Luminant

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

January 28, 2022

Illinois Environmental Protection Agency
DWPC – Permits MC #15
Attn: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: Duck Creek Power Plant Bottom Ash Basin; IEPA ID # W0578010001-03

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Illinois Power Resource Generating, LLC (IPRG) is submitting a construction permit application for the Duck Creek Power Plant Bottom Ash Basin (IEPA ID # W0578010001-03). One hardcopy is provided with this submittal.

The permit application was prepared in accordance with 35 I.A.C. § 845.220 (a) and (d). This submittal includes the completed permit forms as required by § 845.210.

Sincerely,

Cynthia E. Vodopivec

Cynthia Vodopivec
SVP-Environmental Health and Safety

Enclosures

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

Bureau of Water ID Number: W0578010001 **CCR Permit Number:** Initial Permit **Facility Name:** Duck Creek 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		
	Illinois Power Resources Generating, LLC - Duck Creek Power Plant		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	Initial Permit		
1.3	Facility Contact Information		
	Name (first and last) Phil Morris	Title Senior Director - Environmental	Phone Number 618-343-7794
	Email address phil.morris@vistracorp.com		
1.4	Facility Mailing Address		
	Street or P.O. box 1500 Eastport Plaza Dr		
	City or town Collinsville	State IL	Zip Code 62234
1.5	Facility Location		
	Street, route number, or other specific identifier 17751 North CILCO Road		
	County name Fulton	County code (if known)	
	City or town Canton	State IL	Zip Code 61520
1.6	Name of Owner/Operator		
	Illinois Power Resources Generating, LLC		

Facility, Operator, and Owner Info				
1.7	Owner/Operator Contact Information			
	Name (first and last) Phil Morris	Title Senior Director - Environmental	Phone Number 618-343-7794	
	Email address phil.morris@vistracorp.com			
1.8	Owner/Operator Mailing Address			
	Street or P.O. box 1500 Eastport Plaza Dr			
	City or town Collinsville	State IL	Zip Code 62234	

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

Legal Description	
2.1	Legal Description of the facility boundary
	See Attachment A.

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)			
	www.luminant.com/illinois-ccr/			
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.		
	W0578010001-03 (see Attachment A)	☑	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
Cynthia Vodopivec	SVP - Environmental
Signature	**Date Signed**
Cynthia E. Vodopivec	1/27/2022

Form 2CC	Illinois Environmental Protection Agency CCR Surface Impoundment Permit Application Form CCR 2CC – Closure Construction

Bureau of Water ID Number: W0578010001 **CCR Permit Number:** Initial Permit **Facility Name:** Duck Creek Power Plant	For IEPA Use Only

SECTION 1: DESIGN AND CONSTRUCTION PLANS (35 Ill. Adm. Code 845.220)

Design and Construction Plans (Construction History)

1.1	CCR surface impoundment name.	Bottom Ash Basin
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).	W0578010001-03
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).	See Attachment A.
1.4	State the purpose for which the CCR surface impoundment is being used.	See Attachment B.
1.5	How long has the CCR surface impoundment been in operation?	See Attachment B.
1.6	List the types of CCR that have been placed in the CCR surface impoundment.	See Attachment B.

Design and Construction Plans (Continued)			
	1.7	List the name of the watershed within which the CCR surface impoundment is located.	
		See Attachment B.	
	1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
		See Attachment B.	
	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.
		☑	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: NARRATIVE DESCRIPTION OF THE FACILITY (35 Ill. Adm. Code 845.220)

Narrative Description			
	2.1	List the types of CCR expected in the CCR surface impoundments.	
		See Attachment B.	
	2.2	Have you attached a chemical analysis of each type of expected CCR?	
		☑	Yes
	2.3	Estimate of the maximum capacity of the surface impoundment in gallons or cubic yards.	
		See Attachment B.	
	2.4	The rate at which CCR and non-CCR waste streams currently enter the CCR impoundment in gallons per day and dry tons.	
		0 GPD	0 dTn
	2.5	Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.	
		NA	
	2.6	Have you attached an on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment?	
		☑	Yes

SECTION 3: MAPS (35 Ill. Adm. Code 845.220)

Maps			
	3.1	Check the corresponding boxes to indicate that you have attached the following maps:	
		☑	A site location map on the most recent United Sates Geological Survey (USGS) quadrangle of the area from the 7 ½ minute series (topographic) or on another map whose scale clearly shows the information required in 35 Ill. Adm. Code 845.220(a)(3).
		☑	Site plans maps satisfying the requirements of 35 Ill. Adm. Code 845.220(a)(4).

SECTION 4: ATTACHMENTS

Attachments			
	4.1	Check the corresponding boxes to indicate that you have attached the following:	
		☑	A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.
		☑	Plans and specifications fully describing the design, nature, function, and interrelationship of each individual component of the facility.
		☑	The signature and seal of a qualified professional engineer.
		☑	Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under 35 Ill. Adm. Code 845.240.

Attachments (Continued)		☑	A summary of the issues raised by the public during the public notification and public meetings.
		☑	A summary of any revisions, determinations, or other considerations made in response to those issues raised by the public during the public notification and public meetings.
		☑	A list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in erosion control and environmental remediation.
		☑	Certification that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment are participants in a training program that is approved by and registered with the U.S. Department of Labor's Employment and Training Administration and that includes instruction in the operation of heavy equipment and excavation.

SECTION 5: GROUNDWATER MONITORING PROGRAM

Groundwater Monitoring	5.1	Indicate that you have attached the following components of a new groundwater monitoring program or any modifications to an existing groundwater monitoring program by checking the corresponding boxes:	
		☑	A hydrogeologic site investigation meeting the requirements of 35 Ill. Adm. Code 845.620, if applicable.
		☑	Design and construction plans of a groundwater monitoring system meeting the requirements of 35 Ill. Adm. Code 845.630.
		☑	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by 35 Ill. Adm. Code 845.640 and 845.650.

SECTION 6: CLOSURE (35 Ill. Adm. Code 845.220(d))

Closure	6.1	What is the closure prioritization category under 35 Ill. Adm. Code 845.700(g), if applicable?	
		Category 3	
	6.2	Indicate that you have attached the following by checking the corresponding boxes:	
		☑	The final closure plan, as specified in 35 Ill. Adm. Code 845.720(b), which includes the closure alternatives analysis required by 35 Ill. Adm. Code 845.710.
		☑	Proposed schedule to complete closure.
		☐	Post-closure care plan as specified in 35 Ill. Adm. Code 845.780(d).

SECTION 7: GROUNDWATER MODELING (35 Ill. Adm. Code 845.220(d)(3))

Groundwater	7.1	Indicate that you have attached the following by checking the corresponding boxes:	
		☐	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards.
		☐	All modeling inputs and assumptions.
		☐	Description of the fate and transport of contaminants with the selected corrective action over time.

		☐	Capture zone modeling, if applicable.
		☐	Any necessary licenses and software needed to review and access both the model and the data contained within the model.

PERMIT APPLICATION

Part 845 Construction Permit Application for the Bottom Ash Basin

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Submitted by:

Illinois Power Resources Generating, LLC

1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Compiled by:

Golder Associates USA Inc.

701 Emerson Road, Suite 250
Creve Coeur, Missouri 63141

21454861-8-R-1

January 25, 2022

Executive Summary

Introduction

Illinois Power Resources Generating, LLC (IPRG) owns and operates the Bottom Ash Basin at the Duck Creek Power Plant in Fulton County, Illinois. The Bottom Ash Basin is an incised coal combustion residuals (CCR) surface impoundment that was used to manage sluiced bottom ash at the Duck Creek Power Plant from the time construction of the Bottom Ash Basin was completed in early 2008 until the power plant was retired in December 2019. Since the retirement of the Duck Creek Power Plant, the Bottom Ash Basin has no longer received CCR or any other waste stream. IPRG is submitting this Part 845 Construction Permit Application for the Bottom Ash Basin to provide the Illinois Environmental Protection Agency (IEPA) with the information required under 35 Illinois Administrative Code (I.A.C.) 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) for closure of the Bottom Ash Basin.

Closure Method Selection

As required under 35 I.A.C. § 845.710, a closure alternatives analysis has been completed to identify the most appropriate closure method for the Bottom Ash Basin. The following closure alternatives were evaluated:

- closure by removal of CCR with disposal in an on-site landfill
- closure by removal of CCR with disposal in an off-site landfill

Based on the findings of the closure alternatives analysis, the Bottom Ash Basin will be closed by removal of CCR with disposal in the existing permitted on-site landfill. Closure by removal of CCR will be completed in accordance with 35 I.A.C. § 845.740.

Closure Method Description

The Bottom Ash Basin consists of three cells, known as Primary Pond 1, Primary Pond 2, and the Secondary Pond. The liner system for the Bottom Ash Basin consists of (from top to bottom):

- eight inches of reinforced concrete
- one foot of compacted clay
- sixty-mil high-density polyethylene (HDPE) geomembrane

Following the retirement of the Duck Creek Power Plant, nearly all of the CCR contained in the Bottom Ash Basin was removed and disposed in the existing permitted on-site landfill. In accordance with 35 I.A.C. § 845.740(a), closure by removal of CCR will include removing and disposing any remaining CCR, as well as the concrete, compacted clay, and geomembrane components of the liner system. The materials removed will be hauled by truck to the existing permitted on-site landfill and disposed. The existing permitted on-site landfill has sufficient capacity to accept the removed materials. Up to 1 foot of subsoil will be removed beneath the existing liner system, and removal of CCR will be visually confirmed. If subsoils containing CCR are identified, they will be removed and disposed. The closure method described is expected to maintain compliance with the groundwater protection standards, as there have been no exceedances associated with the Bottom Ash Basin to date and there will be no potential source after closure by removal of CCR.

Document Organization

IEPA Application Form CCR 1 and IEPA Application Form CCR 2CC precede this Executive Summary. A checklist identifying the required elements of the Part 845 Construction Permit Application and the location in this document where each element can be found follows this Executive Summary. Supplemental information required under Part 845 is organized in a set of appendices that follow the checklist:

- Appendix A (History of Construction) provides general information about the Bottom Ash Basin and describes its design and construction.
- Appendix B (Narrative Description) describes the types and generation rates of CCR managed in the Bottom Ash Basin.
- Appendix C (Map Package) includes a Site Location Map and a Site Plan Map depicting important site features and information.
- Appendix D (Hydrogeologic Site Characterization) describes hydrogeologic conditions in the vicinity of the Bottom Ash Basin.
- Appendix E (Closure Priority Categorization) identifies the closure priority category assigned to the Bottom Ash Basin.
- Appendix F (Final Closure Plan) provides design information for closure of the Bottom Ash Basin, as well as the results of a closure alternatives analysis that has been conducted to determine the most effective approach for closure of the Bottom Ash Basin.
- Appendix G (Groundwater Monitoring Plan) describes the monitoring locations and procedures that will be used to assess groundwater quality after closure of the Bottom Ash Basin.
- Appendix H (Legal Description) provides the land description of the Bottom Ash Basin facility boundary.
- Appendix I (Public Meetings Information) provides the information pertaining to the public notification and public meetings required under Part 845.
- Appendix J (Training Program Statement) certifies that personnel utilized to construct, install, modify, or close the Bottom Ash Basin will participate in required training programs.

Signature Page

Golder Associates USA Inc.

I, Mark Haddock, being a registered professional engineer in good standing in the State of Illinois, certify to the best of my knowledge that the information contained in this construction permit application has been prepared in accordance with recognized and generally accepted engineering practices.

LICENSED PROFESSIONAL ENGINEER
MARK N. HADDOCK
062-058223
1-25-2022
STATE OF ILLINOIS

Mark Haddock, PE
Principal

https://golderassociates.sharepoint.com/:w:/r/sites/141778/Project%20Files/6%20Deliverables/Reports/8-R-BAB_Permit_App/8-R-1/21454861-8-R-1-Bottom_Ash_Basin_Permit_Application_25JAN22.docx

Regulation	Requirement	Location in Permit Application
Section 845.220 - Construction Permits		
a)	All construction permit applications must contain the following information and documents.	
1)	Design and Construction Plans (Construction History)	Appendix A
A)	Identifying information	Appendix A
i)	The name and address of the person or persons owning or operating the CCR surface impoundment;	Appendix A
ii)	The name associated with the CCR surface impoundment;	Appendix A
iii)	The identification number of the CCR surface impoundment if one has been assigned by the Agency.	Appendix A
B)	A statement of the purpose for which the CCR surface impoundment is being used, how long the CCR surface impoundment has been in operation, and the types of CCR that have been placed in the CCR surface impoundment.	Appendix A
C)	The name and size in acres of the watershed within which the CCR surface impoundment is located.	Appendix A
D)	A description of the physical and engineering properties of the foundation and abutment materials on which the CCR surface impoundment is constructed.	Appendix A
E)	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; the method of site preparation and construction of each zone of the CCR surface impoundment; and the approximate dates of construction of each successive stage of construction of the CCR surface impoundment.	Appendix A
F)	At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR surface impoundment, detailed dimensional drawings of the CCR surface impoundment, including a plan view and cross-sections of the length and width of the CCR surface impoundment, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR surface impoundment due to malfunction or mis-operation.	Appendix A
G)	A description of the type, purpose, and location of existing instrumentation.	Appendix A
H)	Area-capacity curves for the CCR surface impoundment.	Appendix A
I)	A description of each spillway and diversion design features and capacities and calculations used in their determination.	Appendix A
J)	The construction specifications and provisions for surveillance, maintenance, and repair of the CCR surface impoundment.	Appendix A
K)	Any record or knowledge of structural instability of the CCR surface impoundment.	Appendix A
2)	Narrative Description of the Facility. The permit application must contain a written description of the facility with supporting documentation describing the procedures and plans that will be used at the facility to comply with the requirements of this Part. The descriptions must include, but are not limited to, the following information:	Appendix B, Appendix F
A)	The types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR;	Appendix B
B)	An estimate of the maximum capacity of each surface impoundment in gallons or cubic yards;	Appendix B
C)	The rate at which CCR and non-CCR waste streams currently enter the CCR surface impoundment in gallons per day and dry tons;	Appendix B
D)	The estimated length of time the CCR surface impoundment will receive CCR and non-CCR waste streams; and	Appendix B
E)	An on-site transportation plan that includes all existing and planned roads in the facility that will be used during the operation of the CCR surface impoundment.	Appendix B
3)	Site Location Map. All permit applications must contain a site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7½ minute series (topographic), or on such other map whose scale clearly shows the following information:	Appendix C
A)	The facility boundaries and all adjacent property, extending at least 1000 meters (3280 feet) beyond the boundary of the facility;	Appendix C
B)	All surface waters;	Appendix C
C)	The prevailing wind direction;	Appendix C
D)	The limits of all 100-year floodplains;	Appendix C
E)	All natural areas designated as a Dedicated Illinois Nature Preserve under the Illinois Natural Areas Preservation Act [525 ILCS 30];	Appendix C
F)	All historic and archaeological sites designated by the National Historic Preservation Act (16 USC 470 et seq.) and the Illinois Historic Sites Advisory Council Act [20 ILCS 3410]; and	Appendix C
G)	All areas identified as critical habitat under the Endangered Species Act of 1973 (16 USC 1531 et seq.) and the Illinois Endangered Species Protection Act [520 ILCS 10].	Appendix C
4)	Site Plan Map. The application must contain maps, including cross-sectional maps of the site boundaries, showing the location of the facility. The following information must be shown:	Appendix C, Appendix F
A)	The entire facility, including any proposed and all existing CCR surface impoundment locations;	Appendix C
B)	The boundaries, both above and below ground level, of the facility and all CCR surface impoundments or landfills containing CCR included in the facility;	Appendix C
C)	All existing and proposed groundwater monitoring wells; and	Appendix C
D)	All main service corridors, transportation routes, and access roads to the facility.	Appendix C
5)	A narrative description of the proposed construction of, or modification to, a CCR surface impoundment and any projected changes in the volume or nature of the CCR or non-CCR waste streams.	Appendix F
6)	Plans and specifications fully describing the design, nature, function and interrelationship of each individual component of the facility.	Appendix A, Appendix F
7)	A new groundwater monitoring program or any modification to an existing groundwater monitoring program that includes but is not limited to the following information:	
A)	A hydrogeologic site investigation meeting the requirements of Section 845.620, if applicable;	Appendix D
B)	Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630; and	Appendix G
C)	A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data, as required by Sections 845.640 and 845.650.	Appendix G
8)	The signature and seal of a qualified professional engineer	Executive Summary
9)	Certification that the owner or operator of the CCR surface impoundment completed the public notification and public meetings required under Section 845.240, a summary of the issues raised by the public, a summary of any revisions, determinations, or other considerations made in response to those issues, and a list of interested persons in attendance who would like to be added to the Agency's listserv for the facility.	Appendix I

Regulation	Requirement	Location in Permit Application
Section 845.220 - Construction Permits (Continued)		
b)	New Construction. In addition to the requirements in subsection (a), all construction permit applications to build a new CCR surface impoundment, lateral expansion of a CCR surface impoundment, or retrofit of an existing CCR surface impoundment must also contain the following information and documents:	Not applicable - not new construction, lateral expansion, or retrofit
1)	Plans and specifications that demostrate the proposed CCR surface impoundment will meet the location standards in the following sections:	
A)	Section 845.300 (Placement Above the Uppermost Aquifer);	
B)	Section 845.310 (Wetlands);	
C)	Section 845.320 (Fault Areas);	
D)	Section 845.330 (Seismic Impact Zones); and	
E)	Section 845.340 (Unstable Areas and Floodplains).	
2)	Plans and specifications demonstrate the proposed CCR surface impoundment will meet the following design criteria:	
A)	The CCR surface impoundment will have a liner meeting the liner requirements of Section 845.400(b) or (c);	
B)	The CCR surface impoundment will have a leachate collection system meeting the requirements of Section 845.420; and	
C)	The CCR surface impoundment, if not incised, will be constructed with slope protection, as required by Section 845.430.	
3)	CCR fugitive dust control plan (see Section 845.500(b)).	
4)	Preliminary written closure plan (see Section 845.720(a)).	
5)	Initial written post-closure care plan, if applicable (see Section 845.780(d)).	
c)	Corrective Action Construction. In addition to the requirements in subsection (a), all construction permit applications that include any corrective action performed under Subpart F must also contain the following information and documents:	Not applicable - no corrective action included
1)	Corrective action plan (see Section 845.670);	
2)	Groundwater modeling, including:	
A)	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards;	
B)	All modeling inputs and assumptions;	
C)	Description of the fate and transport of contaminants, with the selected closure over time; and	
D)	Capture zone modeling, if applicable.	
3)	Any necessary licenses and software needed to review and access both the models and the data contained within the models required by subsection (c)(2);	
4)	Corrective action groundwater monitoring program, including identification of revisions to the groundwater monitoring system for corrective action; and	
5)	Any interim measures necessary to reduce the contaminants leaching from the CCR surface impoundment, and/or potential exposures to human or ecological receptors, including an analysis of the factors specified in Section 845.680(a)(3).	
d)	Closure Construction. In addition to the requirements in subsection (a), all construction permit applications for closure of the CCR surface impoundment under Subpart G must contain the following information and documents:	
1)	Closure prioritization category under Section 845.700(g), if applicable;	Appendix E
2)	Final closure plan, as specified in Section 845.720(b), which includes the closure alternatives analysis required by Section 845.710;	Appendix F
3)	Groundwater modeling, including:	Not applicable - refer to Appendix F, Attachment 1, Section 3.2.5
A)	The results of groundwater contaminant transport modeling and calculations showing how the closure will achieve compliance with the applicable groundwater standards;	
B)	All modeling inputs and assumptions;	
C)	Description of the fate and transport of contaminants, with the selected closure over time;	
D)	Capture zone modeling, if applicable; and	
E)	Any necessary licenses and software needed to review and access both the model and the data contained within the model.	
4)	Proposed schedule to complete closure; and	Appendix F
5)	Post-closure care plan as specified in Section 845.780(d), if applicable.	Not applicable - 845.780(a)(2)
e)	*Owners or operators of CCR surface impoundments who submitted a closure plan to the agency before May 1, 2019, and who complete closure before July 30, 2021, shall not be required to obtain a construction permit for closure under subsection (d).* [415 ILCS 5/22.58(e)]	Not applicable - closure not completed before July 31, 2021
f)	A single construction permit application may be submitted for new construction, corrective action, and closure if the construction is related to the same multiphased project. The permit application for a project with multiple phases must contain all information required by subsections (a), (b), (c) and (d), as applicable.	Not applicable - not a multiphased project
g)	Duration of Construction Permits	
1)	For any construction permit that is not for the closure or retrofit of the CCR surface impoundment, the construction permit must be issued for fixed terms not to exceed 3 years.	Not applicable - permit application is for closure
2)	For any construction permit for the closure or retrofit of a CCR surface impoundment, the construction permit must be issued for an initial fixed term expiring within the timeframe approved by the Agency in the construction permit or five years, whichever is less. The Agency may renew a construction permit for closure or retrofit in two-year increments under Section 845.760(b).	Acknowledged

Regulation	Requirement	Location in Permit Application
Section 845.620 - Hydrogeologic Site Characterization		
a)	The owner or operator of the CCR surface impoundment must design and implement a hydrogeologic site characterization.	Appendix D
b)	The hydrogeologic site characterization must include, but is not limited to, the following:	
1)	Geologic well logs/boring logs;	Appendix D
2)	Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;	Appendix D
3)	Identification of nearby surface water bodies and drinking water intakes;	Appendix D
4)	Identification of nearby pumping wells and associated uses of the groundwater;	Appendix D
5)	Identification of nearby dedicated nature preserves;	Appendix D
6)	Geologic setting;	Appendix D
7)	Structural characteristics;	Appendix D
8)	Geologic cross-sections;	Appendix D
9)	Soil characteristics;	Appendix D
10)	Identification of confining layers;	Appendix D
11)	Identification of potential migration pathways;	Appendix D
12)	Groundwater quality data;	Appendix D
13)	Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;	Appendix D
14)	A map displaying any known underground mines beneath a CCR surface impoundment;	Appendix D
15)	Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;	Appendix D
16)	Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:	Appendix D
A)	Water table depth;	Appendix D
B)	Hydraulic conductivities;	Appendix D
C)	Effective and total porosities;	Appendix D
D)	Direction and velocity of groundwater flow; and	Appendix D
E)	Map of the potentiometric surface;	Appendix D
17)	Groundwater classification under 35 Ill. Adm. Code 620; and	Appendix D
18)	Any other information requested by the Agency that is relevant to the hydrogeologic site characterization.	Appendix D
Section 845.630 - Groundwater Monitoring Systems (excerpts providing requirements for the construction permit application)		
g)	The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this Section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in subsection (c)(1), the certification must document the basis supporting this determination. The certification must be submitted to the Agency with the appropriate permit application.	Appendix G
Section 845.640 - Groundwater Sampling and Analysis Requirements (excerpts providing requirements for the construction permit application)		
a)	The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and downgradient wells required by Section 845.630. The owner or operator of the CCR surface impoundment must develop a sampling and analysis program that includes procedures and techniques for:	Appendix G
1)	Sample collection;	Appendix G
2)	Sample preservation and shipment;	Appendix G
3)	Analytical procedures;	Appendix G
4)	Chain of custody control; and	Appendix G
5)	Quality assurance and quality control.	Appendix G
b)	The groundwater monitoring program must include sampling and analysis methods that are appropriate for groundwater sampling and that accurately measure constituents and other monitoring parameters in groundwater samples.	Appendix G
f)	Statistical Methods	Appendix G
1)	The owner or operator of the CCR surface impoundment must select one of the statistical methods specified in subsection (f)(1) to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen must be conducted separately for each constituent in each monitoring well.	Appendix G
Section 845.710 - Closure Alternatives (excerpts providing requirements for the construction permit application)		
b)	Before selecting a closure method, the owner or operator of each CCR surface impoundment must complete a closure alternatives analysis. The closure alternatives analysis must examine the following for each closure alternative:	Appendix F
1)	The long- and short-term effectiveness and protectiveness of the closure method, including identification and analyses of the following factors:	Appendix F
A)	The magnitude of reduction of existing risks;	Appendix F
B)	The magnitude of residual risks in terms of likelihood of future releases of CCR;	Appendix F
C)	The the type and degree of long-term management required, including monitoring, operation, and maintenance;	Appendix F
D)	The short-term risks that might be posed to the community or the environment during implementation of such a closure, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants;	Appendix F
E)	The time until closure and post-closure care or the completion of groundwater monitoring under Section 845.740(b) is completed;	Appendix F
F)	The potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, containment or changes in groundwater flow;	Appendix F
G)	The long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities; and	Appendix F
H)	Potential need for future corrective action of the closure alternative.	Appendix F
2)	The effectiveness of the closure method in controlling future releases based on analyses of the following factors:	Appendix F
A)	The extent to which containment practices will reduce further releases; and	Appendix F
B)	The extent to which treatment technologies may be used.	Appendix F
3)	The ease or difficulty of implementing a potential closure method based on analyses of the following types of factors:	Appendix F
A)	Degree of difficulty associated with constructing the technology;	Appendix F
B)	Expected operational reliability of the technologies;	Appendix F
C)	Need to coordinate with and obtain necessary approvals and permits from other agencies;	Appendix F
D)	Availability of necessary equipment and specialists; and	Appendix F
E)	Available capacity and location of needed treatment, storage, and disposal services.	Appendix F
4)	The degree to which the concerns of the residents living within communities where the CCR will be handled, transported and disposed are addressed by the closure method.	Appendix F

Regulation	Requirement	Location in Permit Application
Section 845.710 - Closure Alternatives (excerpts providing requirements for the construction permit application) (Continued)		
c)	In the closure alternative analysis, the owner or operator of the CCR surface impoundment must:	Appendix F
1)	Analyze complete removal of the CCR as one closure alternative, along with the modes for transporting the removed CCR, including by rail, barge, low-polluting trucks, or a combination of these transportation modes;	Appendix F
2)	Identify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not,	Appendix F
3)	Include any other closure method in the alternatives analysis if requested by the Agency.	Appendix F
d)	The analysis for each alternative completed under this Section must:	Appendix F
1)	Meet or exceed a class 4 estimate under the AACE Classification Standard, incorporated by reference in Section 845.150, or a comparable classification practice as provided in the AACE Classification Standard;	Appendix F
2)	Contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards;	Appendix F
3)	Include a description of the fate and transport of contaminants with the closure alternative over time including	Appendix F
4)	Assess impacts to waters in the state.	Appendix F
e)	At least 30 days before submission of a construction permit application for closure, the owner or operator of the CCR surface impoundment must discuss the results of the closure alternatives analysis in a public meeting with interested and affected parties as required by Section 845.240.	Appendix I
Section 845.720 - Closure Plan (excerpts providing requirements for the construction permit application)		
b)	Final Closure Plan	Appendix F
1)	The owner or operator of a CCR surface impoundment must submit to the Agency, as a part of a construction permit application for closure, a final closure plan. The plan must be submitted before the installation of a final cover system or removal of CCR from the surface impoundment for the purpose of closure.	Appendix F
3)	The final closure plan must identify the proposed selected closure method, and must include the information required in subsection (a)(1) and the closure alternatives analysis as specified in Section 845.710.	Appendix F
5)	The owner or operator of the CCR surface impoundment must obtain and submit with its construction permit application for closure a written certification from a qualified professional engineer that the final written closure plan meets the requirements of this Part.	Appendix F
Section 845.750 - Closure with a Final Cover System (excerpts providing requirements for the construction permit application)		
c)	Final Cover System. If a CCR surface impoundment is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and, at a minimum, meets the requirements of this subsection (c). The final cover system must consist of a low permeability layer and a final protective layer. The design of the final cover system must be included in the preliminary and final written closure plans required by Section 845.720 and the construction permit application for closure submitted to the agency.	Appendix F
Section 845.780 - Post-Closure Care Requirements (excerpts providing requirements for the construction permit application)		
d)	Written Post-Closure Care Plan	Not applicable - 845.780(a)(2)
1)	Content of the Plan. The owner or operator of a CCR surface impoundment must prepare a written post-closure care plan that includes, at a minimum, the information specified in this subsection (d)(1).	
A)	A description of the monitoring and maintenance activities required in subsection (b) for the CCR surface impoundment and the frequency at which these activities will be performed;	
B)	The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and	
C)	A description of the planned uses of the property during the post- closure care period. Post-closure use of the property must not disturb the integrity of the final cover, liners, or any other component of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this Part. Any other disturbance is allowed if the owner or operator of the CCR surface impoundment demonstrates that disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The demonstration must be certified by a qualified professional engineer and must be submitted to the Agency.	
4)	The owner or operator of the CCR surface impoundment must obtain a written certification from a qualified professional engineer that the initial, and any amendment of the, written post-closure care plan meets the requirements of this Section.	

