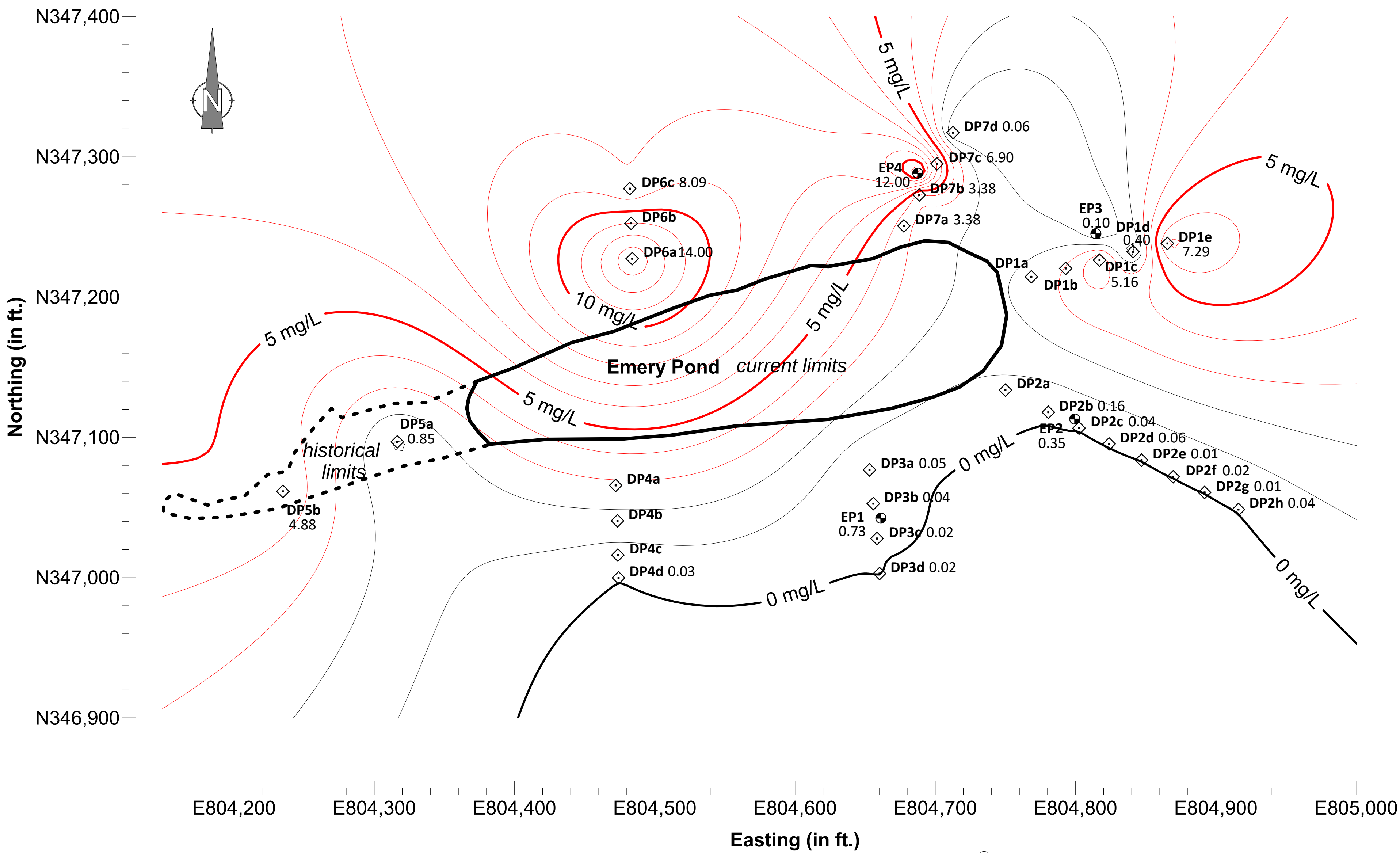
Appendix C

Extent of Impacted Groundwater Isopleth Maps



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (2.0 mg/L)

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

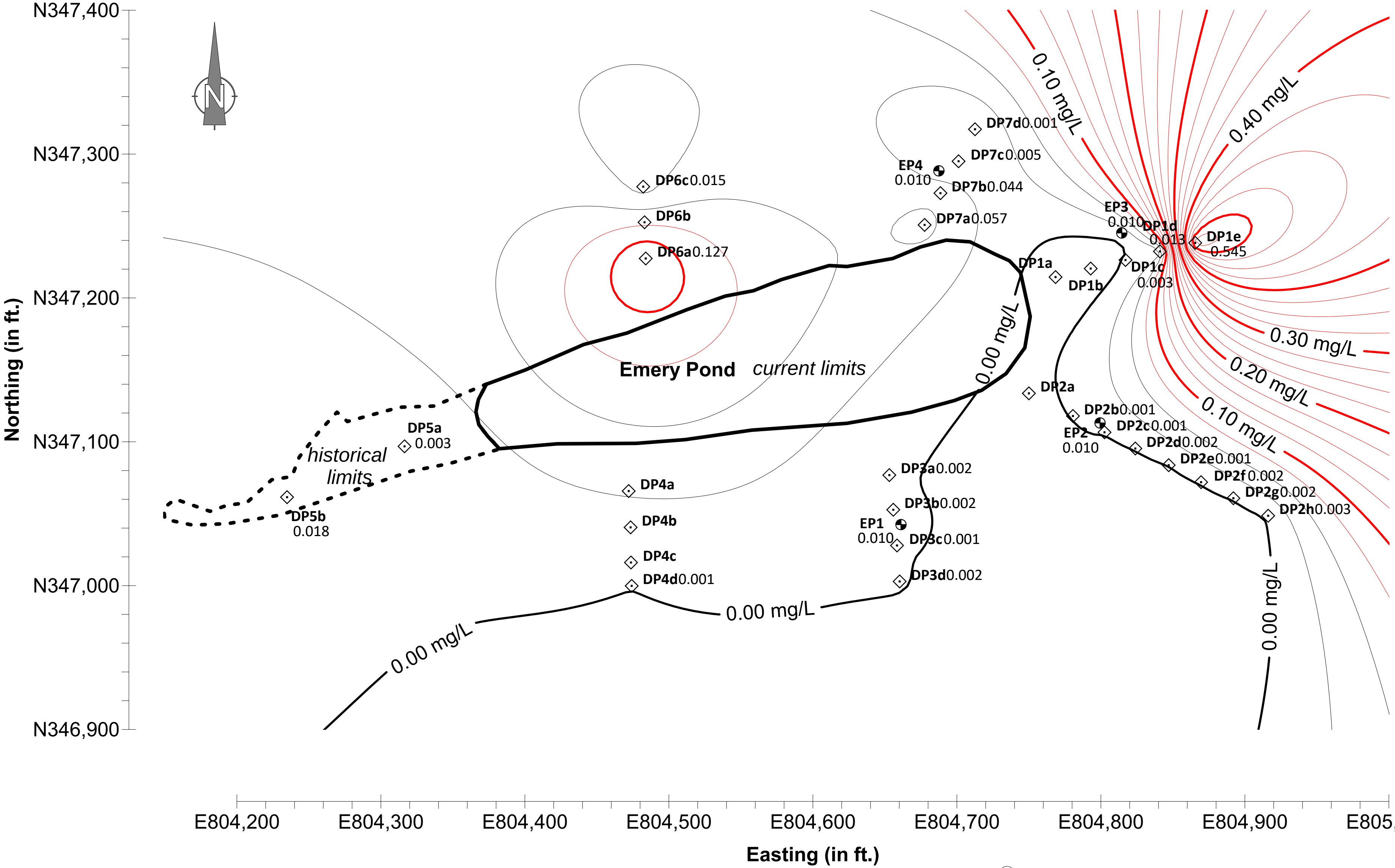
HANSON
Hanson Professional Services Inc.

Boron Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-1



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (0.05 mg/L)

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

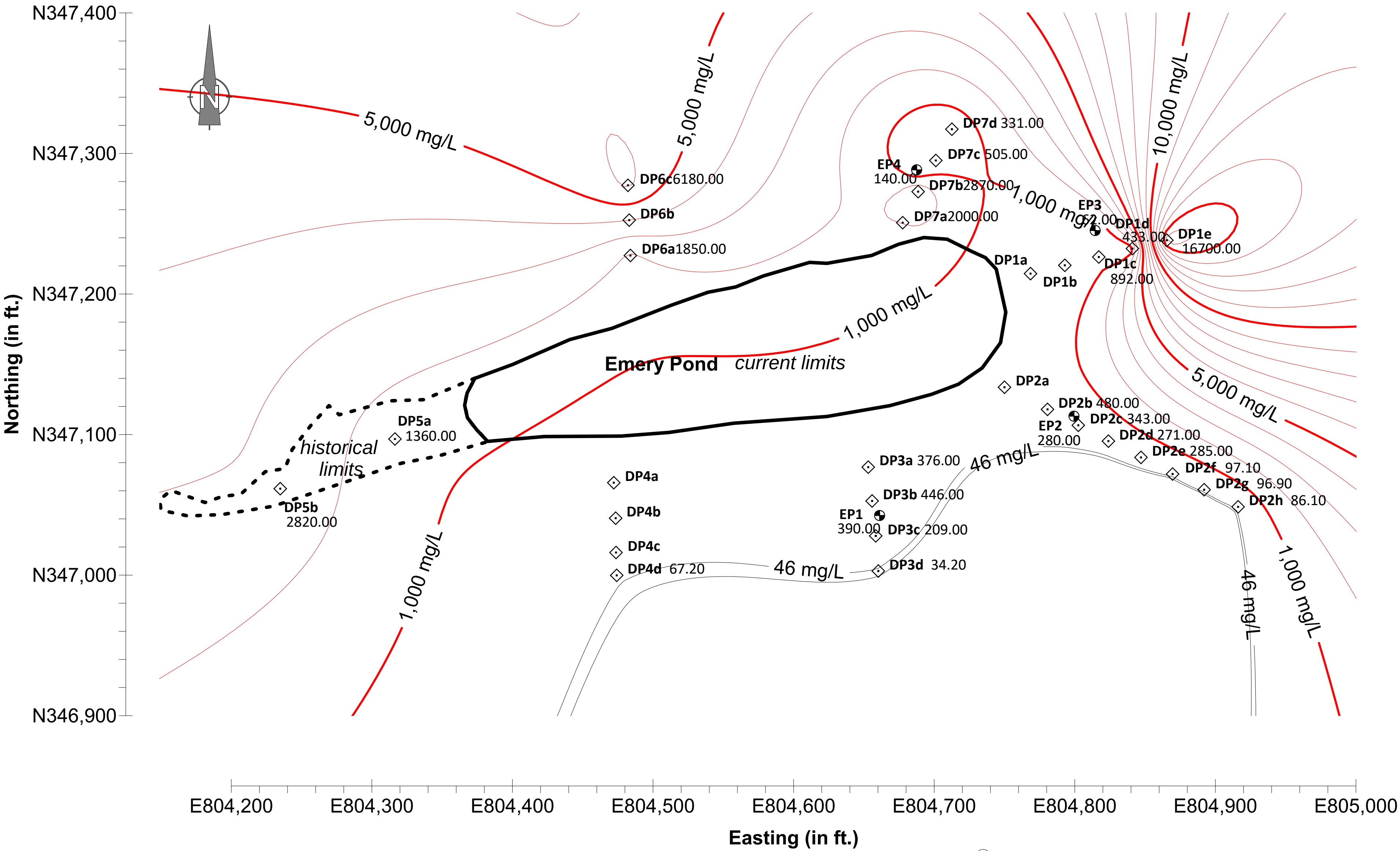
HANSON
Hanson Professional Services Inc.

Cadmium Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-2



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above the GW Protection Std. (46.304 mg/L)

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

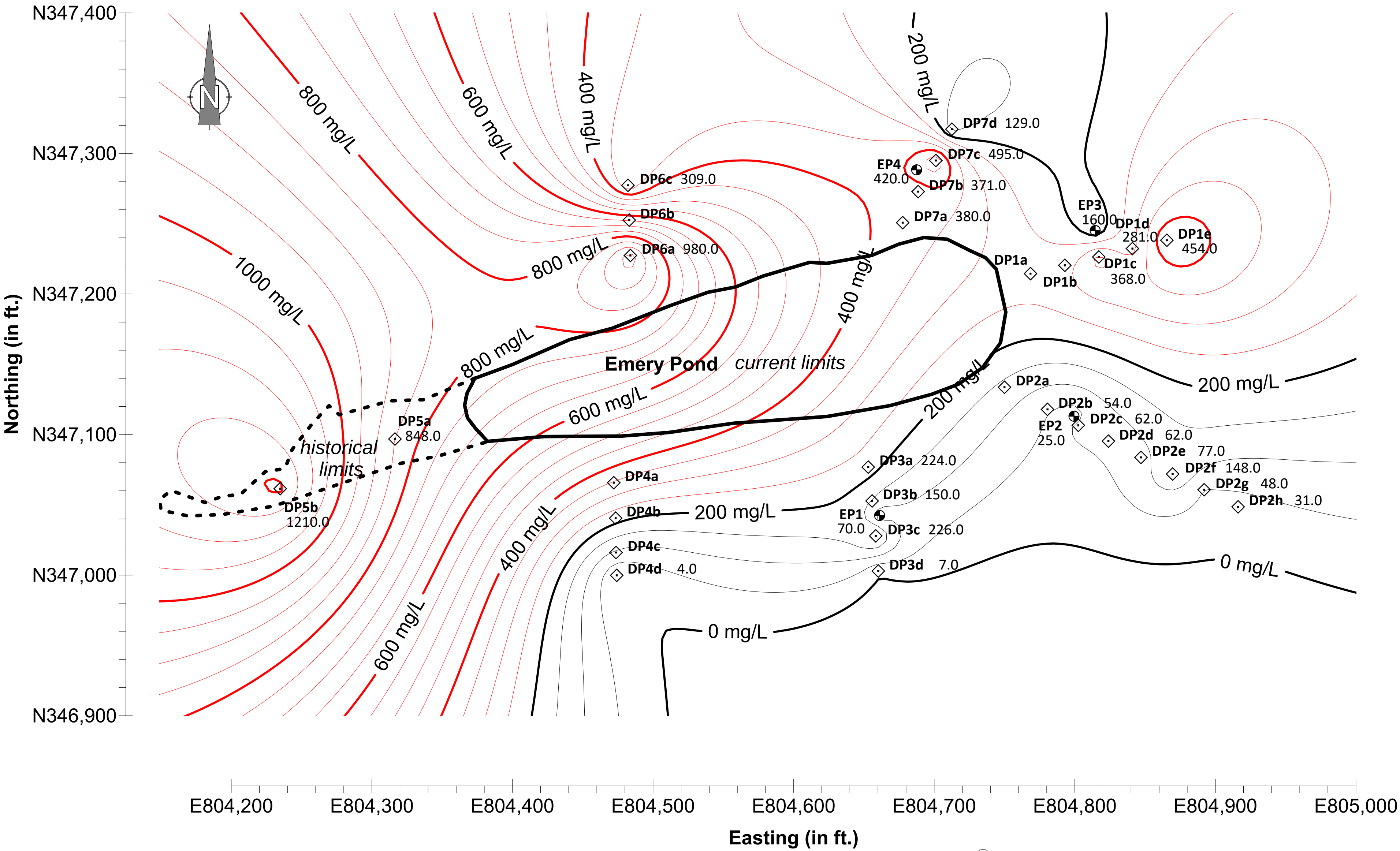
HANSON
Hanson Professional Services Inc.

Calcium Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-3



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (200 mg/L)

Contour Interval = 50 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

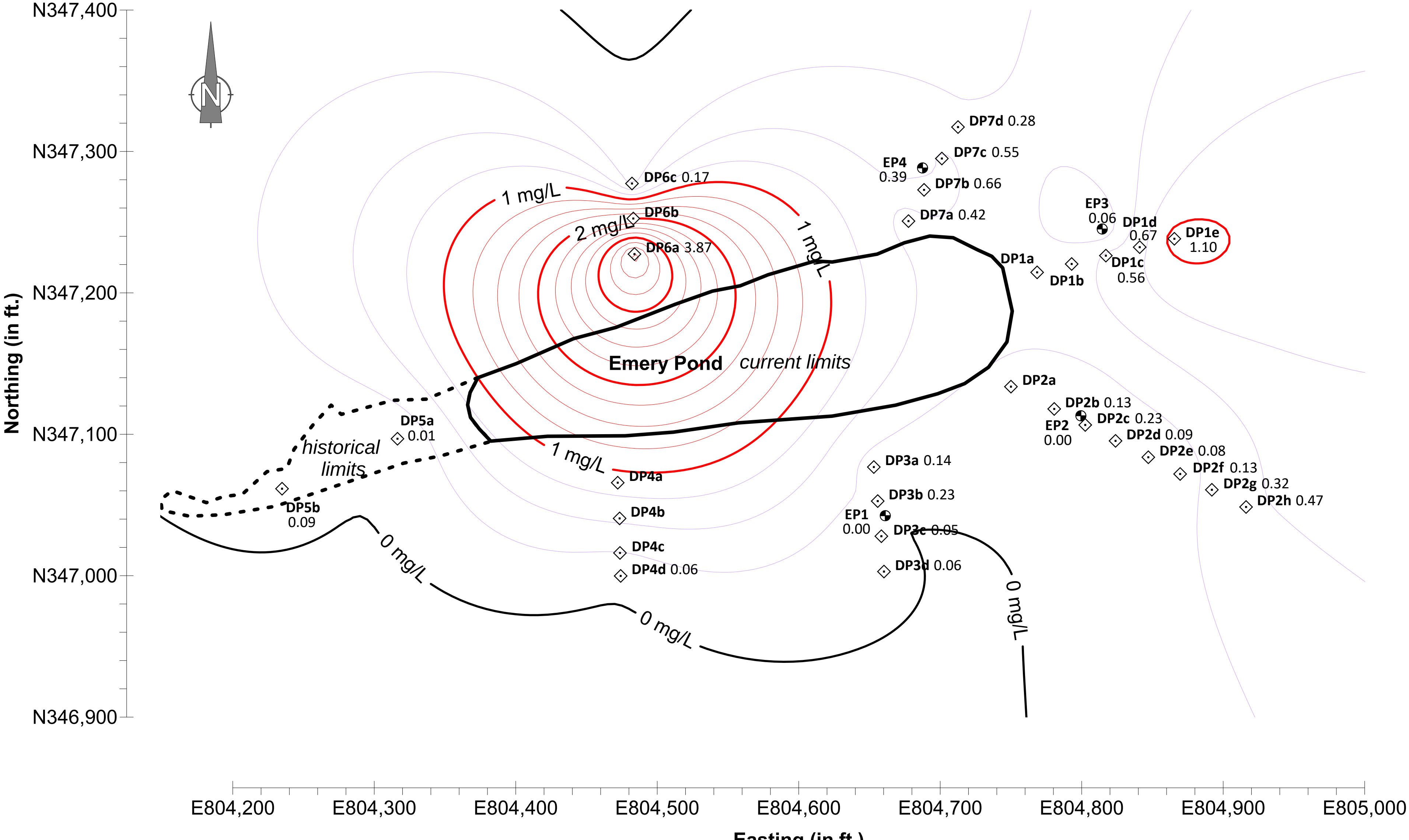
HANSON
Hanson Professional Services Inc.

Chloride Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-4



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Purple contours above the GW Protection Std. (0.0191 mg/L) and Red contours are above the Class II Standard (1.0 mg/L).

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

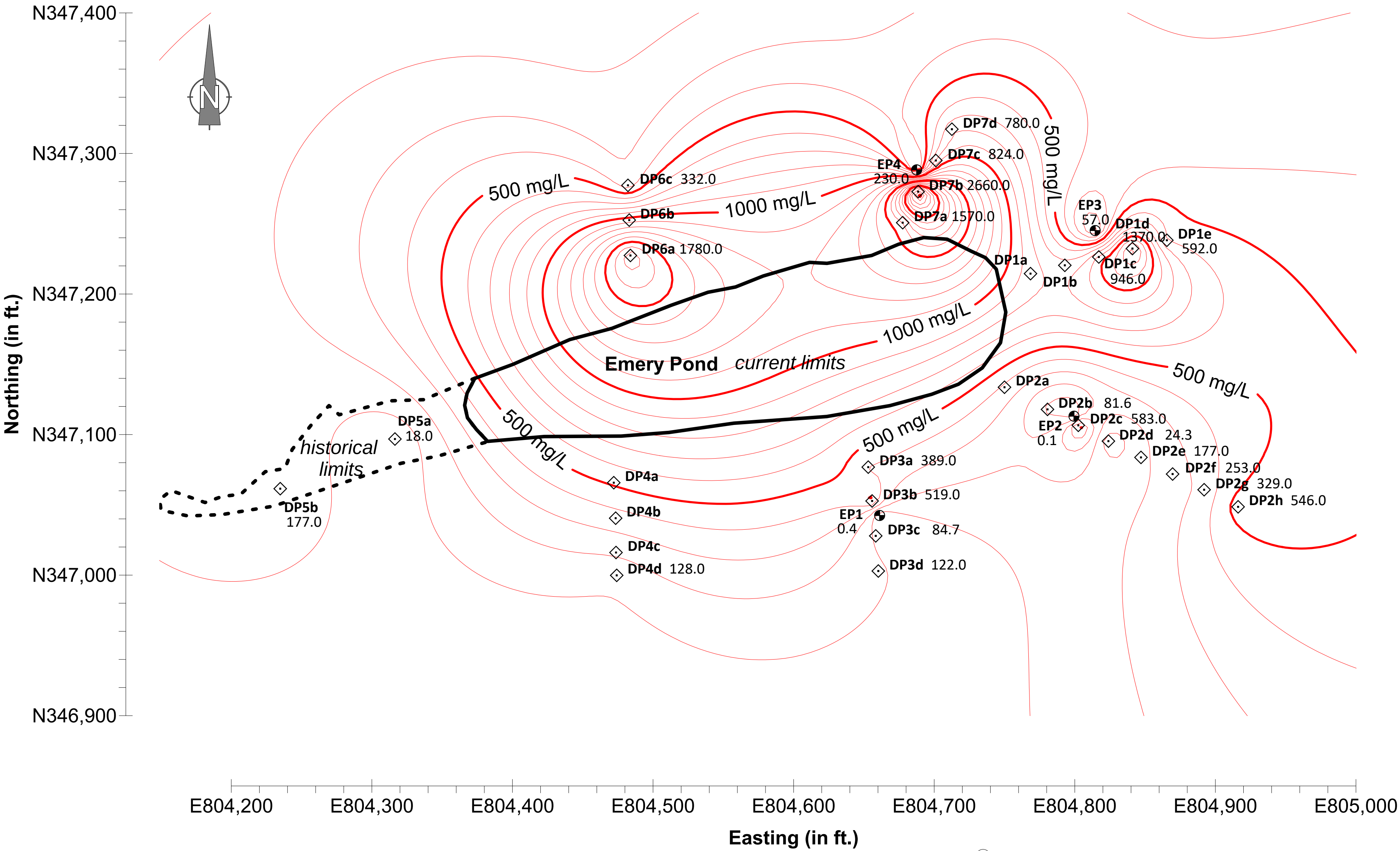
HANSON
Hanson Professional Services Inc.

Cobalt Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-5



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (5.0 mg/L)

Contour Interval = 50 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

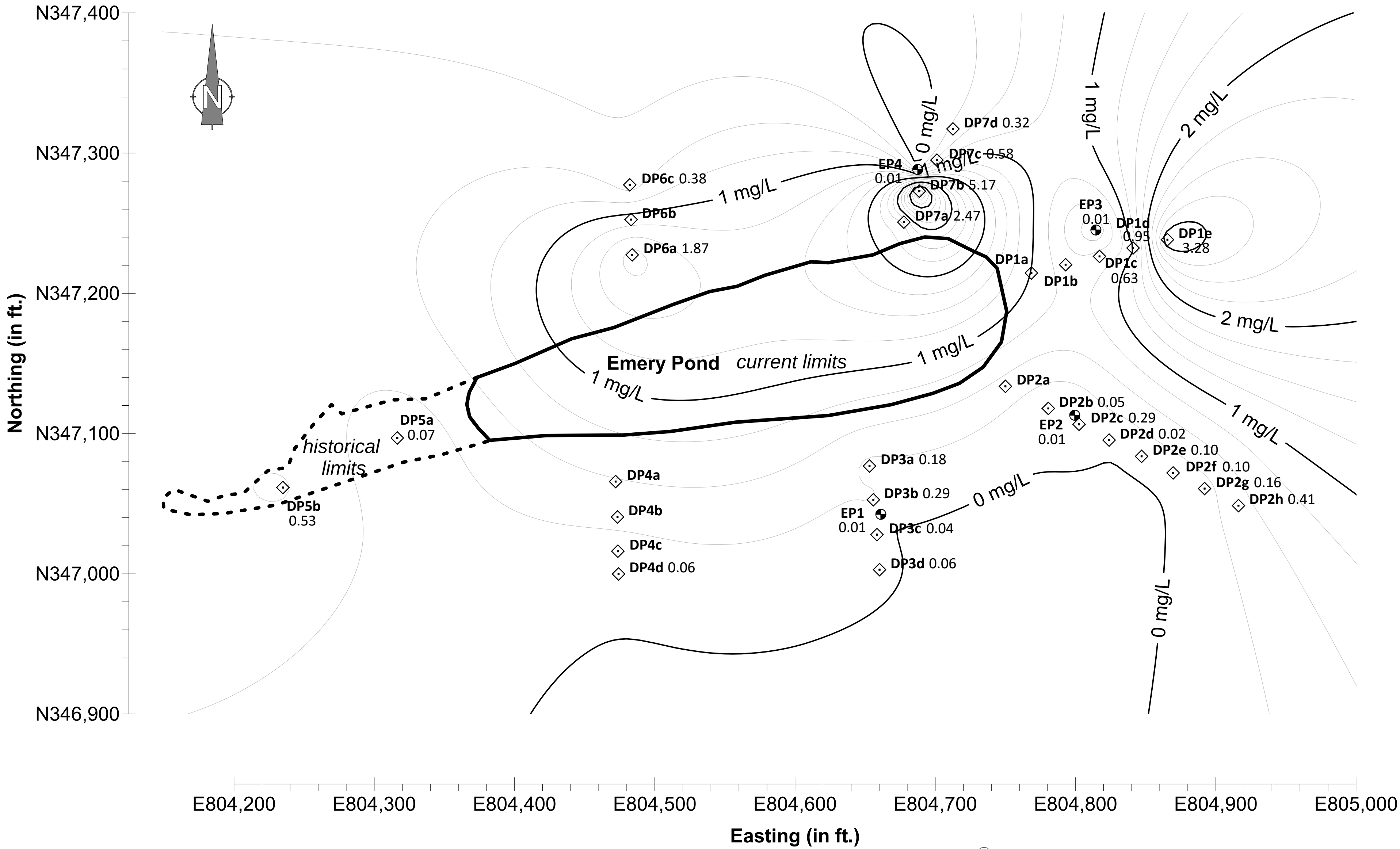
HANSON
Hanson Professional Services Inc.