Table of Contents

APPENDICES

APPENDIX A
History of Construction

APPENDIX B
Narrative Description

APPENDIX C
Map Package

APPENDIX D
Hydrogeologic Site Characterization

APPENDIX E
Closure Priority Categorization

APPENDIX F
Final Closure Plan

APPENDIX G
Groundwater Monitoring Plan

APPENDIX H
Legal Description

APPENDIX I
Public Meetings Information

APPENDIX J
Training Program Statement

APPENDIX A

History of Construction

APPENDIX A

History of Construction for the Bottom Ash Basin

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62234

Submitted by:

Illinois Power Resource Generating, LLC

1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Compiled by:

Golder Associates Inc.
13515 Barrett Parkway Drive, Suite 260
Ballwin, Missouri 63021

21454861-8-R-0

October 22, 2021

Table of Contents

1.0 INTRODUCTION 1

1.1 Identifying Information 1

1.1.1 Ownership 1

1.1.2 Facility Name and Identification Number 1

1.2 Facility Information 1

1.2.1 Statement of Purpose 1

1.2.2 Operational Time Period 2

1.2.3 CCR Material Received 2

1.2.4 Facility Capacity 2

1.2.5 Area–Capacity Curve Analysis 2

1.2.6 Rate of CCR Acceptance 3

1.3 Watershed 3

1.4 Foundation and Abutment Materials 4

2.0 BOTTOM ASH BASIN DESIGN 4

2.1 Spillway and Diversion Design Features 4

3.0 FACILITY CONSTRUCTION 4

3.1 Existing Instrumentation 4

3.2 Construction Specifications 5

3.2.1 Concrete Specifications 5

3.2.2 Earthwork Specifications 5

3.2.3 Geomembrane Specifications 5

3.3 Inspection, Maintenance, and Repairs 5

3.4 Structural Instability Records 5

4.0 REFERENCES 6

TABLES

Table 1: Identification Numbers 1

FIGURES

Figure 1: Area–Capacity Curve for Primary Pond 1 2

Figure 2: Area–Capacity Curve for Primary Pond 2 3

Figure 3: Area–Capacity Curve for the Secondary Pond 3

ATTACHMENTS

Attachment 1
Soil Investigation Data

Attachment 2
Bottom Ash Basin Design Drawings

Attachment 3
Hydrologic and Hydraulic Assessments

Attachment 4
Concrete Specifications

Attachment 5
Earthwork Specifications

Attachment 6
Geomembrane Specifications

1.0 INTRODUCTION

This History of Construction has been prepared to address certain requirements of 35 I.A.C. 845.220(a)(1) for Illinois Power Resource Generating, LLC's (IPRG's) Bottom Ash Basin at the Duck Creek Power Plant near Canton, Illinois. Specifically, this document addresses requirements pertaining to the design and construction history of the Bottom Ash Basin.

1.1 Identifying Information

1.1.1 Ownership

Illinois Power Resource Generating, LLC owns the Duck Creek Power Plant. IPRG owns the entire site, including the Bottom Ash Basin. The Duck Creek Power Plant is located at:

17751 North Cilco Road
Canton, Illinois 61520

1.1.2 Facility Name and Identification Number

The CCR surface impoundment is named the Bottom Ash Basin. The identification numbers for the Bottom Ash Basin are provided in Table 1.

Table 1: Identification Numbers

Agency	Identification Number
IPRG ID Number	CCR Unit ID 205
IEPA ID Number	W0578010001-03
IDNR Dam ID Number	IL50716

1.2 Facility Information

The Bottom Ash Basin is an incised surface impoundment with reinforced concrete slopes and floor. The Bottom Ash Basin is subdivided into Primary Pond 1, Primary Pond 2, and the Secondary Pond. Primary Ponds 1 and 2 temporarily stored sluiced bottom ash from the Duck Creek Power Plant. Primary Ponds 1 and 2 operated alternately so that while one pond was receiving sluiced bottom ash, the other pond could be drained and the accumulated bottom ash could be removed. Removed bottom ash was loaded into trucks and beneficially reused or permanently disposed in the permitted on-site landfill. Water decanted from Primary Ponds 1 and 2 was routed into the Secondary Pond. The Secondary Pond operated as a polishing pond for water clarification. Settled bottom ash particles were periodically removed from the Secondary Pond and disposed in the permitted on-site landfill. Clarified water decanted from the Secondary Pond was routed to the Discharge Canal, which flows into Duck Creek Reservoir, with discharge at a permitted outfall in accordance with the site's National Pollutant Discharge Elimination System (NPDES) permit. The Bottom Ash Basin has not been operated since the Duck Creek Power Plant was retired in December 2019, and appreciable amounts of CCR have been removed and beneficially reused or disposed in the permitted on-site landfill.

1.2.1 Statement of Purpose

The Bottom Ash Basin was historically used to temporarily store and dewater sluiced bottom ash.

1.2.2 Operational Time Period

The Bottom Ash Basin operated from 2009 until the Duck Creek Power Plant was retired in December 2019.

1.2.3 CCR Material Received

The only CCR historically received at the Bottom Ash Basin was bottom ash. The Bottom Ash Basin has not received bottom ash since 2019, and no appreciable amount of bottom ash is currently present in the facility.

1.2.4 Facility Capacity

The facility capacity was estimated by a stage-storage analysis using Autodesk Civil 3D. The cumulative capacity of all three cells of the Bottom Ash Basin is estimated at approximately 4.8 acre-feet or 1.55 million gallons. No appreciable CCR is currently contained in the Bottom Ash Basin.

1.2.5 Area–Capacity Curve Analysis

The facility capacity was estimated by a stage–storage analysis using Autodesk Civil 3D. The area–capacity curves for the three cells of the Bottom Ash Basin are presented in Figure 1, Figure 2, and Figure 3.

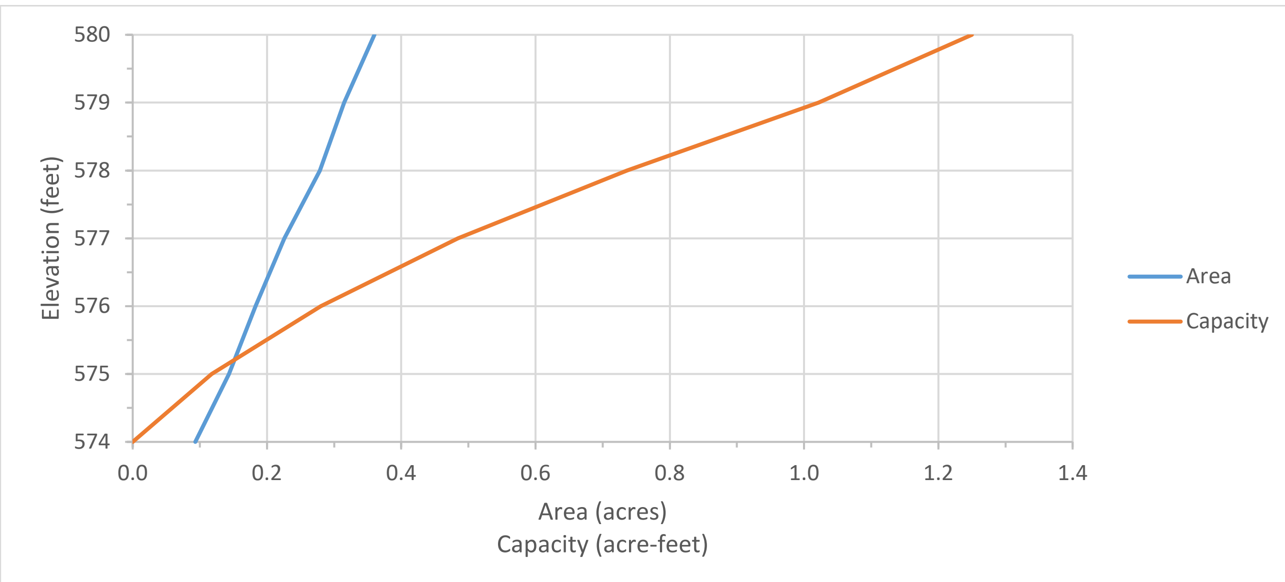


Figure 1: Area–Capacity Curve for Primary Pond 1

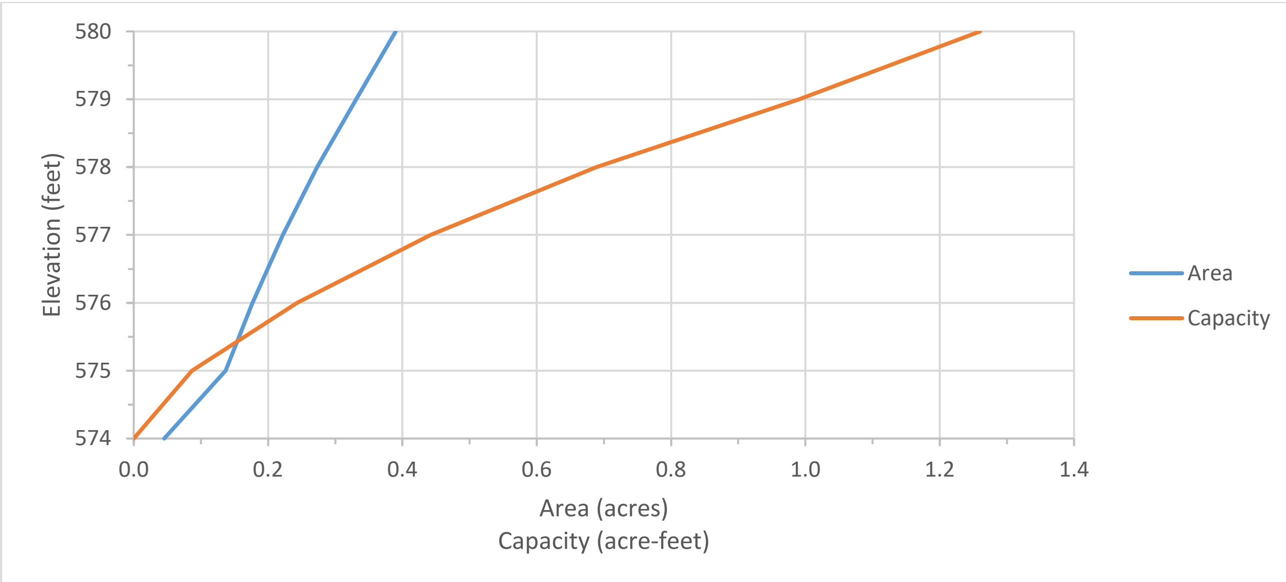


Figure 2: Area–Capacity Curve for Primary Pond 2

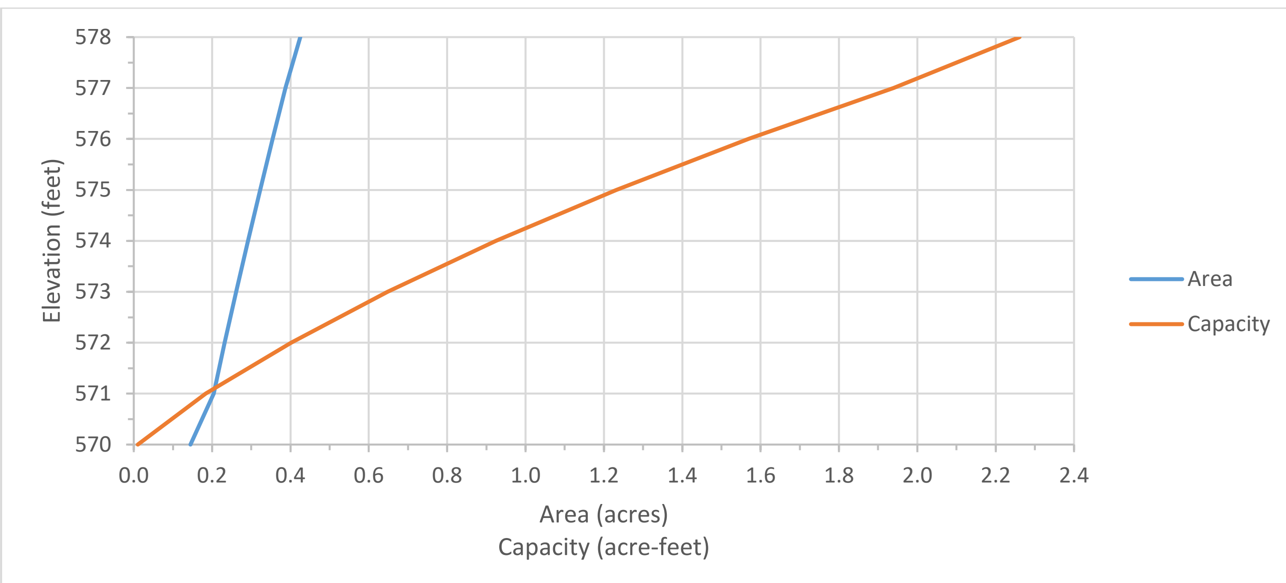


Figure 3: Area–Capacity Curve for the Secondary Pond

1.2.6 Rate of CCR Acceptance

The Bottom Ash Basin is no longer accepting CCR, and no appreciable CCR is currently contained in the Bottom Ash Basin.

1.3 Watershed

The Bottom Ash Basin is located in the Rice Lake-Illinois River Subwatershed with a Hydrologic Unit Code (HUC) of 071300030603. This watershed has a drainage area of 21,188 acres (USGS 2021).

1.4 Foundation and Abutment Materials

Results from the subsurface investigation conducted prior to construction of the Bottom Ash Basin, including the physical and engineering properties of the foundation materials and soils used for construction of the Bottom Ash Basin, are shown in Attachment 1. Native soils in the area of the Bottom Ash Basin are generally low-plasticity silts. Additional information about the soils used to construct the Bottom Ash Basin and the associated construction requirements is provided in Section 3.0.

2.0 BOTTOM ASH BASIN DESIGN

The design of the Bottom Ash Basin was completed by Sargent & Lundy, LLC. The design drawings are provided in Attachment 2. Based on Drawing No. C180-C1000-2, the existing liner system for the facility consists of (from top to bottom):

- eight inches of reinforced concrete
- one foot of compacted clay, placed in 6-inch-thick lifts to at least 95% of the standard Proctor maximum dry density
- sixty-mil high-density polyethylene (HDPE) geomembrane
- at least 6 inches of prepared subgrade (presumably native soils) compacted to at least 95% of the standard Proctor maximum dry density

2.1 Spillway and Diversion Design Features

During operation of the Bottom Ash Basin, bottom ash was hydraulically conveyed (sluiced) from the power plant in 10-inch-diameter, basalt-lined piping and deposited in Primary Pond 1 or Primary Pond 2. Coarse bottom ash particles settled by gravity in the cell where they were deposited, and the sluice water was decanted via 12-inch-diameter corrugated HDPE piping into the Secondary Pond. Further gravity settling occurred in the Secondary Pond before the sluice water was decanted via 12-inch-diameter corrugated HDPE piping into the Discharge Canal. Bottom ash particles gradually accumulated in Primary Pond 1 and Primary Pond 2, requiring periodic cleanout events. During cleanout events, heavy equipment was used to excavate bottom ash out of the cell, stage it on a concrete apron for dewatering as needed, and load it into trucks for beneficial reuse or permanent disposal in the permitted on-site landfill. Primary Pond 1 and Primary Pond 2 could operate alternately, so that bottom ash could be deposited into one cell while the other cell was being cleaned out. After the Duck Creek Power Plant was retired, the remaining bottom ash was removed from the Bottom Ash Basin and beneficially reused or disposed in the permitted on-site landfill. A hydraulic analysis of the Bottom Ash Basin was conducted by AECOM (2016) and is provided in Attachment 3. This analysis included an evaluation of the initial inflow design flood.

3.0 FACILITY CONSTRUCTION

The Bottom Ash Basin was constructed in 2009 in accordance with the Bottom Ash and Low Volume Sump Water Basin and Piping General Work Contract (Sargent & Lundy, LLC 2007). The contract included comprehensive construction specifications and a rigorous construction quality assurance (CQA) program.

3.1 Existing Instrumentation

The Bottom Ash Basin does not have instrumentation that is used for monitoring its operation.

3.2 Construction Specifications

Summaries of the key construction specification sections are provided in the following sections.

3.2.1 Concrete Specifications

The concrete specifications for construction of the Bottom Ash Basin are provided in Attachment 4. According to the specifications for the reinforced concrete layer, the concrete used a conventional mix design (28-day compressive strength of 4,000 pounds per square inch, water-to-cement ratio of 0.5 or less). According to the design drawings (Attachment 1), welded wire reinforcement (W5 wire, 12-inch mesh) was used.

3.2.2 Earthwork Specifications

The earthwork specifications for construction of the Bottom Ash Basin are provided in Attachment 5. Key earthwork components of the Bottom Ash Basin construction included:

- compacted clay (one foot), placed in 6-inch-thick lifts to at least 95% of the standard Proctor maximum dry density
- prepared subgrade (minimum 6 inches) compacted to at least 95% of the standard Proctor maximum dry density

According to Attachment 5, soil used for the compacted clay layer was required to classify as a low-plasticity clay (CL) under the Unified Soil Classification System. The minimum liquid limit was 30, and the plasticity index was required to be between 15 and 40. At least 50% of the material (by weight) needed to pass the No. 200 sieve, with at least 30% finer than 0.002 microns, no more than 10% retained on the ⅜-inch sieve, and no particles larger than ¾ inch. The construction specifications required a hydraulic conductivity of 1 x 10^{-6} centimeters per second (cm/s) or less for the compacted clay layer.

3.2.3 Geomembrane Specifications

Geomembrane specifications used for the construction of the Bottom Ash Basin are provided in Attachment 6. According to the design drawings, the geomembrane was composed of HDPE and had a thickness of 60 mils. According to the specifications, the geomembrane was generally intended to conform to GRI-GM13, which is a commonly used specification for geomembranes in waste containment application. The CQA program for the liner system included destructive and non-destructive testing of geomembrane seams to verify watertightness and strength.

3.3 Inspection, Maintenance, and Repairs

The Bottom Ash Basin is no longer in operation, so the requirement for an operation plan with procedures for inspection, maintenance, and repairs is not applicable. Procedures for inspection, maintenance, and repairs after completion of closure by removal of CCR are provided in the Post-closure Care Plan included in Appendix H of the main permit application.

3.4 Structural Instability Records

There is no record of structural instability associated with the Bottom Ash Basin.

4.0 REFERENCES

AECOM. 2016. CCR Certification Report: Initial Structural Stability Assessment, Initial Safety Factor Assessment, and Initial Inflow Design Flood Control System Plan for Bottom Ash Basin at Duck Creek Power Station. October.

Sargent & Lundy, LLC. 2007. Bottom Ash and Low Volume Sump Water Basin and Piping General Work Contract. September.

USGS (United States Geological Survey). 2021. The National Map Viewer. Available online: https://apps.nationalmap.gov/viewer/ (accessed October 19, 2021)

Signature Page

Golder Associates Inc.

https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/8-r-bab_permit_app/8-r-0/appendixa/21454861-8-r-0-appendixa_bab_history_of_construction_22oct21.docx

ATTACHMENT 1

Soil Investigation Data

FAX TRANSMISSION

TSC

TESTING SERVICE CORPORATION
1701 West Market Street, Suite B
Bloomington, IL 61701
309-821-0430
Fax: 309-821-1242

Company	Hanson Professional Services	Date	February 28, 2006
Attn:	Dan Whalen	From	Doug Ramsey
FAX:	217-788-2503	Pages	11 (Including cover sheet)

COMMENTS:

Following are the boring logs for the Bottom Ash Ponds at Duck Creek.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-1 DATE STARTED 2-21-06 DATE COMPLETED 2-21-06 JOB L-65,577

ELEVATIONS

GROUND SURFACE 579.6

END OF BORING 549.6

WATER TABLE

WHILE DRILLING	19.5 '
AT END OF BORING	Caved @ 15'
24 HOURS	

Offset 3' North

DISTANCE BELOW SURFACE IN FEET	SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0							0.3	579.3	Dark brown clayey TOPSOIL (OL)
	1	SS	2-4 5-11						Brown clayey SILT, trace sand and gravel (ML)
							2.0	577.6	Brown-light brown clayey SILT, trace sand (ML)
	2	ST							
5	3	SS	1-4 5-7						
	A 4 B	SS	3-7 8-8						
							7.5	572.1	Brown clayey SILT, trace sand (ML)
	5	ST							
10									
	6	SS	1-2-3						
15									
							18.0	561.6	Light brown silty SAND, trace gravel (SM)
	A 7 B	SS	1-2-2						
20									
	8	ST							
							24.0	555.6	Brown sandy CLAY, trace gravel (CL)
25									
							28.0	551.6	Brown silty SAND, trace gravel (SM)
	A 9 B	SS	1-1-10						
30									End of Boring at 30'
35									

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types: in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-2 DATE STARTED 2-21-06 DATE COMPLETED 2-21-06 JOB L-65,577

ELEVATIONS

GROUND SURFACE 575.4

END OF BORING 545.4

Offset 4' South

WATER TABLE

WHILE DRILLING	DRY
AT END OF BORING	DRY
24 HOURS	

DISTANCE BELOW SURFACE IN FEET

LENGTH RECOVERY

SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
A						0.3	575.1	Dark brown clayey TOPSOIL (OL)
1	SS	2-4 6-5						Brown clayey SILT, trace sand (ML)
B								
2	ST							
3	SS	3-5 6-6						
4	SS	6-7 7-6						
5	ST							
6	SS	2-1-2						
7	ST					19.0	556.4	Brown-light brown clayey SILT, little sand, trace gravel (ML)
						22.0	553.4	Dark gray silty CLAY, trace sand and gravel (CL)
8	SS	7-12-15						
9	ST							
10	SS	8-13						
								End of Boring at 30'

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types: in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-3 DATE STARTED 2-21-06 DATE COMPLETED 2-21-06 JOB L-65,577

ELEVATIONS		WATER TABLE	
GROUND SURFACE	576.3	WHILE DRILLING	28.0'
END OF BORING	547.0	AT END OF BORING	23.0'
		24 HOURS	

DISTANCE BELOW SURFACE IN FEET

SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γDRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
						0.3	576.0	Dark brown clayey TOPSOIL (OL)
								Brown clayey SILT, trace sand (ML)
1	SS	2-4 6-7						
2	ST							
3	SS	2-3 3-4						
4 A / 4 B	SS	5-5 4-4						
5	SS	0-2 4-5						
6	ST							
						18.0	558.3	Brown silty CLAY, trace sand and gravel (CL)
7	SS	4-8-11						
						23.0	553.3	Gray silty SAND, trace gravel (SM)
8	ST							
9	SS	24-35						
10 A / 10 B	SS	12-50/4"						
								End of Boring at 29.3'

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-4 DATE STARTED 2-21-06 DATE COMPLETED 2-21-06 JOB L-65,577

ELEVATIONS		WATER TABLE	
GROUND SURFACE	575.7	WHILE DRILLING	23.0'
END OF BORING	545.7	AT END OF BORING	22.0'
		24 HOURS	

DISTANCE BELOW SURFACE IN FEET

SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γ DRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
						0.3	575.4	Dark brown clayey TOPSOIL (OL)
1	SS	2-3 4-5						Brown clayey SILT, trace sand (ML)
2	ST							
3	SS	2-4 4-5						
4	SS	4-5 6-6						
5	SS	2-2 2-2						
6	ST							
						17.0	558.7	Gray-brown silty CLAY, little sand, trace gravel (CL)
7	SS	1-1-2						
8	ST					23.0	552.7	Brown silty SAND, trace gravel (SM)
9	SS	7-34-44				24.0	551.7	Brown-gray sandy SILT, trace gravel (ML)
						28.0	547.7	Gray silty CLAY, little sand, trace gravel (CL) 2' Blow-in at 28-1/2'
10	SS	6-9-24						
								End of Boring at 30'

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-5 DATE STARTED 2-22-06 DATE COMPLETED 2-22-06 JOB L-65,577

ELEVATIONS	
GROUND SURFACE	585.0
END OF BORING	555.0

WATER TABLE	
WHILE DRILLING	27.0 '
AT END OF BORING	Caved @ 20'
24 HOURS	

DISTANCE BELOW SURFACE IN FEET	SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0							0.4	584.6	Dark brown clayey TOPSOIL (OL)
	1	SS	1-4 6-6						Brown clayey SILT, trace sand (ML)
	2	ST							
5	3	SS	2-4 4-6						
	4	SS	10-13 12-13						
	5	SS	12-10 9-8						
10									
	6	ST					14.0	571.0	Gray clayey SILT, trace sand (ML)
15									
							18.0	567.0	Brown clayey SILT, trace sand (ML)
	7	SS	2-2-3						
20									
	8	SS	2-2-4						
25									▼
							28.0	557.0	Brown-gray clayey SILT, little sand, trace gravel (ML)
	9	ST							
30									End of Boring at 30'
35									

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-6 DATE STARTED 2-22-06 DATE COMPLETED 2-22-06 JOB L-65,577

ELEVATIONS

GROUND SURFACE 577.5

END OF BORING 547.5

Offset 5' South

WATER TABLE

▽ WHILE DRILLING	19.5 '
▽ AT END OF BORING	20.0 '
▼ 24 HOURS	

SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
						0.3	577.2	Dark brown clayey TOPSOIL (OL)
1	SS	2-5 6-8						Brown clayey SILT, trace sand (ML)
2	ST							
3	SS	1-3 3-4						
4	SS	5-5 5-4						
5	SS	1-2 2-2						
						13.0	564.5	Gray clayey SILT, trace sand (ML)
6	ST							
7 A / B	SS	1-1-3				19.3	558.2	1/2" Sand Seam at 19'-2"
								Gray silty CLAY, trace sand and gravel (CL)
8	ST							
						28.0	549.5	Gray silty SAND (ML)
9	SS	3-3-5						
								End of Boring at 30'

DISTANCE BELOW SURFACE IN FEET (0–35)

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING **B-7** DATE STARTED **2-22-06** DATE COMPLETED **2-22-06** JOB **L-65,577**

ELEVATIONS

GROUND SURFACE ______

END OF BORING ______

WATER TABLE

▽ WHILE DRILLING	DRY
▽ AT END OF BORING	DRY
▼ 24 HOURS	

DISTANCE BELOW SURFACE IN FEET (scale 0–35)

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
							0.3		Dark brown clayey TOPSOIL (OL)
	1	SS	3-7-7						Brown clayey SILT, trace sand (ML)
							3.0		Gray clayey SILT, trace sand (ML)
	2	SS	3-2-2						
							6.0		Brown sandy PEAT (PT)
	3	SS	1-3-3						
							8.5		Brown-gray clayey SILT, little sand, trace gravel (ML)
	4	SS	0-2-2						
							11.0		Brown clayey SILT, trace sand (ML)
	5	SS	0-2-2						
							13.5		Gray silty SAND, trace gravel (SM)
	6	SS	1-2-4						
							18.0		Brown clayey SILT, trace sand and gravel (ML)
	7	SS	2-3-4						
							23.0		Gray-brown silty CLAY, trace sand and gravel (CL)
	A 8 B	SS	1-2-3				24.5		Brown clayey SILT, trace sand and organics (ML)
							27.0		Gray clayey SILT, little sand, trace organics (ML)
	9	SS	1-3-4						
									End of Boring at 30'

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-8 DATE STARTED 2-22-06 DATE COMPLETED 2-22-06 JOB L-65,577

ELEVATIONS
GROUND SURFACE
END OF BORING

WATER TABLE
WHILE DRILLING DRY
AT END OF BORING DRY
24 HOURS

DISTANCE BELOW SURFACE IN FEET

SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γDRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
						0.3		Dark brown clayey TOPSOIL (OL)
1	SS	2-4-5						Brown clayey SILT, trace sand (ML)
2	SS	2-3-5						
3	SS	2-4-6						
						8.0		Gray clayey SILT, trace sand (ML)
4	SS	3-4-5						
						11.0		Brown clayey SILT, trace sand (ML)
5	SS	3-4-4						
						13.0		Gray silty CLAY, trace sand (CL)
6A / 6B	SS	0-2-2				14.5		Gray-brown clayey SILT, trace sand (ML)
						18.0		Gray clayey SILT, trace sand and gravel (ML)
7	SS	0-2-2						
						23.0		Gray silty CLAY, little sand and gravel (CL)
8	SS	0-1-3				25.0		Gray clayey SILT, trace sand (ML)
						28.0		Brown PEAT, trace clayey silt (PT)
9	SS	2-2-4						
								End of Boring at 30'

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-9 DATE STARTED 2-23-06 DATE COMPLETED 2-23-06 JOB L-65,577