Iron Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-6



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 0.25 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

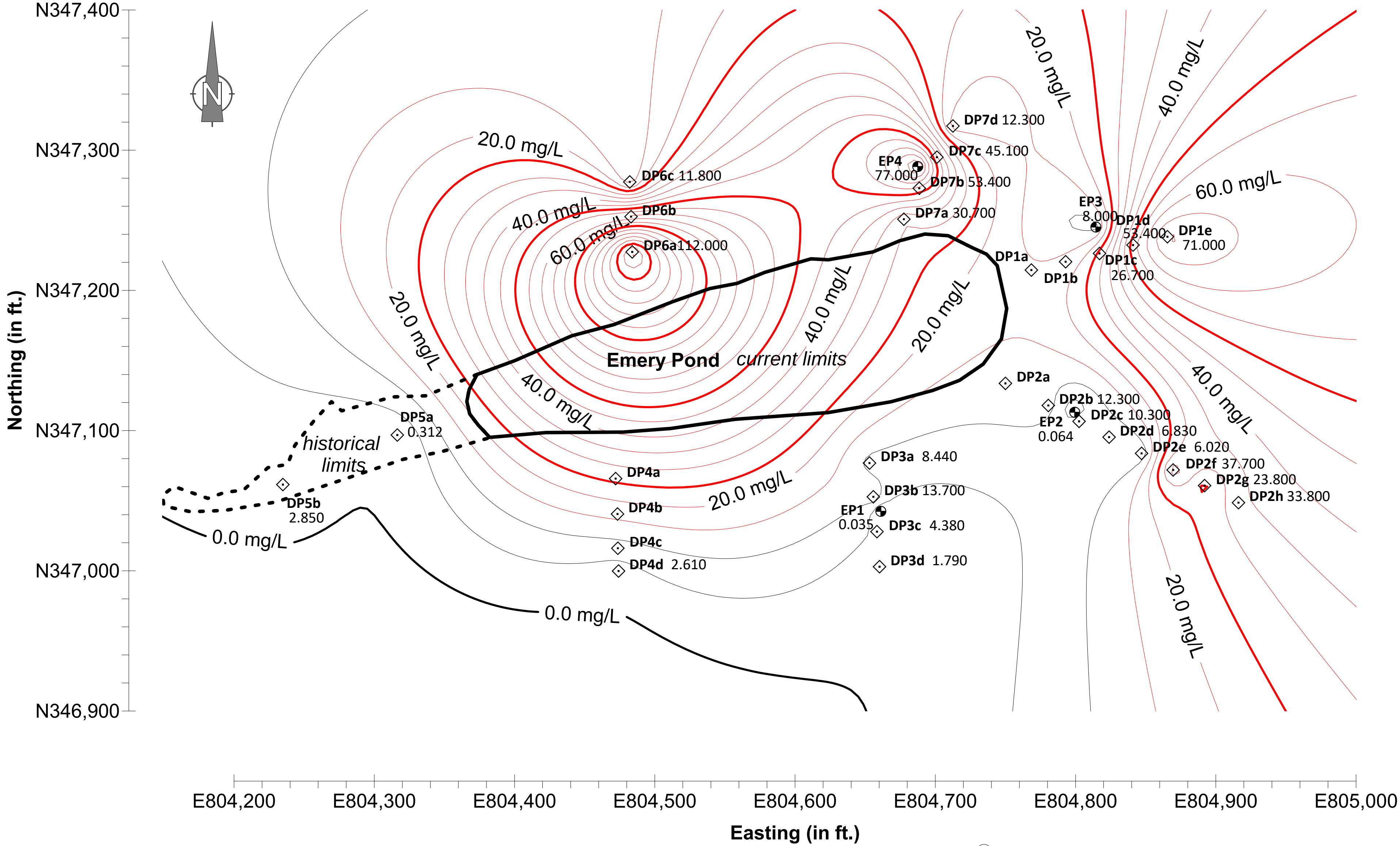
HANSON
Hanson Professional Services Inc.

Lead Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-7



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EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (10.0 mg/L)

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

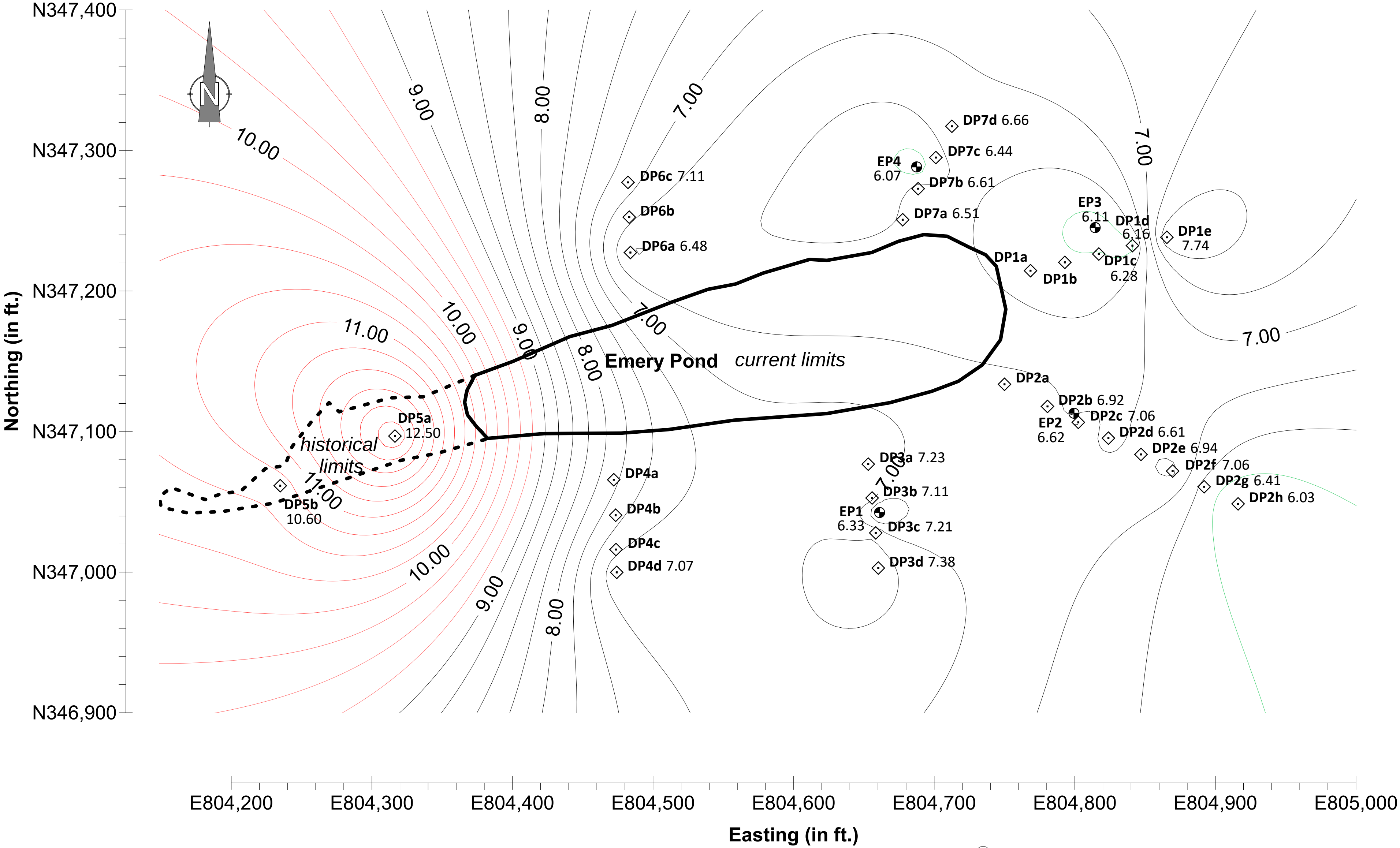
HANSON
Hanson Professional Services Inc.

Manganese Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE C-8

I:\18jobs\18E0022A\Admin\15-Field-Laboratory Data\ManganeseConc_20190319.srf



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Green contours below lower GW Std. and red contours above upper GW Std.

Contour Interval = 0.25 SU
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

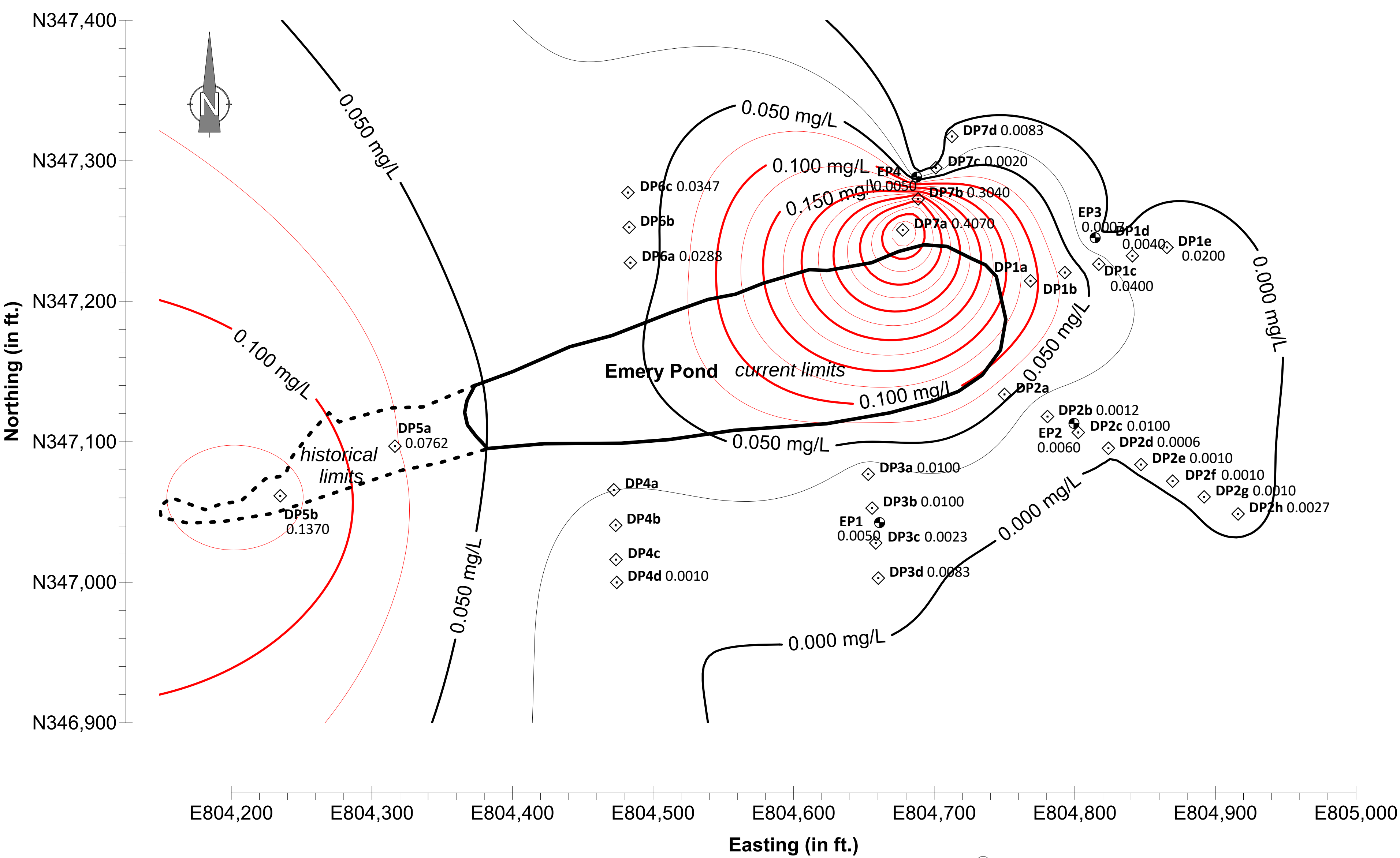
HANSON
Hanson Professional Services Inc.

pH Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-9



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (0.05 mg/L)

Contour Interval = 0.025 mg/L
SCALE: 1 inch equals 100 feet

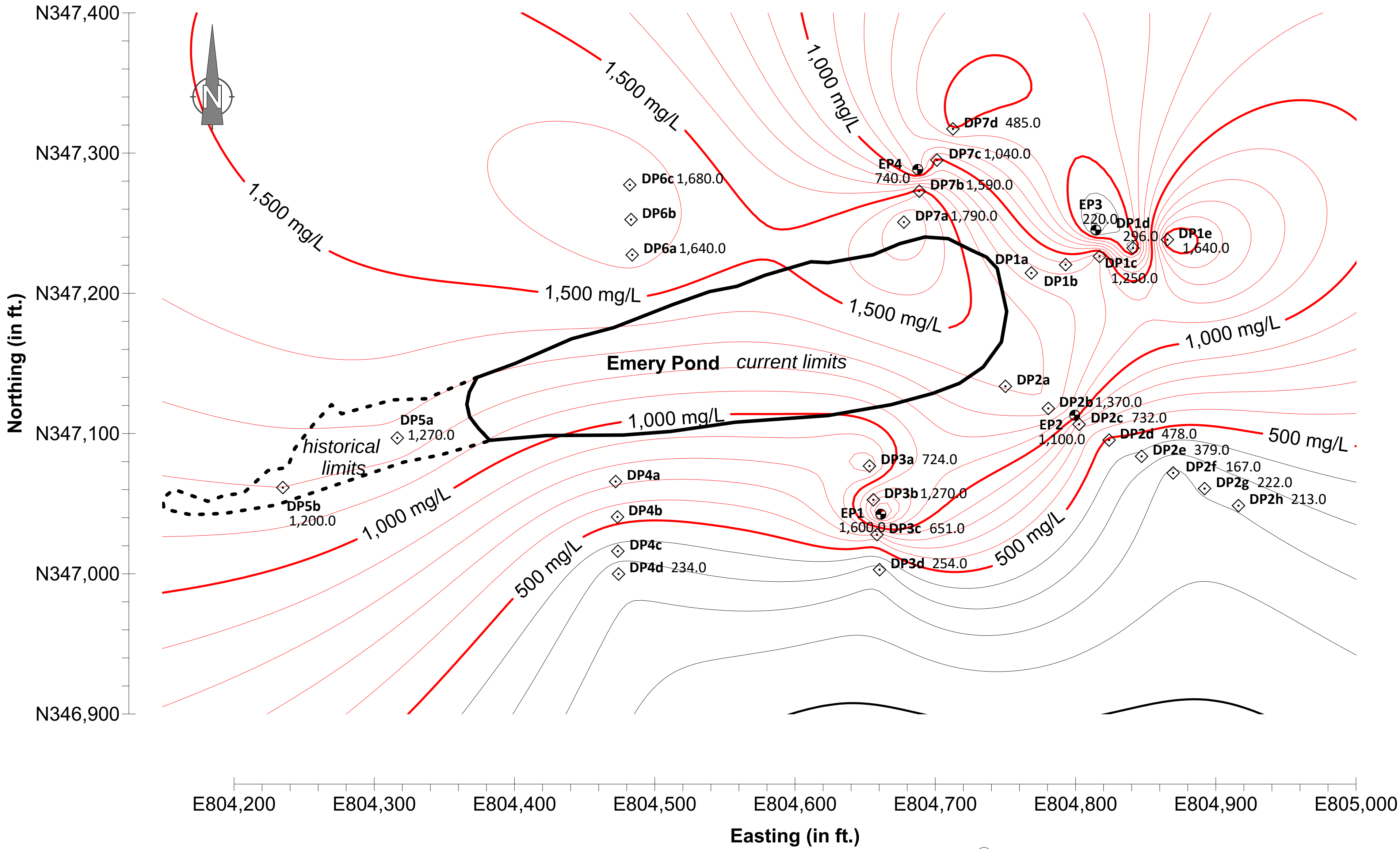
0 ft. 100 ft. 200 ft. 300 ft.

HANSON
Hanson Professional Services Inc.

Selenium Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE C-10



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (400 mg/L)

Contour Interval = 100 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

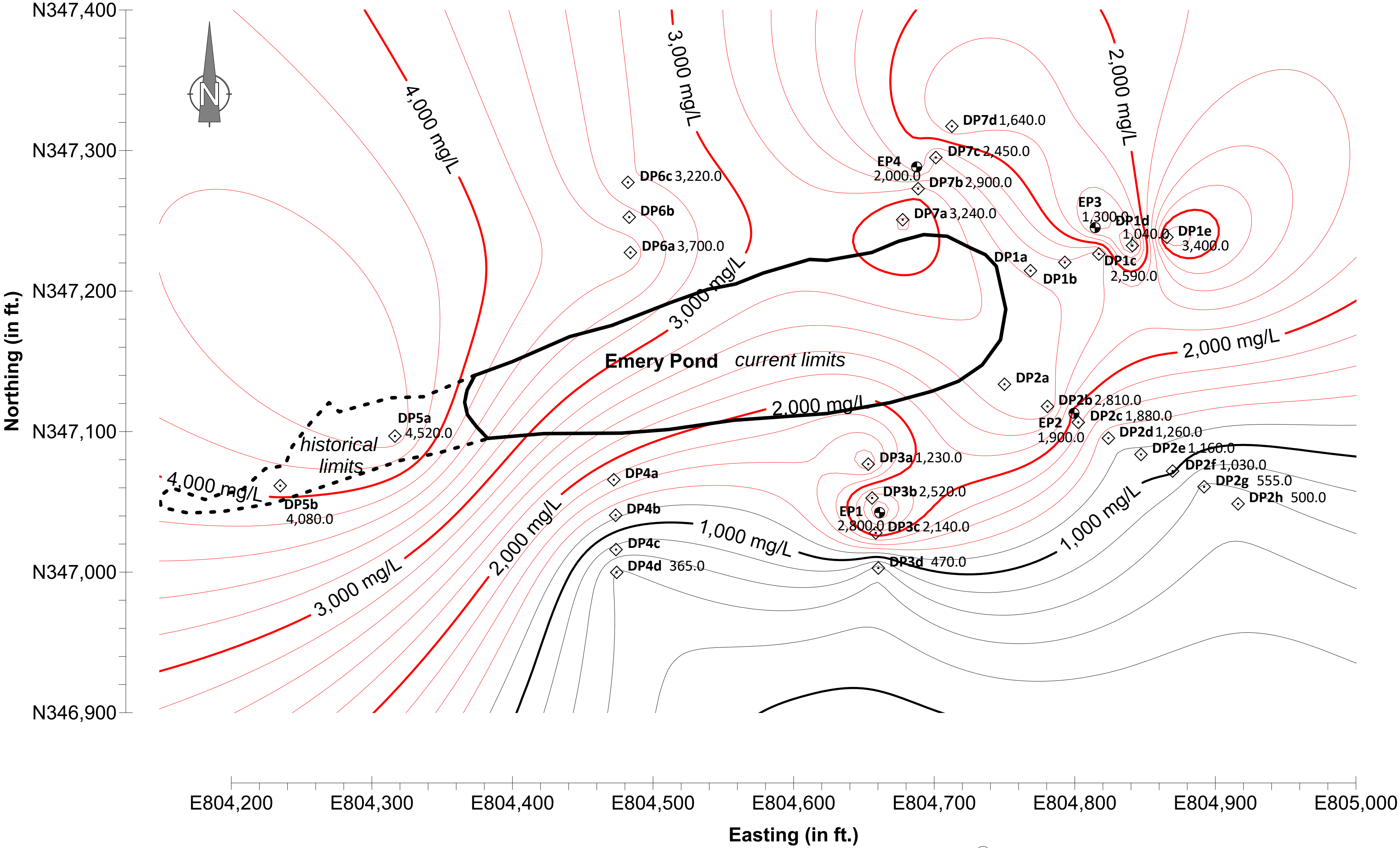
HANSON
Hanson Professional Services Inc.

Sulfate Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-11



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 200 mg/L
SCALE: 1 inch equals 100 feet

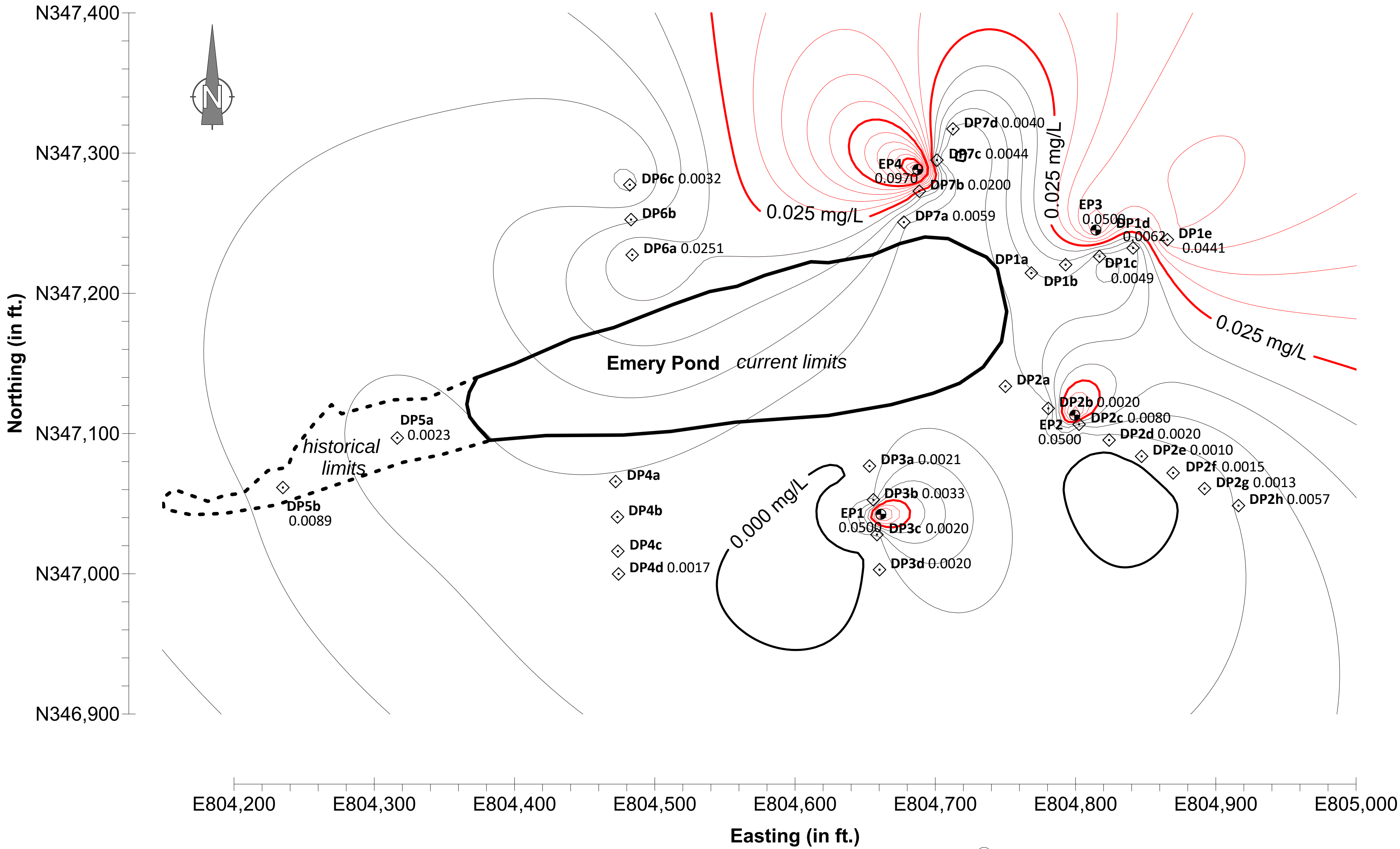
0 ft. 100 ft. 200 ft. 300 ft.

HANSON
Hanson Professional Services Inc.

Total Dissolved Solids Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A | FIGURE C-12



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (0.02 mg/L)
Microbac Laboratory detection limit was 0.05 mg/L.

Contour Interval = 0.005 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

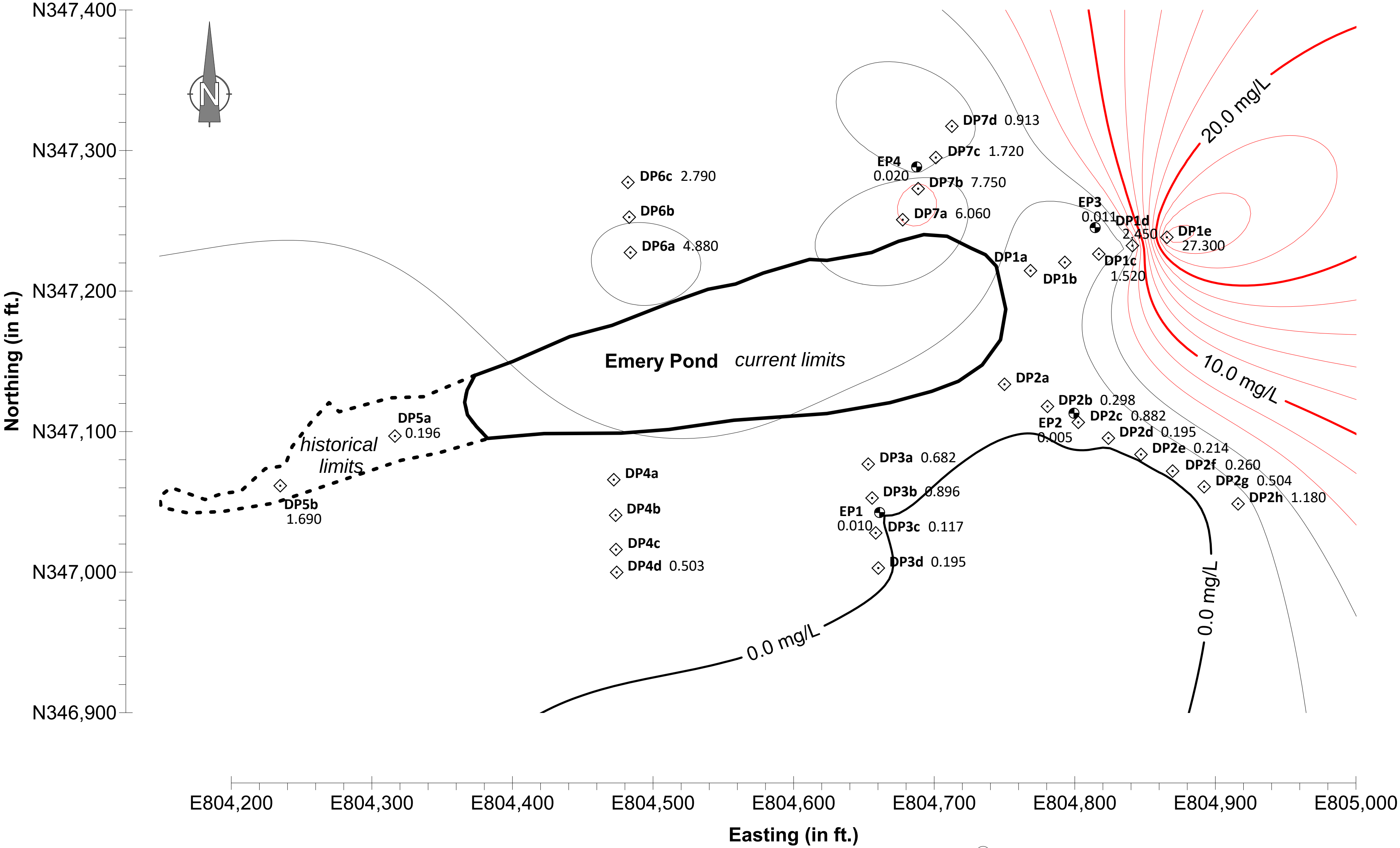
HANSON
Hanson Professional Services Inc.

Thallium Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-13



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (5.0 mg/L)

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

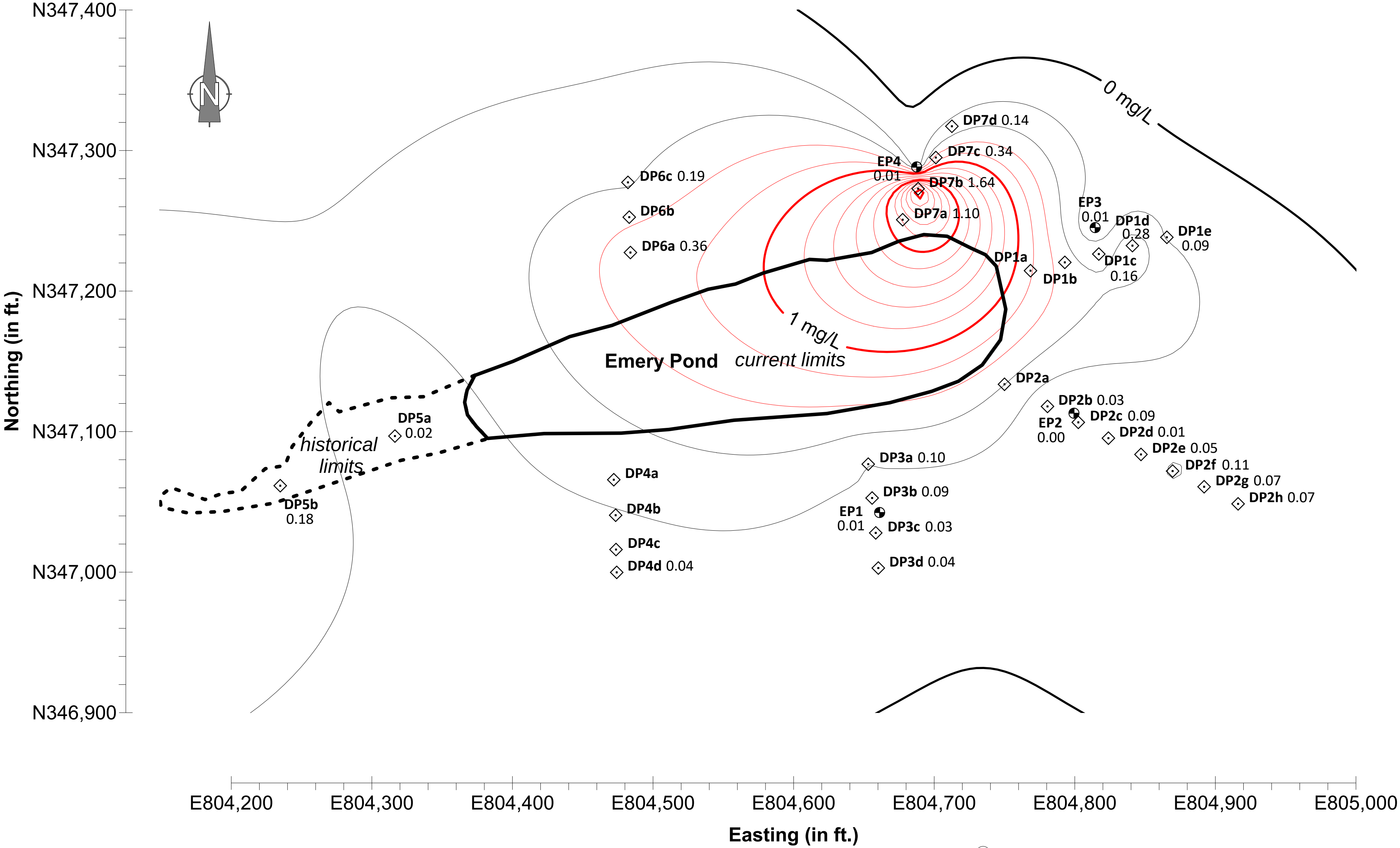
0 ft. 100 ft. 200 ft. 300 ft.

HANSON
Hanson Professional Services Inc.

Zinc Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE C-14



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

NOTE: Red contours above Class II GW Std. (0.2 mg/L)

Contour Interval = 1 mg/L
SCALE: 1 inch equals 100 feet

0 ft. 100 ft. 200 ft. 300 ft.

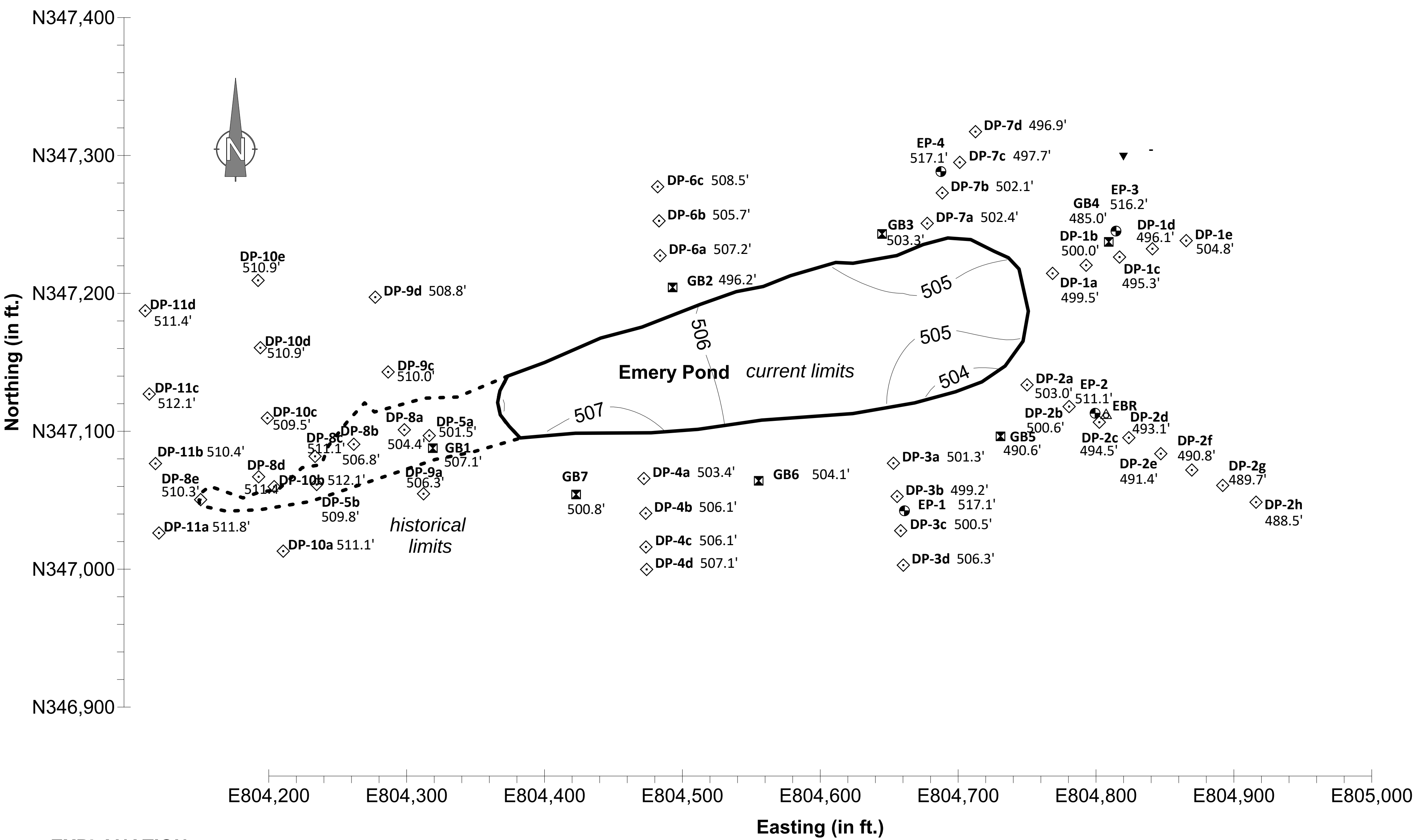
HANSON
Hanson Professional Services Inc.

Arsenic Concentration Isopleth Map

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A

FIGURE C-15



EXPLANATION

- Monitoring Well
- Direct Push Boring
- Bedrock Boring

Contour Interval = 1 foot

SCALE: 1 inch equals 100 feet

0 ft. 30 ft. 61 ft. 91 ft.

HANSON
Hanson Professional Services Inc.

Borehole Bottom Relative to Emery Pond Bottom

EMERY POND
MARION POWER PLANT
WILLIAMSON CO., ILLINOIS

HANSON NO. 18E0022A FIGURE C-16

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Appendix D

Groundwater Management Zone Plat and Description

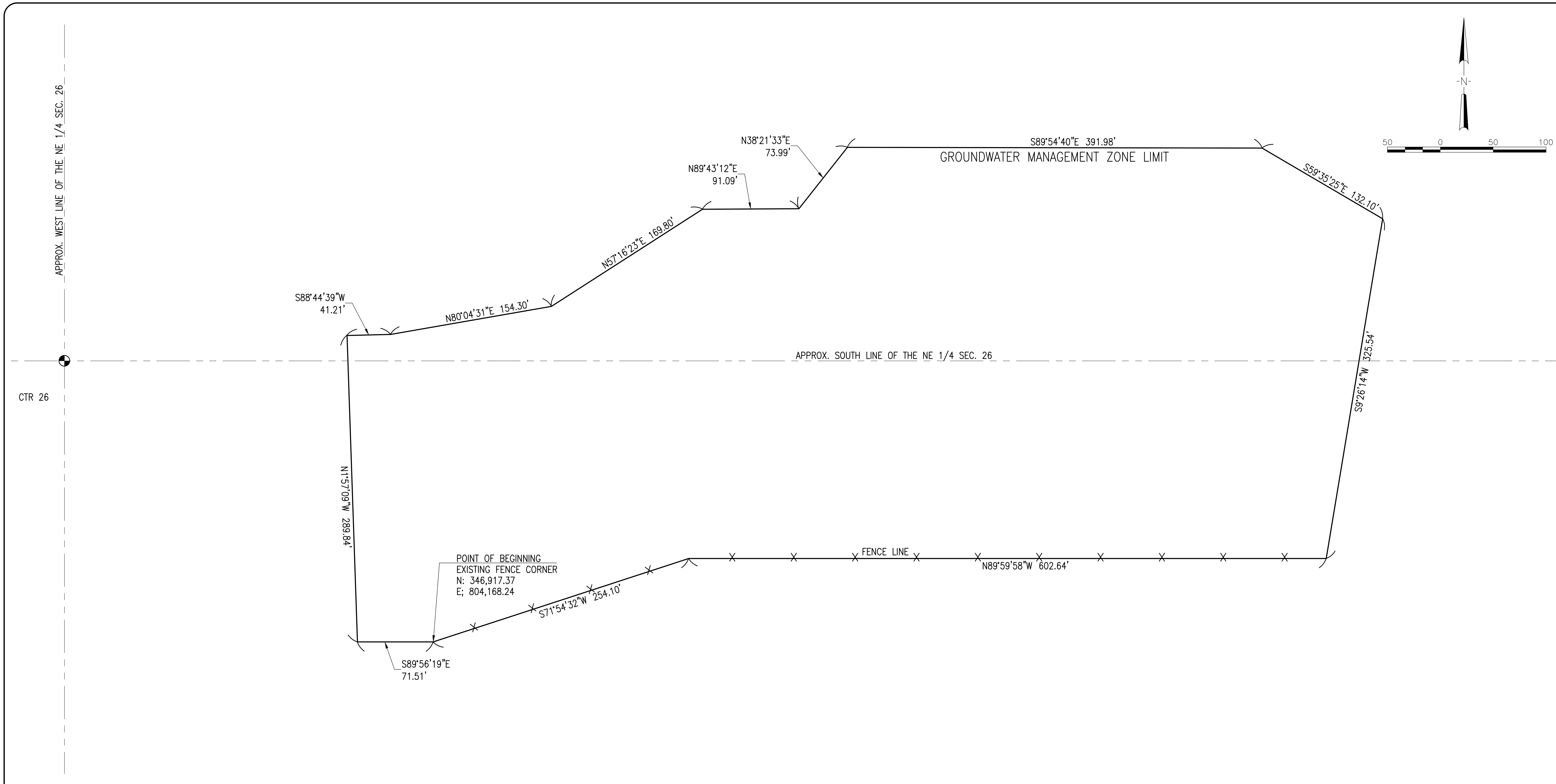
Groundwater Management Zone (GMZ) Limit

LEGAL DESCRIPTION

Part of Parcel 10-2 “A” of the Southern Illinois Power Co-Operative Lake of Egypt area property boundary, being part of the East Half of Section 26, Township 10 South, Range 2 East, Third Principal Meridian, Williamson County, Illinois, more particularly described as follows:

Beginning at a fence corner having an Illinois State Plane Coordinate of Northing 346,917.37 and Easting 804,168.24 (North American Datum of 1983, East Zone), thence on a grid bearing of N 89°-56'-19" W a distance of 71.51 feet; thence N 01°-57'-09" W a distance of 289.84; thence N 88°-44'-39" E a distance of 41.21 feet; thence N 80°-04'-31" E a distance of 154.30 feet; thence N 57°-16'-23" E a distance of 169.80 feet; thence N 89°-43'-12" E a distance of 91.09 feet; thence N 38°-21'-33" E a distance of 73.99 feet; thence S 89°-54'-40" E a distance of 391.98 feet; thence S 59°-35'-25" E a distance of 132.10 feet; thence S 09°-26'-14" W a distance of 325.54 feet; thence N 89°-59'-58" W a distance of 602.64 feet; thence S 71°-54'-32" W a distance of 254.10 feet to the POINT OF BEGINNING.

Containing 7.545 Acres, more or less.



LEGEND

- PARCEL LINE
- SECTION LINE
- X - FENCE LINE

LEGAL DESCRIPTION

Part of Parcel 10-2 "A" of the Southern Illinois Power Co-Operative Lake of Egypt area property boundary, being part of the East Half of Section 26, Township 10 South, Range 2 East, Third Principal Meridian, Williamson County, Illinois, more particularly described as follows:

Beginning at a fence corner having an Illinois State Plane Coordinate of Northing 346,917.37 and Easting 804,168.24 (North American Datum of 1983, East Zone), thence on a grid bearing of N 89°-56'-19" W a distance of 71.51 feet; thence N 01°-57'-09" W a distance of 289.84; thence N 88°-44'-39" E a distance of 41.21 feet; thence N 80°-04'-31" E a distance of 154.30 feet; thence N 57°-16'-23" E a distance of 169.80 feet; thence N 89°-43'-12" E a distance of 91.09 feet; thence N 38°-21'-33" E a distance of 73.99 feet; thence S 89°-54'-40" E a distance of 391.98 feet; thence S 59°-35'-25" E a distance of 132.10 feet; thence S 09°-26'-14" W a distance of 325.54 feet; thence N 89°-59'-58" W a distance of 602.64 feet; thence S 71°-54'-32" W a distance of 254.10 feet to the POINT OF BEGINNING.

Containing 7.545 Acres, more or less.

State of Illinois)
SS
County of Williamson)

We, Hanson Professional Services Inc., Professional Design Firm No. 184-001084, do hereby certify that this is a true and correct representation of an exhibit made for the Southern Illinois Power Co-operative.

Dated, this 26 day of March, 2019.

By: Gary C. Rogers
Gary C. Rogers
Illinois Professional Land Surveyor No. 2957
License Expires 11-30-2020

GARY C. ROGERS
035-2957
PROFESSIONAL LAND SURVEYOR
STATE OF ILLINOIS
SPRINGFIELD, IL.

NOTE:
BASIS OF BEARING ILLINOIS STATE PLANE NORTH AMERICAN DATUM OF 1983, EAST ZONE.

MAR 26, 2019 12:41 PM PADGE01941
I:\18JOBS\18E0022A\CAD\SURVEY\SHEET\C-PROP.DWG

REVISION
DATE

Hanson No.	18E0022A
Filename	C-PROP.DWG
Scale	1"=50'
Date	03/26/2019

LAYOUT	GCR	03/26/2019
DRAWN	WTP	03/26/2019
REVIEWED	GCR	03/26/2019

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Fax: (217) 788-2503
www.hanson-inc.com
Offices Nationwide

HANSON

Hanson Professional Services Inc.
7625 N University St., Suite 200
Peoria, IL 61614
Illinois Licensed Professional Design Firm #184-001084

GROUNDWATER MANAGEMENT ZONE (GMZ) BOUNDARY EXHIBIT

SOUTHERN ILLINOIS POWER CO-OPERATIVE

C1

1 of 1 sheets

Appendix E

Confirmation of an Adequate Corrective Action Forms

Title 35, Illinois Admin. Code, Part 620 – APPENDIX D
Confirmation of an Adequate Corrective Action Pursuant to 35 Ill. Adm. Code 620.250(a)(2)

Pursuant to 35 Ill. Adm. Code 620.250(a) if an owner or operator provides a written confirmation to the Agency that an adequate corrective action, equivalent to a corrective action process approved by the Agency, is being undertaken in a timely and appropriate manner, then a groundwater management zone may be established as a three-dimensional region containing groundwater being managed to mitigate impairment caused by the release of contaminants from a site. This document provides the form in which the written confirmation is to be submitted to the Agency.

Note 1. Parts I and II are to be submitted to IEPA at the time that the facility claims the alternative groundwater standards. Part III is to be submitted at the completion of the site investigation. At the completion of the corrective process, a final report is to be filed which includes the confirmation statement included in Part IV.

Note 2. The issuance of a permit by IEPA's Division of Air Pollution Control or Water Pollution Control for a treatment system does not imply that the Agency has approved the corrective action process.

Note 3. If the facility is conducting a cleanup of a unit which is subject to the requirements of the Resource Conservation and Recovery Act (RCRA) or the 35 Ill. Adm. Code 731 regulations for Underground Storage Tanks, this confirmation process is not applicable and cannot be used.

Note 4. If the answers to any of these questions require explanation or clarification, provide such in an attachment to this document.

Part I. Facility Information

Facility Name	***Southern Illinois Power Cooperative Marion Power Plant***
Facility Address	***11543 Lake Egypt Road, Marion, IL 62959***
County	***Williamson***
Standard Industrial Code (SIC)	***4911***

1. Provide a general description of the type of industry, products manufactured, raw materials used, location and size of the facility.

   Electric power generation and coal combustion residual (CCR) handling. The Emery Pond is an approx. 1-acre CCR Impoundment located within the Marion Power Plant which encompasses approximately 350 acres at the northwest shore of Lake of Egypt.

2. What specific units (operating or closed) are present at the facility which are or were used to manage waste, hazardous waste, hazardous substances, or petroleum?

	YES	NO
Landfill	X	
Surface Impoundment	X	
Land Treatment		X
Spray Irrigation		X
Waste Pile		X
Incinerator		X
Storage Tank (above ground)	X	
Storage Tank (underground)		X
Container Storage Area		X
Injection Well		X
Water Treatment Units	X	
Septic Tanks		X
French Drains		X
Transfer Station		X
Other Units (please describe)		

2. Provide an extract from a USGS topographic or county map showing the location of the site and a more detailed scaled map of the facility with each waste management unit identified in Question 2 or known/suspected source clearly identified. Map scale must be specified, and the location of the facility must be provided with respect to Township, Range and Section.

   The Plant is in the north half of Section 26, Tier 10 South, Range 2 East, of the 3rd PM. Figure 1 has the facility located on a USGS topographic map (7½ minute). Figure 2 shows a scaled map of the Site.

4. Has the facility ever conducted operations which involved the generation, manufacture, processing, transportation, treatment, storage, or handling of "hazardous substances" as defined by the Illinois Environmental Protection Act? Yes ☒ No ☐
   If the answer to this question is "yes" generally describe these operations.

   Chlorine – prior to 1/1/2015, SIPC utilized Liquefied Chlorine Gas to control biofouling in its plant condenser circulating cooling water. Since 1/1/2015, SIPC has used Sodium Hypochlorite Solution (Bleach) to control biofouling.

   Ammonia – Anhydrous Ammonia is utilized on Units 123 and 4 for NOx emission control.

5. Has the facility generated, stored, or treated hazardous waste as defined by the Resource Conservation and Recovery Act? Yes ☐ No ☒
   If the answer to this question is "yes" generally describe these operations.

   SIPC does not generate, store, or treat hazardous wastes. Solid waste generator numbers are listed in Part I. 7., below.

6. Has the facility conducted operations which involved the processing, storage, or handling of petroleum? Yes ☒ No ☐
   If the answer to this question is "yes" generally describe these operations.

   #2 fuel oil is used for coal handling equipment operations and boiler startup fuel for Units 123 & 4.

7. Has the facility ever held any of the following permits?

   a. Permits for any waste storage, waste treatment or waste disposal operation. Yes ☒ No ☐
      If the answer to this question is "yes", identify the IEPA permit numbers.

      Illinois EPA Land (Solid Waste Generator) – 1990555005

      US EPA Land (Solid Waste Generator) – ILD 007813900

      Illinois EPA Water (Construct/Operate) – 2020-EA-65428

   b. Interim Status under the Resources Conservation and Recovery Act (filing of a RCRA Part A application). Yes ☐ No ☒
      If the answer to this question is "yes", attach a copy of the last approved Part A application.

   c. RCRA Part B Permits. Yes ☐ No ☒
      If the answer to this question is "yes", identify the permit log number.

8. Has the facility ever conducted the closure of a RCRA hazardous waste management unit? Yes ☐ No ☒

9. Have any of the following State or federal government actions taken place for a release at the facility?

   a. Written notification regarding known, suspected, or alleged contamination on or emanating from the property (e.g., a Notice pursuant to Section 4(q) of the Environment Protection Act)? Yes ☒ No ☐
      If the to this question is "yes", identify the caption and date of issuance.

      Illinois EPA issued Violation Notice No. W-2018-00041 (ID No. 6364) on July 3, 2018.

c. If either of Items a. or b. were answered by checking "yes", is the notice, order, or decree still in effect? Yes ☒ No ☐

10. What groundwater classification will the facility be subject to at the completion of the remediation?

    Class I ☒ Class II ☒ Class III ☐ Class IV ☐
    If more than one Class applies, please explain.

    Class II groundwater in the Unlithified Unit and upper Bedrock Unit (to a depth of approx. 21.5 ft. BGS at EBR or approx. elevation of 489 ft.) and Class I groundwater in the remaining (identified) Bedrock Unit (where sandstone is thicker than 10 ft.).

11. Describe the circumstances which the release to groundwater was identified.

    Through the monitoring well installation and water sampling guidelines listed in 40 CFR 257.90 Subpart (e).

Based on my inquiry of those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of my knowledge and belief, true and accurate.

Marion Power Station	Donald L Bulley
Facility Name	Signature of Owner/Operator
11543 Lake Egypt Road, Marion, IL 62959	***Southern Illinois Power Cooperative***
Location of Facility	Name of Owner/Operator
1990555005	***July 24, 2020***
Illinois EPA Identification Number	Date

PART II: Release Information

1. Identify the chemical constituents release to the groundwater. Attach additional documents, as necessary.

Chemical Description	Chemical Abstract No.
Arsenic	***7440-38-2***
Boron	***7440-42-8***
Calcium	***14808-79-8***
Chloride	***7782-50-5***
Cobalt	***7440-48-4***
Iron	***7439-89-6***
Lead	***7439-92-1***
Manganese	***7439-96-5***
pH	***13967-14-1***
Selenium	***7782-49-2***
Sulfate	***14808-79-8***
Thallium	***7440-28-0***
Total Dissolved Solids	***10-05-2***
Zinc	***7440-66-6***

1. Describe how the site will be investigated to determine the source or sources of the release.

   The Emery Pond has been investigated as described in the Hydrogeologic Investigation Report (Hanson, 2019a) and subsequent Hydrogeologic Investigation Addendum (Hanson, 2019b).

2. Describe how the site will be investigated to determine the source or sources of the release.

   The investigation is documented in the Hydrogeologic Investigation Report (Hanson, 2019a).

3. Describe how groundwater will be monitored to determine the rate and extent of the release.

   A study of the extent of contamination is included as part of the Hydrogeologic Investigation Report (Hanson, 2019a) and this Corrective Action and Selected Remedy Plan. The monitoring network to monitor the rate and extent of the release is described in the Groundwater Monitoring Plan (Hanson, 2020c).

4. Has the release been contained on-site at the facility?

   Migration of CCR constituents is limited by Lake of Egypt, which acts as a groundwater discharge area and hydraulic barrier.

5. Describe the groundwater monitoring network and groundwater and soil sampling protocols in place at the facility.

   The groundwater monitoring network and sampling protocols are described in the Groundwater Monitoring Plan (Hanson, 2020c).

6. Provide the schedule for investigation and monitoring.

   The site investigation is complete and groundwater monitoring will continue for the regulatory/permitted frequency and monitoring period as described in the Groundwater Monitoring Plan Section 4.2: Sampling Schedule (Hanson, 2020c).

7. Describe the laboratory quality assurance program utilized for the investigation.

   All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with the National Environmental Laboratory Accreditation Program (NELAP) unless noted.

8. Provide a summary of the results of available soil testing and groundwater monitoring associated with the release at the facility. The summary or results should provide the following information: dates of sampling; types of samples taken (soil or water); locations and depths of samples; sampling and analytical methods; analytical laboratories used; chemical constituents for which analyses were performed; analytical detection limits; and concentrations of chemical constituents in ppm (levels below detection should be identified as "ND").

   A narrative summary of the results of groundwater monitoring is discussed in Section 2.1: Groundwater Monitoring History of this report. Analytical data summary tables are available in Appendix A of this report and graphs are available in Appendix B of this report.

Based on my inquiry of those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of knowledge and belief, true and accurate and confirm that the actions identified herein will be undertaken in accordance with the schedule set forth herein.

Marion Power Station	Donald L Bulley
Facility Name	Signature of Owner/Operator
11543 Lake Egypt Road, Marion, IL 62959	***Southern Illinois Power Cooperative***
Location of Facility	Name of Owner/Operator
1990555005	***July 24, 2020***
Illinois EPA Identification Number	Date

Part III: Remedy Selection Information

1. Describe the selected remedy.

   The selected remedy consists of:

   1. ***clean close the current Emery Pond,***
   2. ***clean close the Gypsum Loadout Area and historical portion of the Emery Pond***
   3. ***backfill the Gypsum Loadout Area with clean soil,***
   4. ***construct a new, storm water basin with a CCR compliant composite liner,***
   5. ***add a perimeter drain beneath the outboard toe of the liner for liner protection and to augment groundwater collection, and***
   6. ***use a Groundwater Management Zone (GMZ) during the return to compliance.***

2. Describe other remedies which were considered and why they were rejected.

   Additional mitigation for major cation/anion contaminants is difficult and expensive. Secondary containments (such as slurry walls) are also expensive.

3. Will waste, contaminated soil, or contaminated groundwater be removed from the site in the course of this remediation? Yes ☒ No ☐
   If the answer to this question is "yes", where will the contaminated material be taken?

   Any material removed during the clean closure activities will be taken to a permitted disposal facility (Illinois EPA or DNR Permit) after any needed pre-disposal testing.