ELEVATIONS

GROUND SURFACE ______

END OF BORING ______

WATER TABLE

WHILE DRILLING DRY

AT END OF BORING DRY

24 HOURS ______

DISTANCE BELOW SURFACE IN FEET

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γDRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
								0.6		Dark brown clayey TOPSOIL (OL)
		1	SS	3-4-7						Brown clayey SILT, trace sand and gravel (ML)
		2	SS	5-10-12						
		3	SS	4-7-7						
		4	SS	3-8-10						
		A 5 B	SS	1-2-4				11.0		Brown-gray clayey SILT, trace sand and gravel (ML)
								12.3		Black COAL
								13.0		Brown clayey SILT, trace sand and gravel (ML)
		6	SS	2-3-2						
								18.0		Gray clayey SILT, little sand, trace gravel (ML)
								18.8		Gray silty SAND (SM)
		A 7 B	SS	2-3-2				19.3		Brown-gray clayey SILT, trace sand and gravel (ML)
								23.0		Brown silty CLAY, trace sand and gravel (CL)
		8	SS	0-1-2						
								28.0		Brown clayey SILT, trace sand and gravel (ML)
		9	SS	0-1-2						
										End of Boring at 30'

DRILL RIG NO. 242

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

PROJECT Bottom Ash Ponds, Duck Creek Power Plant, Canton, IL

CLIENT Hanson Professional Services, Inc., 1525 S. Sixth St., Springfield, IL 62703

TSC

BORING B-10 DATE STARTED 2-23-06 DATE COMPLETED 2-23-06 JOB L-65,577

ELEVATIONS

GROUND SURFACE ______

END OF BORING ______

WATER TABLE

WHILE DRILLING DRY

AT END OF BORING DRY

24 HOURS ______

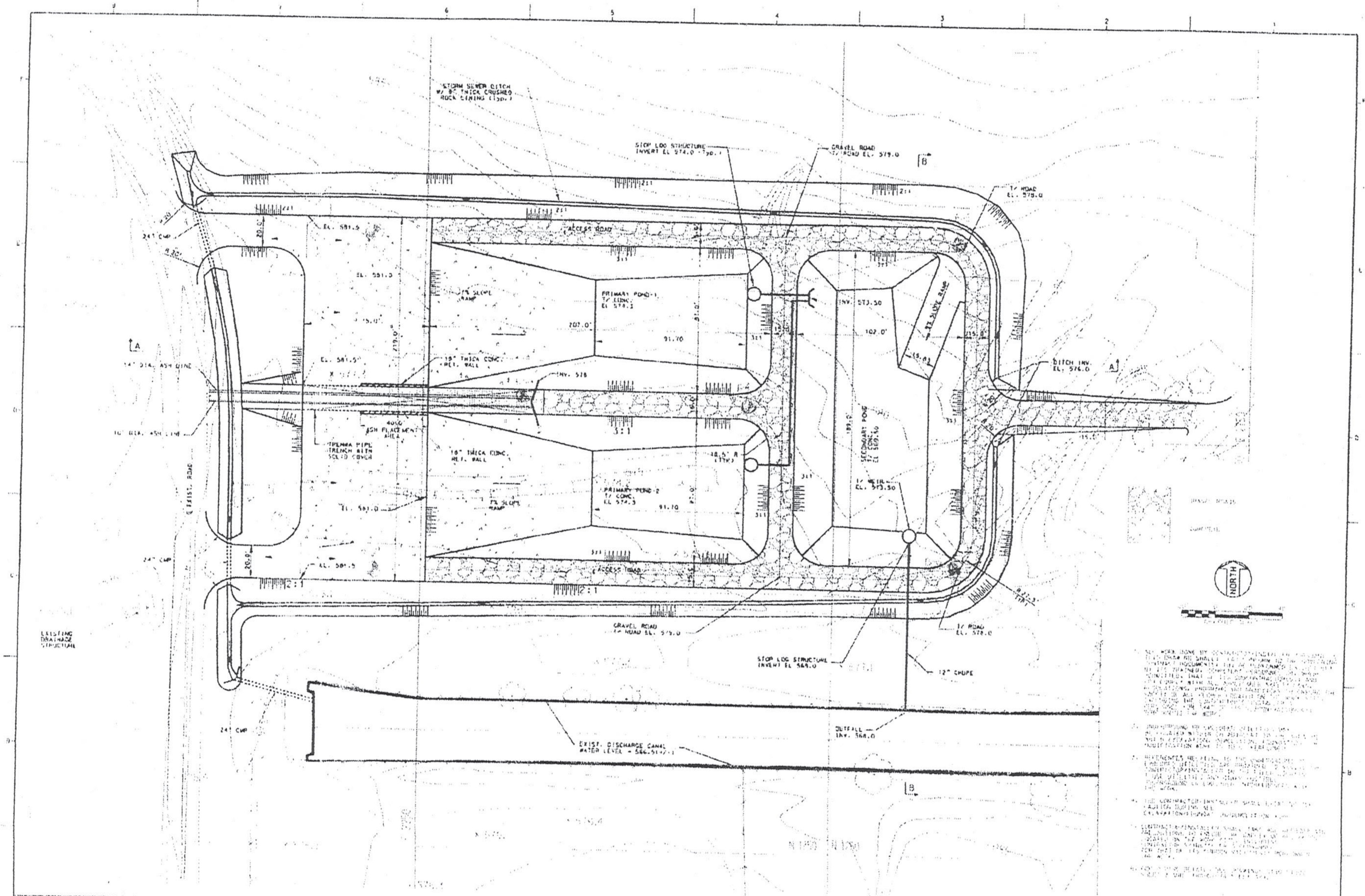
DISTANCE BELOW SURFACE IN FEET

LENGTH / RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Qu	γDRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
									Dark brown clayey TOPSOIL (OL)
							0.6		Brown clayey SILT, trace sand and gravel (ML)
	1	SS	2-5-6						
	2	SS	4-8-10						
	3	SS	3-8-7						
	4	SS	2-4-5						
							11.0		Gray-brown clayey SILT, trace sand (ML)
	5	SS	2-4-5						
							13.0		Brown-gray silty CLAY, trace sand and gravel (CL)
	6	SS	1-1-2						
							18.0		Brown-gray clayey SILT, trace sand and organics (ML)
	7	SS	1-1-3						
							23.0		Brown clayey SILT, trace sand (ML)
	8	SS	0-2-2						
	9	SS	0-2-2						
									End of Boring at 30'

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

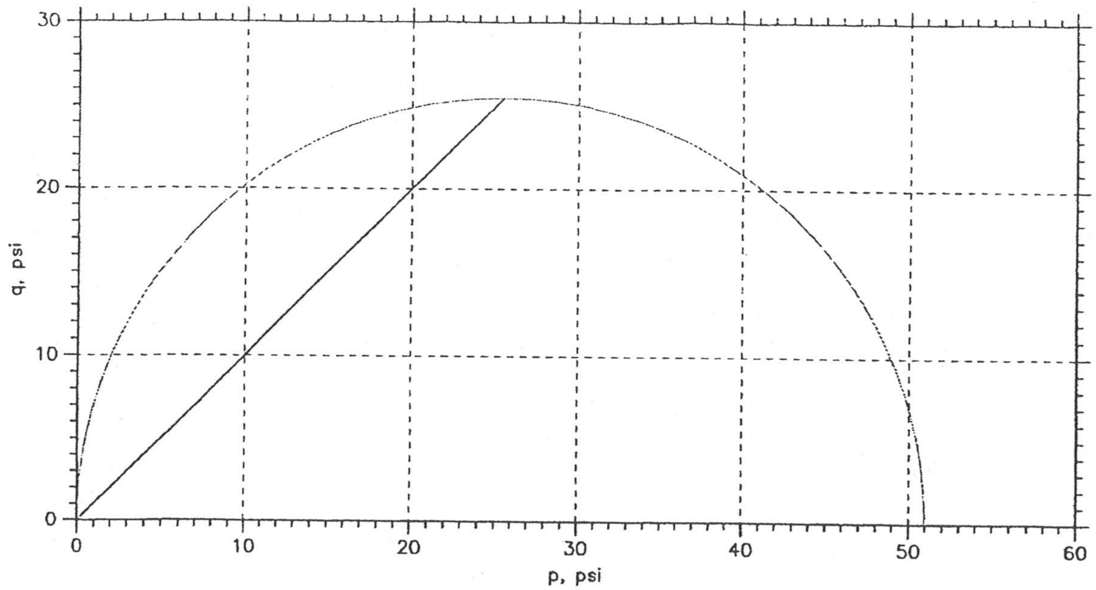
DRILL RIG NO. 242

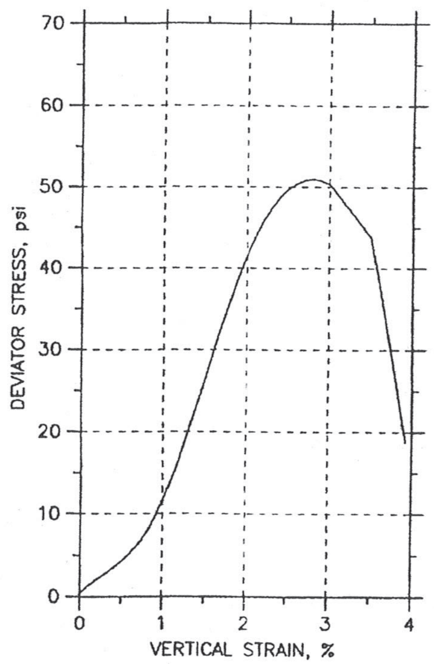
Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.



AMEREN ENERGY RESOURCES GENERATING COMPANY DUCK CREEK GENERATING STATION	
BOTTOM ASH AND LOW VOLUME WASTE BASIN PLAN	DRAWING NO. C-1000 REV. 0

TRIAXIAL COMPRESSION TEST REPORT





Symbol						
Test No.		1				
Initial	Diameter, in	2.875				
	Height, in	5.743				
	Water Content, %	16.07				
	Dry Density, pcf	108.63				
	Saturation, %	78.66				
	Void Ratio	0.55171				
Before Shear	Water Content, %	16.07				
	Dry Density, pcf	117.55				
	Saturation, %	100.00				
	Void Ratio	0.43397				
	Back Press., psi	---				
Minor Prin. Stress, psi		0				
Max. Dev. Stress, psi		50.961				
Time to Failure, min		1.8216				
Strain Rate, %/min		1.5				
B-Value		---				
Specific Gravity		2.70				
Liquid Limit		0				
Plastic Limit		0				
Plasticity Index		0				
Failure Sketch						

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-1
Sample Type: Tube 2-3
Description: Brn. & gray vf. sandy silt.
Remarks:

Mon, 10-APR-2006 14:34:02

TRIAXIAL TEST

'roject: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010

;oring No.: B-1
Tested By: Rin
Checked By: JPK

;ample No.: 2-3
Test Date: 03/06/06
Depth: 2.8-3.3

'est No.: 1
Sample Type: Tube 2-3
Elevation: N/A

;oil Description: Brn. & gray vf. sandy silt.
Remarks:

;pecimen Height: 5.74 in
Piston Area: 0.20 in^2
Filter Correction: 0.00 psi

;pecimen Area: 6.49 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in

;pecimen Volume: 0.02 ft^3
Piston Weight: 0.50 lb
Correction Type: Uniform

.iquid Limit: 0
Plastic Limit: 0
Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
:ontainer ID	42	---		
/t. Container + Wet Soil, gm	64.31	1233.9	1233.9	0
/t. Container + Dry Soil, gm	55.92	1063.1	1063.1	0
/t. Container, gm	3.72	---	0	0
/t. Dry Soil, gm	52.2	1063.1	1063.1	0
/ater Content, %	16.07	16.07	16.07	0.00
/oid Ratio	---	0.55	0.43	---
)egree of Saturation, %	---	78.66	100.00	---
)ry Unit Weight, pcf	---	108.63	117.55	---

(nitial

:nd of Initialization

:nd of Consolidation/A

:nd of Saturation

:nd of Consolidation/B

:nd of Shear

\t Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-1
Sample No.: 2-3
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-3

Project No.: 03S5010
Checked By: JPK
Depth: 2.8-3.3
Elevation: N/A

Soil Description: Brn. & gray vf. sandy silt.
Remarks:

Specimen Height: 5.74 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

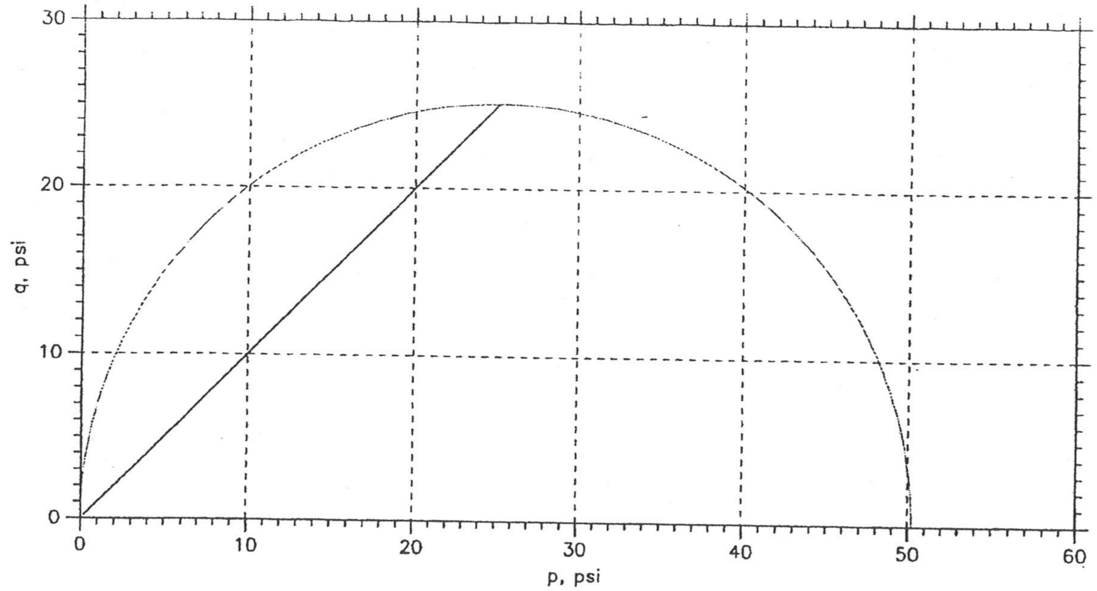
Liquid Limit: 0

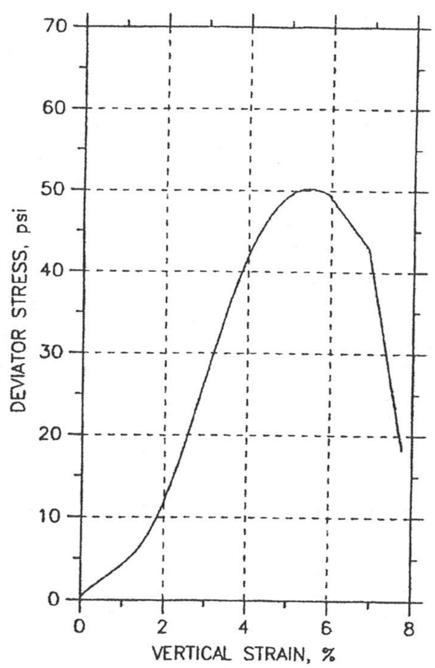
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4918	2.5658	0.39524	0.39524	0.19762	0.19762
2	0.0711	0.099749	6.4983	8.3699	1.288	1.288	0.64401	0.64401
3	0.13777	0.20145	6.5049	13.387	2.058	2.058	1.029	1.029
4	0.20027	0.30023	6.5114	17.814	2.7358	2.7358	1.3679	1.3679
5	0.2672	0.40487	6.5182	22.732	3.4875	3.4875	1.7438	1.7438
6	0.3297	0.50364	6.5247	27.848	4.2681	4.2681	2.134	2.134
7	0.3922	0.60143	6.5311	33.849	5.1827	5.1827	2.5913	2.5913
8	0.45887	0.70509	6.5379	41.227	6.3058	6.3058	3.1529	3.1529
9	0.52137	0.80191	6.5443	50.375	7.6976	7.6976	3.8488	3.8488
10	0.58803	0.90459	6.5511	62.672	9.5667	9.5667	4.7833	4.7833
11	0.65053	1.0004	6.5574	76.248	11.628	11.628	5.8139	5.8139
12	0.7172	1.1041	6.5643	92.971	14.163	14.163	7.0816	7.0816
13	0.78387	1.2048	6.571	112.15	17.068	17.068	8.534	8.534
14	0.84637	1.3007	6.5774	131.93	20.058	20.058	10.029	10.029
15	0.90887	1.4004	6.584	152.78	23.205	23.205	11.603	11.603
16	0.97553	1.5031	6.5909	175.31	26.599	26.599	13.299	13.299
17	1.038	1.6009	6.5974	196.85	29.838	29.838	14.919	14.919
18	1.1047	1.7036	6.6043	218.59	33.099	33.099	16.549	16.549
19	1.1672	1.8004	6.6108	238.37	36.057	36.057	18.029	18.029
20	1.238	1.9031	6.6177	258.14	39.007	39.007	19.504	19.504
21	1.3005	1.9999	6.6243	274.86	41.493	41.493	20.747	20.747
22	1.3672	2.1006	6.6311	290.6	43.824	43.824	21.912	21.912
23	1.4339	2.2043	6.6381	304.08	45.808	45.808	22.904	22.904
24	1.4964	2.3021	6.6448	314.8	47.376	47.376	23.688	23.688
25	1.563	2.4047	6.6518	324.05	48.716	48.716	24.358	24.358
26	1.6255	2.5025	6.6584	331.04	49.717	49.717	24.858	24.858
27	1.6922	2.6052	6.6655	336.35	50.461	50.461	25.231	25.231
28	1.755	2.702	6.6721	339.3	50.853	50.853	25.427	25.427
29	1.8216	2.8057	6.6792	340.38	50.961	50.961	25.481	25.481
30	1.8841	2.9015	6.6858	339.5	50.779	50.779	25.389	25.389
31	1.9508	3.0042	6.6929	337.04	50.357	50.357	25.179	25.179
32	2.2675	3.5	6.7273	294.83	43.827	43.827	21.913	21.913
33	2.5425	3.9264	6.7571	126.61	18.738	18.738	9.369	9.369

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		2			
Initial	Diameter, in	2.855			
	Height, in	2.909			
	Water Content, %	23.02			
	Dry Density, pcf	93.797			
	Saturation, %	77.97			
	Void Ratio	0.79702			
Before Shear	Water Content, %	23.02			
	Dry Density, pcf	103.96			
	Saturation, %	100.00			
	Void Ratio	0.62143			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		50.224			
Time to Failure, min		1.8216			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-1
Sample Type: Tube 5-1
Description: Brn. vf. sandy silt.
Remarks:

Mon, 10-APR-2006 14:34:41

TRIAXIAL TEST

'roject: Duck Creek Ash Pond
Boring No.: B-1
Sample No.: 5-1
Test No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 5-1

Project No.: 03S5010
Checked By: JPK
Depth: 8.0-8.5
Elevation: N/A

Soil Description: Brn. vf. sandy silt.
Remarks:

Specimen Height: 2.91 in
Specimen Area: 6.40 in^2
Specimen Volume: 0.01 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	41	---		
Wt. Container + Wet Soil, gm	82.68	564.05	564.05	0
Wt. Container + Dry Soil, gm	67.92	458.52	458.52	0
Wt. Container, gm	3.79	---	0	0
Wt. Dry Soil, gm	64.13	458.52	458.52	0
Water Content, %	23.02	23.02	23.02	0.00
Void Ratio	---	0.80	0.62	---
Degree of Saturation, %	---	77.97	100.00	---
Dry Unit Weight, pcf	---	93.797	103.96	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

roject: Duck Creek Ash Pond
oring No.: B-1
ample No.: 5-1
est No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 5-1

Project No.: 03S5010
Checked By: JPK
Depth: 8.0-8.5
Elevation: N/A

oil Description: Brn. vf. sandy silt.
emarks:

pecimen Height: 2.91 in
pecimen Area: 6.40 in^2
pecimen Volume: 0.01 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

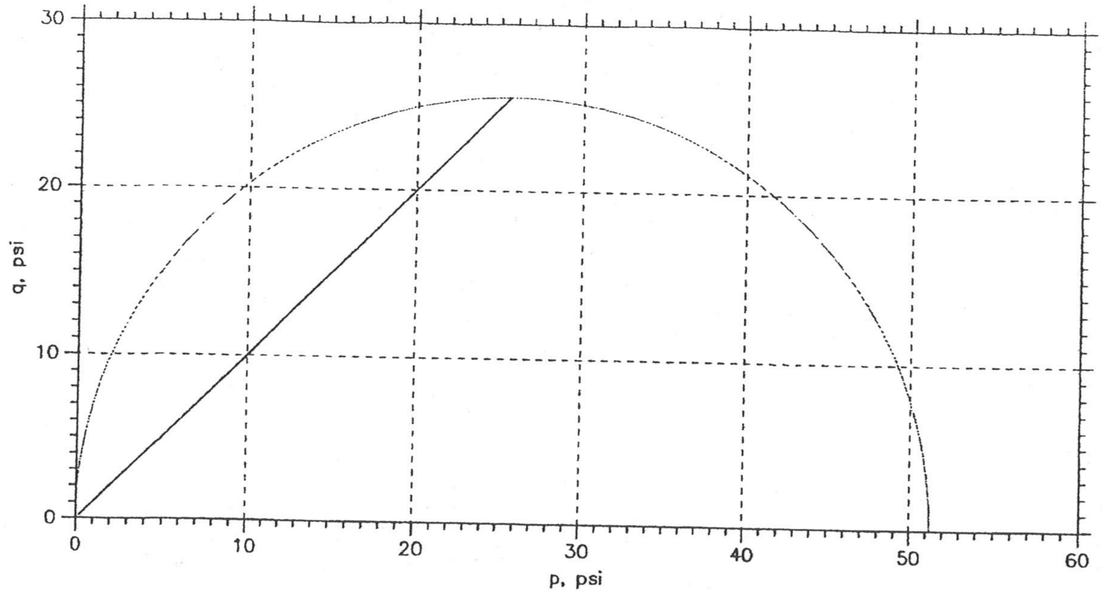
iquid Limit: 0

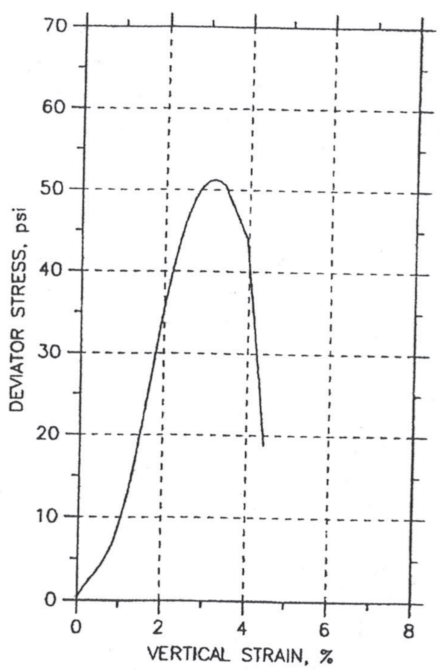
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4018	2.5658	0.4008	0.4008	0.2004	0.2004
2	0.0711	0.19693	6.4144	8.3699	1.3049	1.3049	0.65243	0.65243
3	0.13777	0.39772	6.4274	13.387	2.0828	2.0828	1.0414	1.0414
4	0.20027	0.59271	6.44	17.814	2.7661	2.7661	1.3831	1.3831
5	0.2672	0.79929	6.4534	22.732	3.5226	3.5226	1.7613	1.7613
6	0.3297	0.99429	6.4661	27.848	4.3068	4.3068	2.1534	2.1534
7	0.3922	1.1874	6.4787	33.849	5.2246	5.2246	2.6123	2.6123
8	0.45887	1.392	6.4922	41.227	6.3502	6.3502	3.1751	3.1751
9	0.52137	1.5831	6.5048	50.375	7.7444	7.7444	3.8722	3.8722
10	0.58803	1.7859	6.5182	62.672	9.6149	9.6149	4.8075	4.8075
11	0.65053	1.9751	6.5308	76.248	11.675	11.675	5.8376	5.8376
12	0.7172	2.1797	6.5445	92.971	14.206	14.206	7.1031	7.1031
13	0.78387	2.3786	6.5578	112.15	17.102	17.102	8.5512	8.5512
14	0.84637	2.5678	6.5705	131.93	20.079	20.079	10.039	10.039
15	0.90887	2.7647	6.5838	152.78	23.206	23.206	11.603	11.603
16	0.97553	2.9674	6.5976	175.31	26.572	26.572	13.286	13.286
17	1.038	3.1605	6.6107	196.85	29.778	29.778	14.889	14.889
18	1.1047	3.3632	6.6246	218.59	32.997	32.997	16.499	16.499
19	1.1672	3.5543	6.6377	238.37	35.911	35.911	17.955	17.955
20	1.238	3.7571	6.6517	258.14	38.808	38.808	19.404	19.404
21	1.3005	3.9482	6.6649	274.86	41.24	41.24	20.62	20.62
22	1.3672	4.1471	6.6788	290.6	43.512	43.512	21.756	21.756
23	1.4339	4.3517	6.6931	304.08	45.432	45.432	22.716	22.716
24	1.4964	4.5448	6.7066	314.8	46.939	46.939	23.47	23.47
25	1.563	4.7475	6.7209	324.05	48.216	48.216	24.108	24.108
26	1.6255	4.9406	6.7345	331.04	49.155	49.155	24.577	24.577
27	1.6922	5.1433	6.7489	336.35	49.837	49.837	24.919	24.919
28	1.755	5.3344	6.7625	339.3	50.173	50.173	25.087	25.087
29	1.8216	5.5391	6.7772	340.38	50.224	50.224	25.112	25.112
30	1.8841	5.7283	6.7908	339.5	49.993	49.993	24.997	24.997
31	1.9508	5.931	6.8054	337.04	49.525	49.525	24.762	24.762
32	2.2675	6.9098	6.877	294.83	42.872	42.872	21.436	21.436
33	2.5425	7.7516	6.9397	126.61	18.245	18.245	9.1225	9.1225

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		3			
Initial	Diameter, in	2.862			
	Height, in	5.091			
	Water Content, %	18.82			
	Dry Density, pcf	115.2			
	Saturation, %	109.70			
	Void Ratio	0.46321			
Before Shear	Water Content, %	18.82			
	Dry Density, pcf	111.76			
	Saturation, %	100.00			
	Void Ratio	0.50813			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		51.235			
Time to Failure, min		1.8216			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-1
Sample Type: Tube 8-3
Description: Brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Remarks:

Mon, 10-APR-2006 14:36:35

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-1
Sample No.: 8-3
Test No.: 3

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 8-3

Project No.: 03S5010
Checked By: JPK
Depth: 24.0-24.5
Elevation: N/A

Soil Description: Brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Remarks:

Specimen Height: 5.09 in
Specimen Area: 6.43 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	40	---		
Wt. Container + Wet Soil, gm	44.14	1176.7	1176.7	0
Wt. Container + Dry Soil, gm	37.73	990.36	990.36	0
Wt. Container, gm	3.67	---	0	0
Wt. Dry Soil, gm	34.06	990.36	990.36	0
Water Content, %	18.82	18.82	18.82	0.00
Void Ratio	---	0.46	0.51	---
Degree of Saturation, %	---	109.70	100.00	---
Dry Unit Weight, pcf	---	115.2	111.76	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-1
Sample No.: 8-3
Test No.: 3

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 8-3

Project No.: 03S5010
Checked By: JPK
Depth: 24.0-24.5
Elevation: N/A

Soil Description: Brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Remarks:

Specimen Height: 5.09 in
Specimen Area: 6.43 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