4. Describe how the selected remedy will accomplish the maximum practical restoration of beneficial use of groundwater.

   A new, composite liner system (recompacted soil with HDPE) will limit contaminant migration from the new pond and the perimeter drain will aid in collecting impacted groundwater. Groundwater quality will improve over time as identified in the Groundwater Protection Evaluation (Hanson, 2020a).

5. Describe how the selected remedy will minimize any threat to public health or the environment.

   Clean closure of the Emery Pond and Gypsum *Loadout* Area will limit any new or continuing groundwater impacts. The perimeter toe drain will assist with removal of currently impacted groundwater.

6. Describe how the selected remedy will result in compliance with the applicable groundwater standards.

   The* Groundwater Protection Evaluation (Hanson, 2020a) indicates that water quality will meet the Class I: Potable Resource groundwater standard in approximately 8 years after *the clean closure is completed. The 8-year period is needed for total Arsenic to reach 0.01 mg/L at the downgradient edge of the former CCR impoundment.

7. Provide a schedule for design, construction, and operation of the remedy, including dates for the start and completion.

   A schedule for the remedies is included in Appendix C of the Closure Plan (Hanson, 2020b).

8. Describe how the remedy will be operated and maintained.

   The new pond liner and cover systems will be installed using a quality assurance (QA) program. The pond will be operated in such a way as to reduce the likelihood of any liner damage.

9. Have any of the following permits been issued for the remediation?

   a. Construction or Operating permit from the Division of Water Pollution Control. Yes ☐ No ☒

      But a construction/operating permit application is currently under review with Illinois EPA Bureau of Water.

   b. Land treatment permit from the Division of Water Pollution Control. Yes ☐ No ☒
      If the answer to this question is "yes", identify the permit number.

   c. Construction or Operating permit from the Division of Air Pollution Control. Yes ☐ No ☒
      If the answer to this question is "yes", identify the permit number.

10. How will groundwater at the facility be monitored following completion of the remedy to ensure that the groundwater standards have been attained?

    Quarterly monitoring of the 40 CFR 257 Appendix III and Appendix IV parameter will help determine compliance over time. Assessment monitoring under 40 CFR 257 will also continue.

Based on my inquiry of those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of my knowledge and belief, true and accurate and confirm that the actions identified herein will be undertaken in accordance with the schedule set forth herein.

Marion Power Station	Donald L Crilley
Facility Name	Signature of Owner/Operator
11543 Lake Egypt Road, Marion, IL 62959	***Southern Illinois Power Cooperative***
Location of Facility	Name of Owner/Operator
1990555005	***July 24, 2020***
Illinois EPA Identification Number	Date

APPENDIX H

Proof of Permanent Marker Installation


CCR
IMPOUNDMENT
[EMERY POND]
SOUTHERN ILLINOIS
POWER COOPERATIVE
STORM WATER
BASIN
W19986
00002-10

APPENDIX I

Groundwater Monitoring Plan

35 IAC 845.630(g) Groundwater Monitoring System Certification
Southern Illinois Power Cooperative, Marion Power Plant,
Storm Water Basin (formerly Emery Pond)

In accordance with Title 35 Illinois Administrative Code (35 IAC) 'Part 845, Subpart F, Section 845.630(g), the owner or operator of a coal combustion residual (CCR) unit must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system at the CCR unit has been designed and constructed to meet the requirements of 35 IAC§ 845.630. If the groundwater monitoring system includes the minimum number of monitoring wells specified in 35 IAC § 845.630(c)(1), the certification must document the basis supporting use of the minimum number of monitoring wells. Further, in accordance with 35 IAC § 845.630(e)(1), when completing the groundwater monitoring system certification, the qualified professional engineer must be given access to documentation regarding the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices.

The groundwater monitoring system designed and constructed for the Storm Water Basin includes one (1) upgradient and seven (7) downgradient monitoring wells which exceed the minimum requirements of 35 IAC § 845.630(c)(1). The undersigned has been given access to documentation regarding the design, installation, development, and decommissioning of monitoring wells, piezometers and other measurement, sampling, and analytical devices concerning the Storm Water Basin as described in the Groundwater Monitoring Plan dated March 29, 2019, revised March 24, 2021 and written by Hanson Professional Services Inc.

I, John M. Heyen, a qualified professional engineer in good standing in the State of Illinois, certify that the groundwater monitoring system at the Marion Power Plant Storm Water Basin has been designed and constructed to meet the requirements of 35 IAC § 845.630.

John M. Heyen
Illinois Licensed Professional Engineer
062-058721
(expires November 30, 2021)
signed October 14, 2021

JOHN M HEYEN
062-058721
REGISTERED
PROFESSIONAL
ENGINEER
OF
ILLINOIS

Emery Pond

Groundwater Monitoring Plan

Marion Power Plant
Southern Illinois Power Cooperative
Marion, Williamson County, Illinois

March 29, 2019
revised March 24, 2021

HANSON
Engineering | Planning | Allied Services

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Figures and Tables

Figures

Tables

1. Introduction

The following monitoring plan is for the Southern Illinois Power Cooperative [SIPC] Marion Power Plant's [Plant] Emery Pond [Site]. This update is needed due to the development of a Corrective Action Plan [CAP] and Closure Plan for the Site. Figure 1 shows the location of the Plant.

2. Site Hydrogeology

The site is located in the Shawnee Hills section within the Interior Low Plateaus (physiographic) Province (Leighton et al., 1948). Site geology consists of glacially derived deposits of the Illinoisan Stage overlying Pennsylvanian Age bedrock. Table 1 list the hydro- and litho-stratigraphic units with their descriptions located within 50 feet of the surface at the Site (Willman et al, 1995 and Berg & Kempton, 1988).

Table 1. Site Geologic/Hydrogeologic Units

Litho-stratigraphic Unit	Hydro-stratigraphic Unit	Lithologic Description
Peoria/Roxana Silt	Unlithified Unit	light yellow tan to gray, fine sandy silt
Glasford Formation (undifferentiated)		silty/sandy diamictons with thin lenticular bodies of silt, sand, and gravel
Caseyville Formation	Bedrock Unit	primarily sandstone with shales

As identified in the Hydrogeologic Investigation Report (Hanson, 2019a), groundwater at the Site has been classified as Class II: General Resource Groundwater (35 IAC 620.240) in the Unlithified Unit and the upper (approx. 11 ft.) of the Bedrock Unit. This is the strata the current monitoring system is evaluating. This investigation also concluded that there is no aquifer (as defined by the CCR Rule) at the Site. However, after further review and discussions with Illinois EPA, SIPC continues to monitor the shallow groundwater as the uppermost aquifer for compliance with US EPA and proposed Illinois EPA rules.

3. Groundwater Monitoring Network

The current groundwater monitoring wells for the Site are all screened at the Unlithified Unit/Bedrock Unit interface. Five (5) monitoring wells were installed at five (5) locations around the facility by Holcomb Foundation Engineering Inc. in early-February 2017 under the direction of AECOM (2018). The wells consisted of 2-inch diameter, schedule 40 PVC pipe with 10-ft long, 0.010-inch slotted well screens. A silica sand (grain size 10/20) filter medium was used to construct the sand pack around each well screen. The depth of the screen and the depth to the top of the filter pack were measured and recorded in the field by the geologist. Bentonite chips were placed on top of the sand pack filling the borehole to 2 to 3 ft. below the ground surface or a minimum thickness of 2 ft.

A steel, lockable, protective outer casing was installed for each well. A concrete monument was constructed around the outer casing with the concrete extending from the ground surface to the top of the bentonite seal. After installation, the locations and elevations of the wells were surveyed using the State Plane horizontal grid and elevation system. All surveying was performed under the direction of an Illinois Licensed Professional Land Surveyor. The monitoring system and individual wells were installed to meet the requirements of 40 CFR 257.90-97. Table 2 lists the current monitoring well, locations and elevations.

EXPLANATION

Monitoring Well (existing) ● EP-2

Monitoring Well (proposed) ⊕ EP-5

Scale: 1 inch = 125 feet

Image from Google Earth

HANSON
Hanson Professional Services Inc.

Monitoring Well Location Map

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A

FIGURE 1

I:\14Jobs\14E0037\Admin\15-Field-Laboratory Data\Coffeen\AshLandfill\PZ201012.srf

Table 2. Current Monitoring Well Network

Well ID	Northing	Easting	Ground Elev.	MP[1] Elev.	Gradient
EBG	346,358.14	804,168.155	521.74	524.87	Up
EP-1	347,042.31	804,661.17	517.07	519.72	Down
EP-2	347,113.03	804,799.41	511.15	513.79	Down
EP-3	347,245.08	804,814.53	516.24	518.95	Down
EP-4	347,288.30	804,687.53	517.07	519.74	Down

[1]Measuring Point

3.1. Groundwater Monitoring Program Standards

3.1.1. Monitoring Well Installation

Hanson proposes to add three (3) additional monitoring wells to evaluate groundwater at the limits of the groundwater management zone (GMZ). Locations are shown on Figure 1 with approximate coordinates and elevations listed in Table 3.

Table 3. GMZ Monitoring Wells

Well ID	Northing	Easting	Ground Elev.	Gradient
EP-5	347,113.00	804,800.00	524.00	Edge of GMZ
EP-6	347,245.00	804,815.00	502.00	Edge of GMZ
EP-7	347,288.00	804,688.00	512.00	Edge of GMZ

The groundwater monitoring wells will be designed and constructed in accordance with:

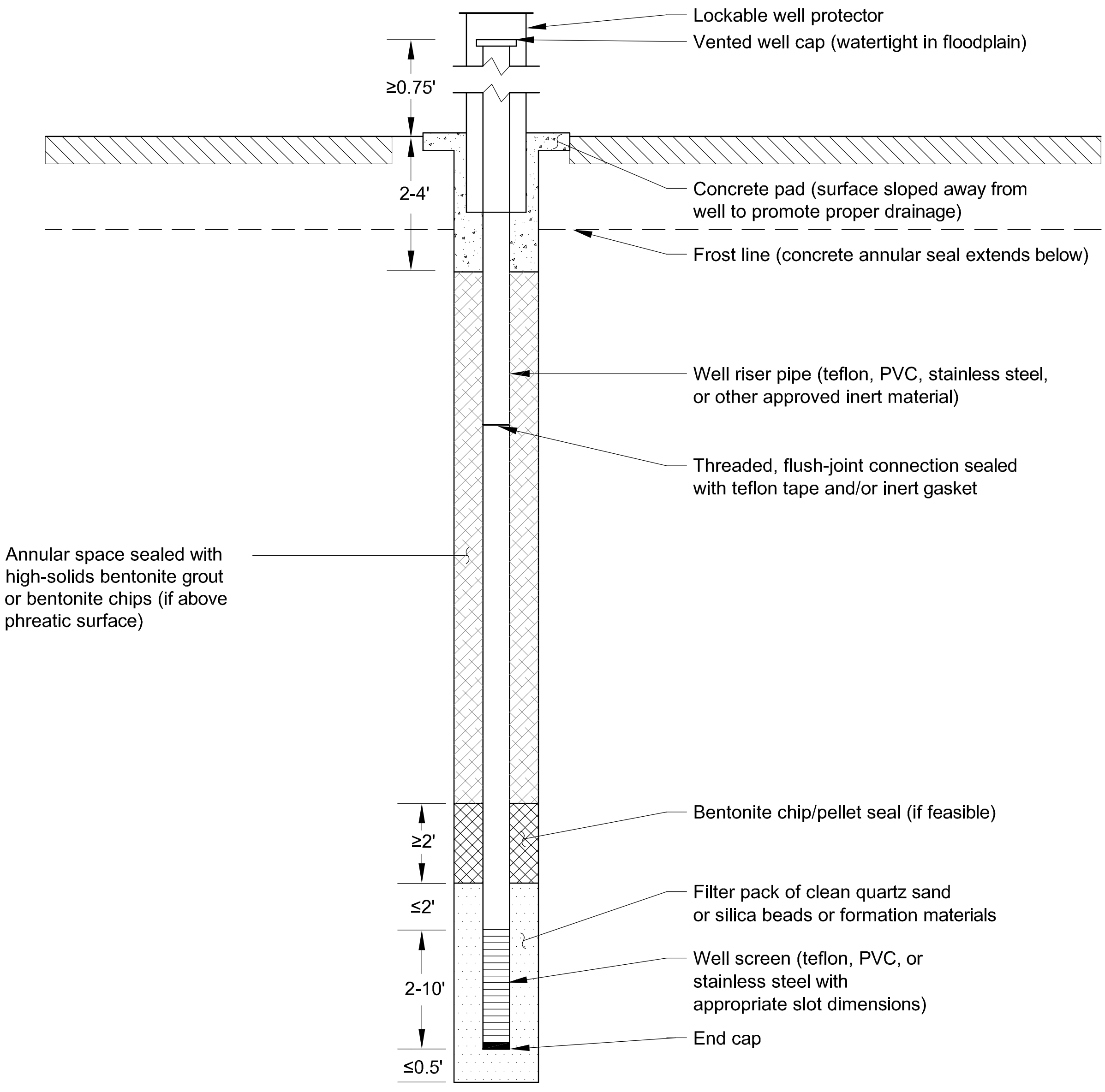
1. Illinois Department of Public Health (IDPH) standards as cited in 77 IAC 920.170; and
2. Chapter 6 – Monitoring Well Design and Construction, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, United States Environmental Protection Agency (U.S. EPA), November 1992.

A typical as-built diagram for groundwater monitoring well construction is provided in Figure 2. New monitoring wells will be constructed to yield groundwater samples that represent the quality of groundwater within the geologic formation(s) monitored at the Site. The monitoring wells should yield sufficient representative quantities of groundwater for the laboratory analyses required.

4. Groundwater Sampling

Hanson (2019a) concluded as part of the Hydrogeologic Investigation that there is no aquifer[†] present beneath the Emery Pond, as that term is defined in both federal and state regulations. However, after further review and discussions with Illinois EPA, SIPC will continue to monitor the shallow groundwater as the uppermost aquifer for compliance with US EPA and proposed Illinois EPA rules.

[†] As defined by 40 CFR 257.53 and 35 IAC 620.110.



After 77 IAC 920.170 and I.E.P.A. Groundwater Monitoring
Network for Non-Hazardous Solid Waste Disposal Facilities
(Final Draft, April 1990)

HANSON
Hanson Professional Services Inc.

GROUNDWATER MONITORING WELL DETAIL

EMERY POND
MARION POWER PLANT
WILLIAMSON COUNTY, ILLINOIS

HANSON NO. 18E0022A FIGURE 2

JUL 10, 2020 8:13 AM HASEN01154
I:\18JOBS\18E0022A\ADMIN\14-REPORTS\MONPLAN\FIG_2WELLDETAIL_20200707.DWG

Therefore, as discussed with IEPA, SIPC agrees to continue monitoring the groundwater surrounding Emery Pond consistent with the Part 845 proposal and as further described below. Should groundwater monitoring requirements under Part 845 change during the rulemaking proceeding, the parties may agree in writing at that time to modify the groundwater monitoring including, potentially, frequency and the constituent list to be consistent with the final rule.

4.1. Sampling Schedule

Groundwater monitoring at the Emery Pond will be conducted quarterly. Sampling for routine analysis shall be conducted in accordance with the low-flow techniques described in Appendix A. The schedule for quarterly sampling is summarized in Table 4.

Table 4. Groundwater Monitoring Schedule

Sampling Quarter	Sampling Months	Report Due Date	Sampling List
1st Quarter	January - March	May 31	G1
2nd Quarter	April - June	August 31	G1
3rd Quarter	July - September	November 30	G1
4th Quarter	October - December	February 28	G1

Groundwater monitoring will continue the schedule outlined in Table 4 until down-gradient water quality has dropped below the relevant standards [40 CFR 257.102(c) and 35 IAC 845.740(b), once approved].

4.2. Parameter Lists

The parameters selected for groundwater monitoring are those parameters found in 40 CFR 257 Appendix III and Appendix IV.‡

Table 5. List G1 – Groundwater Monitoring Constituents

Field Parameters	STORET	Indicator Parameters [in ug/L]	STORET
Dissolved Oxygen	00300	Calcium, total [in mg/L]	00916
pH [S.U.]	00400	Chloride, total [in mg/L]	00940
Oxidation-Reduction Potential [mV]	00090	Chromium, total	01034
Specific Conductance [umohs/cm]	00094	Cobalt, total	01037
Temperature [ºF]	00011	Fluoride, total [in mg/L]	00951
Turbidity [NTU]	00076	Lead, total	01051
Depth to Water [ft below MP]	72109	Lithium, total	01132
Elevation of GW Surface [ft AMSL]	71993	Mercury, total	71900
Indicator Parameters [in ug/L]	**STORET**	Molybdenum, total	01062
Antimony, total	01095	Selenium, total	00147
Arsenic, total	01002	Sulfate, total [in mg/L]	00945
Barium, total	01007	Total Dissolved Solids (TDS) [in mg/L]	70300
Beryllium, total	01012	Thallium, total	01059
Boron, total	01022	Radium 226/228 combined [in pCi/L]	11503
Cadmium, total	01034		

‡ The indicator parameters include all the constituents listed at proposed 35 IAC 845.600 plus Calcium.

4.3. Sampling Procedures

The Sampling Protocol included as Appendix A shall be followed for collecting groundwater samples at the Site. If conditions exist at the time of sampling that could influence the results, such as farmers applying herbicides/pesticides on adjacent fields, it may be necessary to postpone sampling until a later date. Under no circumstances will sample collection deviate from the schedule noted in Section 4.1.

5. Analysis of Site Monitoring Samples

5.1. Laboratory Analysis

Laboratory analysis and testing methods will typically be in accordance with U.S. EPA publication Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (U.S. EPA, 2018) or as superseded by future editions. The specific testing method used for analysis shall have Practical Quantitation Limit (PQL) values that can determine if regulatory and/or site groundwater standards are exceeded. For example, 35 IAC Part 724, Appendix I lists three methods and PQLs for Chromium (7190 = 500 ppb; 6010 = 70 ppb; and 7191 = 10 ppb). Since 35 IAC 620.410 sets the standard for Chromium at 100 ppb, the method necessary to meet or exceed this standard would be 6010. Specific testing methods shall be referenced in the Laboratory Analysis Report.

Other references (unless superseded) for testing methods may include:

a. Test Method: The Determination of Inorganic Anions in Water by Ion (U.S. EPA, 1993),
b. Test Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (U.S. EPA, 1982),
c. Methods for the Determination of Organic Compounds in Drinking Water (U.S. EPA, 1988, and
d. Standard Methods for Determination of Organic and Inorganic Compounds in Drinking Water (U.S. EPA, 2000).

Quality Assurance/Quality Control (QA/QC) programs will likely vary from laboratory to laboratory but will contain the same general methodologies. The QA/QC programs are implemented: to evaluate the accuracy and precision of analytical data in order to establish the quality of the data; to provide an indication of the need for corrective actions, when comparison with existing regulatory or program criteria or data trends show that activities must be changed or monitored to a different degree; and to determine the effect of corrective actions (U.S. EPA, 2018).

Several methodologies will be used by the laboratory to ensure representative analytical results. Some methodologies that may be used are:

a. Calibration checks shall be used to enhance instrument reliability. Instrumental calibration curves will be generated in a manner consistent with the instrument and method utilized. Calibration verification shall be conducted on a regular basis;
b. Laboratory control samples and/or quality control check standards that have been spiked with analyses may be used to monitor the performance of the analytical method;
c. Matrix spike/matrix spike duplicate analyses are samples in which solutions of specific aliquots are added to a sample matrix prior to sample extraction/digestion and analysis. Samples are split into duplicates, spiked, and analyzed. Percent recoveries and relative percent differences are calculated for each of the analyses detected;

d. Replicate samples shall be routinely analyzed to check the precision of the instrumentation and/or methodology employed for all analytical methods; and

e. Where applicable, method blanks are prepared and analyzed each day or samples are batched to ensure that the system is free of contamination.

The QA/QC program at the laboratory will follow method requirements in the U.S. EPA publication Test Methods for Evaluation Solid Waste, Physical/Chemical Methods (U.S. EPA, 2018) and which may be periodically revised in the future. Other published QA/QC methods may be utilized as part of laboratory policy.

6. Licensed Professional Signature/Seal

The geological work product contained in this document has been prepared under my personal supervision and has been prepared and administered in accordance with the standards of reasonable professional skill and diligence.

Rhonald W. Hasenyager, P.G.
Hanson Professional Services Inc.
1525 South Sixth Street
Springfield, IL 62703-2886
(217) 788-2450
Registration No. 196-000246

Seal:

Expires 31 March 2023

Signature: Rhonald W Hasenyager

Date: 24 March 2021

7. References

AECOM, 2018. "2017 Annual Groundwater Monitoring and Corrective Action Report, Coal Combustion Residuals (CCR) Rule, Marion Power Plant, Williamson County, Illinois", AECOM Technical Services, Inc., St. Louis, MO. 31 pp.

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U.S. EPA, 2000. Methods for Determination of Organic and Inorganic Compounds in Drinking Water; Volume 1. EPA 815/R-00/014, U.S. Environmental Protection Agency, National Exposure Research Laboratory, Cincinnati, OH.

US EPA, 2017. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, EQAASOP-GW4, Region 1, Low-Stress (Low-Flow) SOP, Rev. 4, September 19, 2017. U.S. Environmental Protection Agency, Region 1 Quality Assurance Unit, North Chelmsford, MA. 30 pp.

U.S. EPA, 2018. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA/530/SW-846, 3rd Edition (Revision 0); November 1986; Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), V (2015), and VIB (2018).

Appendix A

Sampling Protocol

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

Prepared by: ROBERT REINHART Digitally signed by ROBERT REINHART Date: 2017.09.19 16:15:38 -04'00' ____________
(Robert Reinhart, Quality Assurance Unit) Date

Approved by: JOHN SMALDONE Digitally signed by JOHN SMALDONE Date: 2017.09.20 15:11:00 -04'00' ____________
(John Smaldone, Quality Assurance Unit) Date

Revision Page

Date	**Rev #**	**Summary of changes**	**Sections**
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

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1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the “Monitoring Indicator Field Parameters” section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. <u>All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.</u>

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a “best practice”. For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump’s recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. <u>Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:</u>

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 µm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

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Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

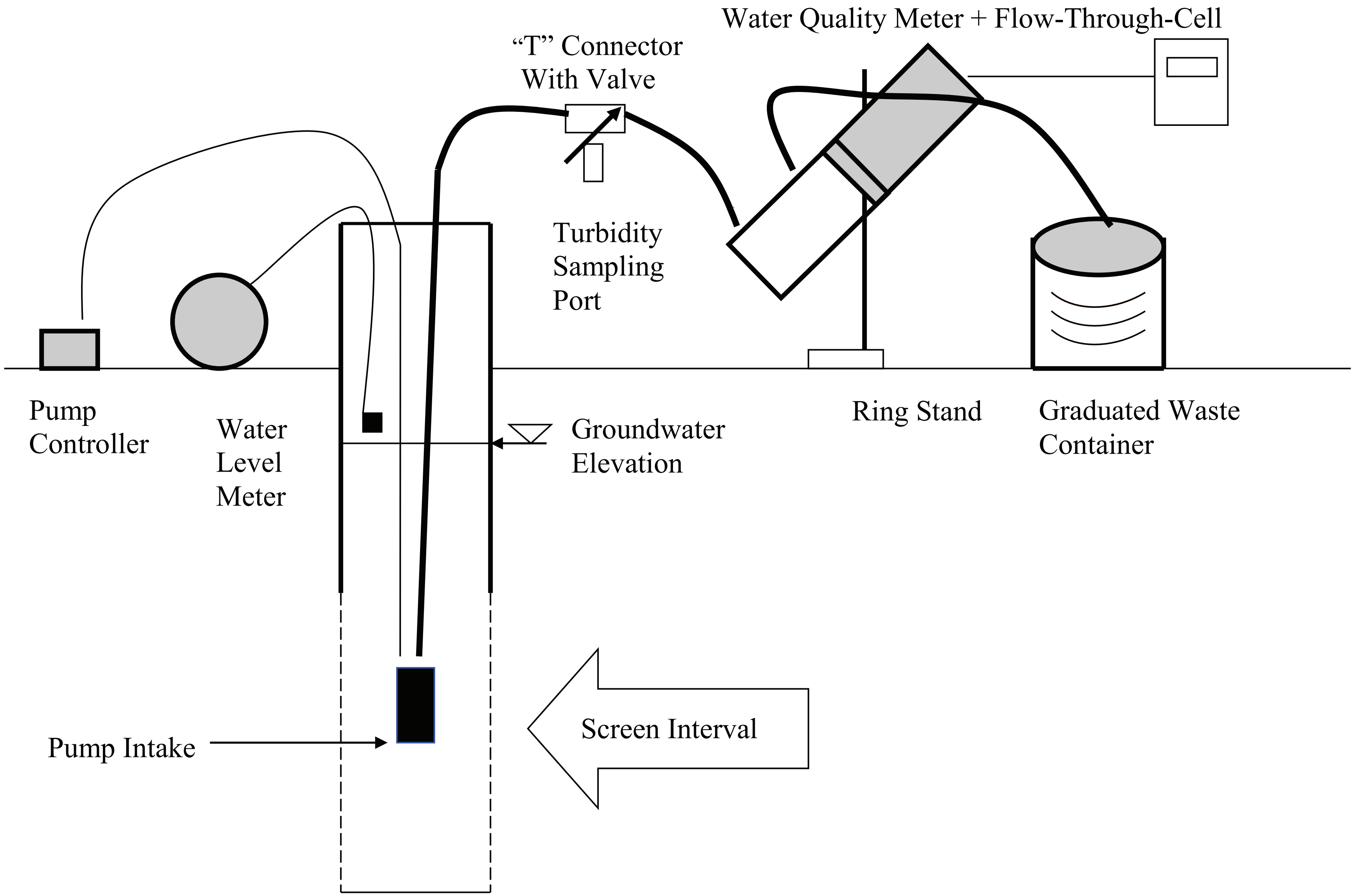
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)________________________________
Well Number_________________ Date_________________________
Field Personnel____
Sampling Organization______________________________________
Identify MP____

Depth to _______/________ of screen
(below MP) top bottom
Pump Intake at (ft. below MP)_________
Purging Device; (pump type)__________
Total Volume Purged ________________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

APPENDIX J

Groundwater Monitoring Plan Addendum #1

WORK PLAN

Groundwater Monitoring Plan Addendum #1

Marion Power Plant
Former Emery Pond
Southern Illinois Power Cooperative

Submitted to:

Southern Illinois Power Cooperative

Submitted by:

Golder Associates Inc.

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October 2021

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TABLES

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ACRONYMS

ASD	Alternative Source Demonstration
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
COC	Chain of Custody
CSM	Conceptual Site Models
DOE	Department of Energy
DQO	Data Quality Objectives
DQR	Data Quality Review
FPR	False Positive Rate
GMP	Groundwater Monitoring Plan
GMZ	Groundwater Management Zone
GPS	Groundwater Protection Standards
IAC	Illinois Administrative Code
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
LCL	Lower Confidence Limit
LOD	Limit of Detection
LPL	Lower Prediction Limit
LTL	Lower Tolerance Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
NBS	National Bureau of Standards
ND	Not Detected
NTU	Nephelometric Turbidity Unit
NEIC	National Enforcement Investigation Center

NELAC	National Environmental Laboratory Accreditation Conference
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
ORP	Oxidation-Reduction Potential
PQL	Practical Quantitation Limit
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAM	Quality Assurance Manual
QC	Quality Control
SIPC	Southern Illinois Power Cooperative
SSD	Statistically Significant Decrease
SSI	Statistically Significant Increase
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
UCL	Upper Confidence Limit
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

1.0 INTRODUCTION

Addendum #1 is the first to the Groundwater Monitoring Plan (GMP) revised March 24, 2021 (Hanson, 2021). The GMP and Addendum #1 were prepared for Southern Illinois Power Cooperative's (SIPC's) Coal Combustion Residual (CCR) surface impoundment, former Emery Pond. The former Emery Pond is subject to the 40 Code of Federal Regulations (CFR) Part 257 (until the United States Environmental Protection Agency (USEPA) approves the Illinois CCR program to operate in lieu of Part 257), and the corresponding Illinois Environmental Protection Agency (IEPA) 35 Illinois Administrative Code (IAC) Part 845. SIPC completed an IEPA approved closure by removal for Emery Pond prior to July 30, 2021. As such, the former Emery Pond is currently in post-closure Corrective Action Monitoring. Together, the GMP and Addendum #1 address the construction, operation, maintenance, and sampling of, and the management and evaluation of field and analytical information from, the groundwater monitoring well network for the former Emery Pond.

The GMP and Addendum #1 provide SIPC technical and administrative information relevant to the requirements of 40 CFR §257.91–257.98 and 35 IAC §845.600-845.680 which state that the owner or operator (i.e., SIPC) of an existing CCR surface impoundment will install, operate, and maintain a groundwater monitoring system; develop and implement a sampling and analysis program; and perform data evaluation, reporting, and notifications. The GMP and Addendum #1 address the methods and practices of constructing and operating the CCR groundwater monitoring program and serve SIPC and contractor personnel as the procedures documents for: a) groundwater monitoring well standard specifications, development, and operation; b) collection, quality assurance/quality control, transportation, and laboratory analysis of groundwater samples; and c) receipt, evaluation, including statistical analysis, validation, and management of data for the former Emery Pond. To address both quality and consistency issues that may arise during monitoring well installation, maintenance and sampling, the groundwater monitoring program makes extensive use of detailed Standard Operating Procedures (SOPs) attached in Appendix A.

This Addendum #1 also provides the requisite information upon which the Illinois qualified professional engineer is relying to certify the appropriateness of the statistical method chosen for evaluating groundwater monitoring data pursuant to 40 CFR §257.93(f)(6) and 35 IAC 845.640(f)(2).

Addendum #1 and the current GMP revised March 24, 2021 (Hanson, 2021) should be consulted and used in combination with one another.

2.0 SYSTEM DESIGN, INSTALLATION, OPERATION AND MAINTENANCE

Based upon the Conceptual Site Model (CSM), supporting hydrogeologic information, and CCR groundwater monitoring regulatory requirements, the groundwater monitoring system has been designed and installed pursuant to 40 CFR §257.91(a), (b), and (c). Supporting details including the hydrogeologic data considered is included in the GMP (Hanson, 2021).

2.1 Monitoring Approach and Well Placement

The groundwater monitoring network was designed to monitor the quality of background groundwater that has not been affected by leakage from a regulated CCR unit and the quality of groundwater passing the waste boundary(ies) of the regulated CCR unit. Based on the CSM and other Site-specific information evaluated during design of the monitoring system, the monitoring well network consists of one background well (EBG) and four downgradient monitoring wells installed around the perimeter of the former Emery Pond. Additionally, as described in the GMP (Hanson, 2021), three additional monitoring well were installed to evaluate groundwater at the limits of the groundwater management zone (GMZ). The groundwater monitoring approach as designed and implemented provides adequate, representative coverage for the former Emery Pond and is protective of human health and the environment. The monitoring well network is displayed on Figure 1 of the GMP (Hanson, 2021) and a summary of the well construction details is provided in Table 1.

2.2 Monitoring Well Construction, Development, and Decommissioning

The current groundwater monitoring wells for the Site were installed by Holcomb Foundation Engineering Inc. in February 2017 under the direction of AECOM (2018) and by Hanson Engineering in October 2021. Drilling and installation of all monitoring wells at the Site have been in accordance with industry-accepted practices. The current groundwater monitoring wells are, and any future groundwater monitoring wells if applicable will be, constructed in accordance with:

1) Illinois Department of Public Health (IDPH) standards as cited in 77 IAC §920.170; and

2) Chapter 6- Monitoring Well Design and Construction, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, United States Environmental Protection Agency, November 1992.

Monitoring well material specifications include two-inch diameter polyvinyl chloride (PVC) riser and screens. All monitoring wells are completed with a locking protective standpipe and a concrete apron for access and surface protection. A typical as-built diagram for groundwater monitoring well construction is provided in Figure 2 of the GMP (Hanson, 2021).

Monitoring wells will be periodically inspected, their condition assessed at each sampling event, and they will be maintained such that they perform to design specifications throughout the life of the monitoring program. New and existing wells will be surveyed by a licensed surveyor to within ±0.05 foot on the horizontal plane and ±0.01 foot vertically. New wells will be surveyed upon installation and existing wells will be surveyed as needed.

Newly constructed wells will be developed to remove particulates that are typically present in the well casing, filter pack, and adjacent aquifer matrix due to construction activities. Development of new monitoring wells will be performed no sooner than 24 hours after well construction. Wells will be developed using an electric submersible pump (whale pump) that can also serve as a surge block (1.82 inches in diameter x 27 inches long).

Wells will be developed using the pump as a surge block and continuous cycles of over-pumping and recovery until relatively clear water is produced, and field parameters (pH, specific conductance, oxidation-reduction potential (ORP), temperature, and turbidity) stabilize indicating good hydraulic communication with the surrounding water bearing zone. Measurements will be collected approximately every five minutes until the parameters stabilize based on three consecutive readings within the following ranges:

- Temperature: +/- 10% - Degrees Celsius
- pH: +/- 0.1 - Standard Units
- Conductivity: +/- 3% - milliSiemens
- ORP: +/- 10 mV - millivolt
- DO: +/- 10% (or +/- 0.1 mg/L if less than 1.0 mg/L) – milligrams per liter
- Turbidity: Less than 5 Nephelometric Turbidity Unit (NTU)

Samples withdrawn from the Facility's monitoring wells should be particulate-free; therefore, wells may require redevelopment from time to time based upon observed turbidity levels during sampling activities. If redevelopment of a monitoring well is required, it will be performed and documented in a manner similar to that used for a new well. The standard well development procedures are provided in Appendix A.

If a CCR monitoring well becomes unusable or deemed no longer required during the life of the groundwater monitoring program, SIPC will decommission the monitoring well. Documentation describing the decommissioning procedures will be included in the Facility operating record. Decommissioned monitoring wells will also be identified in the Annual Monitoring and Corrective Action Report required by 40 CFR §257.90(e) and 35 IAC §845.550(a)(3).

3.0 GROUNDWATER SAMPLING AND ANALYSIS

In accordance with 40 CFR §257.93 and 35 IAC §845.640-650, SIPC has developed and implemented a groundwater monitoring program that includes sampling and analysis procedures that provide an accurate representation of water quality at background and downgradient monitoring wells. The following sections include procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain of custody control, and quality assurance and quality control.

3.1 Sample Goal, Personnel, Approach, and Controls

SIPC's overall goals for the CCR groundwater monitoring program are the collection of representative samples that a) achieve data quality objectives, b) document the effectiveness of the selected groundwater remedy and c) demonstrate compliance with the groundwater protection standards. The collection of samples by qualified, consistent field staff familiar with both program requirements and the specifics of the monitoring network represent a key component and serve as a quality control function that allows the achievement of program goals.

Sampling is being performed by a dedicated contractor team of experienced individuals in accordance with generally accepted practices within the industry and the SOPs discussed herein and provided in Appendix A. The following sections, which are consistent with USEPA low-flow sampling guidance, the requirements of 40 CFR 257, and the requirements of 35 IAC 845, outline the program sample collection procedures.

3.2 Sampling Order

All background and downgradient wells are equipped with dedicated bladder pumps; therefore, the use of dedicated pumps, combined with specific field techniques that address sample collection procedures, minimize the likelihood of cross-contamination and associated effects on samples. Accordingly, the routine sampling order typically follows a sequence based on consideration of field conditions (e.g., access, individual well recharge rates at the time of sampling, potential or actual weather impacts), not necessarily a simple default approach of sampling background locations prior to any downgradient locations.

3.3 Monitoring Well Condition

In accordance with 40 CFR §257.91(e)(2) and 35 IAC §845.630(e)(2), the monitoring wells are being operated and maintained so they perform to their design specifications throughout the life of the monitoring program. During each sampling event, all wells subject to monitoring, are located and their identity confirmed. Prior to performing any water level measurements, purging, or sampling, each monitoring well is visually inspected to assess its integrity. The condition of each monitoring well, including protective bollards, protective steel casings or road boxes, operation and security of locks, concrete pads, PVC casing, and inner cap is assessed for any physical damage or other breach that may indicate compromised integrity. The results of the well inspections are documented in the comments section of the field sampling forms and/or in field notebooks. In addition, any indications of significant damage, tampering, etc. are promptly reported to SIPC site personnel for appropriate follow-up action.

3.4 Equipment Calibration

Equipment used to record field water quality parameters is calibrated each day prior to use. Calibrations are performed following manufacturers' recommendations and, at a minimum, re-checked at the end of each day. Calibration solutions for standardization materials are freshly prepared or taken from non-expired stock. In the absence of manufacturer specifications or regulatory guidance, field equipment is calibrated to within +/- 10 percent of the standard (or 0.1 standard units for pH meters), if possible. Equipment that fails calibration may not be used until repaired and calibrated or replaced. Calibration data are recorded in the field and records are maintained as part of the permanent project file. A sample field Instrument Calibration Form is included in Appendix A.

3.5 Water Level Gauging

To meet the requirements of 40 CFR §257.93(c) and 35 IAC §845.640(c), water levels are determined prior to groundwater purging/sampling. Additionally, monthly water levels are collected to meet the requirements of 35 IAC §845.650(b). Static water levels are measured in each monitoring well prior to purging using an electric meter accurate to 0.01 foot. Measurements are obtained from the surveyed measuring point on each well. To the extent feasible, these measurements are taken within a 24-hour period Facility-wide. Data are recorded on the Record of Water Level Readings form or Groundwater Sample Collection form, examples of which are included in Appendix A.

Prior to initial use and between wells, the portion of the water level indicator that comes in contact with the groundwater in the well is decontaminated to avoid cross-contamination between monitoring wells. In addition to decontaminating the downhole equipment, sampling personnel don new gloves between wells, and more frequently as needed, to minimize potential for cross-contamination.

3.6 Pre-sampling Well Purging

The monitoring wells are sampled following USEPA low-flow sampling protocols. Low-flow sampling is advantageous because it can greatly reduce the volume of water that must be purged from a well before representative samples can be collected, and typically provides for the collection of more representative samples than do other purge methods, as well as consistency in analytical results between sampling events. Low-flow sampling is accomplished using dedicated low-flow bladder pumps.

Purging is targeted at a rate equal to the well yield to avoid drawing stagnant well column water into the pump (i.e., between 100 and 300 milliliters per minute). During the well purge activities, the flow rate and the depth to groundwater is typically monitored on regular intervals (every 3 to 5 minutes) to verify that the purge activities are not removing stagnant water from the water column in the monitoring well. Stabilization of the water column is considered achieved when three consecutive water level measurements vary by 0.3 foot or less at a pumping rate of no more than 300 ml/min.

Depth to water and field water quality parameter measurements are made during purging on approximate 3- to 5-minute intervals. If a field meter equipped with a flow cell is used, the volume of the flow cell is purged between field measurements. Stabilization is attained and purging deemed complete when three consecutive measurements of each field parameter vary within the following ranges:

- Temperature: +/- 10% - Degrees Celsius
- pH: +/- 0.1 - Standard Units
- Conductivity: +/- 3% - milliSiemens
- ORP: +/- 10 mV - millivolt
- DO: +/- 10% (or +/- 0.1 mg/L if less than 1.0 mg/L) – milligrams per liter
- Turbidity: Less than 5 Nephelometric Turbidity Unit (NTU)

If stabilization of the above field parameters is not achieved after purging for two hours, field personnel will proceed with sampling and note on the low-flow sampling field form which parameters were not successfully stabilized. All data gathered during monitoring well purging are recorded on a Groundwater Sample Collection form. Field personnel manage purge water generated during sampling activities in consultation with SIPC site personnel.

In the event that dedicated equipment malfunctions during a sampling event, non-dedicated equipment may be used to collect a groundwater sample, provided the pump and tubing is decontaminated prior to use in each well. The pump and associated discharge hoses will be decontaminated using a non-phosphate-based detergent and water mixture followed by a deionized water rinse to avoid cross-contamination between monitoring wells as provided in the SOPs provided in Appendix A.

3.7 Sample Collection

Once the water quality field measurement data indicate that purging activities have been successfully completed, required samples are collected directly from the discharge line on the dedicated, low-flow pump into laboratory-provided, pre-preserved sample containers selected for the required parameters or compatible parameters (e.g., all metals samples are collected in one bottle). Sample collection is performed at the same rate (or lower) than was used during the well purging process. Sample containers are kept closed until the time each set of sample containers is to be filled. In accordance with 40 CFR §257.93(i) and 35 IAC §845.640(i), groundwater samples collected as part of the monitoring program are not filtered prior to analysis. Groundwater samples are collected in the designated size and type of containers required for specific parameters. Sample containers are filled in such a manner as to prevent loss of preservatives due to spilling or overfilling. The parameter list sampled for is provided in Table 2 and the analytical methods and practical quantitation limits (PQLs) associated with these parameters are provided in Table 3. Planned sample containers, minimum volumes, chemical preservatives, and holding times for each analyte are provided in Table 4. These may change depending on laboratory requirements and will be verified by the field team prior to each sampling event.

3.8 Sample Preservation and Handling

Upon obtaining the groundwater samples, they are packed into insulated, ice-filled coolers that are kept closed unless contents are being removed or added. Sample preservation methods including chemical addition, refrigeration, and protection from light are used to retard biological action, retard hydrolysis, and reduce sorption effects. Samples are kept at no more than 6°C from collection to laboratory delivery. Samples are delivered directly to the laboratory or sent via overnight courier following chain-of-custody (COC) procedures.

3.9 Chain-of-Custody Program

The COC program allows for tracing and documenting sample possession and handling from the time of field collection through laboratory analysis. The COC program includes sample labels, sample seals, field Groundwater Sample Collection forms, and the COC record. Each sample is assigned a unique sample identification number to be recorded on the sample label. Each sample identification number and description is recorded on the field Groundwater Sample Collection form and on the COC document. The COC SOP and sample COC form are provided in Appendix A.

3.9.1 Sample Labels

Sample labels sufficiently durable to remain legible when wet contain the following information, written with indelible ink:

- Site and sample identification number
- Monitoring well number or other location
- Date and time of collection
- Name of collector
- Parameters to be analyzed
- Preservative, if applicable

3.9.2 Sample Seal

The shipping container is sealed to prevent the samples from being disturbed during transport to the laboratory. A seal is placed across the front and back of each cooler containing samples when coolers are ready for shipment. All custody seals are signed and dated.

3.9.3 Field Forms

All field information is completely and accurately documented to become part of the final report for the groundwater monitoring event. Equipment calibration readings are included on field forms. Example field forms are included in Appendix A. The field forms document the following information:

- Identification of the monitoring well
- Sample identification number
- Field meter calibration information
- Static water level depth
- Purge volume
- Time monitoring well was purged
- Date and time of collection
- Parameters requested for analysis
- Preservative used

- Field water quality parameter measurements
- Water levels recorded during low-flow purge
- Field observations on sampling event
- Name of collector(s)
- Weather conditions including air temperature and precipitation

3.9.4 Chain-of-Custody Record

The COC record is required for tracking sample possession from time of collection to time of receipt at the laboratory. The National Enforcement Investigations Center (NEIC) of USEPA considers a sample to be in custody under any of the following conditions:

- It is in the individual's possession
- It is in the individual's view after being in his possession
- It was in the individual's possession, and he/she locked it up
- It is in a designated secure area

All environmental samples are handled under strict COC procedures beginning in the field. The sampler is the field sample custodian, responsible for ensuring that COC procedures are followed. A COC record accompanies each individual shipment. The record contains the following information:

- Sample destination and transporter
- Sample identification numbers
- Signature of collector
- Date and time of collection
- Sample type
- Identification of monitoring well
- Number of sample containers in shipping container
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates of possession

A copy of the completed COC form is placed in a water resistant bag, accompanies the shipment, and is returned to the shipper after the shipping container reaches its destination. The COC record is also used as the analysis request sheet. When shipping by courier, the courier does not sign the COC record: copies of shipping forms are retained to document custody.

4.0 GROUNDWATER MONITORING PROGRAM

SIPC completed an IEPA approved closure by removal for Emery Pond prior to July 30, 2021. As such, the former Emery Pond is currently in post-closure Corrective Action Monitoring pursuant to the requirements of 40 CFR §257.98 and 257.95 and 35 IAC 35 §845.680 and 845.650.

4.1 Background Monitoring

Background monitoring provides a representative baseline of water quality data for each well in the monitoring well network. Pursuant to 40 CFR §257.90(b)(iii) and 257.94(b) and 35 IAC §845.650(b)(1)(A), a minimum of eight independent unfiltered samples are to be collected from each upgradient (i.e., background) and downgradient compliance well at an existing CCR unit. The results of the background monitoring phase are used during statistical analysis of data from samples collected during subsequent Corrective Action Monitoring events. Development of appropriate, statistically valid background values for each constituent/monitoring well is discussed in Section 6.0.

The current background groundwater data set includes all groundwater monitoring data collected prior to the closure by removal of Emery Pond. Background monitoring samples were collected between March 2017 and May 2021. Samples were analyzed by a contract laboratory for the constituents listed in 40 CFR §257 Appendices III and IV. A list of the groundwater quality monitoring parameters analyzed during background monitoring is provided in Section 4.1.1, below. The analytical methods and PQL used during the background phase of the groundwater monitoring program are provided in Table 3. The collected background groundwater data set satisfies the requirements specified in 35 IAC §845.650(b)(1)(A).

4.1.1 Constituents

Samples from all upgradient and downgradient wells monitored during the background phase have been analyzed for 40 CFR §257 Appendix III (boron, calcium, chloride, fluoride, pH [field measurement], sulfate, and total dissolved solids [TDS]) parameters, Appendix IV (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, and radium 226 and 228 [combined]) parameters, and turbidity.

4.2 Corrective Action Monitoring Program

The Corrective Action Monitoring Program is designed to at a minimum meet the requirements of an Assessment Monitoring Program, document the effectiveness of the corrective action remedy, and demonstrate compliance with the groundwater protection standards. Components of the CCR Corrective Action Monitoring Program, including analytical requirements, sampling frequency, and data evaluation, are discussed in the following sections.

4.2.1 Constituents and Sampling Frequency

For at least three years following the April 2021 completion of closure of Emery Pond, SIPC will on at least a quarterly basis sample and analyze groundwater for all constituents listed in 35 IAC §600(a), including calcium and turbidity. Three years after either the closure of Emery Pond, or after three consecutive years of groundwater monitoring whereunder an exceedance of the groundwater protection standard established under 35 IAC §600 does not occur, whichever is longer, SIPC may complete groundwater monitoring as described in 35 IAC §740.

If the Corrective Action monitoring requirements have not already been met, after completion of five years of monitoring SIPC may ask IEPA for approval of a semiannual monitoring frequency if a) the groundwater monitoring effectiveness will not be compromised by reduced frequency of monitoring, b) in the opinion of SIPC, sufficient data have been collected to characterize groundwater, c) the groundwater monitoring does not currently show any statistically significant trends, and d) the concentrations of all constituents are below the groundwater protection standards described below in Section 4.2.2.

4.2.2 Groundwater Protection Standards

Pursuant to 40 CFR §257.95, the Federal Groundwater Protection Standards (GPS) are established for CCR Rule Appendix IV constituents. The proposed GPS is developed based on:

- For constituents for which a maximum contaminant level (MCL) has been established under 40 CFR §141.62 (MCLs for Inorganic Contaminants) or 40 CFR §141.66 (MCLs for Radionuclides) the applicable MCL for that constituent
- For cobalt, lead, lithium, and molybdenum, constituents that do not have MCLs, the health-based standard included in the amended CCR Rule (i.e., Phase 1 Part 1 amendment)
- For constituents for which the background level is higher than the MCL or health-based standard, the background concentration established from the upgradient wells.

Pursuant to 35 IAC §845.600, the IEPA GPS are established for 35 IAC §600(a) constituents. The proposed GPS is developed based on:

- The groundwater protection standard provided in 35 IAC §845.600(a)(1)
- For constituents for which the background level is higher than the levels identified in 35 IAC §845.600(a)(1), the background concentration established from the upgradient wells.

The applicable established GPS will be included in the 40 CFR §257.90(e) and 35 IAC §845.550(a)(3) required Annual Groundwater Monitoring and Corrective Action Reports. The GPS will be updated upon USEPA's and IEPA's promulgation of new and/or revised MCLs. The background-based GPS will be updated every two years by incorporating the monitoring results from the two most recent years into the existing background as described in Section 6.4.

4.2.3 Evaluation and Response

After each monitoring event, the 35 IAC §845.600 constituents detected in the downgradient compliance wells will be evaluated as follows:

- After receipt of the data from the analytical laboratory, SIPC will determine if any constituents are detected above the GPS. If one or more constituents are detected above the GPS, SIPC may choose to confirm the detection with an immediate resample.
- If one or more constituents are detected, and confirmed by immediate resample, SIPC will provide a GPS exceedance notification to IEPA and place the notification in the Facility's operating record and on the publicly available website.
- Within 60 days of completing the quarterly sampling, SIPC will submit all groundwater data and the results of the statistical analysis performed to IEPA.
- Within 60 days of completing the quarterly sampling, SIPC will place all groundwater monitoring data in the operating record as required by 40 CFR §257.105(h)(6) and 35 IAC §845.800(d)(15).

- Within 60 days of a detected GPS exceedance, SIPC may complete an Alternative Source Demonstration (ASD). The ASD would be certified by a qualified professional engineer and placed on the publicly available website within 24 hours of submittal to IEPA.

Corrective Action Monitoring will be considered complete if compliance with the groundwater protection standards has been achieved by demonstrating that concentrations of 35 IAC §845.600 constituents have not exceeded the GPS for a period of three consecutive years.

4.3 Annual Groundwater Monitoring Report

As required by 35 IAC §845.550(a)(3), an Annual Groundwater Monitoring and Corrective Action Report will be submitted to IEPA by January 31 of each year as part of an annual consolidated report. In accordance with IAC 35 §845.610(e), the Annual Groundwater Monitoring and Corrective Action Report will include:

- a depiction of the former Emery Pond and the associated groundwater monitoring network with a visual delineation of any exceedances
- identification of any monitoring wells installed or decommissioned during the preceding year with a narrative description of why those actions were taken
- a potentiometric surface map for each groundwater elevation sampling event required by IAC 35 §845.650(b)(2)
- a summary including the number of groundwater samples that were collected or analysis for each background and downgradient well with the dates samples were collected
- a narrative discussion of any statistically significant increases over background levels for IAC 35 §845.600(a)(1) listed constituents
- a section at the beginning of the annual report providing an overview of the current status of the groundwater monitoring program and corrective action plan as required by 35 §845.610(e)(4).

As required by 40 CFR §257.90(e), a separate, Groundwater Monitoring and Corrective Action Report will be completed to comply with the Federal monitoring program. This annual groundwater monitoring report is similar to that required by IEPA, however, due to the differences in data evaluation requirements (i.e., GPS), two separate reports will be completed until the USEPA approves the Illinois CCR program to operate in lieu of Part 257. The annual groundwater monitoring reports will comply with the recordkeeping requirements specified in 40 CFR §257.105(h)(1) and 35 IAC §845.800, the notification requirements specified in 40 CFR §257.106(h)(1), and the internet requirements specified in 40 CFR §257.107(h)(1) and 35 IAC §845.810.

Records of the background groundwater quality data and subsequent measurements, including concentration data, will be kept in the Facility operating record and placed on the publicly available website in accordance with the 40 CFR §257.107 and 35 IAC §845.810. These records will be maintained throughout the active life of the Facility and the required groundwater monitoring care period. For each parameter, the laboratory certificates-of-analysis will identify the analytical PQL, the analytical Limit of Detection (LOD), the reported concentration, and applicable laboratory quality assurance/quality control (QA/QC) data on surrogate and standards analyses. Statistical evaluations of the analytical data, GPS comparisons, static water level determinations and evaluations, field water quality parameters, and equipment calibration forms will be retained throughout the active life of the Facility.

5.0 ANALYTICAL AND QUALITY CONTROL PROCEDURES

5.1 Data Quality Objectives

As part of the evaluation component of the QA program, analytical results are evaluated for precision, accuracy, representativeness, completeness, and comparability (PARCC). These are defined as follows:

- Precision is the agreement or reproducibility among individual measurements of the same property, usually made under the same conditions
- Accuracy is the degree of agreement of a measurement with the true or accepted value
- Representativeness is the degree to which a measurement accurately and precisely represents a characteristic of a population, parameter, or variations at a sampling point, a process condition, or an environmental condition
- Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions
- Comparability is an expression of the confidence with which one data set can be compared with another data set in regard to the same property.

The accuracy, precision and representativeness of data will be functions of the sample origin, analytical procedures and the specific sample matrices. QC practices for the evaluation of these data quality indicators include the use of accepted analytical procedures, adherence to hold time, and analysis of QC samples (e.g., blanks, replicates, spikes, calibration standards, and reference standards).

Quantitative QA objectives for precision and accuracy, along with sensitivity (detection limits) are established in accordance with the specific analytical methodologies, historical data, laboratory method validation studies, and laboratory experience with similar samples. The representativeness of the analytical data is a function of the procedures used to process the samples.

Completeness is a qualitative characteristic which is defined as the fraction of valid data obtained from a measurement system (e.g., sampling and analysis) compared to that which was planned. Completeness can be less than 100 percent due to poor sample recovery, sample damage, or disqualification of results, which are outside of control limits due to laboratory error or matrix-specific interferences. Completeness is documented by including sufficient information in the laboratory reports to allow the data user to assess the quality of the results. The overall completeness goal for each task is difficult to determine prior to data acquisition. For this project, all reasonable attempts will be made to attain 90% completeness or better (laboratory).

Comparability is a qualitative characteristic, which allows for comparison of analytical results with those obtained by other laboratories. This may be accomplished through the use of standard accepted methodologies, traceability of standards to the National Bureau of Standards (NBS) or USEPA sources, use of appropriate levels of quality control, reporting results in consistent, standard units of measure, and participation in inter-laboratory studies designed to evaluate laboratory performance.

Data quality and the standard commercial report package will be evaluated with respect to PARCC criteria using the laboratory's QA practices, use of standard analytical methods, certifications, participation in inter-laboratory studies, temperature control, adherence to hold times, and COC documentation following the data quality assessment procedures (also frequently referred to Data Validation) described herein. The laboratory QC control limits in place at the time of sample analysis, which are routinely re-evaluated following the procedures in the laboratory quality assurance policies and the requirements of the analytical methods, will be used as the quantitative QC criteria.