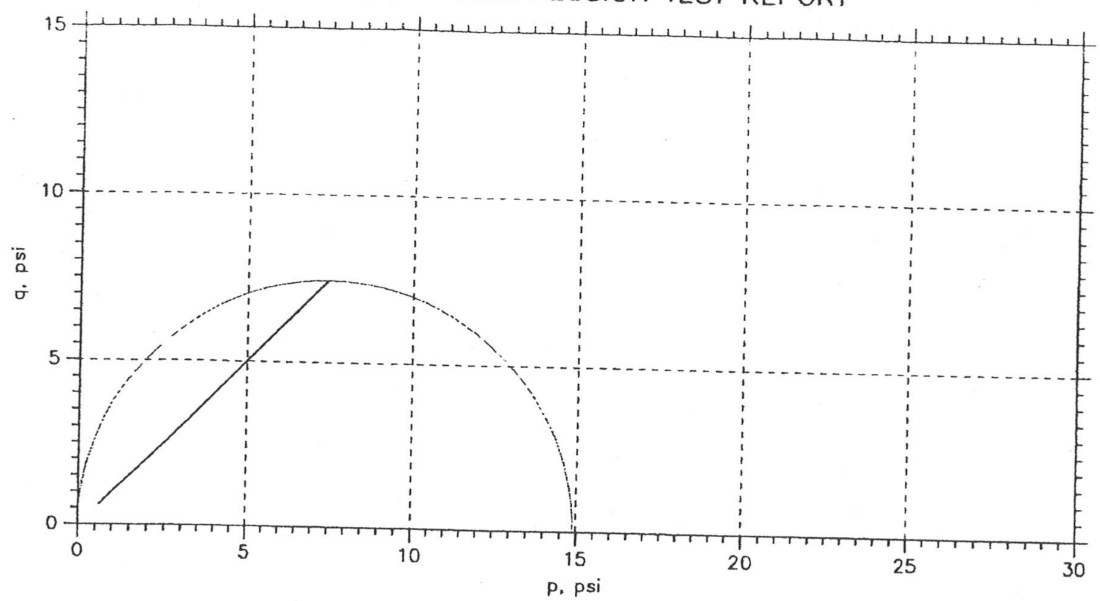
Liquid Limit: 0

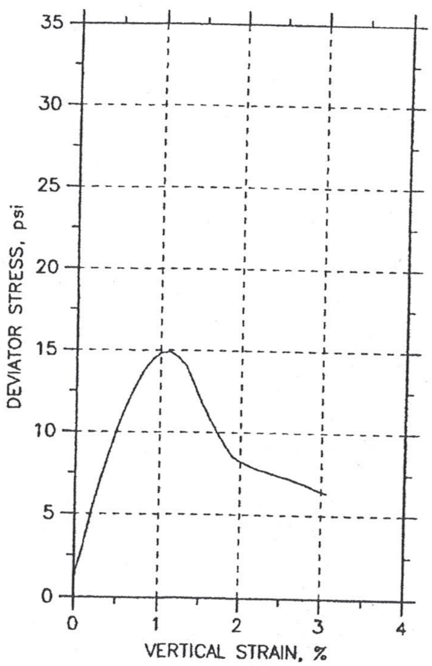
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4332	2.5658	0.39884	0.39884	0.19942	0.19942
2	0.0711	0.11252	6.4405	8.3699	1.2996	1.2996	0.64979	0.64979
3	0.13777	0.22725	6.4479	13.387	2.0762	2.0762	1.0381	1.0381
4	0.20027	0.33868	6.4551	17.814	2.7596	2.7596	1.3798	1.3798
5	0.2672	0.45672	6.4627	22.732	3.5175	3.5175	1.7587	1.7587
6	0.3297	0.56814	6.47	27.848	4.3042	4.3042	2.1521	2.1521
7	0.3922	0.67845	6.4772	33.849	5.2258	5.2258	2.6129	2.6129
8	0.45887	0.79539	6.4848	41.227	6.3574	6.3574	3.1787	3.1787
9	0.52137	0.90461	6.492	50.375	7.7597	7.7597	3.8798	3.8798
10	0.58803	1.0204	6.4996	62.672	9.6425	9.6425	4.8213	4.8213
11	0.65053	1.1286	6.5067	76.248	11.718	11.718	5.8592	5.8592
12	0.7172	1.2455	6.5144	92.971	14.272	14.272	7.1359	7.1359
13	0.78387	1.3591	6.5219	112.15	17.197	17.197	8.5983	8.5983
14	0.84637	1.4672	6.529	131.93	20.206	20.206	10.103	10.103
15	0.90887	1.5798	6.5365	152.78	23.374	23.374	11.687	11.687
16	0.97553	1.6956	6.5442	175.31	26.789	26.789	13.394	13.394
17	1.038	1.8059	6.5515	196.85	30.047	30.047	15.023	15.023
18	1.1047	1.9217	6.5593	218.59	33.326	33.326	16.663	16.663
19	1.1672	2.031	6.5666	238.37	36.3	36.3	18.15	18.15
20	1.238	2.1468	6.5744	258.14	39.265	39.265	19.632	19.632
21	1.3005	2.256	6.5817	274.86	41.762	41.762	20.881	20.881
22	1.3672	2.3696	6.5894	290.6	44.102	44.102	22.051	22.051
23	1.4339	2.4866	6.5973	304.08	46.092	46.092	23.046	23.046
24	1.4964	2.5969	6.6047	314.8	47.663	47.663	23.832	23.832
25	1.563	2.7127	6.6126	324.05	49.005	49.005	24.502	24.502
26	1.6255	2.823	6.6201	331.04	50.004	50.004	25.002	25.002
27	1.6922	2.9389	6.628	336.35	50.746	50.746	25.373	25.373
28	1.755	3.0481	6.6355	339.3	51.134	51.134	25.567	25.567
29	1.8216	3.165	6.6435	340.38	51.235	51.235	25.618	25.618
30	1.8841	3.2731	6.6509	339.5	51.045	51.045	25.522	25.522
31	1.9508	3.389	6.6589	337.04	50.614	50.614	25.307	25.307
32	2.2675	3.9483	6.6977	294.83	44.02	44.02	22.01	22.01
33	2.5425	4.4293	6.7314	126.61	18.81	18.81	9.4048	9.4048

TRIAXIAL COMPRESSION TEST REPORT





Symbol						
Test No.		1				
Initial	Diameter, in	2.798				
	Height, in	5.287				
	Water Content, %	18.06				
	Dry Density, pcf	92.303				
	Saturation, %	59.02				
	Void Ratio	0.82612				
Before Shear	Water Content, %	18.06				
	Dry Density, pcf	113.31				
	Saturation, %	100.00				
	Void Ratio	0.48757				
	Back Press., psi	---				
Minor Prin. Stress, psi		0				
Max. Dev. Stress, psi		14.906				
Time to Failure, min		0.7086				
Strain Rate, %/min		1.5				
B-Value		---				
Specific Gravity		2.70				
Liquid Limit		0				
Plastic Limit		0				
Plasticity Index		0				
Failure Sketch						

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-2
Sample Type: Tube 2-2
Description: Brn. vf. sandy silt.
Remarks:

Mon, 10-APR-2006 14:40:44

TRIAXIAL TEST

roject: Duck Creek Ash Pond
oring No.: B-2
ample No.: 2-2
est No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-2

Project No.: 0355010
Checked By: JPK
Depth: 2.5-3.0
Elevation: N/A

oil Description: Brn. vf. sandy silt.
emarks:

pecimen Height: 5.29 in
pecimen Area: 6.15 in^2
pecimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

iquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
ontainer ID	39	---		
t. Container + Wet Soil, gm	87.1	929.88	929.88	0
t. Container + Dry Soil, gm	74.34	787.64	787.64	0
t. Container, gm	3.68	---	0	0
t. Dry Soil, gm	70.66	787.64	787.64	0
ater Content, %	18.06	18.06	18.06	0.00
oid Ratio	---	0.83	0.49	---
egree of Saturation, %	---	59.02	100.00	---
ry Unit Weight, pcf	---	92.303	113.31	---

nitial

nd of Initialization

nd of Consolidation/A

nd of Saturation

nd of Consolidation/B

nd of Shear

t Failure

TRIAXIAL TEST

roject: Duck Creek Ash Pond
oring No.: B-2
ample No.: 2-2
est No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-2

Project No.: 0355010
Checked By: JPK
Depth: 2.5-3.0
Elevation: N/A

oil Description: Brn. vf. sandy silt.
emarks:

pecimen Height: 5.29 in
pecimen Area: 6.15 in^2
pecimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

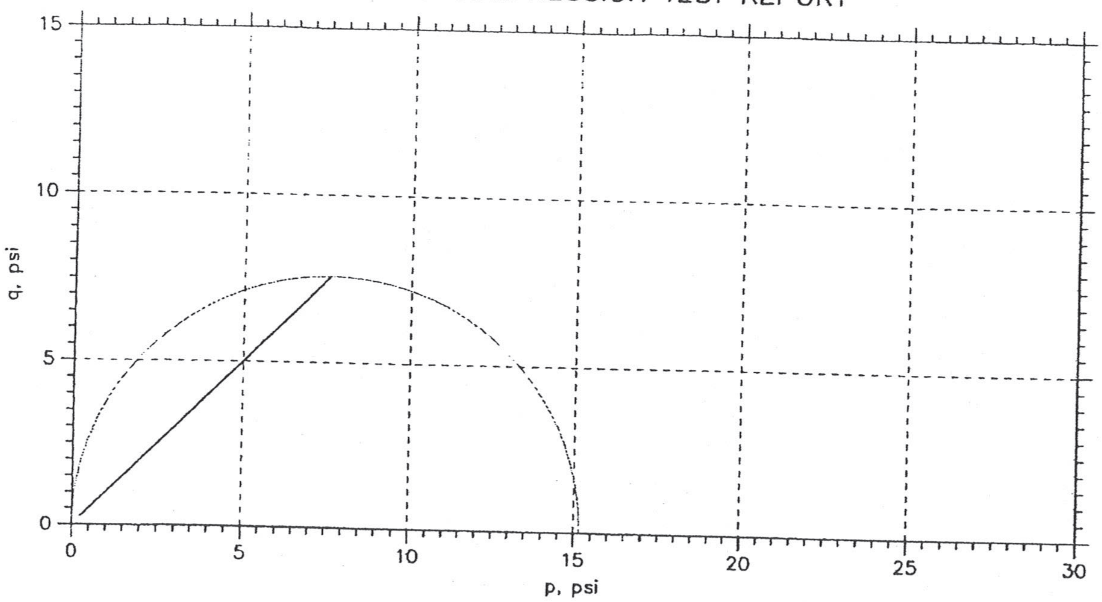
iquid Limit: 0

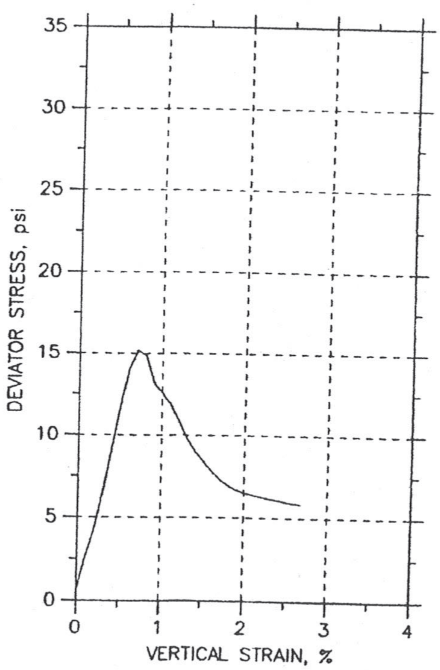
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.1487	7.4845	1.2172	1.2172	0.60862	0.60862
2	0.0711	0.10198	6.155	18.502	3.0061	3.0061	1.503	1.503
3	0.13777	0.20502	6.1614	32.767	5.3181	5.3181	2.659	2.659
4	0.20027	0.30381	6.1675	44.276	7.179	7.179	3.5895	3.5895
5	0.26277	0.40154	6.1735	54.015	8.7495	8.7495	4.3748	4.3748
6	0.32943	0.50246	6.1798	63.656	10.301	10.301	5.1503	5.1503
7	0.39193	0.60338	6.1861	71.919	11.626	11.626	5.813	5.813
8	0.45443	0.70217	6.1922	79.297	12.806	12.806	6.403	6.403
9	0.51693	0.80096	6.1984	85.298	13.761	13.761	6.8807	6.8807
10	0.5836	0.90506	6.2049	89.823	14.476	14.476	7.2381	7.2381
11	0.6461	1.0039	6.2111	92.184	14.842	14.842	7.4209	7.4209
12	0.7086	1.1016	6.2172	92.676	14.906	14.906	7.4532	7.4532
13	0.77527	1.2046	6.2237	91.004	14.622	14.622	7.3111	7.3111
14	0.83777	1.3024	6.2299	88.052	14.134	14.134	7.067	7.067
15	0.90027	1.399	6.236	81.56	13.079	13.079	6.5395	6.5395
16	0.96693	1.5042	6.2426	73.887	11.836	11.836	5.9179	5.9179
17	1.0297	1.6019	6.2488	67.787	10.848	10.848	5.424	5.424
18	1.0922	1.6996	6.255	62.672	10.019	10.019	5.0097	5.0097
19	1.163	1.8038	6.2617	57.36	9.1605	9.1605	4.5802	4.5802
20	1.2255	1.9004	6.2678	53.425	8.5237	8.5237	4.2618	4.2618
21	1.2922	2.0045	6.2745	51.654	8.2324	8.2324	4.1162	4.1162
22	1.3547	2.0991	6.2806	50.277	8.0052	8.0052	4.0026	4.0026
23	1.4255	2.2053	6.2874	48.9	7.7774	7.7774	3.8887	3.8887
24	1.488	2.303	6.2937	48.113	7.6446	7.6446	3.8223	3.8223
25	1.5505	2.3997	6.2999	47.227	7.4965	7.4965	3.7483	3.7483
26	1.6172	2.5006	6.3064	46.342	7.3484	7.3484	3.6742	3.6742
27	1.6839	2.6015	6.313	45.555	7.2161	7.2161	3.6081	3.6081
28	1.7464	2.6993	6.3193	44.473	7.0376	7.0376	3.5188	3.5188
29	1.813	2.8012	6.3259	43.391	6.8592	6.8592	3.4296	3.4296
30	1.8797	2.9043	6.3326	42.014	6.6345	6.6345	3.3172	3.3172
31	1.9422	3.0009	6.339	40.735	6.4261	6.4261	3.2131	3.2131
32	1.9839	3.0636	6.3431	40.243	6.3444	6.3444	3.1722	3.1722

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		2			
Initial	Diameter, in	2.825			
	Height, in	5.581			
	Water Content, %	17.84			
	Dry Density, pcf	99.818			
	Saturation, %	69.96			
	Void Ratio	0.68862			
Before Shear	Water Content, %	17.84			
	Dry Density, pcf	113.75			
	Saturation, %	100.00			
	Void Ratio	0.48177			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		15.18			
Time to Failure, min		0.45417			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-2
Sample Type: Tube 5-2
Description: Red. brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Remarks:

Wed, 08-MAR-2006 09:33:01

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-2
Sample No.: 5-2
Test No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 5-2

Project No.: 03S5010
Checked By: JPK
Depth: 8.5-9.0
Elevation: N/A

Soil Description: Red. brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Remarks:

Specimen Height: 5.58 in
Specimen Area: 6.27 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	38	---		
Wt. Container + Wet Soil, gm	61.29	1080.1	1080.1	0
Wt. Container + Dry Soil, gm	52.57	916.58	916.58	0
Wt. Container, gm	3.7	---	0	0
Wt. Dry Soil, gm	48.87	916.58	916.58	0
Water Content, %	17.84	17.84	17.84	0.00
Void Ratio	---	0.69	0.48	---
Degree of Saturation, %	---	69.96	100.00	---
Dry Unit Weight, pcf	---	99.818	113.75	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-2
Sample No.: 5-2
Test No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 5-2

Project No.: 03S5010
Checked By: JPK
Depth: 8.5-9.0
Elevation: N/A

Soil Description: Red. brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Remarks:

Specimen Height: 5.58 in
Specimen Area: 6.27 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

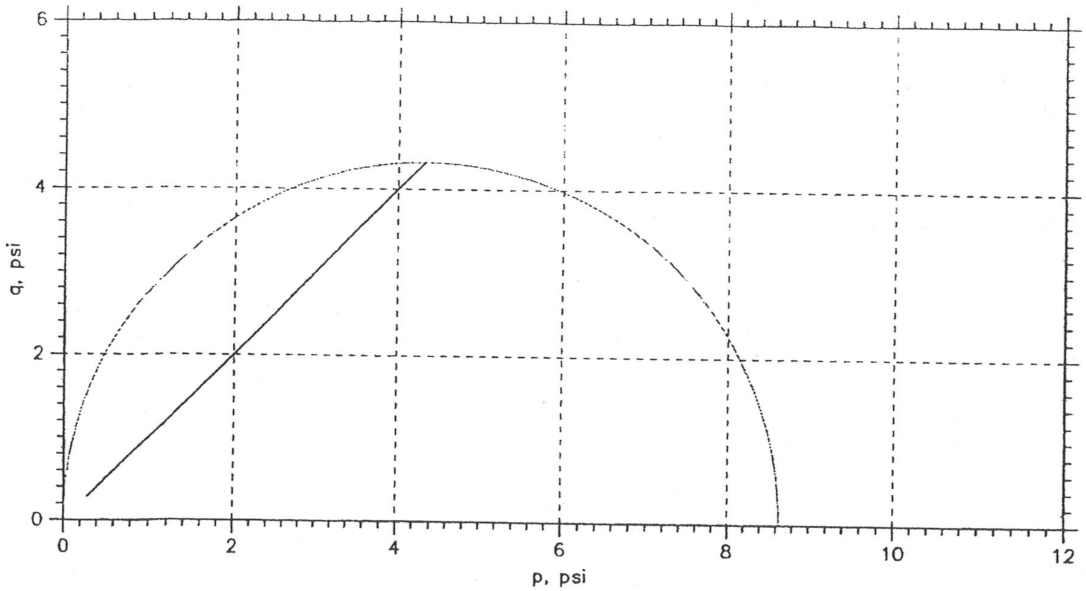
Liquid Limit: 0

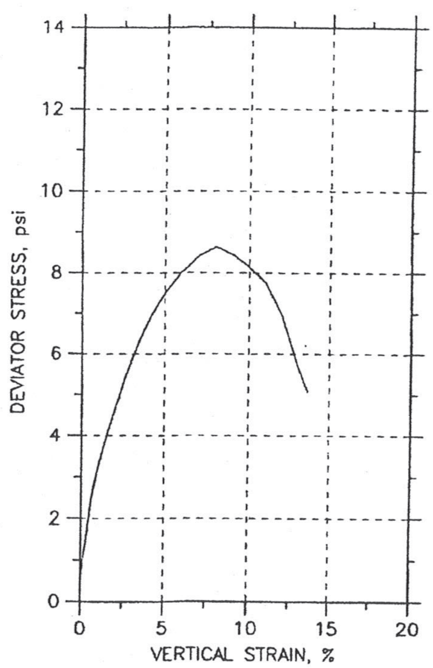
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.268	3.2545	0.51922	0.51922	0.25961	0.25961
2	0.070833	0.10164	6.2743	15.945	2.5412	2.5412	1.2706	1.2706
3	0.13333	0.20026	6.2805	26.274	4.1834	4.1834	2.0917	2.0917
4	0.2	0.30391	6.2871	40.932	6.5104	6.5104	3.2552	3.2552
5	0.2625	0.40052	6.2932	57.852	9.1928	9.1928	4.5964	4.5964
6	0.325	0.49914	6.2994	73.887	11.729	11.729	5.8646	5.8646
7	0.39167	0.60379	6.306	88.348	14.01	14.01	7.005	7.005
8	0.45417	0.70241	6.3123	95.824	15.18	15.18	7.5902	7.5902
9	0.51667	0.80103	6.3186	93.856	14.854	14.854	7.427	7.427
10	0.58333	0.90368	6.3251	83.035	13.128	13.128	6.5639	6.5639
11	0.64583	1.0033	6.3315	79.396	12.54	12.54	6.2699	6.2699
12	0.70833	1.1009	6.3377	75.461	11.907	11.907	5.9533	5.9533
13	0.77083	1.2015	6.3442	69.165	10.902	10.902	5.451	5.451
14	0.83333	1.3002	6.3505	62.574	9.8533	9.8533	4.9266	4.9266
15	0.9	1.4048	6.3573	57.557	9.0537	9.0537	4.5268	4.5268
16	0.9625	1.5034	6.3636	53.72	8.4417	8.4417	4.2209	4.2209
17	1.025	1.6001	6.3699	49.982	7.8466	7.8466	3.9233	3.9233
18	1.0919	1.7037	6.3766	46.834	7.3446	7.3446	3.6723	3.6723
19	1.1586	1.8003	6.3829	44.571	6.983	6.983	3.4915	3.4915
20	1.2253	1.905	6.3897	42.702	6.683	6.683	3.3415	3.3415
21	1.2878	2.0026	6.3961	41.522	6.4918	6.4918	3.2459	3.2459
22	1.3503	2.1002	6.4024	40.932	6.3931	6.3931	3.1966	3.1966
23	1.4169	2.2028	6.4092	40.145	6.2636	6.2636	3.1318	3.1318
24	1.4794	2.2994	6.4155	39.456	6.1501	6.1501	3.0751	3.0751
25	1.5461	2.4021	6.4222	39.062	6.0824	6.0824	3.0412	3.0412
26	1.6128	2.5047	6.429	38.374	5.9689	5.9689	2.9844	2.9844
27	1.6753	2.6013	6.4354	37.882	5.8865	5.8865	2.9433	2.9433
28	1.7211	2.6708	6.44	37.587	5.8365	5.8365	2.9182	2.9182

TRIAXIAL COMPRESSION TEST REPORT





Symbol						
Test No.		1				
Initial	Diameter, in	2.81				
	Height, in	5.343				
	Water Content, %	22.37				
	Dry Density, pcf	97.962				
	Saturation, %	83.81				
	Void Ratio	0.72061				
Before Shear	Water Content, %	22.37				
	Dry Density, pcf	105.09				
	Saturation, %	100.00				
	Void Ratio	0.60392				
	Back Press., psi	---				
Minor Prin. Stress, psi		0				
Max. Dev. Stress, psi		8.6405				
Time to Failure, min		5.4688				
Strain Rate, %/min		1.5				
B-Value		---				
Specific Gravity		2.70				
Liquid Limit		0				
Plastic Limit		0				
Plasticity Index		0				
Failure Sketch						

Project: Duck Creek Ash Pond	
Location: Canton, Illinois	
Project No.: 03S5010	
Boring No.: B-3	
Sample Type: Tube 6-1	
Description: Brn. & gray vf. sandy silt (tr. clay).	
Remarks:	

Mon, 10-APR-2006 14:44:01

TRIAXIAL TEST

'roject: Duck Creek Ash Pond
:oring No.: B-3
:ample No.: 6-1
'est No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 6-1

Project No.: 03S5010
Checked By: JPK
Depth: 13.0-13.5
Elevation: N/A

:oil Description: Brn. & gray vf. sandy silt (tr. clay).
:emarks:

;pecimen Height: 5.34 in
;pecimen Area: 6.20 in^2
;pecimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

.iquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
:ontainer ID	37	---		
't. Container + Wet Soil, gm	118.95	1042.6	1042.6	0
't. Container + Dry Soil, gm	97.88	852.06	852.06	0
't. Container, gm	3.68	---	0	0
't. Dry Soil, gm	94.2	852.06	852.06	0
'ater Content, %	22.37	22.37	22.37	0.00
'oid Ratio	---	0.72	0.60	---
'egree of Saturation, %	---	83.81	100.00	---
'ry Unit Weight, pcf	---	97.962	105.09	---

:nitial

:nd of Initialization

:nd of Consolidation/A

:nd of Saturation

:nd of Consolidation/B

:nd of Shear

't Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-5
Sample No.: 6-1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 6-1

Project No.: 03S5010
Checked By: JPK
Depth: 13.0-13.5
Elevation: N/A

Soil Description: Brn. & gray vf. sandy silt (tr. clay).
Remarks:

Specimen Height: 5.34 in
Specimen Area: 6.20 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

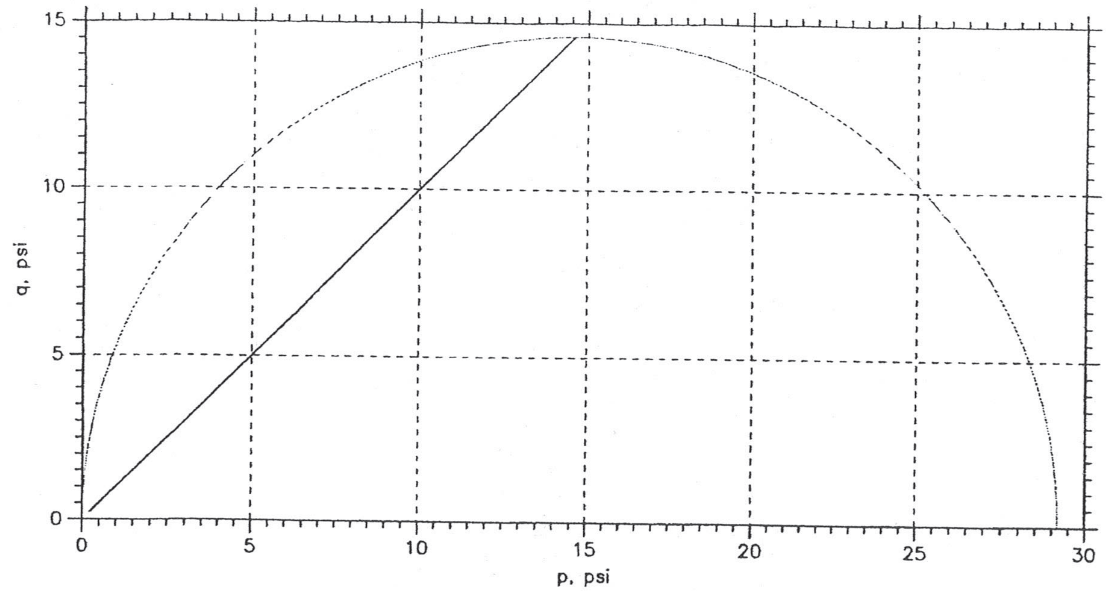
Liquid Limit: 0

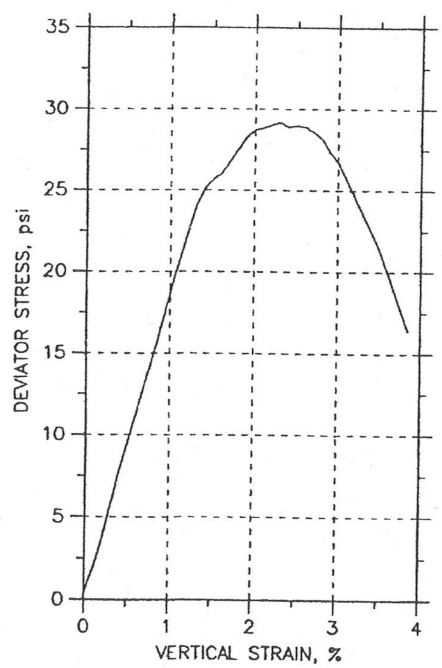
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.2016	3.5496	0.57237	0.57237	0.28618	0.28618
2	0.075267	0.10511	6.2081	5.9105	0.95207	0.95207	0.47603	0.47603
3	0.13777	0.20182	6.2141	7.3861	1.1886	1.1886	0.5943	0.5943
4	0.20443	0.30273	6.2204	9.1569	1.4721	1.4721	0.73603	0.73603
5	0.2711	0.40469	6.2268	11.026	1.7707	1.7707	0.88537	0.88537
6	0.3336	0.49929	6.2327	12.993	2.0847	2.0847	1.0424	1.0424
7	0.40027	0.60231	6.2392	14.863	2.3821	2.3821	1.1911	1.1911
8	0.46693	0.70427	6.2456	16.535	2.6475	2.6475	1.3237	1.3237
9	0.53387	0.80518	6.2519	17.814	2.8493	2.8493	1.4247	1.4247
10	0.60053	0.90504	6.2582	18.994	3.0351	3.0351	1.5175	1.5175
11	0.6672	1.0059	6.2646	20.076	3.2047	3.2047	1.6024	1.6024
12	0.7297	1.1006	6.2706	21.06	3.3585	3.3585	1.6793	1.6793
13	0.79637	1.1994	6.2769	22.044	3.5119	3.5119	1.756	1.756
14	0.86303	1.3003	6.2833	22.929	3.6492	3.6492	1.8246	1.8246
15	0.9297	1.3991	6.2896	23.815	3.7863	3.7863	1.8932	1.8932
16	1.0005	1.5042	6.2963	24.798	3.9386	3.9386	1.9693	1.9693
17	1.0672	1.6041	6.3027	25.782	4.0906	4.0906	2.0453	2.0453
18	1.1341	1.705	6.3092	26.569	4.2112	4.2112	2.1056	2.1056
19	1.205	1.8048	6.3156	27.454	4.3471	4.3471	2.1735	2.1735
20	1.2716	1.9047	6.322	28.34	4.4827	4.4827	2.2414	2.2414
21	1.3383	2.0045	6.3284	29.127	4.6025	4.6025	2.3013	2.3013
22	1.405	2.1033	6.3348	30.012	4.7376	4.7376	2.3688	2.3688
23	1.4716	2.2022	6.3412	30.701	4.8414	4.8414	2.4207	2.4207
24	1.5383	2.2999	6.3476	31.586	4.9761	4.9761	2.488	2.488
25	1.6091	2.404	6.3543	32.471	5.1101	5.1101	2.5551	2.5551
26	1.6758	2.5007	6.3606	33.258	5.2288	5.2288	2.6144	2.6144
27	1.7466	2.6047	6.3674	34.144	5.3622	5.3622	2.6811	2.6811
28	1.8133	2.7036	6.3739	34.931	5.4803	5.4803	2.7401	2.7401
29	1.88	2.7992	6.3802	35.619	5.5828	5.5828	2.7914	2.7914
30	1.9508	2.9022	6.3869	36.406	5.7001	5.7001	2.8501	2.8501
31	2.0177	3.001	6.3935	37.292	5.8328	5.8328	2.9164	2.9164
32	2.3641	3.5045	6.4268	40.833	6.3536	6.3536	3.1768	3.1768
33	2.7057	4.0038	6.4602	43.883	6.7927	6.7927	3.3964	3.3964
34	3.0516	4.5031	6.494	46.539	7.1664	7.1664	3.5832	3.5832
35	3.3974	5.0024	6.5281	48.998	7.5057	7.5057	3.7528	3.7528
36	4.0977	6.0021	6.5976	53.031	8.038	8.038	4.019	4.019
37	4.7896	7.0017	6.6685	56.179	8.4246	8.4246	4.2123	4.2123
38	5.4688	8.0013	6.7409	58.245	8.6405	8.6405	4.3203	4.3203
39	6.1479	9.0052	6.8153	57.557	8.4452	8.4452	4.2226	4.2226
40	6.8274	10.003	6.8909	56.081	8.1385	8.1385	4.0692	4.0692
41	7.494	11	6.9681	54.015	7.7518	7.7518	3.8759	3.8759
42	8.1568	12.002	7.0474	48.998	6.9526	6.9526	3.4763	3.4763
43	8.8151	13.005	7.1286	40.636	5.7004	5.7004	2.8502	2.8502
44	9.2531	13.66	7.1827	36.308	5.0549	5.0549	2.5275	2.5275