5.2 Quality Assurance/Quality Control Samples

This section describes the various QA/QC samples that are collected in the field and analyzed in the laboratory and the frequency at which they will be performed. A summary of the groundwater and QA/QC samples is provided in Table 5.

5.2.1 Field Equipment Rinsate Blanks

In situations where sampling equipment is not dedicated or disposable, an equipment rinsate blank is collected. The equipment rinsate blanks are prepared in the field using laboratory-supplied analyte-free water. The water is poured over and through each type of sampling equipment following decontamination and submitted to the laboratory for analysis of target constituents. One rinsate blank is collected for every 10 samples, if needed (e.g., equipment malfunction requires use of different, non-dedicated bladder pump).

5.2.2 Field Duplicates

Field duplicates are collected by sampling the same location twice, but the field duplicate is assigned a unique sample identification number. Samplers document which location is used for the duplicate sample. One field duplicate is collected for every 10 samples.

Field duplicate samples are given a unique sample ID and is submitted with a generic sampling time of 12:00 so that the sample time cannot be used to deduce the sampling location. The location where the field duplicate sample is collected is recorded on both the field form and in the field notebook.

5.2.3 Field Blank

Field blanks are also collected as part of the field sampling QA/QC program. The purpose of the field blank is to detect any contamination that might be introduced into the groundwater samples through the air or through sampling activities.

Field blanks are prepared in the field (at the sampling site) using laboratory-supplied bottles and deionized or laboratory reagent-quality water. Each field blank is prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. Preservatives are added to specific sample bottles as required. The well at which the field blank is prepared is identified on the Field Log along with any observations that may help explain anomalous results (e.g., prevailing wind direction, up-wind potential sources of contamination). Once a field blank is collected, it is handled and shipped in the same manner as the rest of the samples.

Field blank results are reported in the laboratory results as separate samples. One field blank is collected for every 15 samples.

5.2.4 Laboratory Quality Control Samples

SIPC will select a laboratory to analyze the groundwater sample with an established QC check program using procedural (method) blanks, laboratory control spikes, matrix spikes, and duplicates. These QC samples are used to determine if results may have been affected by field activities or procedures used in sample transportation or if matrix interferences are an issue. One (1) Matrix Spike (MS)/ Matrix Spike Duplicate (MSD) set (i.e., one sample plus one MS, and one MSD sample at one location) is collected per 20 samples.

5.3 Laboratory Quality Control Procedures

The laboratory selected by SIPC will adhere to a quality assurance program that complies with the National Environmental Laboratory Accreditation Conference (NELAC) program, documented in a Quality Assurance Manual (QAM). The QAM will describe the laboratory's experience, its organizational structure, and procedures in place to provide quality analytical data. The QAM will outline the sampling, analysis, and reporting procedures used by the laboratory. The laboratory selected by SIPC will be responsible for the implementation of and adherence to the QA/QC requirements outlined in their QAM.

Audits are an important component of a quality assurance program at a laboratory. Therefore, a laboratory with internal system and performance audits conducted periodically to ensure adherence by all laboratory departments to the QAM will be selected. External audits are conducted by accrediting agencies or states. These reports are transmitted to department managers for review and response. The selected laboratory will take corrective measures for any finding or deficiency found in an audit per their accreditation requirements.

Data Quality Reviews (DQRs), or equivalent, are requests submitted to a laboratory to formally review results that differ from historical results, or that exceed certain permit requirements or quality control criteria. The laboratory prepares a formal written response to DQRs explaining discrepancies. The DQR is the first line of investigation following any anomalous result.

5.3.1 Laboratory Documentation

Upon receipt of the samples at the laboratory selected, it is recommended that the laboratory complete the following:

- The samples will be examined upon receipt to ensure collection in USEPA-approved containers for the requested analysis. The sample collection data and time will also be reviewed to ensure the USEPA-required sample holding time has not expired or will not expire before the analysis can be performed.
- The information concerning transportation mode and manner will be reported on the form. Samples will be transported on ice or under refrigeration, and the inside temperature of the cooler recorded upon opening.
- The pH of each sample as well as the sample appearance will be recorded if required by the analytical method. Also, preservative adjustments, filtration, and sample splitting will also occur as required prior to distribution. Sample adjustments will be fully documented.

During analysis of the samples, it is recommended that the laboratory agent maintain the integrity of the samples as follows:

- During the sample analysis period, the samples will be preserved in accordance with method guidelines.
- If at any point during the analysis process, the results are considered technically inaccurate, the analysis will be performed again if holding times have not been exceeded.
- Documentation activities should be completed with permanent ink in a legible manner with mistakes crossed out with a single line and initialed by the laboratory agent.

5.4 Laboratory Analyses

Analytical procedures will be performed in accordance with USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* as updated and other USEPA-approved methods. The monitoring program constituents, along with proposed test methods and PQLs, are listed in Tables 2 and 3. The selected analytical methods provide PQLs that are below applicable groundwater standards.

Alternate methods may be used if they have the same or lower PQL. Methods with higher PQLs will be considered if the concentration of the parameter is such that an alternate test method with a higher PQL will provide the same result.

5.4.1 Practical Quantification Limits

Laboratory-specific PQLs will be used as the reporting limits for quantified detections of required monitored constituents. Laboratory PQLs should be reported with the sample results.

5.4.2 Limits of Detection

Laboratory-specific LODs will be used as the reporting limits for estimated detections of required monitored constituents. Constituents detected at concentrations above the LOD but below the PQL will be reported as estimated with a qualifying flag on the laboratory certificates of analysis. Laboratory PQLs should be reported with the sample results.

5.4.3 Method Blanks

Laboratory method blanks are used during the analytical process to detect any laboratory-introduced contamination that may occur during analysis. A minimum of one method blank should be analyzed by the laboratory per sample batch.

5.5 Data Review, Verification, and Validation

Following receipt of the analytical data from the subcontract laboratory, Golder validates the groundwater data in accordance with the National Function Guidelines for Inorganic Data Review (USEPA 2017) and Evaluation of Radiochemistry Fata Usability- Department of Energy (DOE 1997) including a review for completeness and compliance of sample specific information and field QC. Data is evaluated for precision, accuracy, representativeness, completeness, and comparability. Professional judgment, in conjunction with USEPA guidance documents, is used to determine data usability and where necessary, professional judgment is used to evaluate scenarios not specifically described in the referenced documents. Should the data validation identify deficiencies that were not addressed, after consultation with SIPC, Golder would move to a more extensive validation for that data package. Complete data packages and analytical results are stored in the operating record.

5.6 Reconciliation with User Requirements

Throughout the project, SIPC and Golder will determine if project data quality objectives (DQO) are being met and assess whether the data being collected is sufficient and appropriate. Periodic evaluations of the monitoring program will be made to determine if a change in frequency or analytical parameters is appropriate. Individuals making measurements throughout the process will also assess whether the DQO are being met.

Individuals making field measurements will determine whether field quality control criteria were met. The field QA/QC will be overseen by the sampler. Corrective actions will be initiated in the field as necessary. This corrective action may include recalibration of instruments or use of a different type of instrument.

The analysts in the laboratory will determine if analytical QC criteria are achieved. Corrective action in the form of re-analysis or re-calibration may be warranted. Laboratory analytical data and field data will be assessed by a data validation specialist under the direction of the QA Manager to determine usability with regard to the DQO.

As noted in the data validation guidelines, data may not always meet precision and accuracy requirements but may still be considered usable. The data will be assessed with regard to the project DQO, and professional judgment used in conjunction with guidance documents will determine data usability.

6.0 STATISTICAL EVALUATION OF DATA

Following completion of data validation, statistical analysis of the data is performed as discussed in the following subsections. These techniques represent an appropriate, reasonable approach to groundwater data analysis for a CCR Unit in the Corrective Action monitoring phase, are protective of human health and the environment, and incorporate statistical and other evaluation methodologies appropriate for determining compliance with the GPS. SIPC will use a statistical analysis program meeting the applicable requirements of 40 CFR §257.98 and 35 IAC §845.680, which references the statistical analysis provisions of 40 CFR §257.93(f) and 257.93(g) and 35 IAC §845.640(f) and 845.640(g).

6.1 Overall Statistical Approach for Corrective Action

This section outlines the statistical methodologies that will be used to evaluate the data collected from the Site during the Corrective Action monitoring period. Previous statistical analyses for the former Emery Pond used methodologies that were appropriate for Detection and Assessment monitoring, specifically identifying statistically significant increases (SSI) relative to background concentrations and the GPS. However, SIPC has since completed an approved closure by removal for Emery Pond, which also served as part of the approved corrective action. Thus, the former Emery Pond has entered the Corrective Action phase (40 CFR §257.98 and 35 IAC §845.680). As described in the United States Environmental Protection Agency's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance*), dated March 2009, during the Detection and Assessment monitoring phases, the goal of the statistical monitoring program is to identify SSIs relative to background or the established criteria, allowing the owner/operator to determine if a release(s) has occurred and to respond by implementing Corrective Action (i.e., a groundwater remedy), if necessary. Conversely, the goal of the post-remedy Corrective Action monitoring program is to demonstrate compliance with the GPS (described below in Section 6.3.1). Thus, the goal of the statistical analysis procedures being employed pursuant to this addendum is to analyze the data to determine when groundwater concentrations are consistently below the established criteria, which the *Unified Guidance* refers to as "statistically significant decreases" (SSDs). According to both the Federal and Illinois rules, under Corrective Action monitoring, groundwater compliance is demonstrated when concentrations are below the established GPS for a period of three consecutive years, at which point groundwater monitoring is no longer required.

SIPC intends to fulfill the requirements of 40 CFR §257.98 and 35 IAC §845.680 using a confidence interval approach relative to a fixed GPS. This methodology is the recommended approach for Corrective Action programs in the *Unified Guidance*. As stated therein, "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."

6.2 General Statistical Methods

Although confidence intervals are the general statistical approach for data evaluation during the Corrective Action program, it will continue to be necessary to examine the data for outliers, anomalies, and trends during the Corrective Action monitoring period. Outliers and anomalies are generally defined as inconsistently large or small values that can occur as a result of sampling, laboratory, transportation, or transcription errors, or even by chance alone. Statistically significant trends indicate a source of systematic error, or may be indicative of actual contamination. Both outliers/anomalies and trends will be evaluated and corrected (if appropriate) before valid statistical evaluation can be implemented. If outliers or trends are not identified and addressed appropriately, false positives (i.e., an indication of a release when none exists) and/or false negatives (i.e., falsely concluding there is no release in the presence of an actual release) could result.

6.2.1 Outliers

To prevent the inclusion of anomalous data in the dataset, the background monitoring data will be evaluated using time vs. concentration graphs. Following the receipt of data from each Corrective Action monitoring event, parameter concentrations that appear anomalous on a time vs. concentration graph or concentrations that are identified as outliers based on a statistical test may be marked as outliers in the database. Alternatively, consistent with the groundwater monitoring program standard procedures (see Sections 4.1 and 4.2), additional independent samples may be collected to verify the anomalous result. If the anomalous result is not verified, the outlier/anomaly will be removed from the dataset to maintain the accuracy of the evaluation method.

An outlier is a value that is statistically different from most other values in a data set for a given groundwater chemical constituent. Reasons for outliers may include:

- Sampling errors or field contamination
- Analytical errors or laboratory contamination
- Recording or transcription errors
- Faulty sample preparation or preservation, or shelf-life exceedance
- Extreme, but accurately detected, environmental conditions (e.g., spills, migration from the Facility).

Formal testing for outliers will be performed on each data set. Testing for the presence of outliers will be performed using the methods described in the *Unified Guidance*. The outlier test assumes the background data are normally distributed. Thus, if the background data are log-normally distributed, the outlier test will be applied to the log-normally transformed data and not the raw data.

If a statistical outlier is identified based on an outlier test, the source of the abnormal measurement will be investigated. Valid reasons for the outlier values may include: contaminated sampling equipment, laboratory contamination of the sample, errors in transcription of the data values, or the value may be a true, but extreme data point. Once a specific reason for the outlier is documented, the data point will be excluded from further statistical analysis. If a plausible reason cannot be identified, the result should be treated as a true but extreme value and should remain in the database. However, in some cases, professional judgement may be necessary and would be used to remove extreme outliers, even when an underlying cause cannot be identified. As described in Section 5.2.3 of the *Unified Guidance*, the removal of extreme outliers (even those for which a cause cannot be identified) has the effect of reducing the background mean and standard deviation, thus resulting in more conservative (i.e., protective) statistical calculations. If the most recent data point is identified as an outlier, it is generally inappropriate to remove the data point until additional data (e.g., verification sample or next sampling event) are available to support the data removal.

Identified outliers should not actually be removed from the database, but should be maintained in SIPC's database and simply flagged as outliers. Even extreme outliers may ultimately be identified as members of the actual sample population over time, as additional data are added to the database. It is important to remember that the true population can never be known, because it would take an infinite number of samples to perfectly identify a given population. Statistical analysis is a procedure for modeling the true population using a limited number of existing data points, but as more data are gathered, the true population can be more closely modeled.

6.2.2 Managing Linear Trends

Along with data normality and sample independence, one of the important assumptions of statistical data analysis is the absence of trends in the background data set. It is generally inappropriate to calculate a confidence interval when a data series exhibits a trend. If, based on a statistical trend analysis (e.g., Mann-Kendall/Sen's Slope Analysis), trends are noted in the intrawell Corrective Action monitoring data, additional information and records will be evaluated to determine an underlying cause. Trends can result from a multitude of causes, including natural temporal variability, incomplete well development (particularly for new background wells), well damage or deterioration, systematic laboratory or field sampling errors, influence of an off-Site upgradient source, and leakage from a CCR unit. No matter the source, it is generally considered inappropriate to incorporate trending data in statistical calculations, since trends will typically result in an over-estimate of the background variability.

However, following Corrective Action (i.e., closure by removal), trends in the data are expected and, in fact, may be considered a positive indicator. Specifically, because SIPC elected to perform closure by removal, decreasing trends are expected in those wells that have reported SSIs during the Detection and Assessment monitoring periods. If trends are noted during the Corrective Action period, the most appropriate course is to apply "confidence bands" around the trend line. Confidence bands are simply a confidence interval method that is applied to trending datasets. The Unified Guidance recommends the use of confidence bands for determining compliance of trending data during both the Assessment and Corrective Action monitoring periods. Additional discussion of confidence intervals and confidence bands is provided below in Section 6.3.3. For those constituent-well pairs that show statistically significant trends, the results of the confidence band approach will be used for the purpose of determining compliance with GPS.

6.2.3 Normality Testing

Following the review of data for outliers and trends, the data will be tested for normality using the Shapiro-Wilk Test of Normality (either single group or multiple group version) for sample size up to 50, and the Shapiro-Francia Test of Normality for sample size more than 50, or other acceptable test methods. If an alternative test method is proposed for evaluating the normality of data, SIPC will provide supporting information with the statistical analysis results demonstrating that the alternative method has a similar level of power to detect deviations from the normal distribution as the Shapiro-Wilk and Shapiro-Francia test methods, as appropriate. The following guidelines are used for decisions in normality testing:

1) If the raw data are not normally distributed, then the data should be natural log-transformed and re-tested for normality using the above methods.

2) If the raw or the natural log-transformed data are normally distributed, then a normal distribution test (also referred to as a Parametric test) can be applied.

3) If neither the raw nor the natural log-transformed data fit a normal distribution, then a distribution-free test will be applied.

6.2.4 Reporting of Low and Zero Values

Constituents that are not present above the LOD for the analytical procedure are reported as not detected (ND), or less than the LOD, rather than as zero or not present, and the laboratory's LOD is to be provided on the analytical report. There are a variety of ways to deal with data that include values below detection limits. However, during Corrective Action, when intrawell confidence intervals are calculated from datasets that include ND values, a value of ½ of the LOD will be used in the calculation.

If concentrations are above the LOD but below the laboratory PQL, the value will be reported as a J-flagged concentration (J-value). J-values will be used in the statistical calculations to be performed during the Corrective Action monitoring period.

6.2.5 Statistical Power

As discussed above, one of the primary goals of the selection of a proper statistical evaluation method is to limit the potential for results to indicate false positives or false negatives. During Corrective Action, the primary concern is a false negative (i.e., compliance has been achieved when concentrations are actually still exceeding the GPS). As stated in the *Unified Guidance*, during Corrective Action, "the most important consideration is to ensure that the true population parameter is actually below the clean-up standard before declaring remediation a success". Thus, the *Unified Guidance* recommends the use of a "reasonably low, fixed, test-wise false positive rate" (FPR). For the former Emery Pond, the test-wise FPR (α) will be 0.05, which means that during future monitoring there will be a 5% chance of incorrectly declaring that a well-constituent pair is "in compliance" when its concentrations are actually above the GPS.

6.2.6 Verification Sampling

Verification Sampling is an important aspect of any statistical analysis program, as it decreases the potential for false positives and false negatives. For the former Emery Pond, verification sampling will be completed as a "1 of 2 pass strategy". As described above, if an initial statistical exceedance is reported, then verification sampling will be performed to confirm the initial exceedance. Verification samples should be collected on a schedule that allows for physical independence of the samples. In a 1 of 2 pass strategy, if the concentration of the verification sample does not confirm the original sample result, then the original result is flagged as an outlier in the database. If the verification result confirms the original result, both values are retained in the database.

6.3 Corrective Action Statistical Analysis Method

This section discusses the procedures, methods, and processes that will be implemented as part of the Corrective Action statistical evaluation. As described above, Corrective Action statistics are appropriate given that SIPC has completed closure by removal for the former Emery Pond. The following sections discuss the procedures, methods, and processes that will be implemented as part of the Corrective Action statistical evaluation.

As described above, the general statistical procedures described in Sections 6.2 (outliers, trends, normality, etc.) will be performed prior to the calculation of confidence intervals described below. Please refer to those sections for descriptions on the methods and techniques required to complete these analyses.

6.3.1 Establishing a Ground Water Protection Standard

Following the removal of outliers and the performance of general statistics described in Sections 6.2, the GPS will be developed. The GPS is a key element of Corrective Action, in that it is used to determine when groundwater concentrations are “in compliance” and the former Emery Pond can exit Corrective Action. A GPS has been established for all Appendix IV constituents according to 40 CFR §257.95 and each of the constituents in 35 IAC §845.600. Pursuant to 40 CFR §257.95, the Federal GPS is equal to either the MCL, the health-based standard included in the Phase 1 Part 1 amendment for constituents that do not have MCLs, or for those constituents whose background concentration is greater than the MCL or health-based standard, the background concentration established from upgradient wells. Pursuant to 35 IAC §845.600, the IEPA GPS is equal to the value published in 35 IAC §845.600(1). However, as indicated in 35 IAC §845.600(2), for those constituents whose background concentration[1] is greater than the default values in 35 IAC §845.600(1), a GPS will be established from the background data.

The *Unified Guidance* provides two acceptable approaches for establishing a background-based GPS (unless all values are ND, in which case the background-based GPS will be set equal to the LOD). The two methods are: (1) the tolerance interval and (2) the prediction interval.

6.3.1.1 Tolerance Interval Based GPS

If the background dataset is normally or transformed normally distributed, the *Unified Guidance* recommends Tolerance Intervals over the Prediction Intervals for establishing a GPS. The GPS should be based on a 95 percent coverage/95 percent confidence tolerance interval. If the background data are non-normal (even after transformation), then a large number of background observations are required to calculate a non-parametric tolerance interval (typically a minimum of 60 background observations are required to meet these requirements). If there is an insufficient number of background observations to calculate a non-parametric tolerance interval, then a non-parametric Prediction Interval approach should be used, as described below.

The Upper Tolerance Limit (UTL) is calculated for each detected 40 CFR Part 257 Appendix IV and 35 IAC §845.600 constituent (and the Lower Tolerance Limit (LTL) for pH). Tolerance Limits, as outlined in the *Unified Guidance* (Section 17.2), are a concentration limit that is designed to contain a pre-specified percentage of the dataset population. Two coefficients associated tolerance intervals are (1) the specified population proportion and (2) the statistical confidence. The coverage coefficient (γ), which is used to contain the population portion, and the tolerance coefficient (or confidence level ($1-\alpha$)), which is used to set the confidence of the test. Typically, the UTL is calculated to have both coverage and confidence of 95%.

Tolerance limits can be completed using both parametric (Section 17.2.1 of *Unified Guidance*) or non-parametric methods (Section 17.2.2 of *Unified Guidance*). However, as described above, the non-parametric method requires at least 60 background (or historical) measurements in order to achieve 95% confidence with 95% coverage. Tolerance Intervals can be calculated using most groundwater statistical software packages.

6.3.1.2 Prediction Interval Based GPS

If the minimum requirements for calculating a Tolerance Intervals cannot be met, then a Prediction Interval method should be used. The *Unified Guidance* suggests using a prediction interval about a future mean for

1 The background concentration is based on data from a monitoring well (or wells) that is uninfluenced by the CCR unit.

normally/transformed-normally distributed datasets or a prediction interval about a future median for datasets with a high percent of ND or non-normally distributed data.

For the establishment of a GPS, a one-sided prediction interval (or two-sided for pH) is calculated using background (or historical) datasets based on a specified number of future comparisons - four future comparisons is typical. The Upper Prediction Limit (UPL), and Lower Prediction Limit (LPL) for pH, that is calculated as a product of this method then becomes the GPS, and is compared against the confidence interval for the compliance data, as described below.

6.3.2 Confidence Intervals for Corrective Action

Once the GPS is established for each constituent, the *Unified Guidance* recommends the confidence interval method to evaluate the groundwater data from the Corrective Action monitoring network. Using confidence intervals, compliance is identified by comparing the calculated intrawell confidence interval for each well and constituent pair against the established GPS. A confidence interval statistically defines the upper and lower bounds of a specified population within a stipulated level of significance. As described above under Statistical Power, confidence intervals for the former Emery Pond will be calculated using a FPR of 0.05, which is also referred to as the 95% Confidence Interval. Confidence intervals are required to be calculated based on a minimum of four independent observations, but more representative confidence intervals are achieved with a growing data set. Thus, confidence intervals will be recalculated following the receipt and incorporation of new data from each Corrective Action monitoring event.

Confidence intervals will be calculated on a well-constituent pair basis for each constituent in 40 CFR Part 257 Appendix IV and 35 IAC §845.600. A minimum of four values are required to calculate a confidence interval. Closure by removal of the former Emery Pond was completed on April 5, 2021 with final inspection May 28, 2021. Thus, the first Corrective Action statistical analysis will be completed following the first quarter 2022 monitoring event, which will be the fourth Corrective Action monitoring event following the completion of the closure by removal. It is inappropriate to calculate the confidence interval using data from the period prior to the completion of closure by removal, because those data represent conditions prior to completion of the closure process, and the results of statistical analysis of those data would produce inappropriate conclusions.

The specific type of confidence interval should be based the attributes of the data being analyzed, including: (1) the data distribution, (2) the detection frequency, and (3) potential trends in the data. The table below identifies the criteria for determining which confidence interval method should be applied to each well-constituent pair. The method and procedure for calculating the Upper Confidence Limit (UCL) and Lower Confidence Limit (LCL) is provided in the section reference from the *Unified Guidance*, which is listed in the last column of the table below.

Data Distribution	**Non-detect Frequency**	**Data Trend**	***Unified Guidance*** **Confidence Interval Method**
Normal	Low	Stable	Confidence Interval Around Normal Mean (Section 21.1.1)
Transformed Normal (Log-Normal)	Low	Stable	Confidence Interval Around Lognormal Arithmetic Mean (Section 21.1.3)
Non-normal	N/A	Stable	Nonparametric Confidence Interval Around Median (Section 21.2)
Statistically Significant Trend Noted	Low	Trend	Confidence Band Around Theil-Sen Line (Section 21.3.2)

In a Corrective Action program, the UCL is the attribute of prime interest for determining compliance. If the UCL is below the GPS, the well-constituent pair is considered to be in compliance. If the UCL (or both the UCL and LCL) is greater than the GPS, the test is considered to be a statistical exceedance and the well-constituent pair is not in compliance, and additional Corrective Action monitoring is required.

During Corrective Action, a per test FPR (α) of 0.05 will be used as an initial error level for calculating the two-tailed confidence intervals for the Corrective Action well network (which means 2.5% FPR per tail). In some cases, it is appropriate to adjust the FPR of the confidence interval based on the number of data points available as well as the distribution of the data being evaluated. If deemed necessary, an approach is provided in Section 22 of the *Unified Guidance* for determining an appropriate per test FPR based on the data characteristics.

6.3.3 Confidence Intervals for Trending Data

As described above in Section 6.2.2, trends are expected during Corrective Action monitoring, because the remedy is expected to result in improving groundwater conditions, which may mean increasing trends for naturally occurring constituents whose concentrations were diminished by CCR impacts, and decreasing trends for other constituents that increased due to influence from the CCR unit.

If a trend is not managed when constructing a confidence interval, the confidence interval will inadvertently incorporate both natural variability in the underlying population and variation due to the trend. Thus, the confidence interval will be wider than it should be, making it more difficult to demonstrate compliance with the GPS. The confidence interval will have less statistical power to judge the success of remedial efforts.

As stated in the *Unified Guidance*, "when a linear trend is present, it is possible to construct an appropriate confidence interval built around the estimated trend. A continuous series of confidence intervals is estimated at each point along the trend", which is "termed a simultaneous confidence band. An upper or lower confidence band will tend to follow the estimated trend line whether the trend is increasing or decreasing. It is computed once the trend line has been estimated."

For the former Emery Pond, if a statistically significant trend is noted in the Corrective Action monitoring data, a confidence band will be constructed around the trend. The trend analysis method for the former Emery Pond will be the Mann-Kendall/Sens Slope Analysis. The Theil-Sen trend line that results from a Sens Slope Analysis is a non-parametric alternative to linear regression, meaning the Theil-Sen method can be applied to data with less regard for the data normality assumptions required to construct a linear regression line. As indicated in the table above, the non-parametric confidence band method is further described in Section 21.3.2 of the *Unified Guidance*.

In some situations, anticipated or existing trends may temporarily reverse during the monitoring program, especially in early stages post-remedy. As described above, due to the removal of the source materials, it is anticipated that trends will decrease with time; however, an initial increase may occur prior to the onset of decreasing concentrations. Ground-disturbing activity related to the removal can sometimes result in short-term increases in concentrations, as the stable groundwater regime is destabilized by the removal. Typically, however, the groundwater regime eventually returns to stabilized conditions and trends return to normal. In the event trend reversals are noted during future Corrective Action groundwater monitoring, it may be necessary to adjust the data set to correct for these trend reversals. Adjustments may include the exclusion of data prior to the trend reversal and/or the institution of moving windows. If a moving window approach is selected, a minimum of eight values will be contained in the moving window, starting with the most recent observation, and including at least the seven previous observations. The same confidence band approach will be applied to the adjusted data set, regardless of whether the data set is adjusted to exclude data prior to a trend reversal or whether a moving window approach is used.

6.3.4 Response to Statistical Exceedances during Corrective Action

If the UCL exceeds the GPS during future Corrective Action monitoring events, other than natural attenuation and confirmatory monitoring, no additional actions are required. As described in the *Corrective Action and Selected Remedy Plan, Including GMZ Petition*, by Hanson, dated March 29, 2019 and revised March 30, 2021, because the selected remedy for the former Emery Pond was closure by removal, if statistical exceedances are noted during future Corrective Action monitoring events, monitored natural attenuation (MNA) will be used to aid in returning groundwater to achieve the applicable standards. Complementing the removal of the CCR source materials from Emery Pond, MNA functions as a finishing or polishing step in the timely return to groundwater standards compliance.