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		1			
Initial	Diameter, in	2.87			
	Height, in	5.733			
	Water Content, %	18.05			
	Dry Density, pcf	111.29			
	Saturation, %	94.70			
	Void Ratio	0.51452			
Before Shear	Water Content, %	18.05			
	Dry Density, pcf	113.33			
	Saturation, %	100.00			
	Void Ratio	0.48724			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		29.193			
Time to Failure, min		1.6172			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond	
Location: Canton, Illinois	
Project No.: 03S5010	
Boring No.: B-4	
Sample Type: Tube 2-2	
Description: Brn. & gray vf. sandy silt / so. clay.	
Remarks:	

Wed, 08-MAR-2006 09:27:55

TRIAXIAL TEST

roject: Duck Creek Ash Pond
oring No.: B-4
ample No.: 2-2
est No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-2

Project No.: 03S5010
Checked By: JPK
Depth: 2.5-3.0
Elevation: N/A

oil Description: Brn. & gray vf. sandy silt / so. clay.
emarks:

p[illegible]n Height: 5.73 in
p[illegible]n Area: 6.47 in^2
pe[illegible]en Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

iquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
ontainer ID	33	---		
t. Container + Wet Soil, gm	77.14	1279	1279	0
t. Container + Dry Soil, gm	65.91	1083.5	1083.5	0
t. Container, gm	3.68	---	0	0
t. Dry Soil, gm	62.23	1083.5	1083.5	0
ater Content, %	18.05	18.05	18.05	0.00
oid Ratio	---	0.51	0.49	---
egree of Saturation, %	---	94.70	100.00	---
ry Unit Weight, pcf	---	111.29	113.33	---

nitial

nd of Initialization

nd of Consolidation/A

nd of Saturation

nd of Consolidation/B

nd of Shear

t Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-4
Sample No.: 2-2
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-2

Project No.: 0355010
Checked By: JPK
Depth: 2.5-3.0
Elevation: N/A

Soil Description: Brn. & gray vf. sandy silt / so. clay.
Remarks:

Specimen Height: 5.73 in
Specimen Area: 6.47 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

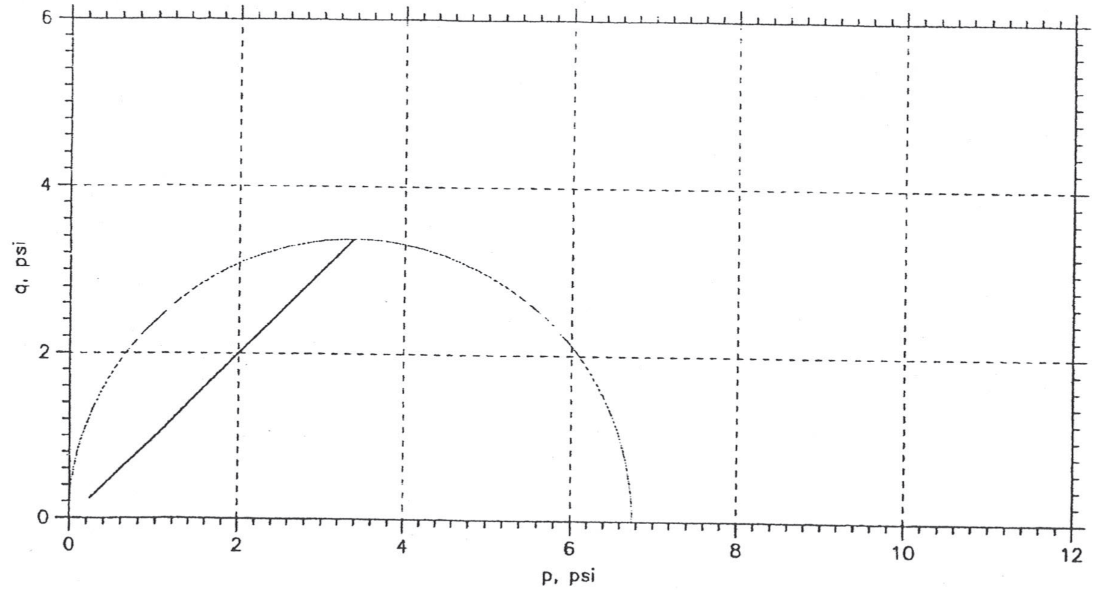
Liquid Limit: 0

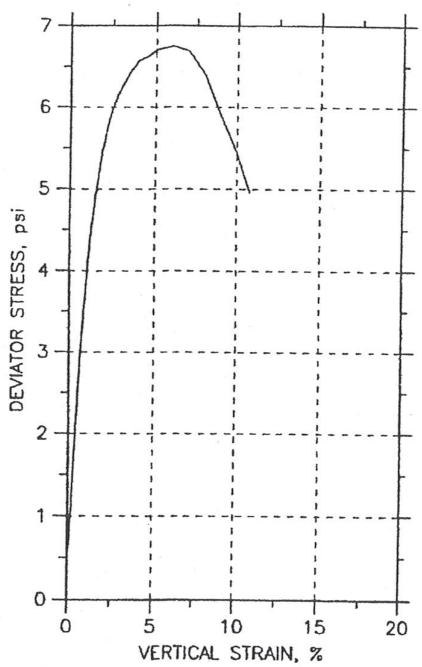
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4692	2.861	0.44224	0.44224	0.22112	0.22112
2	0.079433	0.10188	6.4758	12.403	1.9153	1.9153	0.95765	0.95765
3	0.15443	0.20474	6.4825	23.519	3.6281	3.6281	1.8141	1.8141
4	0.2211	0.29977	6.4887	36.406	5.6107	5.6107	2.8054	2.8054
5	0.29193	0.40067	6.4953	49.884	7.68	7.68	3.84	3.84
6	0.36277	0.50158	6.5019	61.983	9.5332	9.5332	4.7666	4.7666
7	0.4336	0.6015	6.5084	73.592	11.307	11.307	5.6536	5.6536
8	0.50443	0.69946	6.5148	85.2	13.078	13.078	6.5389	6.5389
9	0.57527	0.80037	6.5214	97.103	14.89	14.89	7.4449	7.4449
10	0.6461	0.90029	6.528	109.3	16.743	16.743	8.3717	8.3717
11	0.7211	1.0041	6.5349	122.38	18.728	18.728	9.364	9.364
12	0.78777	1.0992	6.5411	134.29	20.53	20.53	10.265	10.265
13	0.8586	1.201	6.5479	146.39	22.357	22.357	11.178	11.178
14	0.92943	1.3029	6.5546	157.41	24.014	24.014	12.007	12.007
15	1.0005	1.4058	6.5615	164.78	25.114	25.114	12.557	12.557
16	1.0672	1.5037	6.568	168.42	25.643	25.643	12.822	12.822
17	1.1339	1.6017	6.5746	171.08	26.022	26.022	13.011	13.011
18	1.2047	1.6997	6.5811	175.8	26.713	26.713	13.357	13.357
19	1.2755	1.8016	6.5879	181.31	27.522	27.522	13.761	13.761
20	1.3422	1.9005	6.5946	186.33	28.255	28.255	14.127	14.127
21	1.413	2.0053	6.6016	189.67	28.731	28.731	14.366	14.366
22	1.4797	2.1023	6.6082	190.66	28.852	28.852	14.426	14.426
23	1.5464	2.2003	6.6148	191.93	29.016	29.016	14.508	14.508
24	1.6172	2.3031	6.6218	193.31	29.193	29.193	14.597	14.597
25	1.6839	2.4021	6.6285	191.54	28.897	28.897	14.448	14.448
26	1.7505	2.501	6.6352	192.33	28.986	28.986	14.493	14.493
27	1.8214	2.6039	6.6422	191.93	28.896	28.896	14.448	14.448
28	1.888	2.7038	6.649	190.07	28.586	28.586	14.293	14.293
29	1.9547	2.8018	6.6557	187.51	28.172	28.172	14.086	14.086
30	2.0214	2.9007	6.6625	182.39	27.376	27.376	13.688	13.688
31	2.088	2.9997	6.6693	178.26	26.729	26.729	13.364	13.364
32	2.4302	3.4993	6.7038	143.93	21.47	21.47	10.735	10.735
33	2.6677	3.8529	6.7285	110.09	16.361	16.361	8.1807	8.1807

TRIAXIAL COMPRESSION TEST REPORT





Symbol						
Test No.		2				
Initial	Diameter, in	2.827				
	Height, in	5.231				
	Water Content, %	22.95				
	Dry Density, pcf	98.049				
	Saturation, %	86.18				
	Void Ratio	0.71909				
Before Shear	Water Content, %	22.95				
	Dry Density, pcf	104.07				
	Saturation, %	100.00				
	Void Ratio	0.6197				
	Back Press., psi	---				
Minor Prin. Stress, psi		0				
Max. Dev. Stress, psi		6.7485				
Time to Failure, min		3.9471				
Strain Rate, %/min		1.5				
B-Value		---				
Specific Gravity		2.70				
Liquid Limit		0				
Plastic Limit		0				
Plasticity Index		0				
Failure Sketch						

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-4
Sample Type: Tube 6-1
Description: Brn. & gray vf. sandy silt.
Remarks:

Wed, 08-MAR-2006 09:29:31

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-4
Sample No.: 6-1
Test No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 6-1

Project No.: 03S5010
Checked By: JPK
Depth: 13.0-13.5
Elevation:

Soil Description: Brn. & gray vf. sandy silt.
Remarks:

Specimen Height: 5.23 in
Specimen Area: 6.28 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	36	---		
Wt. Container + Wet Soil, gm	104.99	1039	1039	0
Wt. Container + Dry Soil, gm	86.08	845.07	845.07	0
Wt. Container, gm	3.69	---	0	0
Wt. Dry Soil, gm	82.39	845.07	845.07	0
Water Content, %	22.95	22.95	22.95	0.00
Void Ratio	---	0.72	0.62	---
Degree of Saturation, %	---	86.18	100.00	---
Dry Unit Weight, pcf	---	98.049	104.07	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-4
Sample No.: 6-1
Test No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 6-1

Project No.: 03S5010
Checked By: JPK
Depth: 13.0-13.5
Elevation:

Soil Description: Brn. & gray vf. sandy silt.
Remarks:

Specimen Height: 5.23 in
Specimen Area: 6.28 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

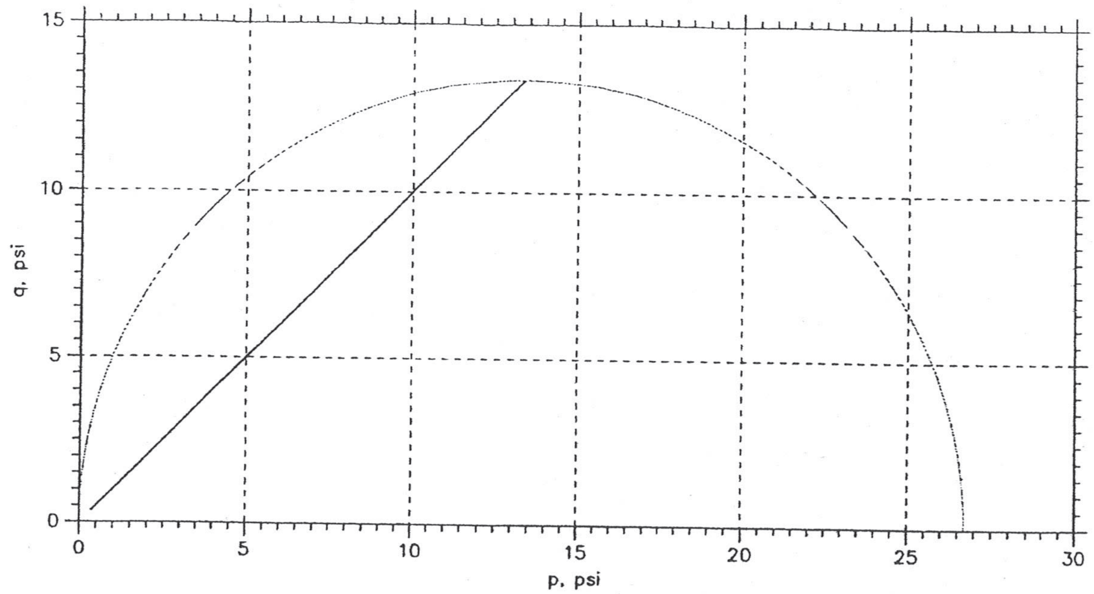
Liquid Limit: 0

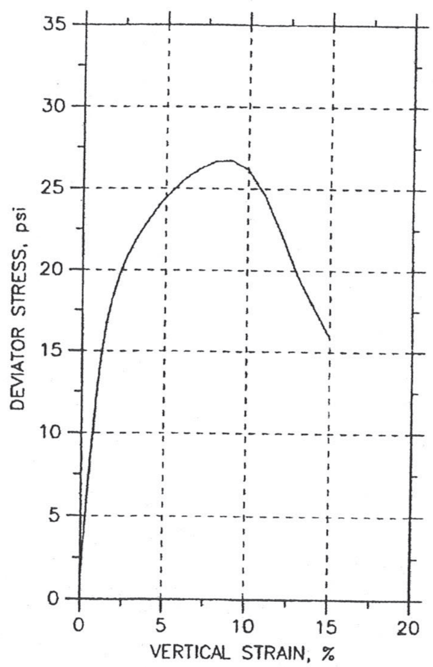
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.2768	2.9593	0.47147	0.47147	0.23573	0.23573
2	0.07135	0.09985	6.2831	4.6317	0.73716	0.73716	0.36858	0.36858
3	0.14218	0.20614	6.2898	6.9927	1.1117	1.1117	0.55587	0.55587
4	0.20885	0.30492	6.296	9.452	1.5013	1.5013	0.75063	0.75063
5	0.27552	0.40477	6.3024	11.911	1.89	1.89	0.94499	0.94499
6	0.34218	0.50354	6.3086	14.272	2.2624	2.2624	1.1312	1.1312
7	0.40885	0.60339	6.315	16.732	2.6495	2.6495	1.3248	1.3248
8	0.47135	0.69895	6.321	18.994	3.0049	3.0049	1.5025	1.5025
9	0.54218	0.80524	6.3278	21.257	3.3593	3.3593	1.6796	1.6796
10	0.60468	0.90402	6.3341	23.028	3.6355	3.6355	1.8177	1.8177
11	0.66718	1.0006	6.3403	24.7	3.8957	3.8957	1.9479	1.9479
12	0.73385	1.1016	6.3468	26.372	4.1552	4.1552	2.0776	2.0776
13	0.80052	1.2046	6.3534	27.848	4.3832	4.3832	2.1916	2.1916
14	0.86718	1.3045	6.3598	29.127	4.5798	4.5798	2.2899	2.2899
15	0.92968	1.4	6.366	30.209	4.7454	4.7454	2.3727	2.3727
16	0.99635	1.5031	6.3726	31.389	4.9256	4.9256	2.4628	2.4628
17	1.063	1.6062	6.3793	32.373	5.0747	5.0747	2.5373	2.5373
18	1.1258	1.7017	6.3855	33.258	5.2084	5.2084	2.6042	2.6042
19	1.1966	1.8048	6.3922	34.144	5.3415	5.3415	2.6707	2.6707
20	1.2591	1.9004	6.3984	34.931	5.4593	5.4593	2.7296	2.7296
21	1.3258	2.0024	6.4051	35.619	5.5611	5.5611	2.7805	2.7805
22	1.3883	2.099	6.4114	36.308	5.663	5.663	2.8315	2.8315
23	1.455	2.201	6.4181	36.997	5.7644	5.7644	2.8822	2.8822
24	1.5216	2.3041	6.4249	37.587	5.8502	5.8502	2.9251	2.9251
25	1.5841	2.3996	6.4312	38.177	5.9363	5.9363	2.9681	2.9681
26	1.6508	2.5005	6.4378	38.669	6.0065	6.0065	3.0033	3.0033
27	1.7175	2.6025	6.4446	38.964	6.046	6.046	3.023	3.023
28	1.78	2.6992	6.451	39.259	6.0858	6.0858	3.0429	3.0429
29	1.8386	2.799	6.4576	39.751	6.1557	6.1557	3.0779	3.0779
30	1.9052	2.901	6.4644	40.046	6.1949	6.1949	3.0974	3.0974
31	1.9719	2.9998	6.471	40.341	6.2342	6.2342	3.1171	3.1171
32	2.3011	3.499	6.5044	41.817	6.429	6.429	3.2145	3.2145
33	2.6388	4.0015	6.5385	42.997	6.576	6.576	3.288	3.288
34	2.968	4.5061	6.573	43.489	6.6163	6.6163	3.3082	3.3082
35	3.293	5.0022	6.6074	44.276	6.701	6.701	3.3505	3.3505
36	3.9471	6.0006	6.6775	45.063	6.7485	6.7485	3.3742	3.3742
37	4.6099	7.0034	6.7495	45.162	6.6911	6.6911	3.3455	3.3455
38	5.2724	7.9998	6.8226	43.686	6.4031	6.4031	3.2015	3.2015
39	5.9354	9.0026	6.8978	40.636	5.8912	5.8912	2.9456	2.9456
40	6.5896	10.002	6.9744	37.882	5.4315	5.4315	2.7158	2.7158
41	7.1065	10.778	7.0351	34.832	4.9512	4.9512	2.4756	2.4756

TRIAXIAL COMPRESSION TEST REPORT





		Test 1			
Symbol					
Test No.		1			
Initial	Diameter, in	2.858			
	Height, in	5.499			
	Water Content, %	23.50			
	Dry Density, pcf	100.49			
	Saturation, %	93.69			
	Void Ratio	0.67737			
Before Shear	Water Content, %	23.50			
	Dry Density, pcf	103.12			
	Saturation, %	100.00			
	Void Ratio	0.6346			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		26.709			
Time to Failure, min		6.1227			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-5
Sample Type: Tube 6-2
Description: Brn. gray vf. sandy silty clay.
Remarks:

Wed, 08-MAR-2006 09:30:44

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-5
Sample No.: 6-2
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 6-2

Project No.: 03S5010
Checked By: JPK
Depth: 13.5-14
Elevation:

Soil Description: Brn. gray vf. sandy silty clay.
Remarks:

Specimen Height: 5.50 in
Specimen Area: 6.42 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

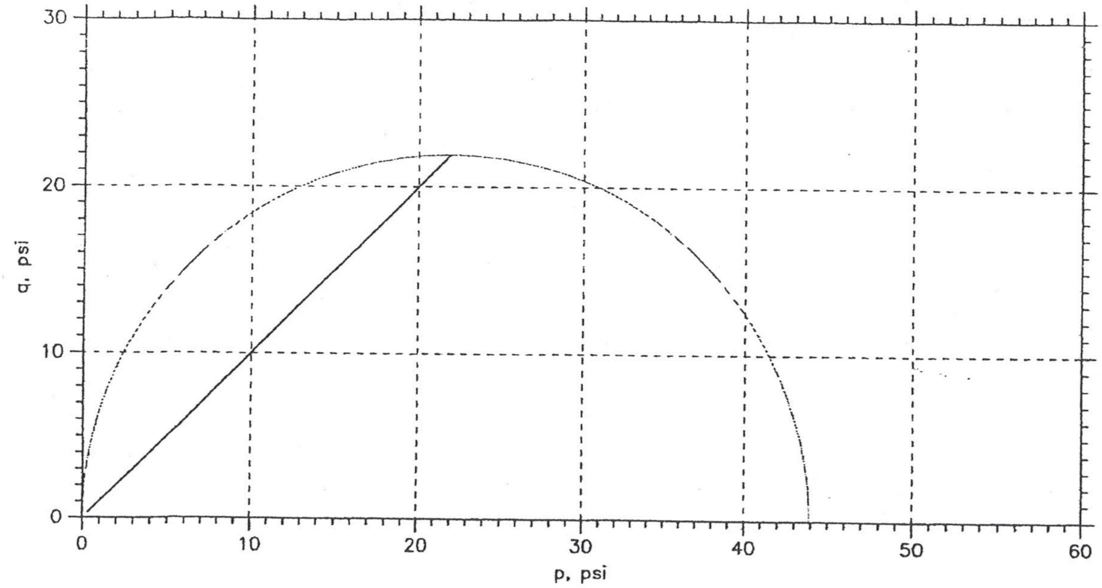
Liquid Limit: 0

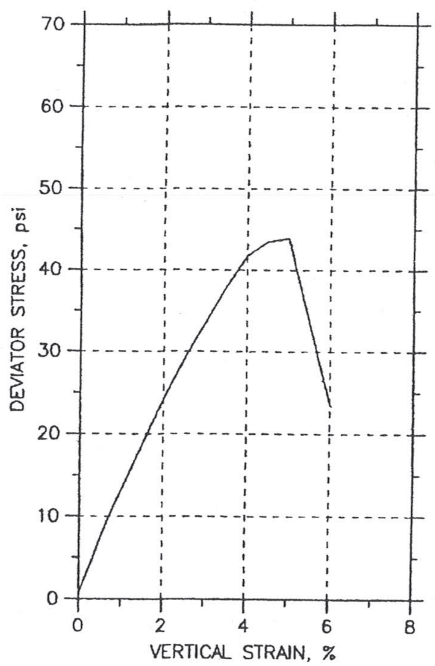
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4153	4.5333	0.70665	0.70665	0.35332	0.35332
2	0.079417	0.10111	6.4218	16.928	2.6361	2.6361	1.318	1.318
3	0.15025	0.20324	6.4283	24.798	3.8577	3.8577	1.9288	1.9288
4	0.21692	0.30027	6.4346	33.554	5.2146	5.2146	2.6073	2.6073
5	0.28775	0.40036	6.441	41.62	6.4617	6.4617	3.2309	3.2309
6	0.35858	0.50147	6.4476	49.49	7.6757	7.6757	3.8379	3.8379
7	0.42942	0.6036	6.4542	57.655	8.9329	8.9329	4.4665	4.4665
8	0.49608	0.69961	6.4605	65.328	10.112	10.112	5.056	5.056
9	0.56692	0.7997	6.467	72.706	11.243	11.243	5.6213	5.6213
10	0.63775	0.90081	6.4736	79.887	12.341	12.341	6.1703	6.1703
11	0.70858	1.0019	6.4802	86.282	13.315	13.315	6.6573	6.6573
12	0.77942	1.1041	6.4869	92.184	14.211	14.211	7.1054	7.1054
13	0.84608	1.2001	6.4932	97.201	14.97	14.97	7.4849	7.4849
14	0.91692	1.3012	6.4998	101.82	15.666	15.666	7.8329	7.8329
15	0.98775	1.4023	6.5065	106.05	16.3	16.3	8.1499	8.1499
16	1.0586	1.5024	6.5131	109.69	16.842	16.842	8.4211	8.4211
17	1.1336	1.6035	6.5198	113.14	17.353	17.353	8.6765	8.6765
18	1.2044	1.7026	6.5264	116.19	17.803	17.803	8.9014	8.9014
19	1.2755	1.8047	6.5332	119.14	18.236	18.236	9.118	9.118
20	1.3422	1.8997	6.5395	121.5	18.579	18.579	9.2897	9.2897
21	1.413	2.0028	6.5464	124.06	18.951	18.951	9.4753	9.4753
22	1.4839	2.1039	6.5531	126.32	19.276	19.276	9.6381	9.6381
23	1.5505	2.202	6.5597	128.48	19.587	19.587	9.7934	9.7934
24	1.6214	2.3051	6.5666	130.45	19.866	19.866	9.9329	9.9329
25	1.688	2.4022	6.5732	132.32	20.13	20.13	10.065	10.065
26	1.7547	2.5002	6.5798	134.19	20.394	20.394	10.197	10.197
27	1.8255	2.6034	6.5867	135.86	20.627	20.627	10.313	10.313
28	1.8922	2.7024	6.5934	137.53	20.859	20.859	10.43	10.43
29	1.9589	2.8005	6.6001	139.01	21.062	21.062	10.531	10.531
30	2.0297	2.9036	6.6071	140.49	21.263	21.263	10.631	10.631
31	2.0964	3.0007	6.6137	142.06	21.48	21.48	10.74	10.74
32	2.4385	3.4991	6.6479	148.75	22.375	22.375	11.188	11.188
33	2.7802	4.0046	6.6829	154.65	23.141	23.141	11.571	11.571
34	3.1177	4.503	6.7178	160.26	23.856	23.856	11.928	11.928
35	3.4552	5.0025	6.7531	165.08	24.445	24.445	12.222	12.222
36	4.1305	6.0003	6.8248	173.83	25.471	25.471	12.736	12.736
37	4.7974	7.0002	6.8981	180.52	26.17	26.17	13.085	13.085
38	5.4599	8.0041	6.9734	185.84	26.649	26.649	13.325	13.325
39	6.1227	9.002	7.0499	188.3	26.709	26.709	13.354	13.354
40	6.7768	10.001	7.1281	186.72	26.195	26.195	13.097	13.097
41	7.4354	11.003	7.2084	177.38	24.607	24.607	12.303	12.303
42	8.0815	12.001	7.2901	162.52	22.293	22.293	11.147	11.147
43	8.7398	13.003	7.3741	145.11	19.678	19.678	9.8391	9.8391
44	9.3987	14	7.4596	131.83	17.672	17.672	8.8361	8.8361
45	10.049	14.999	7.5473	119.43	15.825	15.825	7.9123	7.9123
46	10.053	15.006	7.5479	119.43	15.823	15.823	7.9117	7.9117

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		1			
Initial	Diameter, in	2.809			
	Height, in	5.319			
	Water Content, %	15.68			
	Dry Density, pcf	117.73			
	Saturation, %	98.10			
	Void Ratio	0.43165			
Before Shear	Water Content, %	15.68			
	Dry Density, pcf	118.41			
	Saturation, %	100.00			
	Void Ratio	0.42343			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		43.9			
Time to Failure, min		3.4594			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-6
Sample Type: Tube 2-1
Description: Brn. & gray vf. sandy silt.
Remarks:

Wed, 08-MAR-2006 09:34:31

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-6
Sample No.: 2-1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-1

Project No.: 03S5010
Checked By: JPK
Depth: 2.0-2.5
Elevation: N/A

Soil Description: Brn. & gray vf. sandy silt.
Remarks:

Specimen Height: 5.32 in
Specimen Area: 6.20 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	36	---		
Wt. Container + Wet Soil, gm	93.25	1178.5	1178.5	0
Wt. Container + Dry Soil, gm	81.11	1018.7	1018.7	0
Wt. Container, gm	3.7	---	0	0
Wt. Dry Soil, gm	77.41	1018.7	1018.7	0
Water Content, %	15.68	15.68	15.68	0.00
Void Ratio	---	0.43	0.42	---
Degree of Saturation, %	---	98.10	100.00	---
Dry Unit Weight, pcf	---	117.73	118.41	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-6
Sample No.: 2-1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 2-1

Project No.: 03S5010
Checked By: JPK
Depth: 2.0-2.5
Elevation: N/A

Soil Description: Brn. & gray vf. sandy silt.
Remarks:

Specimen Height: 5.32 in
Specimen Area: 6.20 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

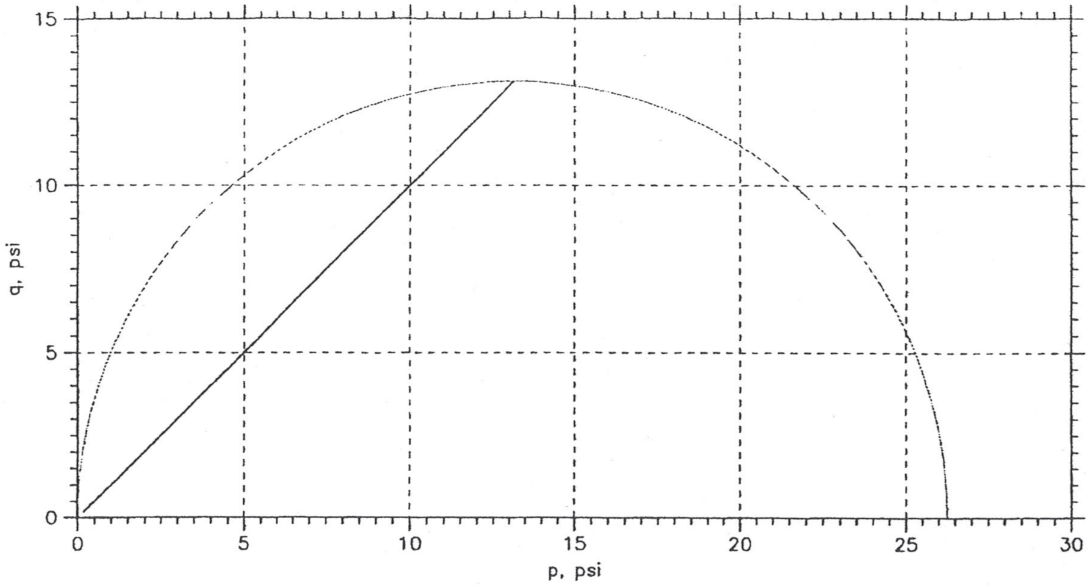
Liquid Limit: 0

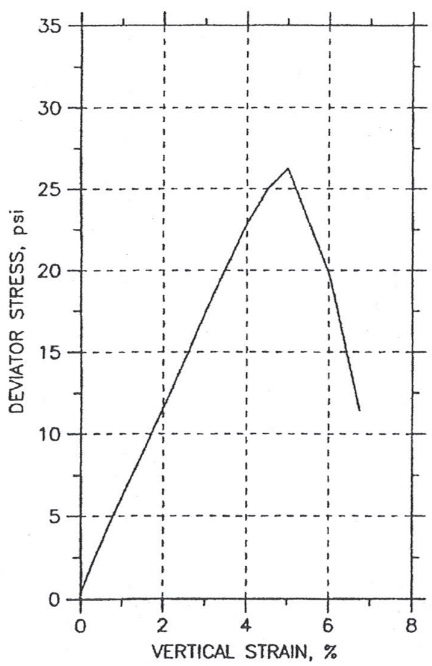
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.1972	3.9431	0.63627	0.63627	0.31814	0.31814
2	0.075	0.10031	6.2034	12.108	1.9518	1.9518	0.97592	0.97592
3	0.14583	0.20379	6.2098	20.47	3.2964	3.2964	1.6482	1.6482
4	0.2125	0.3041	6.2161	28.635	4.6066	4.6066	2.3033	2.3033
5	0.27942	0.40229	6.2222	37.095	5.9617	5.9617	2.9809	2.9809
6	0.34608	0.50155	6.2284	45.752	7.3457	7.3457	3.6728	3.6728
7	0.41275	0.6008	6.2346	53.72	8.6164	8.6164	4.3082	4.3082
8	0.48358	0.70533	6.2412	61.885	9.9156	9.9156	4.9578	4.9578
9	0.55025	0.80459	6.2474	69.066	11.055	11.055	5.5276	5.5276
10	0.61692	0.90384	6.2537	76.051	12.161	12.161	6.0805	6.0805
11	0.68358	1.001	6.2598	82.839	13.233	13.233	6.6167	6.6167
12	0.75442	1.1045	6.2664	90.02	14.366	14.366	7.1828	7.1828
13	0.82108	1.2005	6.2725	96.906	15.449	15.449	7.7247	7.7247
14	0.89192	1.304	6.279	104.28	16.608	16.608	8.3041	8.3041
15	0.95858	1.4022	6.2853	111.27	17.703	17.703	8.8515	8.8515
16	1.0253	1.4994	6.2915	117.96	18.749	18.749	9.3744	9.3744
17	1.0961	1.6018	6.2981	125.34	19.901	19.901	9.9504	9.9504
18	1.1628	1.7	6.3043	132.22	20.973	20.973	10.487	10.487
19	1.2339	1.7992	6.3107	139.01	22.028	22.028	11.014	11.014
20	1.3047	1.9017	6.3173	145.99	23.11	23.11	11.555	11.555
21	1.3755	2.0062	6.324	153.08	24.206	24.206	12.103	12.103
22	1.4422	2.1033	6.3303	159.47	25.192	25.192	12.596	12.596
23	1.5089	2.2026	6.3367	166.06	26.206	26.206	13.103	13.103
24	1.5755	2.2997	6.343	172.06	27.126	27.126	13.563	13.563
25	1.6464	2.4022	6.3497	178.65	28.136	28.136	14.068	14.068
26	1.713	2.5003	6.3561	184.85	29.083	29.083	14.541	14.541
27	1.7839	2.6038	6.3628	191.44	30.088	30.088	15.044	15.044
28	1.8505	2.701	6.3692	197.25	30.969	30.969	15.484	15.484
29	1.9214	2.8034	6.3759	203.25	31.877	31.877	15.939	15.939
30	1.988	2.9016	6.3824	208.56	32.678	32.678	16.339	16.339
31	2.0589	3.004	6.3891	214.27	33.536	33.536	16.768	16.768
32	2.4091	3.5013	6.422	243.48	37.914	37.914	18.957	18.957
33	2.7591	4.0008	6.4554	269.55	41.756	41.756	20.878	20.878
34	3.1091	4.5044	6.4895	282.05	43.462	43.462	21.731	21.731
35	3.4594	5.0007	6.5234	286.37	43.9	43.9	21.95	21.95
36	4.1385	6.0006	6.5928	155.54	23.592	23.592	11.796	11.796
37	4.1635	6.0376	6.5954	153.96	23.344	23.344	11.672	11.672

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		2			
Initial	Diameter, in	2.82			
	Height, in	5.867			
	Water Content, %	48.72			
	Dry Density, pcf	72.273			
	Saturation, %	98.75			
	Void Ratio	1.3322			
Before Shear	Water Content, %	48.72			
	Dry Density, pcf	72.793			
	Saturation, %	100.00			
	Void Ratio	1.3156			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		26.26			
Time to Failure, min		3.4636			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-6
Sample Type: Tube 6-3
Description: Brn. & gray vf. sandy silt. (organic)
Remarks:

Wed, 08-MAR-2006 09:35:07

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-6
Sample No.: 6-3
Test No.: 2

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 6-3

Project No.: 03S5010
Checked By: JPK
Depth: 14.0-14.5
Elevation: N/A

Soil Description: Brn. & gray vf. sandy silt. (organic)
Remarks:

Specimen Height: 5.87 in
Specimen Area: 6.25 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

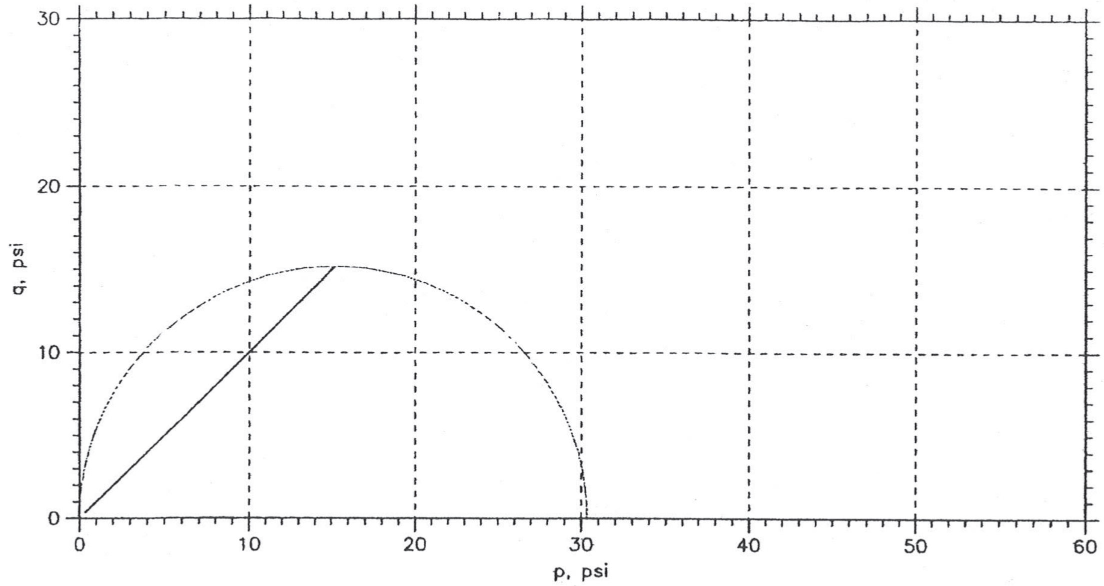
Liquid Limit: 0

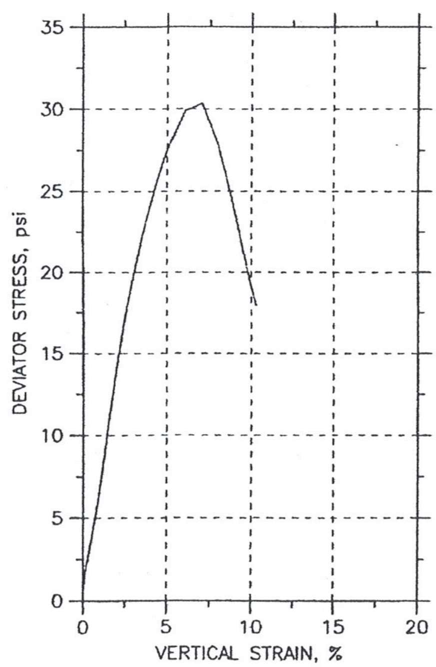
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.2458	2.2707	0.36356	0.36356	0.18178	0.18178
2	0.075267	0.10051	6.2521	6.4024	1.024	1.024	0.51202	0.51202
3	0.1461	0.20294	6.2585	10.239	1.636	1.636	0.81801	0.81801
4	0.21277	0.30154	6.2647	13.977	2.2311	2.2311	1.1156	1.1156
5	0.2836	0.40492	6.2712	17.912	2.8563	2.8563	1.4281	1.4281
6	0.35027	0.50256	6.2773	21.552	3.4333	3.4333	1.7166	1.7166
7	0.41693	0.59925	6.2835	25.192	4.0092	4.0092	2.0046	2.0046
8	0.48777	0.70359	6.2901	28.733	4.568	4.568	2.284	2.284
9	0.5586	0.80506	6.2965	32.373	5.1414	5.1414	2.5707	2.5707
10	0.62527	0.9027	6.3027	35.718	5.6671	5.6671	2.8335	2.8335
11	0.69193	0.99939	6.3089	39.062	6.1917	6.1917	3.0958	3.0958
12	0.76277	1.1028	6.3154	42.604	6.746	6.746	3.373	3.373
13	0.82943	1.1995	6.3216	45.85	7.2529	7.2529	3.6265	3.6265
14	0.90027	1.3009	6.3281	49.293	7.7896	7.7896	3.8948	3.8948
15	0.9711	1.4034	6.3347	52.835	8.3405	8.3405	4.1703	4.1703
16	1.0378	1.4991	6.3409	56.179	8.8599	8.8599	4.43	4.43
17	1.1086	1.6005	6.3474	59.721	9.4087	9.4087	4.7044	4.7044
18	1.1839	1.7039	6.3541	63.262	9.9562	9.9562	4.9781	4.9781
19	1.2505	1.7997	6.3603	66.705	10.488	10.488	5.2439	5.2439
20	1.3214	1.9021	6.3669	70.345	11.049	11.049	5.5243	5.5243
21	1.3922	2.0045	6.3736	74.083	11.624	11.624	5.8118	5.8118
22	1.4589	2.1012	6.3799	77.625	12.167	12.167	6.0836	6.0836
23	1.5297	2.2036	6.3865	81.461	12.755	12.755	6.3776	6.3776
24	1.5964	2.2994	6.3928	85.003	13.297	13.297	6.6483	6.6483
25	1.6672	2.3999	6.3994	88.839	13.883	13.883	6.9413	6.9413
26	1.738	2.5004	6.406	92.676	14.467	14.467	7.2336	7.2336
27	1.8089	2.6038	6.4128	96.513	15.05	15.05	7.525	7.525
28	1.8797	2.7043	6.4194	100.45	15.647	15.647	7.8237	7.8237
29	1.9505	2.8038	6.426	104.28	16.229	16.229	8.1143	8.1143
30	2.0172	2.8996	6.4323	108.02	16.794	16.794	8.3969	8.3969
31	2.088	3.001	6.439	111.96	17.387	17.387	8.6936	8.6936
32	2.4383	3.4998	6.4723	130.94	20.231	20.231	10.116	10.116
33	2.78	4.0014	6.5061	148.55	22.833	22.833	11.416	11.416
34	3.1216	4.503	6.5403	163.6	25.015	25.015	12.507	12.507
35	3.4636	5.0027	6.5747	172.65	26.26	26.26	13.13	13.13
36	4.1386	6.004	6.6447	131.44	19.78	19.78	9.8902	9.8902
37	4.6471	6.7554	6.6983	76.444	11.413	11.413	5.7063	5.7063

TRIAXIAL COMPRESSION TEST REPORT





Symbol						
Test No.		3				
Initial	Diameter, in	2.867				
	Height, in	5.789				
	Water Content, %	14.41				
	Dry Density, pcf	124.58				
	Saturation, %	110.21				
	Void Ratio	0.35294				
Before Shear	Water Content, %	14.41				
	Dry Density, pcf	121.35				
	Saturation, %	100.00				
	Void Ratio	0.38899				
	Back Press., psi	---				
Minor Prin. Stress, psi		0				
Max. Dev. Stress, psi		30.356				
Time to Failure, min		4.793				
Strain Rate, %/min		1.5				
B-Value		---				
Specific Gravity		2.70				
Liquid Limit		0				
Plastic Limit		0				
Plasticity Index		0				
Failure Sketch						

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: B-6
Sample Type: Tube 8-3
Description: Gray f. sandy clayey silt (tr. c. sand & sm. gravel).
Remarks:

Wed, 08-MAR-2006 09:36:08

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-6
Sample No.: 8-3
Test No.: 3

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 8-3

Project No.: 03S5010
Checked By: JPK
Depth: 24.0-24.5
Elevation: N/A

Soil Description: Gray f. sandy clayey silt (tr. c. sand & sm. gravel).
Remarks:

Specimen Height: 5.79 in
Specimen Area: 6.46 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	34	---		
Wt. Container + Wet Soil, gm	91.26	1398.3	1398.3	0
Wt. Container + Dry Soil, gm	80.23	1222.2	1222.2	0
Wt. Container, gm	3.67	---	0	0
Wt. Dry Soil, gm	76.56	1222.2	1222.2	0
Water Content, %	14.41	14.41	14.41	0.00
Void Ratio	---	0.35	0.39	---
Degree of Saturation, %	---	110.21	100.00	---
Dry Unit Weight, pcf	---	124.58	121.35	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: B-6
Sample No.: 8-3
Test No.: 3

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/06/06
Sample Type: Tube 8-3

Project No.: 0355010
Checked By: JPK
Depth: 24.0-24.5
Elevation: N/A

Soil Description: Gray f. sandy clayey silt (tr. c. sand & sm. gravel).
Remarks:

Specimen Height: 5.79 in
Specimen Area: 6.46 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

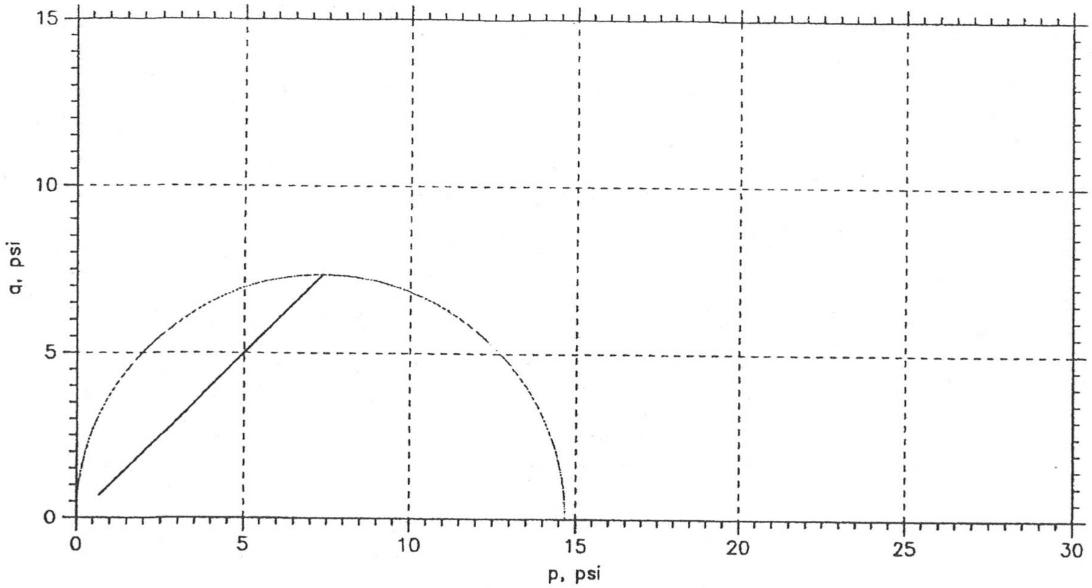
Liquid Limit: 0

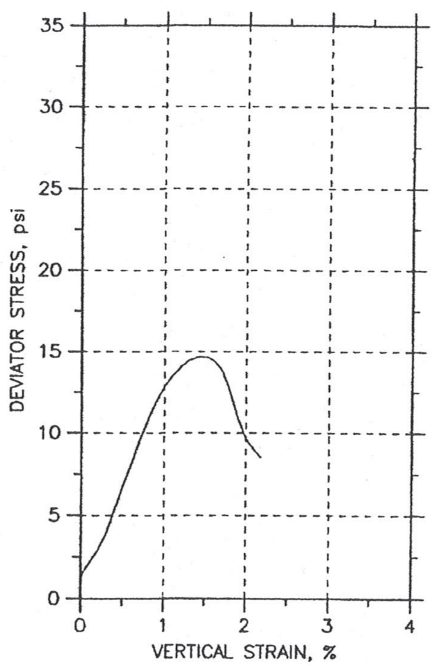
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4557	4.4349	0.68698	0.68698	0.34349	0.34349
2	0.079417	0.10478	6.4625	10.337	1.5996	1.5996	0.7998	0.7998
3	0.14608	0.20179	6.4688	13.682	2.1151	2.1151	1.0575	1.0575
4	0.21275	0.29978	6.4751	17.027	2.6296	2.6296	1.3148	1.3148
5	0.28358	0.40262	6.4818	20.568	3.1732	3.1732	1.5866	1.5866
6	0.35442	0.50352	6.4884	24.208	3.731	3.731	1.8655	1.8655
7	0.42108	0.60053	6.4947	27.749	4.2726	4.2726	2.1363	2.1363
8	0.49192	0.70434	6.5015	31.586	4.8583	4.8583	2.4291	2.4291
9	0.55885	0.80039	6.5078	35.029	5.3826	5.3826	2.6913	2.6913
10	0.62968	0.90128	6.5144	39.161	6.0114	6.0114	3.0057	3.0057
11	0.70052	1.0031	6.5211	43.784	6.7142	6.7142	3.3571	3.3571
12	0.76718	1.0992	6.5275	48.506	7.4311	7.4311	3.7155	3.7155
13	0.83802	1.2011	6.5342	53.425	8.1762	8.1762	4.0881	4.0881
14	0.90885	1.3029	6.541	58.54	8.9498	8.9498	4.4749	4.4749
15	0.97968	1.4038	6.5476	63.557	9.7069	9.7069	4.8535	4.8535
16	1.0505	1.5047	6.5544	68.476	10.447	10.447	5.2237	5.2237
17	1.1172	1.6008	6.5608	73.198	11.157	11.157	5.5785	5.5785
18	1.1925	1.6997	6.5674	77.92	11.865	11.865	5.9324	5.9324
19	1.2633	1.8016	6.5742	82.74	12.586	12.586	6.2928	6.2928
20	1.3341	1.9025	6.5809	87.462	13.29	13.29	6.6451	6.6451
21	1.405	2.0034	6.5877	92.086	13.978	13.978	6.9892	6.9892
22	1.4758	2.1043	6.5945	96.513	14.635	14.635	7.3177	7.3177
23	1.5425	2.2013	6.601	100.74	15.262	15.262	7.6308	7.6308
24	1.6133	2.3041	6.608	105.07	15.901	15.901	7.9503	7.9503
25	1.68	2.4012	6.6146	109.1	16.495	16.495	8.2473	8.2473
26	1.7508	2.504	6.6215	113.24	17.101	17.101	8.5506	8.5506
27	1.8175	2.602	6.6282	117.17	17.678	17.678	8.8388	8.8388
28	1.8841	2.7	6.6349	120.81	18.208	18.208	9.1042	9.1042
29	1.955	2.8028	6.6419	124.65	18.767	18.767	9.3834	9.3834
30	2.0216	2.9018	6.6487	128.29	19.295	19.295	9.6476	9.6476
31	2.0925	3.0036	6.6556	131.83	19.807	19.807	9.9035	9.9035
32	2.4344	3.5004	6.6899	147.96	22.117	22.117	11.059	11.059
33	2.7719	4	6.7247	162.52	24.168	24.168	12.084	12.084
34	3.1094	4.4996	6.7599	175.31	25.934	25.934	12.967	12.967
35	3.4555	5.0031	6.7957	187.02	27.52	27.52	13.76	13.76
36	4.1263	6.0024	6.868	205.22	29.88	29.88	14.94	14.94
37	4.793	7.0017	6.9418	210.72	30.356	30.356	15.178	15.178
38	5.4513	8.0009	7.0172	195.28	27.829	27.829	13.914	13.914
39	6.1143	9.0022	7.0944	168.52	23.754	23.754	11.877	11.877
40	6.7729	10.003	7.1733	136.45	19.022	19.022	9.5111	9.5111
41	6.9688	10.304	7.1974	129.07	17.934	17.934	8.9668	8.9668

TRIAXIAL COMPRESSION TEST REPORT





Symbol						
Test No.		1				
Initial	Diameter, in	2.875				
	Height, in	6				
	Water Content, %	17.23				
	Dry Density, pcf	102.94				
	Saturation, %	72.95				
	Void Ratio	0.63749				
Before Shear	Water Content, %	17.23				
	Dry Density, pcf	115.05				
	Saturation, %	100.00				
	Void Ratio	0.46508				
	Back Press., psi	---				
Minor Prin. Stress, psi		0				
Max. Dev. Stress, psi		14.688				
Time to Failure, min		1.0516				
Strain Rate, %/min		1.5				
B-Value		---				
Specific Gravity		2.70				
Liquid Limit		0				
Plastic Limit		0				
Plasticity Index		0				
Failure Sketch						

Project: Duck Creek Ash Pond	
Location: Canton, Illinois	
Project No.: 03S5010	
Boring No.: Bag B-3	
Sample Type: Compacted	
Description: Brn. vf. sandy silt.	
Remarks:	

Mon, 10-APR-2006 14:59:18

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: Bag B-3
Sample No.: 1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 03S5010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

Soil Description: Brn. vf. sandy silt.
Remarks:

Specimen Height: 6.00 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	36	---		
Wt. Container + Wet Soil, gm	111.08	1233.7	1233.7	0
Wt. Container + Dry Soil, gm	95.3	1052.5	1052.5	0
Wt. Container, gm	3.69	---	0	0
Wt. Dry Soil, gm	91.61	1052.5	1052.5	0
Water Content, %	17.23	17.23	17.23	0.00
Void Ratio	---	0.64	0.47	---
Degree of Saturation, %	---	72.95	100.00	---
Dry Unit Weight, pcf	---	102.94	115.05	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: Bag B-3
Sample No.: 1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 03S5010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

Soil Description: Brn. vf. sandy silt.
Remarks:

Specimen Height: 6.00 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

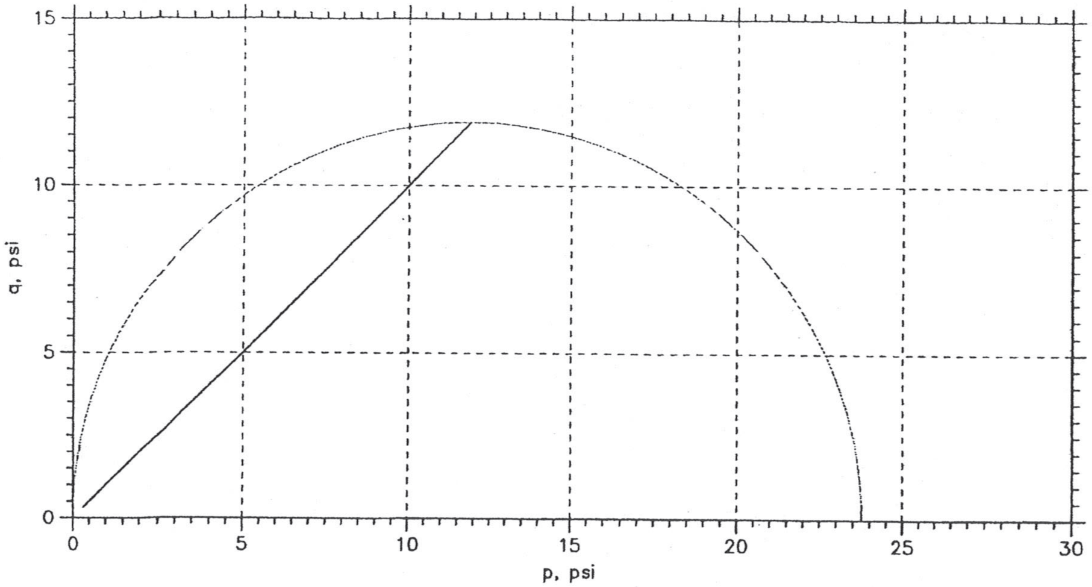
Liquid Limit: 0

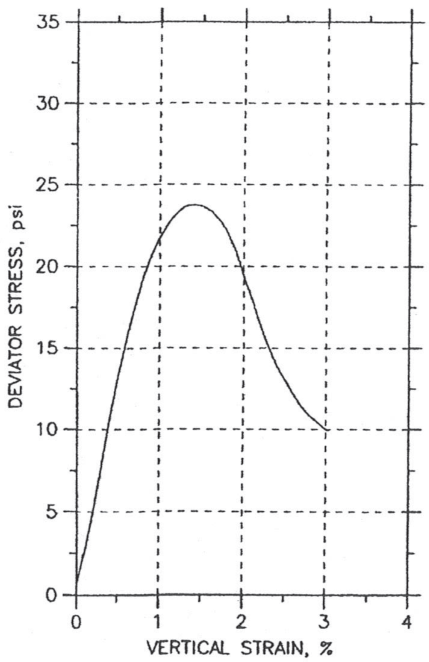
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4918	8.9601	1.3802	1.3802	0.69011	0.69011
2	0.071883	0.10016	6.4983	13.977	2.1509	2.1509	1.0754	1.0754
3	0.14297	0.20125	6.5049	18.797	2.8897	2.8897	1.4449	1.4449
4	0.2138	0.30515	6.5117	25.585	3.9291	3.9291	1.9646	1.9646
5	0.28073	0.40063	6.5179	34.537	5.2988	5.2988	2.6494	2.6494
6	0.35573	0.50172	6.5245	44.079	6.7559	6.7559	3.378	3.378
7	0.42657	0.60469	6.5313	53.031	8.1196	8.1196	4.0598	4.0598
8	0.49323	0.70016	6.5376	61.983	9.4811	9.4811	4.7406	4.7406
9	0.56407	0.80313	6.5444	70.837	10.824	10.824	5.4121	5.4121
10	0.6349	0.90422	6.551	78.412	11.969	11.969	5.9847	5.9847
11	0.70573	1.0034	6.5576	84.413	12.872	12.872	6.4362	6.4362
12	0.7724	1.1017	6.5641	89.036	13.564	13.564	6.782	6.782
13	0.84323	1.2028	6.5708	92.774	14.119	14.119	7.0596	7.0596
14	0.9099	1.2992	6.5773	95.234	14.479	14.479	7.2396	7.2396
15	0.98073	1.4022	6.5841	96.611	14.673	14.673	7.3367	7.3367
16	1.0516	1.5052	6.591	96.808	14.688	14.688	7.3439	7.3439
17	1.1182	1.6016	6.5975	95.135	14.42	14.42	7.21	7.21
18	1.1891	1.7008	6.6041	91.397	13.839	13.839	6.9197	6.9197
19	1.2602	1.8028	6.611	82.15	12.426	12.426	6.2131	6.2131
20	1.3268	1.8992	6.6175	71.919	10.868	10.868	5.434	5.434
21	1.3977	2.0013	6.6244	63.754	9.6242	9.6242	4.8121	4.8121
22	1.4727	2.1014	6.6312	59.426	8.9616	8.9616	4.4808	4.4808
23	1.5268	2.1791	6.6364	56.573	8.5246	8.5246	4.2623	4.2623