6.3.5 Exiting Corrective Action

As specified in 40 CFR §257.98(c) and 35 IAC §845.680(c), in order to exit Corrective Action, it must be demonstrated that:

1) The owner or operator of the CCR surface impoundment demonstrates compliance with the GPS established by IAC 35 §845.600 has been achieved at all points within the plume of contamination that lies beyond the waste boundary;

2) The GPS has not been exceeded for each well-constituent pair for a period of three consecutive years, based on the results of the confidence interval/confidence band approach described above; and,

3) All actions required to complete the remedy have been satisfied.

6.4 Updating Background Values in Corrective Action

The *Unified Guidance* suggests that updating statistical limits should only be completed after a minimum of 4 to 8 new measurements are available (i.e., every 2 to 4 years of semiannual monitoring, assuming no verification sampling). The periodic update of background datasets, during which additional data are incorporated into the background, improves statistical power and accuracy by providing a more conservative estimate of the true background population. For the Corrective Action monitoring program, updating of background values will only apply to those GPS that are based on background data.

Prior to incorporating additional data into the background dataset, a test should be performed to demonstrate that the "new data" are from the same statistical population as the existing background results. Below are three methods that can be used in determining if the new data should be included in the background:

- Time Series Graphs can be used as a qualitative test to assist with the determination whether a new group of data match the historical data or if there is a concentration trend that could be indicative of a release or evolving groundwater conditions.

- Box-Whisker plots can also be used to determine whether or not the datasets are similar.

- Mann-Whitney (or Wilcoxon Rank) Test is a quantitative test used to evaluate the ranked medians of both the historical and "new dataset" populations. An α of 0.05 should be used for this evaluation. After calculation, if the Mann-Whitney statistic does not exceed the calculated critical value, the test assumes that the two data populations have equal medians, and therefore are likely from the same statistical population.

Ultimately, the Mann-Whitney (Wilcoxon Rank Sum) Test is the statistical test that will be used to determine whether new observations should be included in the background dataset. It is important to note that a failure of the Mann-Whitney Test does not automatically preclude the incorporation of new data into the background; however, if differences are noted, a review of the new data will be conducted to determine if the noted difference is a result of a change in the natural conditions of the groundwater or if it is the result of a potential release from the CCR Unit. If the new data are included in the background dataset, the GPS will be recalculated, as described in Section 6.3.1 above.

7.0 FUTURE REVISIONS

In conformance with the applicable requirements of the CCR Rule, and of 35 IAC §845 this Addendum #1 addresses the construction, operation, maintenance, and sampling of, and the management and evaluation of field and analytical information from, the groundwater monitoring well network at former Emery Pond. Should future amendments to the regulations create additional or different requirements, and/or Site changes occur that require modifications to the existing program, SIPC will modify the Groundwater Monitoring Plan and/or prepare an Addendum #2 and implement appropriate procedural modifications to the existing program.

8.0 REFERENCES

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EPA. 2015. 40 CFR Parts 257 and 261; Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. April 17.

EPA. 2017. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, EQAASOP-GW4, Region 1, Low-Stress (Low-Flow) SOP, Rev 4, September 19.

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Hanson. 2021. Groundwater Monitoring Plan Revised March 24.

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IEPA. 2021. 35 IAC Part 845 Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments, Effective April 21.

Robin, M.L. and Gillham, R.W. 1987. Field evaluation of well purging procedures: Groundwater Monitoring Review, v.7, No. 4, pp.85-93

Table 1: Monitoring Well Construction Details
Southern Illinois Power Cooperative Marion Station
Marion, Illinois

CCR Unit	Monitoring Well ID	Ground Surface Elevation (ft-msl)	Total Borehole Depth (ft)	Top of Casing Elevation (ft-msl)	Sounded Well Depth (ft-btoc)	Well Material	Screen Length (ft)	Screen Depth		Screen Elevation		
								Top (ft-btoc)	Bottom (ft-btoc)	Top (ft-btoc)	Middle (ft-msl)	Bottom (ft-msl)
Emery Pond	EBG	521.74	25.00	524.87	28.13	2" Sch 40 PVC	10	18.13	28.13	506.74	501.74	496.74
	EP-1	517.07	31.00	519.72	33.65	2" Sch 40 PVC	10	23.65	33.65	496.07	491.07	486.07
	EP-2	511.15	15.00	513.79	17.64	2" Sch 40 PVC	10	7.64	17.64	506.15	501.15	496.15
	EP-3	516.24	26.50	518.95	29.21	2" Sch 40 PVC	10	19.21	29.21	499.74	494.74	489.74
	EP-4	517.07	18.50	519.74	21.17	2" Sch 40 PVC	10	11.17	21.17	508.57	503.57	498.57
	EP-5	524.64	16.32	527.59	16.32	2" Sch 40 PVC	4.5	11.30	15.79	516.29	514.05	511.80
	EP-6	502.08	13.62	505.11	13.62	2" Sch 40 PVC	4.5	8.59	13.12	496.52	494.26	491.99
	EP-7	512.49	18.50	515.44	18.50	2" Sch 40 PVC	9.6	9.36	18.00	506.08	501.26	497.44

Notes:
ft-msl = Feet above mean sea level
ft-btoc = Feet below top of casing
2" Sch 40 PVC = Two-inch diameter well, constructed of schedule 40 polyvinyl chloride materials
AECOM, 2018, 2017 Annual Groundwater Monitoring and Corrective Action Report, January 31, 2018.

Prepared by: DFSC
Checked by: DPJ
Reviewed by: MAH

Table 2: Groundwater Quality Monitoring Parameters
Southern Illinois Power Cooperative Marion Station
Marion, Illinois

Monitoring Parameter	
Field Parameters	Temperature, pH, Conductivity, Dissolved Oxygen, and Turbidity
Appendix III[1]	Boron
	Calcium
	Chloride
	Fluoride
	Sulfate
	pH
	Total Dissolved Solids (TDS)
Appendix IV[1]	Antimony
	Arsenic
	Barium
	Beryllium
	Cadmium
	Chromium
	Cobalt
	Fluoride
	Lead
	Lithium
	Mercury
	Molybdenum
	Selenium
	Thallium
	Radium 226 and 228 combined

Notes:

1.) Analyte lists match requirements for monitoring from USEPA Rule 40 CFR Part 257.94(b) and 35 IAC Part 845.600(a)

Prepared By:	DFSC
Checked By:	DPJ
Reviewed By:	MAH

Table 3: Analytical Methods and Limits of Quantitation
Southern Illinois Power Cooperative Marion Station
Marion, Illinois

Analyte[1]	Analytical Method[2,3,4]	Preservative	Hold Times	PQL (mg/L)	LOD (mg/L)	MCL (mg/L)	IEPA Part 845 Standard (mg/L)[5]
Antimony	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.00045	0.006	0.006
Arsenic	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.00038	0.010	0.01
Barium	SW-846 6010B	HNO_3, pH <2	6 months	0.0025	0.0007	2.000	2
Beryllium	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.00025	0.004	0.004
Boron	SW-846 6010B	HNO_3, pH <2	6 months	0.02	0.009	-	2
Cadmium	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.00013	0.005	0.005
Calcium	SW-846 6010B	HNO_3, pH <2	6 months	0.1	0.035	-	NA
Chloride	SM 4500-Cl E	Unpreserved	28 days	1	0.5	-	200
Chromium	SW-846 6020A	HNO_3, pH <2	6 months	0.0015	0.0007	0.100	0.1
Cobalt	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.000115	0.100	0.006
Fluoride	SW-846 9214	Unpreserved	28 days	0.1	0.037	4	4
Lead	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.0006	0.015	0.0075
Lithium	SW-846 6020A	HNO_3, pH <2	6 months	0.003	0.00145	-	0.04
Mercury	SW-846 7470A	HNO_3, pH <2	28 days	0.0002	0.000055	0.002	0.002
Molybdenum	SW-846 6020A	HNO_3, pH <2	6 months	0.0015	0.0006	-	0.1
pH	SW-846 9040B Field	Unpreserved	15 Minutes	1	0	-	6.5-9.0
Radium 226 & 228	EPA 903.0/904.0	HNO_3, pH <2	6 months	1.0 (pCi/L)	-	5.0 (pCi/L)	5.0 (pCi/L)
Selenium	SW-846 6020A	HNO_3, pH <2	6 months	0.001	0.0006	0.050	0.05
Sulfate	SW-846 9036	Unpreserved	28 days	10	6.14	-	400
Thallium	SW-846 6020A	HNO_3, pH <2	6 months	0.002	0.00095	0.002	0.002
Total Dissolved Solids	SM 2540 C	Unpreserved	7 days	20	16	-	1200
Turbidity	SM 2130 B Field	Unpreserved	15 Minutes	1	1	-	-

Notes:

1.) Analyte lists matches requirements USEPA Appendix III and Appendix IV Constituents - 40 CFR Part 257. Monitoring, and IEPA 35 IAC 845.600
2.) SW-846 denotes Test Methods for Evaluating Solid Waste, Physical- Chemical Methods, EPA publication SW-846, 3rd edition, and subsequent updates.
3.) Other industry-used or agency-approved methods may be used provided that they produce the necessary level of precision and accuracy for data use and reporting.
4.) Updates to the methods listed here are approved for use.
5.) Groundwater protection standard provided in 35 IAC 845.600(a)(1).
Dash (-) = no information available

HNO_3 - Nitric acid

MCL = Maximum Contaminant Level from USEPA 2016 Edition of the Drinking Water Standards and Health Advisories. (http://water.epa.gov/drink/contaminants/index.cfm.)

mg/L = Milligrams per liter

LOD = Limit of Detection

pCi/L = Picocuries per liter

PQL = Practical Quantitation Limit

SM = Standard Method

Prepared By: DFSC
Checked By: HTV
Reviewed By: MAH

GOLDER
MEMBER OF WSP

Table 4: Sample Container Information and Hold Times
Southern Illinois Power Cooperative Marion Station
Marion, Illinois

Parameter	Container & Volume	Preservative	Maximum Holding Time
pH, Specific Conductance, temperature, ORP, turbidity	Flow through cell	None	15 minutes (field analysis)
Mercury (total)	Plastic, 250 mL	HNO_3 to pH<2	28 days
Metals (total) except mercury			6 months
Total Dissolved Solids (TDS)	Plastic, 250 mL	None	7 days
Fluoride, Chloride, Sulfate			28 days
Radium 226/228	Plastic, 2 L	HNO_3 to pH<2	6 months

Notes:
mL = Milliliter
HNO_3 = Nitric acid

Prepared By:	DFSC
Checked By:	HTV
Reviewed By:	MAH

Table 5: Groundwater and QA/QC Sampling Plan
Southern Illinois Power Cooperative Marion Station
Marion, Illinois

CCR Unit	Well ID	Analyte Group	Field Samples	Filtered?	Field Duplicates[1]	Field Blank[2]	MS/MSD[3]
Former Emery Pond	EBG, EP-1, EP-2, EP-3, EP-4, EP-5, EP-6, EP-7	Radium	7	No	1	1	2
		Metals					
		TDS/Anions/pH					
		Field Parameters					
			Total Samples:		**11**		

Notes:
1.) Field duplicates will be collected at a frequency of 1 per 10 samples, per analysis, per sampling round.
2.) Field blank will be collected at a frequency of 1 per 15 samples, per analysis, per sampling round using laboratory provided deionized water
3.) Matrix spike and matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 1 per 20 samples, per analysis, per sampling round (2 MS/MSD samples equals 1 MS and 1 MSD)
4.) Must sample for monitoring well water-quality parameters including temperature, pH, dissolved oxygen, specific conductance, oxidation-reduction potential, and turbidity. Turbidity must be <5 NTU's in all samples

Prepared By: DFSC
Checked By: DPJ
Reviewed By: MAH

APPENDIX A

Standard Operating Procedures

Appendix A - SOPs

Field Methods and Standard Operating Procedures

Submitted to:

Southern Illinois Power Cooperative

Marion Plant
Marion, Illinois

Submitted by:

Golder Associates Inc.

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Table of Contents

1.0 STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs) are instructions that an individual or organization follow to document routine or repetitive field or office activities. The development and use of SOPs are an integral part of a successful quality system as SOPs provide individuals with information to perform work properly, and facilitate consistency in the quality and integrity of work products and results. The proper use and execution of SOPs reduces variation and promotes quality through consistent implementation of a process or procedure, even in cases of temporary or permanent personnel changes.

Reporting to and in consultation with the Project Manager, the sampler's responsibilities include understanding and complying with all applicable project requirements including, but not limited to, work plans, data collection and documentation forms, field methods, equipment calibration, sample chain of custody, and standard operating procedures. The sampler will furthermore be responsible for his understanding of and adherence to these foundational elements of the project.

1.1 SOP-1 Utility Clearance Procedures

The potential for unknown or unmarked utilities is a potential issue at the Site. The purpose of this SOP is to describe the methods for clearing utility locations. The scope of this document is limited to field operations and protocols applicable during advancement of soil borings and monitoring wells on and off-Site.

Responsibilities

Southern Illinois Power Cooperative (SIPC) personnel will provide assistance locating the utilities. SIPC's subcontractors will be responsible to oversee the utility clearance procedures to reduce the potential for encountering a utility during the subsurface assessment activities. Field personnel are required to follow this SOP and adhere to utility mark out locations. An example utility clearance form is provided as Attachment A.

Procedures

The utility locating procedures will include:

- Contacting Call Before You Dig service to clear utilities within the public right-of-ways (***800-382-5544 or 811 in state)***. Golder personnel will use the Call Before You Dig clearance field form (Attachment A) to record the Call Before You Dig ticket number and list the utilities contacted by Call Before You Dig. Call Before You Dig does not contact local utilities including municipal water and sewer companies. SIPC or their subcontractors will be responsible for contacting the local utility companies. Utility color coding for Call Before You Dig companies include:

RED	Electric power lines, cables or conduits, and lighting cables.
YELLOW	Gas, oil, steam, petroleum or other hazardous liquid or gaseous materials.
ORANGE	Communications, cable TV, alarm or signal lines, cables, or conduits.
BLUE	Water, irrigation, and slurry lines.
GREEN	Sewers, storm sewer facilities, or other drain lines.
WHITE	Proposed excavation
PINK	Temporary survey markings.
PURPLE	Reclaimed water, irrigation and slurry lines.

- Review existing Site utility maps with SIPC personnel knowledgeable with site utilities. SIPC personnel will pre-approve all intrusive sampling locations
- Advance the boring outside the area of a marked utility

1.2 SOP-2 Field Log Book and Field Form Procedures

The field log book provides a means to record daily significant events, observations, and measurements during sampling and monitoring activities. Sufficient data and observations shall be recorded in the field log book and/or field forms to enable reconstruction of field events.

Responsibilities

It is the responsibility of the sampler to maintain centralized daily records of all significant field events, observations, and measurements during field assessment activities. The sampler is responsible for maintaining complete records of their actions, observations, etc., in the field log books. If observations and measurements are taken in an area where the field log book may become contaminated separate waterproof bound and numbered field log books may be maintained. The sampler will make photocopies of all field data entries on a regular basis (preferably at the end of each day but at least on a weekly basis or upon return to home office) and submit the copies to SIPC for inclusion in the Facility operating record. The entries shall be signed and dated at the completion of each task or at the end of each day. The sampler is responsible for assuring that forms are completed in waterproof ink.

If an individual makes an error while filling out the log book, a line shall be drawn through the error and the correction entered. Individual pages, which will be sequentially numbered, shall not be removed from bound log books.

1.2.1 Field Log Book

The sampler is responsible for logging dates, times, subcontractors, field personnel, field activities, field observations, and any other pertinent information during field activities. Field log book entries shall be legible and include, at a minimum, the following information:

- Date
- Project name and number
- Weather and temperature
- List of personnel present including subcontractors and visitors. The time of arrival and departure shall be noted next to each name
- Business phone calls along with the name of the field personnel making the call and the phone call recipient, time, and a brief description of the topic of conversation
- A description of the activities of subcontractors (e.g., drillers, survey contractor, etc.) and subcontractor down-time. Next to the entry, note the reason for the down-time. Log information or observations regarding the subcontractor's performance in the field log book
- Description of field activities completed including soil boring advancement, monitoring well installation and sampling activities including measurements if not noted on a field form

1.2.2 Photo-Documentation

Photographs may be taken during the sampling to document field activities and may serve to verify information entered in the field logbook. When a photograph is taken, the following information will be written in the logbook or will be recorded in a separate field photography book:

- Time, date, location, and, if appropriate, weather conditions
- Description of the subject photographed (including the photograph direction)
- Name of person taking the photograph

1.2.3 Equipment Calibration Forms Procedures

Equipment calibration forms are required to record and track daily calibration of each instrument. The equipment manual provides instructions on proper calibration procedures. Information to be recorded shall include the following:

- Date and time of calibration
- Equipment calibrated with model number and/or identification number
- Media used to calibrate instrument (e.g., solutions or gas)
- Calibration media information, lot numbers, and concentration
- Pre- and post-calibration readings

Follow the provided instructions and record the necessary information on the calibration field forms. Field personnel will provide the original Calibration Forms to SIPC, for inclusion in the Facility operating record. An example calibration form is provided as Attachment B.

1.2.4 Groundwater *Sample* Collection Field Form Procedures

Information collected during groundwater sampling shall be recorded on groundwater sample collection field forms and field log books, as appropriate. The groundwater sample collection field form provides a record of the sampling methods and equipment, monitoring well information, and chemical analyses performed (see Attachment C). The field sampling records should accurately document field sampling procedures and data collection. Because sampling procedures may alter the chemical results, documenting sampling process is an important part of verifying the integrity of the samples. The following information shall be recorded in the groundwater sample collection form:

- Date and time of purging and sampling
- Sampling location designations
- Depth to water
- Total depth of well
- Standing water column
- Well inside diameter
- Volume of standing water in well
- Purging and sampling device
- Purge volume
- Sample time
- Field observations such as odor, color, and apparent turbidity
- Field water quality data including pH, ORP, specific conductivity, temperature, dissolved oxygen, and turbidity
- Chemical analyses requested
- Number of samples provided for each laboratory analysis and quality assurance samples, as required

The groundwater sample collection field forms shall be legible, dated, and signed by the person making the entry. Field personnel will provide the original groundwater sample collection forms to SIPC, for inclusion in the Facility operating record.

1.2.5 Soil Boring and Monitoring Well Installation Logging Procedures

Information collected during advancement of soil borings and installation of monitoring wells shall be recorded on soil borings and monitoring well logs, as appropriate (see Attachment D). The soil boring and well installation log provides a record of boring advancement methods and equipment, lithology, site and decontamination procedures, well construction methods, and well completion information (e.g., depth of well). These boring logs are intended to provide accurate descriptions of the lithology and sampling procedures. The following information shall be recorded in the soil boring and well installation log:

- Date and start/end time of boring advancement

- Type of equipment used and drillers name and company information
- Lithologic descriptions including lithology (i.e., Unified Soil Classification System), color, texture, moisture, and weathering
- Field screening readings (e.g., photo-ionization detector, as needed)
- Sampling depth and designations
- Depth to water
- Total depth of boring
- Well installation methods
- Well materials
- Boring diameter

The soil boring and well installation logs shall be legible, dated, and signed by the person making the entry. Field personnel will provide the original soil boring and well installation log to SIPC, for inclusion in the Facility operating record.

1.3 SOP-3 Groundwater Monitoring Well Installation/Development

A driller licensed by the Illinois Environmental Protection Agency (IEPA) will advance the soil borings and install monitoring wells. The driller will obtain drilling permits for the monitoring wells and piezometers, if needed; and a surveyor licensed in the State of Illinois will survey the wells.

1.3.1 Monitoring Well Installation Procedures

Monitoring wells will be installed by advancing 4.25-inch inside diameter (ID) hollow-stem augers or a six-inch diameter core barrel with a Sonic drill rig. The wells will be completed with two-inch diameter, five-foot long or 10-foot long, 0.010-inch (No. 10-slot) polyvinyl chloride (PVC) screen and appropriate lengths of two-inch diameter, 10-foot long flush–threaded (with a Teflon seal) PVC riser pipe. A sand pack consisting of a clean, washed, acid-resistant, #5-sized silica sand will be poured inside the boreholes. The sand pack will be poured and continuously sounded until it extends to at least two-feet above the top of the screened interval. A minimum two-foot bentonite seal will be placed on top of the filter pack and the remaining annular space between the borehole and the riser will be grouted (Portland Type I cement/bentonite mix) using tremie pipe (side discharge) from above the bentonite seal to approximately 1.5-feet ground surface. Bentonite content in the mix will be 2 to 5 percent by weight to help reduce shrinkage. The wells will be completed with stick-up protective steel casings and protective bollards. The outer protective casing will be lockable and locks will be keyed identically. A typical well construction schematic is provided in Attachment E.

1.3.2 Monitoring Well Development

All newly constructed wells and piezometers will be developed to remove particulates that are present in the well casing, filter pack, and adjacent aquifer matrix due to construction activities. Development of new monitoring wells will be performed no sooner than 24 hours after well construction. Wells will be developed using an electric submersible pump (whale pump) that can also serve as a surge block (1.82 inches in diameter x 27-inches long). Existing wells will also be developed before groundwater samples are collected.

Wells will be developed using the pump as a surge block and continuous cycles of over-pumping and recovery until relatively clear water is produced, and field parameters (pH, specific conductance, ORP, temperature, and turbidity) stabilize indicating good hydraulic communication with the surrounding water bearing zone. Measurements will be collected approximately every three to five minutes until the parameters stabilize based on three consecutive readings within the following ranges:

- Temperature: +/- 10% - Degrees Celsius
- pH: +/- 0.1 - Standard Units
- Conductivity: +/- 3% - milliSiemens
- ORP: +/- 10 mV - millivolt
- DO: +/- 10% (or +/- 0.1 mg/L if less than 1.0 mg/L) – milligrams per liter
- Turbidity: Less than 5 Nephelometric Turbidity Unit (NTU)

Samples withdrawn from the Facility's monitoring wells should be clay- and silt-free; therefore, wells may require redevelopment from time to time based upon observed turbidity levels during sampling activities. If redevelopment of a monitoring well is required, it will be performed and documented in a manner similar to that used for a new well. An example well development form is provided as Attachment F.

1.3.3 Dedicated Pumps

QED Environmental Systems (QED) dedicated bladder pumps will be placed into each monitoring well. The pumps will consist of MicroPurge bladder pumps with stainless-steel/Teflon construction, 316 stainless steel bladder pump inlet screen, and a Dura-Flex Teflon bladder. The polyethylene tubing is twin bonded, tangle-free design with ¼-inch outside diameter (OD) poly sample tube with ¼-inch OD poly air line.

1.4 SOP-4 Equipment Decontamination Procedures

This SOP describes the methods for decontaminating equipment and tools used during the assessment activities. The scope of this SOP is limited to field operations and protocols applicable during advancement of soil borings, monitoring well installation, and sampling equipment.

1.4.1 Decontamination Equipment and Solutions

Specifications for standard cleaning materials include:

- Soap shall be a phosphate-free laboratory detergent such as Liquinox® or Alconox®. Use of other detergent must be justified and documented in the field log books and investigative reports.
- Tap water may be used from any municipal water system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

- Analyte free water (distilled water) is tap water that has been treated with activated carbon and a standard deionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other organic or inorganic compounds (i.e., at or above analytical detection limits).

1.4.2 Field Water Quality Meter and Water Level Meter Decontamination Procedures

The drilling contractor will use the procedures in this section to decontaminate the drill rig and drilling tools used to advance the soil borings. The procedures include:

1. Thoroughly pressure steam-clean the drill rig and tools (e.g., macro core sampler) upon arrival on Site over a dedicated decontamination pad.
2. The driller will decontaminate downhole tools (e.g., split-spoons) between each boring location using an Alconox water solution and a distilled water rinse or pressure steam cleaner.
3. During well installation, the driller must use a new pair of disposal vinyl or latex gloves while handling the well materials.
4. Well materials used on Site must be new and wrapped in plastic.

1.5 SOP-5 Groundwater Sampling Procedures

Groundwater samples (see Table 5 from the Groundwater Monitoring Plan Addendum 1) shall be collected using the following equipment and procedures:

1.5.1 Sampling Equipment Description

Reusable and expendable equipment and materials required for groundwater sampling includes, but may not be limited to:

Reusable:

- Dedicated bladder pumps
- YSI 600XL flow-through cell or equivalent field water quality meter
- Electric groundwater level monitoring meter graduated in increments of 0.01 feet
- Groundwater Collection Form – Attachment C
- First-aid kit – present on-Site at all times
- Fire extinguisher – present on-Site at all times
- Monitoring well keys
- Calculator

Expendable:

- Sample bottles
- Coolers and ice – The laboratory will provide the coolers. Field sampling personnel will purchase ice as necessary to maintain sample temperatures less than 6°C
- Latex or Nitrile gloves as appropriate – purchased by the sampler as needed
- Alconox®/Liquinox® (mild detergent) – purchased by the sampler as needed
- Distilled water – purchased by the sampler as needed or provided by the lab

1.5.2 Purging and Sampling Procedures

Groundwater samples will be collected using the low flow purge and sampling technique[1]. Groundwater sample collection procedures include:

- Calibrating the YSI 600XL or equivalent field water quality meter in accordance with the manufacturer's recommendations each day prior to collecting groundwater samples and checking the meter calibration at the end of each sampling day (see Attachment B).
- Connecting the discharge end of the polyethylene tubing to the YSI 600XL or equivalent field water quality meter and measuring and recording pH, specific conductance, ORP, turbidity, and temperature of the purge water. Field personnel will record the field water quality parameters once the flow-through cell is completely full. Do not wait for stabilization of the field water quality parameters before recording the readings from the field water quality meter.
- Each well will be purged at a rate between approximately 100 to 300 milliliters per minute (ml/min). The water level in the well will be monitored approximately every three to five minutes during pumping using an electronic water level meter, and ideally the pumping rate should equal the well recharge rate with little or no water level drawdown in the well (ideally less than 0.3 feet). At least one foot of water will be maintained over the intake to reduce the risk of the pump suction being broken, or entrainment of air in the sample.
- During purging, field parameters (temperature, pH, turbidity, specific conductance, ORP and DO) will be monitored with an in-line direct reading instrument (such as a YSI or equivalent flow-through cell) and turbidity meter. Measurements will be collected approximately every three to five minutes until the parameters stabilize based on three consecutive readings within the following ranges:
  - Temperature: +/- 10%
  - pH: +/- 0.1 Standard Units
  - Conductivity: +/- 3%
  - ORP: +/- 10 mV
  - DO: +/- 10% (or +/- 0.1 mg/L if less than 1.0 mg/L)
  - Turbidity: Less than 5 Nephelometric Turbidity Unit (NTU)

  In the event that one or more of the above field parameters does not completely stabilize after three well volumes have been purged, up to two additional well volumes will be purged for a total of five well volumes. Purging will then be considered complete.
- Following measurement of the field water quality parameters, cut the discharge end of the silicon tubing (just in front of the discharge end of the polyethylene pump tubing) and collect the groundwater samples using laboratory-prepared sample containers by allowing the pump discharge to flow gently down the inside of the bottle with minimal turbulence.
- Following sample collection, the groundwater sample will be placed in a cooler on ice for preservation during shipment to a laboratory for analysis in accordance with Chain-of-Custody SOP.