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		1			
Initial	Diameter, in	2.875			
	Height, in	6			
	Water Content, %	16.74			
	Dry Density, pcf	103.22			
	Saturation, %	71.40			
	Void Ratio	0.63303			
Before Shear	Water Content, %	16.74			
	Dry Density, pcf	116.09			
	Saturation, %	100.00			
	Void Ratio	0.45196			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		23.772			
Time to Failure, min		0.91772			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond	
Location: Canton, Illinois	
Project No.: 03S5010	
Boring No.: Bag B-4	
Sample Type: Compacted	
Description: Yel. brn. vf. sandy silt.	
Remarks:	

Mon, 10-APR-2006 15:03:21

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: Bag B-4
Sample No.: 1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 0355010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

Soil Description: Yel. brn. vf. sandy silt.
Remarks:

Specimen Height: 6.00 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	36	---		
Wt. Container + Wet Soil, gm	60.16	1232	1232	0
Wt. Container + Dry Soil, gm	52.07	1055.3	1055.3	0
Wt. Container, gm	3.74	---	0	0
Wt. Dry Soil, gm	48.33	1055.3	1055.3	0
Water Content, %	16.74	16.74	16.74	0.00
Void Ratio	---	0.63	0.45	---
Degree of Saturation, %	---	71.40	100.00	---
Dry Unit Weight, pcf	---	103.22	116.09	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

'roject: Duck Creek Ash Pond
:oring No.: Bag B-4
;ample No.: 1
'est No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 0355010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

;oil Description: Yel. brn. vf. sandy silt.
:emarks:

;pecimen Height: 6.00 in
;pecimen Area: 6.49 in^2
;pecimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

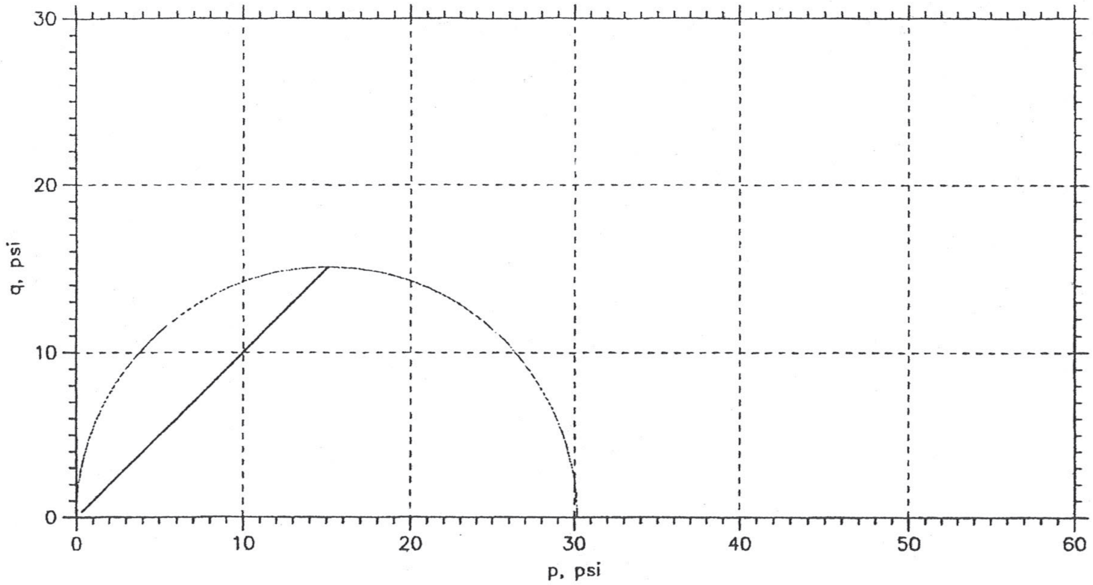
.iquid Limit: 0

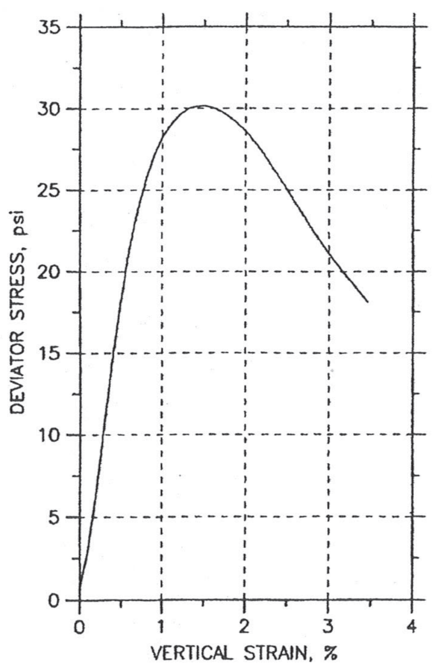
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4918	4.1398	0.6377	0.6377	0.31885	0.31885
2	0.075267	0.10203	6.4984	17.027	2.6201	2.6201	1.3101	1.3101
3	0.13828	0.20031	6.5048	31.783	4.886	4.886	2.443	2.443
4	0.20912	0.29953	6.5113	50.08	7.6913	7.6913	3.8456	3.8456
5	0.27995	0.40437	6.5182	69.46	10.656	10.656	5.3282	5.3282
6	0.34662	0.50734	6.5249	86.478	13.254	13.254	6.6268	6.6268
7	0.40912	0.60375	6.5312	101.04	15.47	15.47	7.735	7.735
8	0.47162	0.7011	6.5376	113.73	17.396	17.396	8.6979	8.6979
9	0.53412	0.80032	6.5442	125.24	19.137	19.137	9.5686	9.5686
10	0.60078	0.90516	6.5511	135.37	20.664	20.664	10.332	10.332
11	0.66328	1.0034	6.5576	142.75	21.768	21.768	10.884	10.884
12	0.72578	1.0999	6.564	148.65	22.646	22.646	11.323	11.323
13	0.79272	1.2038	6.5709	152.98	23.281	23.281	11.641	11.641
14	0.85522	1.3048	6.5776	155.64	23.661	23.661	11.831	11.831
15	0.91772	1.4022	6.5841	156.52	23.772	23.772	11.886	11.886
16	0.98022	1.5005	6.5907	156.13	23.689	23.689	11.844	11.844
17	1.0469	1.6053	6.5977	154.36	23.395	23.395	11.698	11.698
18	1.1094	1.7045	6.6044	151.01	22.865	22.865	11.433	11.433
19	1.1719	1.8028	6.611	145.99	22.084	22.084	11.042	11.042
20	1.2344	1.903	6.6177	138.42	20.916	20.916	10.458	10.458
21	1.3013	2.0013	6.6244	128.19	19.351	19.351	9.6755	9.6755
22	1.3638	2.1005	6.6311	118.84	17.922	17.922	8.9611	8.9611
23	1.4305	2.2035	6.6381	108.32	16.318	16.318	8.1588	8.1588
24	1.493	2.3055	6.645	99.759	15.013	15.013	7.5063	7.5063
25	1.5555	2.4047	6.6518	92.381	13.888	13.888	6.9441	6.9441
26	1.618	2.5021	6.6584	86.675	13.017	13.017	6.5087	6.5087
27	1.6805	2.5994	6.6651	81.068	12.163	12.163	6.0816	6.0816
28	1.7472	2.7042	6.6722	75.657	11.339	11.339	5.6696	5.6696
29	1.8097	2.8016	6.6789	72.411	10.842	10.842	5.4209	5.4209
30	1.8763	2.9064	6.6861	69.361	10.374	10.374	5.187	5.187
31	1.9388	3.0019	6.6927	67.001	10.011	10.011	5.0055	5.0055
32	1.9555	3.0281	6.6945	66.41	9.9201	9.9201	4.96	4.96

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		1			
Initial	Diameter, in	2.875			
	Height, in	6			
	Water Content, %	15.54			
	Dry Density, pcf	106.33			
	Saturation, %	71.68			
	Void Ratio	0.58524			
Before Shear	Water Content, %	15.54			
	Dry Density, pcf	118.74			
	Saturation, %	100.00			
	Void Ratio	0.4195			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		30.167			
Time to Failure, min		0.97578			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond

Location: Canton, Illinois

Project No.: 03S5010

Boring No.: Bag B-5

Sample Type: Compacted

Description: Yel. brn. vf. sandy silt / so. clay.

Remarks:

Mon, 10-APR-2006 15:00:37

TRIAXIAL TEST

roject: Duck Creek Ash Pond	Location: Canton, Illinois	Project No.: 03S5010
oring No.: Bag B-5	Tested By: Rin	Checked By: JCC
ample No.: 1	Test Date: 03/16/06	Depth: 1.0-10.0
est No.: 1	Sample Type: Compacted	Elevation: N/A

oil Description: Yel. brn. vf. sandy silt / so. clay.
emarks:

pecimen Height: 6.00 in	Piston Area: 0.20 in^2	Filter Correction: 0.00 psi
pecimen Area: 6.49 in^2	Piston Friction: 0.00 lb	Membrane Correction: 0.00 lb/in
pecimen Volume: 0.02 ft^3	Piston Weight: 0.50 lb	Correction Type: Uniform

iquid Limit: 0	Plastic Limit: 0	Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
ontainer ID	31	---		
t. Container + Wet Soil, gm	114.96	1256.1	1256.1	0
t. Container + Dry Soil, gm	99.99	1087.1	1087.1	0
t. Container, gm	3.64	---	0	0
t. Dry Soil, gm	96.35	1087.1	1087.1	0
ater Content, %	15.54	15.54	15.54	0.00
oid Ratio	---	0.59	0.42	---
egree of Saturation, %	---	71.68	100.00	---
ry Unit Weight, pcf	---	106.33	118.74	---

nitial

nd of Initialization

nd of Consolidation/A

nd of Saturation

nd of Consolidation/B

nd of Shear

t Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: Bag B-5
Sample No.: 1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 03S5010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

Soil Description: Yel. brn. vf. sandy silt / so. clay.
Remarks:

Specimen Height: 6.00 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

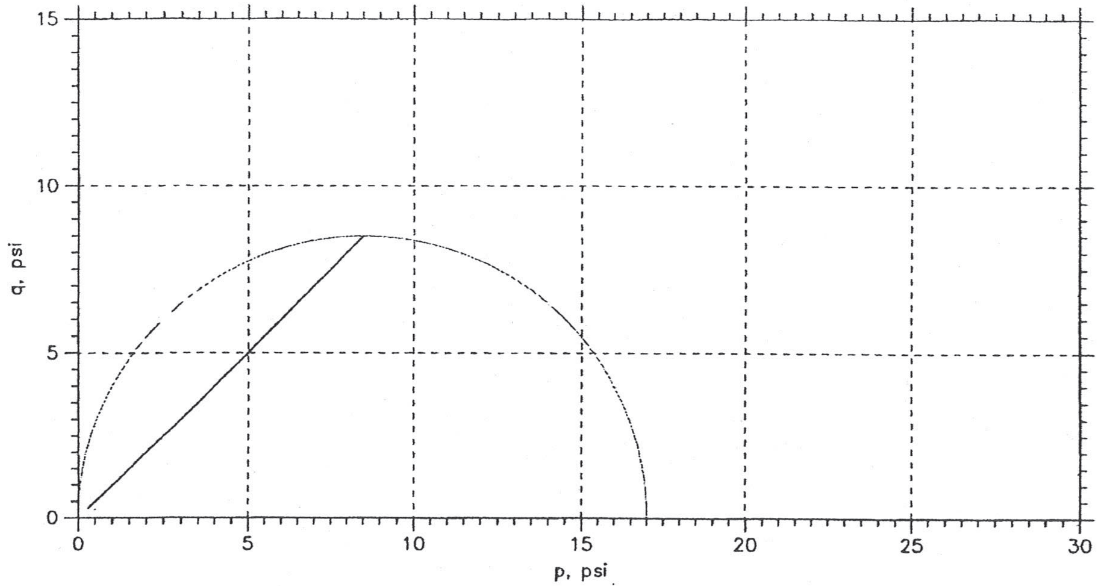
Liquid Limit: 0

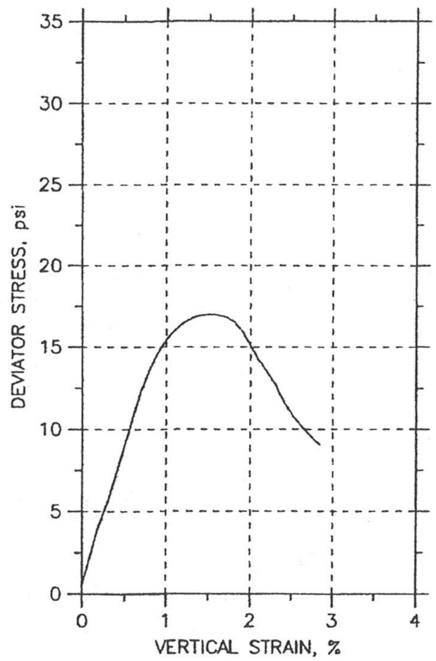
Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4918	4.5333	0.69831	0.69831	0.34916	0.34916
2	0.075517	0.10016	6.4983	19.388	2.9835	2.9835	1.4917	1.4917
3	0.14218	0.20031	6.5048	42.407	6.5193	6.5193	3.2597	3.2597
4	0.20885	0.30047	6.5114	69.165	10.622	10.622	5.3111	5.3111
5	0.27552	0.4025	6.518	96.414	14.792	14.792	7.3959	7.3959
6	0.33802	0.50172	6.5245	120.02	18.396	18.396	9.1979	9.1979
7	0.40052	0.59907	6.5309	139.21	21.315	21.315	10.657	10.657
8	0.46718	0.70578	6.538	155.93	23.85	23.85	11.925	11.925
9	0.52968	0.80219	6.5443	168.03	25.676	25.676	12.838	12.838
10	0.59218	0.90141	6.5509	177.67	27.122	27.122	13.561	13.561
11	0.65885	1.0053	6.5577	185.34	28.263	28.263	14.132	14.132
12	0.72135	1.1027	6.5642	190.75	29.06	29.06	14.53	14.53
13	0.78385	1.2	6.5707	194.59	29.615	29.615	14.808	14.808
14	0.85052	1.303	6.5775	197.15	29.973	29.973	14.987	14.987
15	0.91328	1.4003	6.584	198.33	30.123	30.123	15.061	15.061
16	0.97578	1.4995	6.5906	198.82	30.167	30.167	15.084	15.084
17	1.0425	1.6044	6.5977	198.23	30.046	30.046	15.023	15.023
18	1.105	1.7036	6.6043	196.85	29.807	29.807	14.903	14.903
19	1.1719	1.8019	6.6109	194.89	29.479	29.479	14.74	14.74
20	1.2344	1.9002	6.6176	192.43	29.078	29.078	14.539	14.539
21	1.301	2.0041	6.6246	189.18	28.557	28.557	14.279	14.279
22	1.3635	2.1024	6.6312	185.34	27.95	27.95	13.975	13.975
23	1.4302	2.2053	6.6382	181.02	27.269	27.269	13.634	13.634
24	1.4927	2.3027	6.6448	176.39	26.546	26.546	13.273	13.273
25	1.5552	2.4028	6.6516	171.37	25.764	25.764	12.882	12.882
26	1.6177	2.5002	6.6583	166.55	25.015	25.015	12.507	12.507
27	1.6844	2.6041	6.6654	160.95	24.147	24.147	12.073	12.073
28	1.7469	2.7024	6.6721	155.73	23.341	23.341	11.67	11.67
29	1.8094	2.7997	6.6788	150.52	22.537	22.537	11.268	11.268
30	1.876	2.9036	6.6859	145.5	21.762	21.762	10.881	10.881
31	1.9385	3	6.6926	140.98	21.065	21.065	10.532	10.532
32	2.2385	3.4615	6.7246	121.6	18.083	18.083	9.0413	9.0413

TRIAXIAL COMPRESSION TEST REPORT





Symbol					
Test No.		1			
Initial	Diameter, in	2.875			
	Height, in	6			
	Water Content, %	16.47			
	Dry Density, pcf	103.32			
	Saturation, %	70.46			
	Void Ratio	0.63133			
Before Shear	Water Content, %	16.47			
	Dry Density, pcf	116.66			
	Saturation, %	100.00			
	Void Ratio	0.44482			
	Back Press., psi	---			
Minor Prin. Stress, psi		0			
Max. Dev. Stress, psi		17.001			
Time to Failure, min		0.9802			
Strain Rate, %/min		1.5			
B-Value		---			
Specific Gravity		2.70			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Duck Creek Ash Pond
Location: Canton, Illinois
Project No.: 03S5010
Boring No.: Bag B-6
Sample Type: Compacted
Description: Yel. brn. vf. sandy silt (tr. clay).
Remarks:

Mon, 10-APR-2006 15:01:39

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: Bag B-6
Sample No.: 1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 03S5010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

Soil Description: Yel. brn. vf. sandy silt (tr. clay).
Remarks:

Specimen Height: 6.00 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Before Test Trimmings	Before Test Specimen+Ring	After Test Specimen+Ring	After Test Trimmings
Container ID	30	---		
Wt. Container + Wet Soil, gm	118.06	1230.5	1230.5	0
Wt. Container + Dry Soil, gm	101.88	1056.4	1056.4	0
Wt. Container, gm	3.67	---	0	0
Wt. Dry Soil, gm	98.21	1056.4	1056.4	0
Water Content, %	16.47	16.47	16.47	0.00
Void Ratio	---	0.63	0.44	---
Degree of Saturation, %	---	70.46	100.00	---
Dry Unit Weight, pcf	---	103.32	116.66	---

Initial

End of Initialization

End of Consolidation/A

End of Saturation

End of Consolidation/B

End of Shear

At Failure

TRIAXIAL TEST

Project: Duck Creek Ash Pond
Boring No.: Bag B-6
Sample No.: 1
Test No.: 1

Location: Canton, Illinois
Tested By: Rin
Test Date: 03/16/06
Sample Type: Compacted

Project No.: 03S5010
Checked By: JCC
Depth: 1.0-10.0
Elevation: N/A

Soil Description: Yel. brn. vf. sandy silt (tr. clay).
Remarks:

Specimen Height: 6.00 in
Specimen Area: 6.49 in^2
Specimen Volume: 0.02 ft^3

Piston Area: 0.20 in^2
Piston Friction: 0.00 lb
Piston Weight: 0.50 lb

Filter Correction: 0.00 psi
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

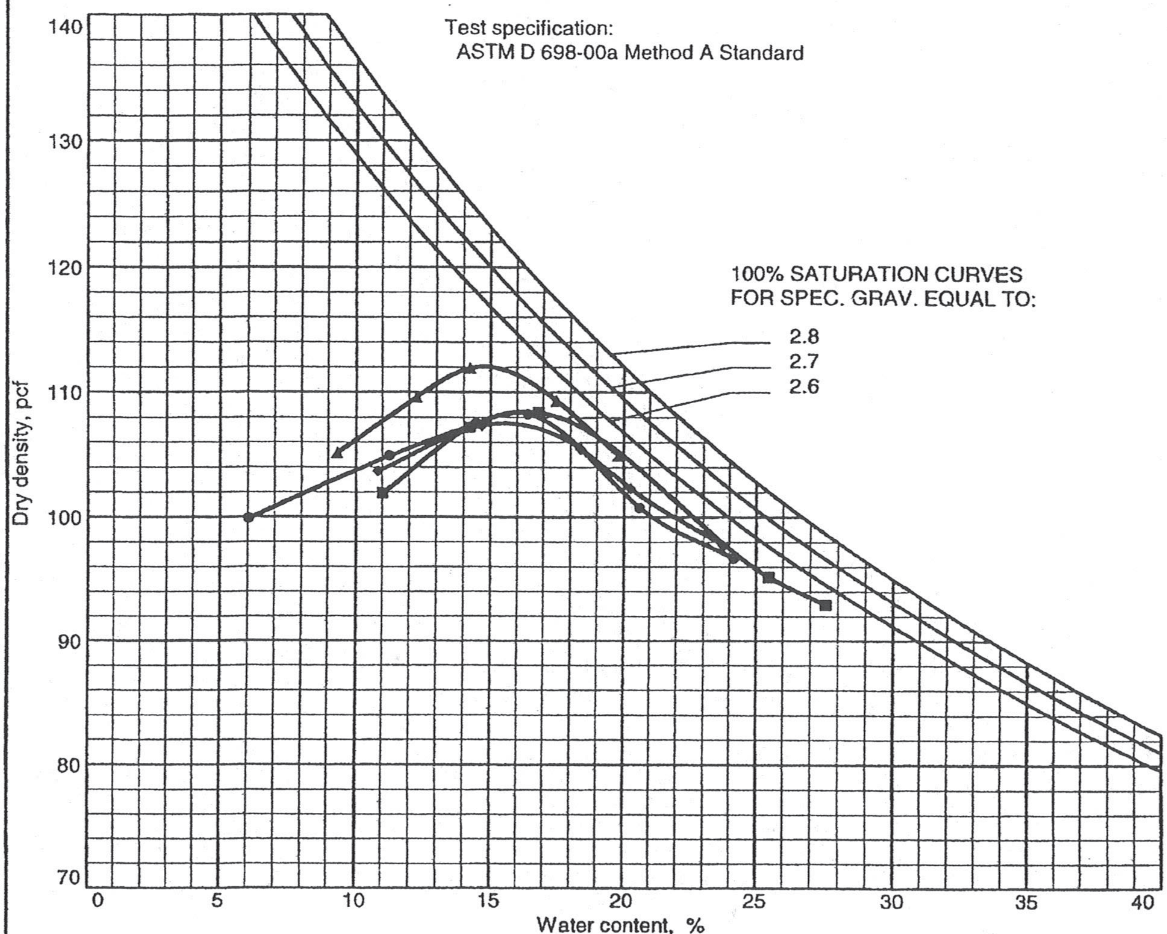
Liquid Limit: 0

Plastic Limit: 0

Specific Gravity: 2.70

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress psi	Vertical Stress psi	p psi	q psi
1	0	0	6.4918	3.8447	0.59224	0.59224	0.29612	0.29612
2	0.071617	0.10109	6.4984	15.256	2.3477	2.3477	1.1738	1.1738
3	0.13828	0.20125	6.5049	27.159	4.1752	4.1752	2.0876	2.0876
4	0.20495	0.30234	6.5115	36.308	5.576	5.576	2.788	2.788
5	0.27603	0.41092	6.5186	48.506	7.4412	7.4412	3.7206	3.7206
6	0.33853	0.50078	6.5245	58.54	8.9724	8.9724	4.4862	4.4862
7	0.4052	0.60375	6.5312	70.148	10.74	10.74	5.3702	5.3702
8	0.47187	0.70484	6.5379	81.068	12.4	12.4	6.1999	6.1999
9	0.53437	0.80313	6.5444	89.528	13.68	13.68	6.8401	6.8401
10	0.59687	0.90235	6.5509	96.217	14.688	14.688	7.3438	7.3438
11	0.65937	1.0006	6.5574	101.33	15.453	15.453	7.7266	7.7266
12	0.72603	1.1045	6.5643	105.46	16.066	16.066	8.0332	8.0332
13	0.78853	1.2038	6.5709	108.32	16.484	16.484	8.2422	8.2422
14	0.85103	1.302	6.5774	110.28	16.767	16.767	8.3836	8.3836
15	0.91353	1.3994	6.5839	111.47	16.93	16.93	8.4649	8.4649
16	0.9802	1.5042	6.5909	112.06	17.001	17.001	8.5007	8.5007
17	1.0427	1.6016	6.5975	111.96	16.97	16.97	8.4849	8.4849
18	1.1052	1.6999	6.6041	111.37	16.863	16.863	8.4317	8.4317
19	1.1719	1.8019	6.6109	109.5	16.563	16.563	8.2816	8.2816
20	1.2344	1.902	6.6177	105.56	15.952	15.952	7.9758	7.9758
21	1.2971	2.0022	6.6244	99.562	15.03	15.03	7.5148	7.5148
22	1.3596	2.1005	6.6311	94.053	14.184	14.184	7.0918	7.0918
23	1.4263	2.1997	6.6378	89.528	13.488	13.488	6.7438	6.7438
24	1.493	2.3045	6.6449	84.314	12.688	12.688	6.3442	6.3442
25	1.5555	2.4028	6.6516	77.723	11.685	11.685	5.8424	5.8424
26	1.618	2.5011	6.6583	72.608	10.905	10.905	5.4524	5.4524
27	1.6846	2.605	6.6654	68.574	10.288	10.288	5.144	5.144
28	1.7471	2.7005	6.672	65.131	9.7619	9.7619	4.881	4.881
29	1.8096	2.7997	6.6788	61.885	9.2659	9.2659	4.633	4.633
30	1.843	2.8512	6.6823	60.508	9.0549	9.0549	4.5274	4.5274

COMPACTION TEST REPORT



	SOIL DATA								
	SOURCE	SAMPLE NO.	ELEV./ DEPTH (ft.)	USCS	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	MAXIMUM DRY DENSITY pcf	OPTIMUM MOISTURE CONTENT (%)
●		Bag B-3	1.0-10.0		15	21.5	28.2	108.3	16.0
■		Bag B-4	1.0-10.0		18.4	22.4	30.6	108.5	16.3
▲		Bag B-5	1.0-10.0		13.7	20.5	30.1	112.0	14.7
◆		Bag B-6	1.0-10.0		18.8	22.3	29.2	107.5	15.6

HANSON
Hanson Professional Services Inc.