1.6 SOP-6 Chain-of-Custody Procedures

The intent of this SOP is to provide guidance to maintain sample integrity. The chain-of-custody form provides evidence and documentation of sample collection, shipment, laboratory receipt, and laboratory custody until

[1] The procedure is based upon the USEPA Region II document entitled "Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling" dated March 20, 1998.

disposal of the sample. The chain-of-custody form identifies each sample collected and the individuals responsible for sample collection, shipment, and receipt.

Once collected, samples are considered to be in one's custody if they are: (1) in the custodian's possession or view; (2) in a secured location (under lock) with restricted access; or (3) in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s).

Responsibilities

Field personnel who collect the samples are responsible to initiate the chain-of-custody protocol. Upon sample collection, but prior to storage, shipment, or transportation, field personnel shall properly and completely fill out the chain-of-custody form with a waterproof ink pen. The sampler shall review the form prior to sample storage, shipment, or transportation. If an individual makes an error during the completion of the chain-of-custody form, a line shall be drawn through the error and the correction entered. Field personnel completing the form shall initial and date the error. Under no circumstances is white-out or erasing acceptable. Field sampling personnel are responsible for making a copy of the completed chain-of-custody form and giving the form to SIPC. SIPC or designee shall review the form and place it in the project file with the field sampling forms. Upon receipt by the laboratory, the laboratory sample custodian shall assume responsibility for completing the chain-of-custody procedures. Upon completion of analysis, the laboratory shall submit a copy of the completed chain-of-custody form with the analytical data for inclusion in the Facility operating record.

Equipment Description

- Chain-of-custody forms
- A waterproof ink pen

Procedures

Field personnel shall use a waterproof ink pen to complete the chain-of-custody forms. Preparation of the chain-of-custody form includes:

- Complete the chain-of-custody form by entering the project name, client name, laboratory name and address, the person to whom the chemical analyses results shall be reported, and invoicing information at the top of the form. An example Chain-of-custody form is provided as Attachment G.
- COC(s) will be completed and sent with the samples for each shipment.
- Sample-specific information shall include the field identification number, the date and time the sample is collected, the depth at which the sample was taken, the type of sample (e.g., groundwater, soil, etc.), the type of analyses requested, and preservatives used. Samples shall be grouped for shipment with other samples for similar analysis and use a common form. More than one chain-of-custody form shall be used if the number of samples placed in a cooler is greater than the number of entry spaces on the chain-of-custody form.
- The COC record will identify the contents of each shipment and maintain the custodial integrity of the samples. A locked seal will be placed across the front and back of each cooler containing

samples when coolers are ready for shipment. All custody seals will be signed and dated. The chain-of-custody form will be cross-checked for errors and signed.

- Each person taking possession of the samples shall sign and date the chain-of-custody both as a recipient and as a relinquisher of the samples. When the samples are delivered to the laboratory, the laboratory sample custodian will sign the chain-of-custody as the last recipient of the samples.
- If the samples are directly transported to the laboratory, the chain-of-custody shall be kept in the possession of the person delivering the samples. Upon receipt by the laboratory, the sample receiver(s) shall open the shipping containers, compare the contents with the chain-of-custody form, and sign and date the form. Any discrepancies shall be noted on the chain-of-custody form and the Project Manager notified immediately.
- Prior to shipment by a commercial carrier, make a copy of the chain-of-custody form. If the samples are delivered directly to the laboratory by field personnel, a copy of the form shall be made after the laboratory representative signs and dates the chain-of-custody form.
- Chain-of-custody forms shall be maintained with the analytical data.

1.7 SOP-7 Investigation Derived Wastes

Field personnel will containerize the purge water generated during sampling activities and determine disposal options in consultation with SIPC personnel.

https://golderassociates.sharepoint.com/sites/147128/project files/6 deliverables/groundwater monitoring plan/draft/appendix a - sops/appendix a- sops updated format 102021.docx

ATTACHMENT A

Utility Contact Form

Golder field personnel must keep a copy of this completed form on Site during subsurface assessment activities and place a copy in the project file.

Date: Call Before You Dig contacted: Call Before You Dig Ticket Number:

Project Name: Project Number:

Golder Employee contacting Call Before You Dig: Project Manager Name:

The following section need to be completed prior to contacting Call Before You Dig.

Name and City/State of boring/excavation contractor:

Address/location where work will be completed (address, city, state):

Closest Cross Street:

Type of Work: Depth of excavation/boring:

Has the excavation/boring location been pre-marked with white paint? Yes ☐ No ☐
Marking Personnel: Date:

Where on property will the work will be completed: Dates work to be completed:

Complete the following section with information provided by Call Before You Dig.

Utilities that Call Before You Dig will contact under this ticket number (provided by Call Before You Dig):

1.
2.
3.
4.
5.
6.
7.
8.

Utilities not contacted by Call Before You Dig:

Town Sewer:	Date Contacted:	Contacted by:
Town Water:	Date Contacted:	Contacted by:
Other Utilities:	Date Contacted:	Contacted by:

Approved start date and time to begin work (provided by Call Before You Dig):
Call Berfore You Dig Ticket expiration date (provided by Call Before You Dig):

Indiana Call Before You Dig may not contact Town Water and Sewer Departments for markouts. It is Golder's responsibility to contact the Town Water and Sewer Departments for markouts.

ATTACHMENT B

YSI Calibration Form

CALIBRATION FORM

GOLDER
MEMBER OF WSP

GAI Project Name: ____________ **Project Number:** ____________

Golder Personnel Present: ____________

Date: ____________

Meter Type: **YSI**

Model Number: ____________

S/N ____________

Specific Conductivity **Lot # :** **Expire Date:**

Standard	Unit		Meter reading		Time	
1.413	mS/cm					Initial
						Check
						Check

Acceptable Range 1.342-1.484

Dissolved Oxygen

Baro Pressure	Temp ^{o}C	% D.O.	mg / L D.O.	D.O. Charge	Time	
						Initial
						Check
						Check

pH

4.01 Buffer: Lot #: **Exp. Date:** **7.01 Buffer: Lot #:** **Exp. Date:**

Standard	Meter reading		Meter reading		Meter reading
	Initial		Check		Check
Time		Acceptable Range			
4.01		3.81-4.21			
7.01		6.75-7.36			
10.00		9.50-10.50			

10.00 Buffer: Lot #: **Exp. Date:**

ORP **Lot#:** **Expire Date:**

Standard	Meter reading		Meter reading		Meter reading
	Initial		Check		Check
Time		Acceptable Range			
240.0		228-252			

Turbidity

Meter Type: **LaMotte**

Model Number: **20/20**

S/N

Standard	Meter reading		Meter reading		Meter reading
	Initial		Check		Check
Time		Acceptable Range			
1.00		0.95-1.05			
10.00		9.50-10.5			

Comments:

Sampler Signature: ____________ Date: ____________

ATTACHMENT C

Groundwater Sample Collection Form

GROUNDWATER SAMPLE COLLECTION FORM

GOLDER
MEMBER OF WSP

~~SITE DESCRIPTION~~

Project Name: SIPC
Project Number: 21467997
Location: Marion

~~SAMPLE DESCRIPTION~~

Sample ID:
Date:
Time at Well Site:
Time of Sample Collection:
Sampled by:
Sampling Method: Bladder Pump
Type of Sampling Equipment: Pump tubing

~~WEATHER CONDITIONS~~

Temperature:
Wind:
Precipitation:

~~FIELD BLANK NOTES~~

Field Blank Name:
Field Blank /Rinse Water type:

Lot Number:
Analyses:

~~VOLUME OF WATER TO BE PURGED~~

Casing Inside Diameter: inches
Casing Volume: liters/ft
Column of Water in Well: feet
Volume of Water in Well: liters
Well Volumes to Purge:
Min. Volume to be Purged: liters
Method of Purging:
Well Purged Dry?: Yes No

~~COLUMN OF WATER IN WELL BEFORE PURGE~~

Total Depth of Well: ft TOC
Depth to Water : ft TOC
Column of Water in Well: ft
Depth to Water after Purge: ft TOC

Appearance of Sample:

~~WELL PURGE CONTROL~~

	Purge 1	Purge 2	Purge 3	Purge 4	Purge 5	Purge 6	Purge 7
Time:							
Volume Removed (liters):							
pH:							
Specific Conductance (uS/cm):							
Temperature (Degrees C):							
Turbidity (NTU):							
ORP (millivolts):							
DO (mg/l) :							
Water Level (ft BTOC)							

Starting Purge Time:
Ending Purge Time:
Average Purge Rate: ml/min
Total Volume Purged: liters

~~SAMPLE CONTAINERS REQUIRED~~

Analysis	Container Number, Type and Size	Filter	Preservative and Source
Metals (6020A - 7471B)	(1) 500 ml Plastic Container	No	HNO3
Hardness (CaCO3) (2320B)	(1) 125 ml Plastic container	No	HNO3
Radium 226/228	(1) 2-Liter Plastic Container	No	None
Fluoride, Chloride, Sulfate	(1) 250-ml plastic container	No	None
Total Dissolved Solids (TDS)	(1) 200-ml Plastic Container	No	None

Chain of Custody #:
Shuttle ID:
Trip Blank ID:
Lab Name:
Air Bill #:

~~REMARKS:~~ 2" - 0.617 liters/ft 1" - 0.053 liters/ft
1.5" - 0.347 liters/ft

Field Team Leader:

ATTACHMENT D

Soil Boring and Monitoring Well Installation Log

FIELD BORING LOG

GOLDER
MEMBER OF WSP

MANCHESTER, NEW HAMPSHIRE

DEPTH HOLE	JOB NO. 21467997	PROJECT SIPC	BORING NO.
DEPTH SOIL DRILL	GA INSP.	DRILLING METHOD	SHEET
DEPTH ROCK CORE	WEATHER	DRILLING COMPANY	SURFACE ELEV.
NO. DIST. SA. UD. SA.	TEMP.	DRILL RIG DRILLER	DATUM
DEPTH WL.	HRS. PROD.	WT. SAMPLER HAMMER DROP	STARTED
TIME WL.	HRS. DELAYED	WT. CASING HAMMER DROP	COMPLETED

SAMPLE TYPES

- A.S. AUGER SAMPLE
- C.S. CHUNK SAMPLE
- D.O DRIVE OPEN (SPLIT SPOON)
- D.S. DENISON SAMPLE
- P.S. PITCHER SAMPLE
- R.C. ROCK CORE
- S.T. SLOTTED TUBE
- T.O. THIN-WALLED OPEN
- T.P. THIN-WALLED PISTON
- W.S. WASH SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	MP	NON-PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION
RANGE OF PROPORTITION

"TRACE"	0-10%
"LITTLE"	10%-20%
"SOME"	20%-35%
"ADJECTIVE" (e.g. "SILTY", "SANDY")	35%-50%
"AND"	50%

CONSISTENCY – BLOWS/FT.

NON-COHESIVE SOILS

VL	VERY LOOSE	0-4
LS	LOOSE	4-10
CP	COMPACT	10-30
DN	DENSE	30-50
VD	VERY DENSE	>50

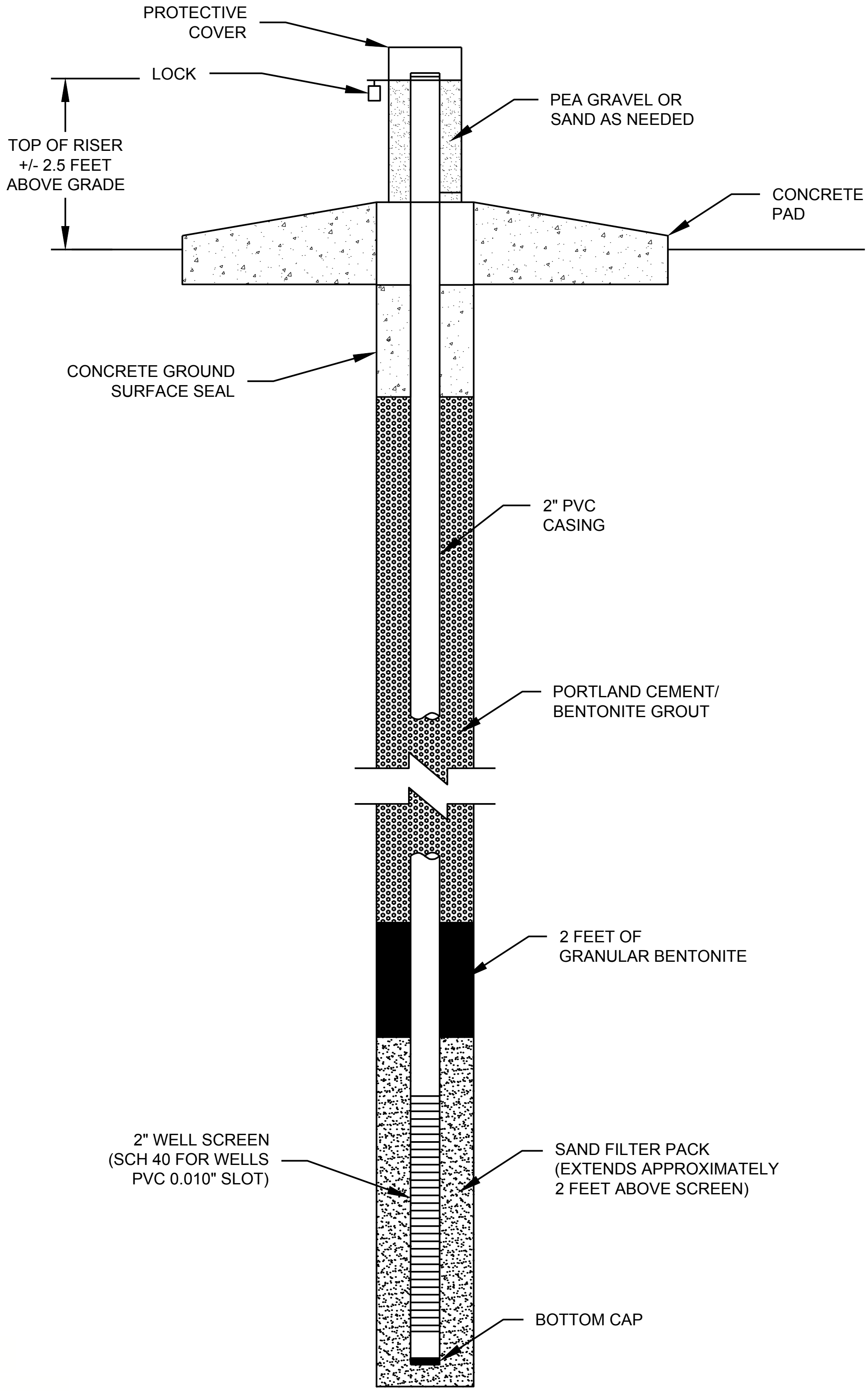
COHESIVE SOILS

VS	VERY SOFT	0-2
S	SOFT	2-4
FM	FIRM	4-8
ST	STIFF	8-30
H	HARD	>30

ELEV. / DEPTH	WELL CONSTRUCTION	PID (ppm)		SAMPLES NO.	TYPE	HAMMER BLOWS PER 6" (FORCE)	REC. / ATT.	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES

ATTACHMENT E

Typical Well Schematic



CLIENT
SIPC

PROJECT
GROUNDWATER MONITORING PROGRAM

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2016-07-08
DESIGNED	RWC
PREPARED	JSP
REVIEWED	
APPROVED	

TITLE
TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM

PROJECT NO.	SUBTITLE	REV.	FIGURE
21467997	A	0	1

ATTACHMENT F

Well Development Form

GOLDER
MEMBER OF WSP

WELL DEVELOPMENT FIELD RECORD

JOB NAME ____________________ JOB NO. ________ WELL NO. ________

DEVELOPED BY ____________________ DATE OF INSTALL. ________ SHEET ____ OF ____

STARTED DEVEL. ________ / ________ COMPLETED DEVEL. ________ / ________
DATE TIME DATE TIME

W.L. BEFORE DEVEL. ______ / ______ / ______ AFTER DEVEL. ______ / ______ / ______
DEPTH DATE TIME DEPTH DATE TIME

WELL DEPTH: BEFORE DEVEL. ________ AFTER DEVEL. ________ WELL DIA. (In) ________

STANDING WATER COLUMN (FT.) ________ STANDING WELL VOLUME ________ gal.

SCREEN LENGTH ________ DRILLING WATER LOSS ________ gal.

DATE/TIME	VOLUME REMOVED (GALS)	FIELD PARAMETERS SPEC. COND. (umhos/cm)	TEMP. (C)	pH (s.u.)	OTHER	REMARKS
		= TOTAL VOLUME REMOVED (gal.)				

DEVELOPMENT METHOD: ____________________

NOTES:

ATTACHMENT G

Example Chain of Custody Form

PRINT PDF

CHAIN OF CUSTODY

Pg __ of __ Workorder # ______________

TEKLAB INC, 5445 Horseshoe Lake Road, Collinsville, IL 62234 Phone (618) 344-1004 Fax (618) 344-1005

Client: ____

Address: ____

City/State/Zip: ____

Contact: ______________________ Phone: ________________

Email: Fax:

Samples on: ☐ ICE ☐ BLUE ICE ☐ NO ICE _____ °C LTG# _____

Preserved in: ☐ LAB ☐ FIELD **FOR LAB USE ONLY**

LAB NOTES:

Client Comments:

Are these samples known to be involved in litigation? If yes, a surcharge will apply: ☐ Yes ☐ No

Are these samples known to be hazardous? ☐ Yes ☐ No

Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section: ☐ Yes ☐ No

PROJECT NAME/NUMBER

SAMPLE COLLECTOR'S NAME

RESULTS REQUESTED

☐ Standard ☐ 1-2 Day (100% Surcharge)

☐ Other ________ ☐ 3 Day (50% Surcharge)

BILLING INSTRUCTIONS

 # and Type of Containers

INDICATE ANALYSIS REQUESTED

Lab Use Only	Sample ID	Date/Time Sampled	Matrix	UNP	HNO3	NaOH	H2SO4	HCL	MeOH	NaHSO4	TSP	Other														
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							

Relinquished By	Date/Time	Received By	Date/Time

*The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions

Terms and Conditions:
When Client requests analytical or other services from Teklab, Inc. (hereafter referred to as Teklab) the terms and conditions set forth in this agreement shall prevail. Requests for services may be in the form of apurchase order, electronic order, telephonic order or verbal order. Client's act of sample delivery or shipment to Teklab accompanied by a properly signed Chain of Custody shall constitute acceptance by Client todo business with Teklab under the terms and conditions of this agreement. Any conflicting and/or preprinted terms and conditions of any Client request/purchase order are null and void. Any third party agreementsbetween Client and another party are in no way to be incorporated into this agreement unless agreed to in writing by Teklab and Client. This agreement may be amended only by written agreement between Teklaband Client.

Pricing:
Fees for analysis or other services requested by Client shall be the current Teklab listed pricing schedule unless otherwise agreed to by Teklab and Client. Other pricing agreements may be in the form of a Teklabpricing quote. Teklab reserves the right to charge additional fees for expedited analytical results when Client requests expedited results, as determined by Teklab. No discounted pricing shall be accepted foranalytical results which take longer than the initially agreed upon time frame, unless specifically agreed to by Teklab and Client. Teklab reserves the right to change its listed pricing without notification.

Quality Assurance/Quality Control:
Teklab shall perform its services in a manner consistent with the Teklab Quality Assurance/Quality Control (QA/QC) manual and Teklab's Standard Operating Procedures (SOP's) in effect at the time of theagreement. It is the responsibility of Client to ensure that Teklab's QA/QC manual and SOP's conform to Client's specific requirements. Teklab reserves the right to deviate from its QA/QC manual and/or SOP'sprovided that the deviations are consistent with generally accepted industry practices and are deemed necessary, by Teklab personnel. In the event that Client desires deviations from the Teklab QA/QC manual orSOP's Client must submit the request in writing prior to submission of samples to Teklab. It is the responsibility of Client to submit any project or permit specific required methodologies, reporting limits or otherinformation prior to the submission of samples to Teklab.

Sample Acceptance:
Teklab reserves the right to refuse acceptance of samples or return previously accepted samples to Client when such action is deemed warranted by the Teklab laboratory director or his/her representative. It is theresponsibility of Client to inform Teklab, prior to sample submission, when samples are known to be involved with litigation or known to be hazardous. Client shall submit all samples either through personaldelivery, via a courier (such as the U.S. Mail, UPS, Federal Express, etc.) or through submission to a Teklab employee at a location other than the facility located at 5445 Horseshoe Lake Road. A properlycompleted Chain of Custody must accompany all samples.

It is the responsibility of Client to ensure that all samples are collected in accordance with generally accepted sampling protocols or site specific sampling requirements. It is the responsibility of Client to ensure thatall samples are shipped or transported in a manner consistent with all federal, state or local laws. The risk of loss or damage to any sample shall remain with Client until Teklab sample acceptance is complete.Sample acceptance shall be completed once Teklab personnel have signed the properly completed Chain of Custody that accompanied the samples. It is the responsibility of Client to ensure that all samples arereceived with an adequate amount of time for Teklab to perform analysis within the applicable holding times, as specified in the Teklab QA/QC manual. Samples with holding times of seven days or greater must bereceived with, at least, four days of holding time remaining. Samples with holding times less than seven days must be received with, at least, one half of the holding time still remaining. Teklab reserves the right tocharge and Client agrees to pay additional fees for samples received with less than the above stated holding times remaining.Go here for a full description of our sample acceptance policy.

Resampling:
In the event that resampling is required, for whatever reason, Teklab in no way accepts responsibility for fees associated with the resampling. Teklab may assume all or a portion of the resampling costs if agreed toin writing by Teklab and Client, such fees will be determined and agreement made prior to the initiation of the resampling event. The fees, which Teklab may agree to pay, shall be the lesser of the actual samplingfees or the total amount paid by Client for work covered under this agreement.

Re-analysis:
In the event that re-analysis is requested by Client, Client agrees to pay Teklab fees equivalent to those already agreed upon or the Teklab list price, plus any applicable surcharge for expedited analytical results.

Sample Retention:
Samples are routinely retained for 30 days after sample acceptance is complete. Samples may be returned to Client, at no cost to Teklab, if so requested or if deemed appropriate by the Teklab laboratory directoror his/her representative. Longer sample retention times may be possible, if requested by Client and agreed to by Teklab. Client agrees to pay Teklab an additional fee of $40.00 per month per sample whensamples are to be retained for a period longer than the time period indicated above. Sample retention times shall be calculated from the date of sample acceptance by Teklab and shall be rounded into wholemonths with sample storage during any one day of the month constituting a charge for storage during the entire month.

Subcontracting:
Teklab reserves the right to subcontract any or all portions of the services it provides. Subcontracting will occur in a manner consistent with the Teklab QA/QC manual and/or SOP's.

Continued on next page:

Reports and Data:
Teklab maintains copies of reports and data for the time period and in the manner specified in its QA/QC manual and/or applicable SOP's in effect at the time of sample acceptance. Additional copies of analyticalrepo
and/or analytical data, including QA/QC data, pertaining to Client's samples may be obtained, prior to data destruction, for additional fees, as deemed appropriate by Teklab.

Indemnification:
Client shall indemnify and hold harmless Teklab and its respective owners, officers, directors and employees individually and jointly from and against any and all causes of action, claims, injuries, lawsuits,demands, judgements, damages, losses, liabilities, fines, penalties, expenses and other charges directly or indirectly arising from or related to:
(a) the negligent actions, omissions or willful misconduct of Client;
(b) Client's breach of its warranties or obligations under this agreement;
(c) Teklab's performance of services,provided, however that the foregoing indemnification shall not apply to the extent any damages are caused solely by the gross negligence or willful misconduct of Teklab. In any e
Teklab's liability will be limitedto the lesser of (a) actual damages or (b) the amount of compensation paid to Teklab for services under this agreement.

Payment:
Client agrees to remit payment to Teklab within 30 days of receipt of invoice. If Client defaults in punctual payment, all past due amounts will bear interest at the rate of eighteen percent (18%) per annum or thehighes
permitted by law, whichever is lesser, and customer shall reimburse Teklab for all costs of collection incurred, including (without limitation) reasonable attorney fees. Acceptance of payment by Teklab inno way consti
a waiver of Teklab's rights or claims that Teklab may have against Client.

Termination:
Either Client or Teklab may terminate this agreement by sending written Notice of Termination. Upon termination, Client shall be invoiced for services performed and charges incurred prior to termination.

Miscellaneous:
(a) Except for the obligation to make payments hereunder, neither party shall be in default for its failure to perform or delay in performance caused by events beyond its reasonable control, including, but not limitedto, strikes, riots, imposition of laws or governmental orders, fires, acts of God, and inability to obtain acceptable Quality Control results, and the affected party shall be excused from performance during theoccurrence of
events;
(b) This Agreement shall be binding on and shall inure to the benefit of the parties hereto and their respective successors and assigns;
(c) This Agreement represents the entire agreement between the parties and supersedes any and all other agreements, whether written or oral, that may exist between the parties;
(d) This Agreement shall be construed in accordance with the law of the state of Illinois; and
(e) All written notification required by this Agreement shall be by Certified Mail, Return Receipt Requested. If any provision of this Agreement is declared invalid or unenforceable, then such provision shall besevered
and shall not affect the remainder of this Agreement; however, the parties shall amend this Agreement to give effect, to the maximum extent allowed, to the intent and meaning of the severedprovision. In the event Te
successfully enforces its rights against Client hereunder, Client shall be required to pay Teklab's attorneys' fees and court costs.

APPENDIX K

Statistical Methods Certification

October 13, 2021

Certification of Appropriateness of Selected Statistical Method (35 IAC §845.640(f)(2))

Southern Illinois Power Cooperative
Former Emery Pond
Marion Power Plant

I, Mark Haddock, being a Professional Engineer in accordance with the laws of the State of Illinois, and having experience in the collection and interpretation of information from groundwater monitoring systems at surface impoundments, do hereby state that I am qualified in the subject matter of statistical analysis of CCR groundwater monitoring data. I have personally examined and am familiar with the statistical methods selected for evaluation of groundwater monitoring information for the Southern Illinois Power Cooperative (SIPC) former Emery Pond, prepared by Golder Associates Inc. and dated October 2021. Based on an inquiry of those individuals immediately responsible for selecting the statistical approach, I believe that the selected statistical methods, a narrative of which is provided herein, are appropriate for the applications outlined below.

SIPC has selected statistical methods that were developed in accordance with the requirements of 35 IAC §845.640 using methodology presented in Statistical Analysis of Groundwater Data at RCRA Facilities, Unified Guidance, March 2009, EPA 530/R-09-007 (Unified Guidance). The statistical evaluation techniques described in the Groundwater Monitoring Plan Addendum #1 (Golder, October 2021) will be used for Corrective Action monitoring.

In consideration of the above and in accordance with 35 IAC §845.640(f)(2), I certify to the best of my knowledge, information, and belief that the statistical methodologies described herein are appropriate for evaluating the groundwater monitoring data for the former Emery Pond.

Mark Haddock
Illinois Professional Engineer
License #062-058223

October 13, 2021
Date

GOLDER
MEMBER OF WSP

golder.com