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project No.: 03S5010 5000 **Plate**

MOISTURE DENSITY TEST DATA

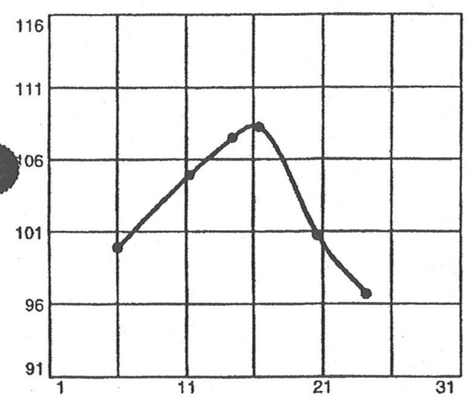
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Specimen Data

Source:
Sample No.: Bag B-3
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt.
USCS Classification:
Natural Moisture: 15 **Liquid Limit:** 28.2 **Plastic Limit:** 21.5
Percent retained on No.4 sieve: 0.0
Percent passing No. 200 sieve: 99.7 **Specific gravity:**

Test Data And Results For Curve 1

Type of test: ASTM D 698-00a Method A Standard
Mold Dia.: 4.00 in. **Hammer Wt.:** 5.5 lb. **Drop:** 12 in.
Layers: three **Blows per Layer:** 25



POINT NO.	1	2	3	4	5	6
WM + WS	12.72	13.08	13.29	13.39	13.24	13.19
WM	9.19	9.19	9.19	9.19	9.19	9.19
WW+T	91.40	84.60	100.30	95.10	92.60	96.20
WD+T	86.40	76.40	88.10	82.20	77.40	78.20
TARE	3.80	3.70	3.70	3.70	3.70	3.70
MOIST	6.1	11.3	14.5	16.4	20.6	24.2

MOISTURE	6.1	11.3	14.5	16.4	20.6	24.2
DRY DEN	99.9	104.9	107.5	108.3	100.8	96.7

Max dry den= 108.3 pcf **Opt moisture=** 16.0 %

Oversize Correction Not Applied

MOISTURE DENSITY TEST DATA

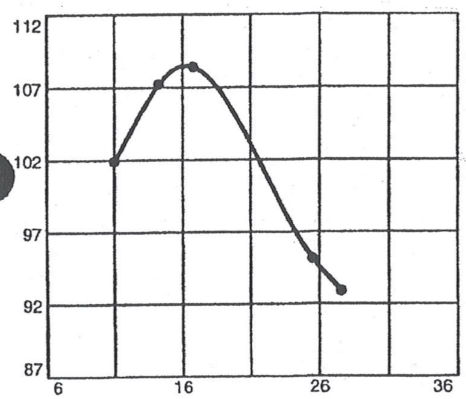
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Specimen Data

Source:
Sample No.: Bag B-4
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt.
USCS Classification:
Natural Moisture: 18.4 **Liquid Limit:** 30.6 **Plastic Limit:** 22.4
Percent retained on No.4 sieve: 0.0
Percent passing No. 200 sieve: 98.9 **Specific gravity:**

Test Data And Results For Curve 2

Type of test: ASTM D 698-00a Method A Standard
Mold Dia.: 4.00 in. **Hammer Wt.:** 5.5 lb. **Drop:** 12 in.
Layers: three **Blows per Layer:** 25



POINT NO.	1	2	3	4	5
WM + WS	12.96	13.27	13.41	13.17	13.14
WM	9.19	9.19	9.19	9.19	9.19
WW+T	97.30	99.30	95.30	100.70	94.50
WD+T	88.00	87.40	82.10	81.00	74.90
TARE	3.60	3.70	3.70	3.70	3.80
MOIST	11.0	14.2	16.8	25.5	27.6
MOISTURE	11.0	14.2	16.8	25.5	27.6
DRY DEN	101.9	107.2	108.4	95.2	92.9

Max dry den= 108.5 pcf **Opt moisture=** 16.3 %

Oversize Correction Not Applied

MOISTURE DENSITY TEST DATA

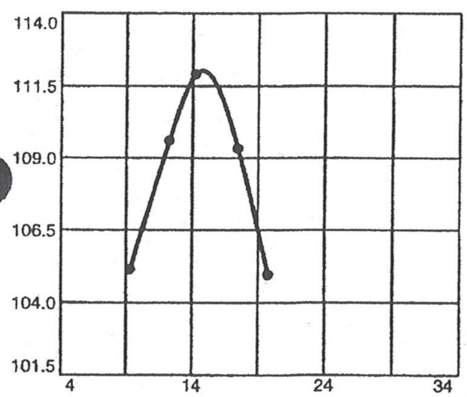
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Specimen Data

Source:
Sample No.: Bag B-5
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt / so. clay.
USCS Classification:
Natural Moisture: 13.7 **Liquid Limit:** 30.1 **Plastic Limit:** 20.5
Percent retained on No.4 sieve: 0.1
Percent passing No. 200 sieve: 93.1 **Specific gravity:**

Test Data And Results For Curve 3

Type of test: ASTM D 698-00a Method A Standard
Mold Dia.: 4.00 in. **Hammer Wt.:** 5.5 lb. **Drop:** 12 in.
Layers: three **Blows per Layer:** 25



POINT NO.	1	2	3	4	5
WM + WS	13.02	13.29	13.45	13.47	13.38
WM	9.19	9.19	9.19	9.19	9.19
WW+T	95.20	99.80	98.40	97.80	99.30
WD+T	87.40	89.30	86.60	83.80	83.50
TARE	3.70	3.70	3.70	3.70	3.70
MOIST	9.3	12.3	14.2	17.5	19.8
MOISTURE	9.3	12.3	14.2	17.5	19.8
DRY DEN	105.1	109.6	111.9	109.3	105.0

Max dry den= 112.0 pcf **Opt moisture=** 14.7 %

Oversize Correction Not Applied

MOISTURE DENSITY TEST DATA

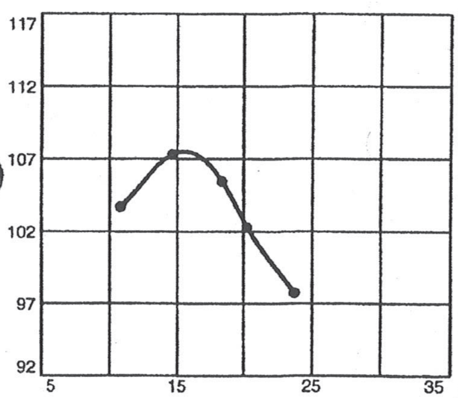
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Specimen Data

Source:
Sample No.: Bag B-6
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt (tr. clay).
USCS Classification:
Natural Moisture: 18.8 **Liquid Limit:** 29.2 **Plastic Limit:** 22.3
Percent retained on No.4 sieve: 0.0
Percent passing No. 200 sieve: 99.0 **Specific gravity:**

Test Data And Results For Curve 4

Type of test: ASTM D 698-00a Method A Standard
Mold Dia.: 4.00 in. **Hammer Wt.:** 5.5 lb. **Drop:** 12 in.
Layers: three **Blows per Layer:** 25



POINT NO.	1	2	3	4	5
WM + WS	13.02	13.29	13.35	13.29	13.22
WM	9.19	9.19	9.19	9.19	9.19
WW+T	98.70	99.90	99.60	99.80	97.60
WD+T	89.40	87.60	84.70	83.60	79.60
TARE	3.70	3.70	3.70	3.70	3.80
MOIST	10.9	14.7	18.4	20.3	23.7
MOISTURE	10.9	14.7	18.4	20.3	23.7
DRY DEN	103.7	107.3	105.4	102.3	97.7

Max dry den= 107.5 pcf **Opt moisture=** 15.6 %

Oversize Correction Not Applied

HANSON®

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	05S3010	TEST DATE:	3/13/2006
CLIENT:	Sgt. & Lundy	BORING #:	B-3
JOB DESCRIPTION:	Ash Pond	SAMPLE #:	2
SAMPLE DESCRIPTION:	Yel. Brn. Vf. Sandy silt	DEPTH (FT):	1.0-10.0
		FILE NAME:	Duck Creek Ash Pond

SPECIMEN WEIGHT (G)	941.98
SPECIMEN HEIGHT (IN)	4.629
DIAMETER (IN)	2.865
AREA (SQ IN)	6.447
VOLUME (CU IN)	29.842
WET DENSITY (PCF)	120.25
DRY DENSITY (PCF)	103.02
WT. DRY SOIL (G)	807.01
VOLUME DRY SOIL (CU IN	18.240
SP.GR. ASSUMED	2.70
POROSITY (%)	38.88
HEIGHT OF HEAD (PSI)	5.00
HYDRAULIC GRADIANT	29.9
1/4 PORE VOLUME	47.53

WATER CONTENT OF TRIMMINGS

	BEFORI TEST	AFTER TEST
TARE + WET SOIL (G)	253.75	1044.89
TARE + DRY SOIL (G)	217.92	854.45
TARE (G)	3.68	50.12
WATER (G)	35.83	190.44
DRY SOIL (G)	214.24	804.33
WATER CONTENT (%)	16.72	23.68

STD. MAX. DEN.(LBS/CU.FT.)	108.40
OPTIMUM MOISTURE (%)	16.10
% COMPACTION	95.04
PRESSURE HEAD (CM H2O)	189.86
PANEL NUMBER	5

TEST METHOD USED: IEPA ASTM D5084

PERMEANT USED: TAP WATER

HANSON.
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 05S3010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-3
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 4.629
DIAMETER (IN) 2.865
AREA (SQ IN) 6.447

HEIGHT OF HEAD (PSI) 5.00
PRESSURE HEAD (CM H2O) 351.59
PANEL NUMBER 5
FILE NAME: uck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
3/22/2006	11:31:10	3/22/2006	11:38:30	13.60	13.6000	7.33	7.33	2.49E-05	2.49E-05
3/22/2006	12:47:40	3/22/2006	13:01:00	23.60	37.2000	13.33	20.67	2.37E-05	2.43E-05
3/22/2006	13:04:00	3/22/2006	13:17:06	23.10	60.3000	13.10	33.77	2.36E-05	2.37E-05
3/22/2006	13:20:30	3/22/2006	13:34:50	25.10	85.4000	14.33	48.10	2.35E-05	2.35E-05
3/22/2006	13:40:00	3/22/2006	13:53:10	23.50	108.9000	13.17	61.27	2.39E-05	2.37E-05
3/22/2006	13:55:30	3/22/2006	14:09:00	24.30	133.2000	13.50	74.77	2.41E-05	2.40E-05
3/22/2006	14:11:00	3/22/2006	14:24:30	24.50	157.7000	13.50	88.27	2.43E-05	2.42E-05
3/22/2006	14:32:30	3/22/2006	14:46:00	24.50	182.2000	13.50	101.77	2.43E-05	2.43E-05
3/22/2006	14:47:30	3/22/2006	15:01:00	24.50	206.7000	13.50	115.27	2.43E-05	2.43E-05
3/22/2006	15:04:00	3/22/2006	15:17:30	24.60	231.3000	13.50	128.77	2.44E-05	2.44E-05
3/22/2006	15:20:00	3/22/2006	15:33:38	24.50	255.8000	13.63	142.40	2.41E-05	2.43E-05
3/22/2006	15:36:30	3/22/2006	15:50:00	24.50	280.3000	13.50	155.90	2.43E-05	2.42E-05

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

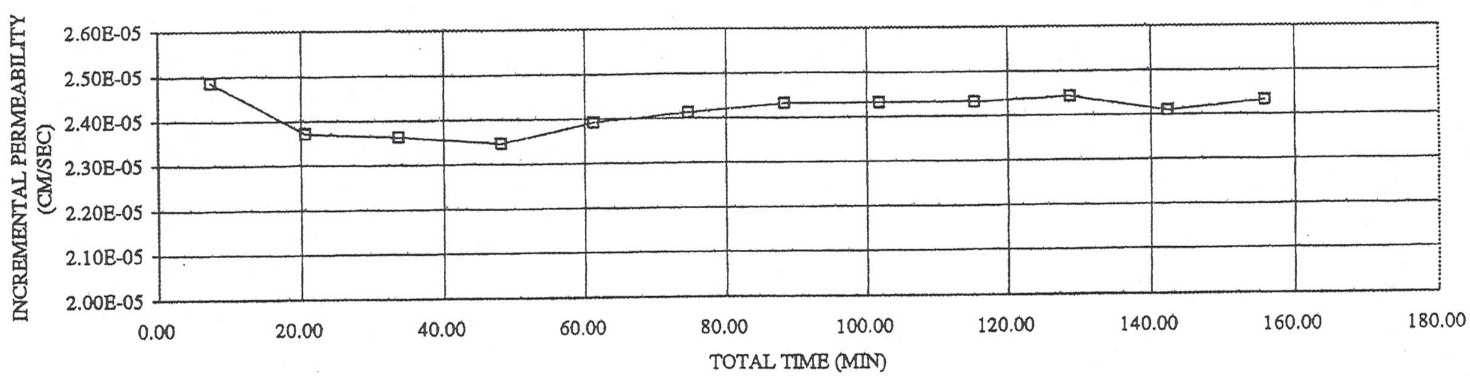
JOB NUMBER: 05S3010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-3
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 4.629
DIAMETER (IN) 2.865
AREA (SQ IN) 6.447

HEIGHT OF HEAD (PSI) 5.00
PRESSURE HEAD (CM H2O) 351.59
PANEL NUMBER 5
FILE NAME: uck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)



HANSON®

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	05S5010	TEST DATE:	1/27/2006
CLIENT:	Sgt. & Lundy	BORING #:	B-4
JOB DESCRIPTION:	Ash Pond	SAMPLE #:	2
SAMPLE DESCRIPTION:	Yel. Brn. Vf. Sandy silt..	DEPTH (FT):	1.0-10
		FILE NAME:	; Creek Ash Pond

			WATER CONTENT OF TRIMMINGS BEFORI TEST	AFTER TEST
SPECIMEN WEIGHT (G)	978.64			
SPECIMEN HEIGHT (IN)	4.776			
DIAMETER (IN)	2.874	TARE + WET SOIL (G)	250.70	1080.75
AREA (SQ IN)	6.487	TARE + DRY SOIL (G)	216.37	888.44
VOLUME (CU IN)	30.983	TARE (G)	3.71	50.09
WET DENSITY (PCF)	120.33	WATER (G)	34.33	192.31
DRY DENSITY (PCF)	103.37	DRY SOIL (G)	212.66	838.35
WT. DRY SOIL (G)	840.76	WATER CONTENT (%)	16.40	22.94
VOLUME DRY SOIL (CU IN	19.002			
SP.GR. ASSUMED	2.70			
POROSITY (%)	38.67	STD. MAX. DEN.(LBS/CU.FT.)	108.50	
HEIGHT OF HEAD (PSI)	5.10	OPTIMUM MOISTURE (%)	16.40	
HYDRAULIC GRADIANT	29.6	% COMPACTION	95.28	
1/4 PORE VOLUME	49.08	PRESSURE HEAD (CM H2O)	189.86	
		PANEL NUMBER	3	

TEST METHOD USED: IEPA ASTM D5084 PERMEANT USED: Tap Water

HANSON.
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 05S5010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-4
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 4.776
DIAMETER (IN) 2.874
AREA (SQ IN) 6.487

HEIGHT OF HEAD (PSI) 5.10
PRESSURE HEAD (CM H2O) 358.62
PANEL NUMBER 3
FILE NAME: 'uck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
3/22/2006	11:35:10	3/22/2006	11:40:00	4.10	4.1000	4.83	4.83	1.14E-05	1.14E-05
3/22/2006	12:49:10	3/22/2006	13:21:00	23.90	28.0000	31.83	36.67	1.01E-05	1.08E-05
3/22/2006	13:24:00	3/22/2006	13:58:00	24.20	52.2000	34.00	70.67	9.59E-06	9.85E-06
3/22/2006	14:00:25	3/22/2006	14:34:30	23.80	76.0000	34.08	104.75	9.41E-06	9.50E-06
3/22/2006	14:37:00	3/22/2006	15:10:00	23.50	99.5000	33.00	137.75	9.59E-06	9.50E-06
3/22/2006	15:12:30	3/22/2006	15:45:00	23.80	123.3000	32.50	170.25	9.86E-06	9.73E-06
3/22/2006	15:47:01	3/22/2006	16:19:00	23.90	147.2000	31.98	202.23	1.01E-05	9.97E-06
3/23/2006	8:15:00	3/23/2006	8:47:30	24.30	171.5000	32.50	234.73	1.01E-05	1.01E-05
3/23/2006	8:49:00	3/23/2006	9:21:00	24.10	195.6000	32.00	266.73	1.01E-05	1.01E-05
3/23/2006	9:23:00	3/23/2006	9:55:00	24.30	219.9000	32.00	298.73	1.02E-05	1.02E-05
3/23/2006	9:58:00	3/23/2006	10:29:30	24.00	243.9000	31.50	330.23	1.03E-05	1.02E-05
3/23/2006	10:32:00	3/23/2006	11:04:00	24.90	268.8000	32.00	362.23	1.05E-05	1.04E-05
3/23/2006	11:13:00	3/23/2006	11:38:00	19.50	288.3000	25.00	387.23	1.05E-05	1.05E-05
3/23/2006	13:03:00	3/23/2006	13:34:00	23.80	312.1000	31.00	418.23	1.03E-05	1.04E-05
3/23/2006	13:36:30	3/23/2006	14:08:00	24.20	336.3000	31.50	449.73	1.03E-05	1.03E-05

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

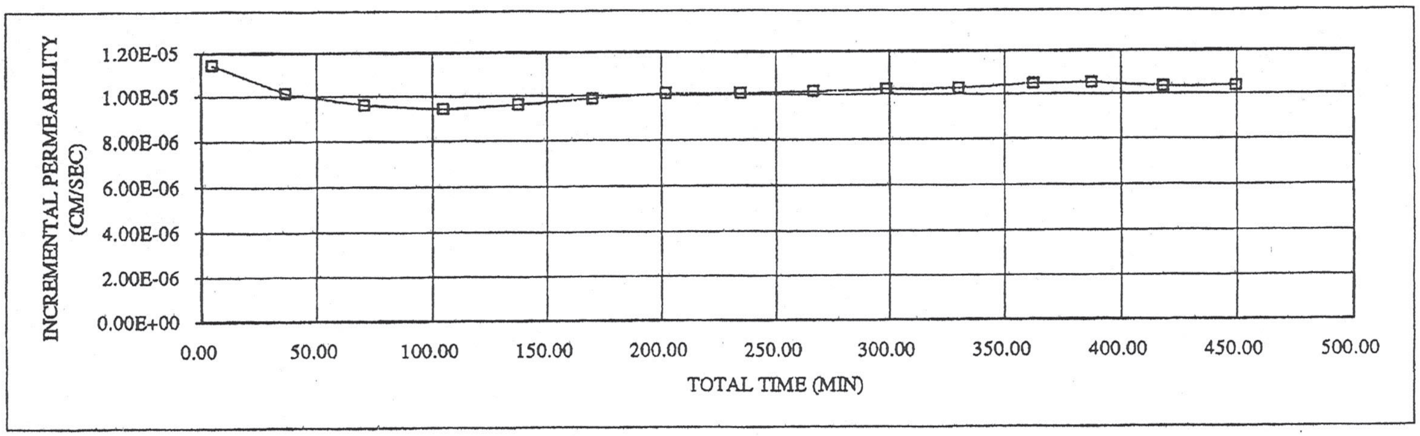
JOB NUMBER: 05S5010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-4
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 4.776
DIAMETER (IN) 2.874
AREA (SQ IN) 6.487

HEIGHT OF HEAD (PSI) 5.10
PRESSURE HEAD (CM H2O) 358.62
PANEL NUMBER 3
FILE NAME: uck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)



HANSON®

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	05S5010	TEST DATE:	1/27/2006
CLIENT:	Sgt. & Lundy	BORING #:	B-5
JOB DESCRIPTION:	Ash Pond	SAMPLE #:	2
SAMPLE DESCRIPTION:	Yel. Brn. Vf. Sandy silt / so. Clay.	DEPTH (FT):	1.0-10.0
		FILE NAME:	: Creek Ash Pond

			WATER CONTENT OF TRIMMINGS	
			BEFORI TEST	AFTER TEST
SPECIMEN WEIGHT (G)	944.87			
SPECIMEN HEIGHT (IN)	4.474			
DIAMETER (IN)	2.877	TARE + WET SOIL (G)	251.34	1036.52
AREA (SQ IN)	6.501	TARE + DRY SOIL (G)	218.71	872.26
VOLUME (CU IN)	29.085	TARE (G)	15.17	50.11
WET DENSITY (PCF)	123.76	WATER (G)	32.63	164.26
DRY DENSITY (PCF)	106.05	DRY SOIL (G)	203.54	822.15
WT. DRY SOIL (G)	809.66	WATER CONTENT (%)	16.70	19.98
VOLUME DRY SOIL (CU IN	18.299			
SP.GR. ASSUMED	2.70			
POROSITY (%)	37.08	STD. MAX. DEN.(LBS/CU.FT.)	112.00	
HEIGHT OF HEAD (PSI)	4.80	OPTIMUM MOISTURE (%)	14.70	
HYDRAULIC GRADIANT	29.7	% COMPACTION	94.69	
1/4 PORE VOLUME	44.18	PRESSURE HEAD (CM H2O)	189.86	
		PANEL NUMBER	4	

TEST METHOD USED: IEPA ASTM D5084

PERMEANT USED: TAP WATER

HANSON.

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 05S5010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-5
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 4.474
DIAMETER (IN) 2.877
AREA (SQ IN) 6.501

HEIGHT OF HEAD (PSI) 4.80
PRESSURE HEAD (CM H2O) 337.52
PANEL NUMBER 4
FILE NAME: Duck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
3/22/2006	13:08:00	3/22/2006	16:32:15	11.20	11.2000	204.25	204.25	7.34E-07	7.34E-07
3/23/2006	8:17:00	3/23/2006	10:23:45	6.30	17.5000	126.75	331.00	6.65E-07	6.99E-07
3/23/2006	10:23:45	3/23/2006	11:38	2.90	20.4000	74.25	405.25	5.23E-07	5.94E-07
3/24/2006	8:59:00	3/24/2006	15:31:25	20.20	40.6000	392.42	797.67	6.89E-07	6.06E-07
3/24/2006	15:52:40	3/24/2006	17:50:15	6.40	47.0000	117.58	915.25	7.28E-07	7.08E-07
3/27/2006	8:08:00	3/27/2006	11:24:50	8.90	55.9000	196.83	1112.08	6.05E-07	6.67E-07
3/27/2006	11:24:50	3/27/2006	17:21:10	15.60	71.5000	356.33	1468.42	5.86E-07	5.95E-07

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

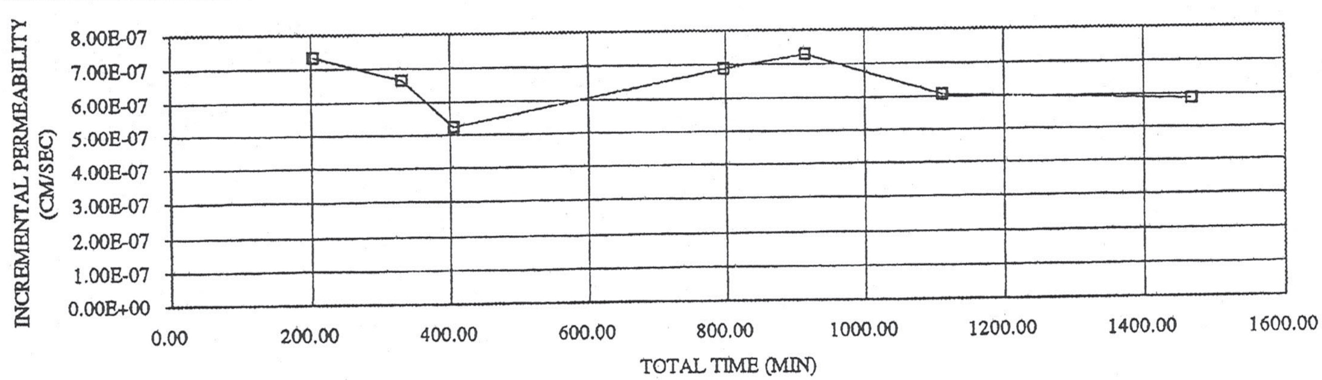
JOB NUMBER: 05S5010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-5
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 4.474
DIAMETER (IN) 2.877
AREA (SQ IN) 6.501

HEIGHT OF HEAD (PSI) 4.80
PRESSURE HEAD (CM H2O) 337.52
PANEL NUMBER 4
FILE NAME: Duck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)



HANSON.

Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

ASTM D5084

JOB NUMBER:	05S5010	TEST DATE:	3/22/2006
CLIENT:	Sgt. & Lundy	BORING #:	B-6
JOB DESCRIPTION:	Ash Pond	SAMPLE #:	2
SAMPLE DESCRIPTION:	Yel. Brn. Vf. Sandy silt (tr. Clay).	DEPTH (FT):	1.0-10.0
		FILE NAME:	k Creek Ash Pond

WATER CONTENT OF TRIMMINGS

			BEFORI TEST	AFTER TEST
SPECIMEN WEIGHT (G)	726.71			
SPECIMEN HEIGHT (IN)	3.576			
DIAMETER (IN)	2.859	TARE + WET SOIL (G)	256.28	818.17
AREA (SQ IN)	6.420	TARE + DRY SOIL (G)	221.19	673.54
VOLUME (CU IN)	22.957	TARE (G)	16.03	50.11
WET DENSITY (PCF)	120.59	WATER (G)	35.09	144.63
DRY DENSITY (PCF)	102.98	DRY SOIL (G)	205.16	623.43
WT. DRY SOIL (G)	620.57	WATER CONTENT (%)	17.10	23.20
VOLUME DRY SOIL (CU IN	14.026			
SP.GR. ASSUMED	2.70			
POROSITY (%)	38.90	STD. MAX. DEN.(LBS/CU.FT.)	107.50	
HEIGHT OF HEAD (PSI)	3.80	OPTIMUM MOISTURE (%)	15.70	
HYDRAULIC GRADIANT	29.4	% COMPACTION	95.79	
1/4 PORE VOLUME	36.59	PRESSURE HEAD (CM H2O)	189.86	
		PANEL NUMBER	8	

TEST METHOD USED: IEPA ASTM D5084 PERMEANT USED: TAP WATER

HANSON.
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

JOB NUMBER: 05S5010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-6
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 3.576
DIAMETER (IN) 2.859
AREA (SQ IN) 6.420

HEIGHT OF HEAD (PSI) 3.80
PRESSURE HEAD (CM H2O) 267.21
PANEL NUMBER 8
FILE NAME: uck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)
3/22/2006	13:10:00	3/22/2006	13:32:00	23.50	23.5000	22.00	22.00	1.46E-05	1.46E-05
3/22/2006	13:34:00	3/22/2006	14:03:30	23.70	47.2000	29.50	51.50	1.10E-05	1.28E-05
3/22/2006	14:05:00	3/22/2006	14:38:30	24.20	71.4000	33.50	85.00	9.88E-06	1.04E-05
3/22/2006	14:40:30	3/22/2006	15:15:00	24.00	95.4000	34.50	119.50	9.52E-06	9.70E-06
3/22/2006	15:16:40	3/22/2006	15:51:00	23.80	119.2000	34.33	153.83	9.48E-06	9.50E-06
3/22/2006	15:56:45	3/22/2006	16:31:00	23.80	143.0000	34.25	188.08	9.51E-06	9.49E-06
3/23/2006	8:19:00	3/23/2006	8:54:00	23.70	166.7000	35.00	223.08	9.26E-06	9.38E-06
3/23/2006	8:57:00	3/23/2006	9:32:00	24.10	190.8000	35.00	258.08	9.42E-06	9.34E-06
3/23/2006	9:34:30	3/23/2006	10:09:00	24.10	214.9000	34.50	292.58	9.56E-06	9.49E-06
3/23/2006	10:12:00	3/23/2006	10:46:00	23.70	238.6000	34.00	326.58	9.53E-06	9.55E-06
3/23/2006	10:48:00	3/23/2006	11:22:00	23.80	262.4000	34.00	360.58	9.58E-06	9.56E-06
3/23/2006	11:24:00	3/23/2006	11:38:04	10.50	272.9000	14.07	374.65	1.02E-05	9.89E-06
3/23/2006	13:07:00	3/23/2006	13:42:00	24.30	297.2000	35.00	409.65	9.50E-06	9.85E-06
3/23/2006	13:45:00	3/23/2006	14:20:00	24.50	321.7000	35.00	444.65	9.58E-06	9.54E-06

HANSON.
Hanson Professional Services Inc.

CONSTANT HEAD PERMEABILITY TEST

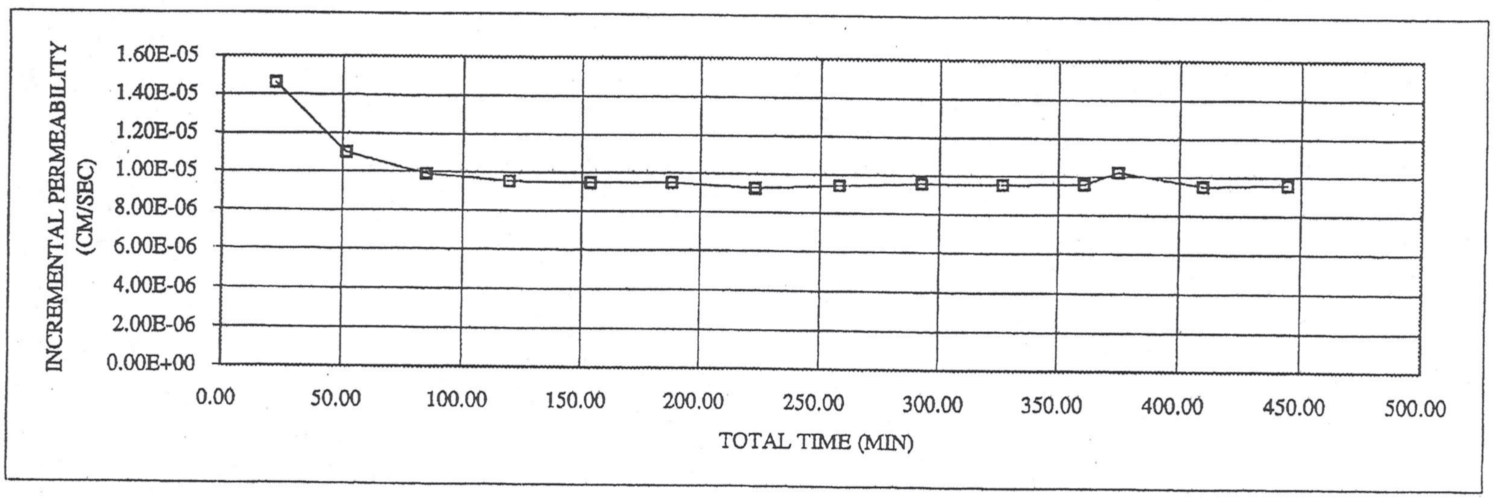
JOB NUMBER: 05S5010
CLIENT: Sgt. & Lundy
JOB DESCRIPTION: Ash Pond

TEST DATE: 1/27/2006
BORING #: B-6
SAMPLE #: 2
DEPTH (FT): 1.0-10.0

SPECIMEN HEIGHT (IN) 3.576
DIAMETER (IN) 2.859
AREA (SQ IN) 6.420

HEIGHT OF HEAD (PSI) 3.80
PRESSURE HEAD (CM H2O) 267.21
PANEL NUMBER 8
FILE NAME: uck Creek Ash Pond

START DATE	START TIME	STOP DATE	STOP TIME	INCREMENT. FLOW (CC)	TOTAL FLOW (CC)	INCREMENT. TIME (MIN)	TOTAL TIME (MIN)	INCREMENTAL PERMEABILITY (CM/SEC)	AVERAGE PERMEABILITY (CM/SEC)



Geotechnical Requirements for Soil Borings

1, Drill six (6) boreholes B-1 through B-6 at the locations shown on the plan and having following coordinates:

B-1	N-1617.9, E-2220.9
B-2	N-1415.7, E-2224.8
B-3	N-1521.0, E-2307.5
B-4	N-1517.4, E-2443.2
B-5	N-1615.5, E-2572.8
B-6	N-1422.1, E-2573.8

2, Holes shall be drilled to a depth of 30 feet. If rock is encountered at a depth of less than 30 feet, the boring shall be terminated when auger refusal is attained.

3, Perform continuous split spoon sampling in all borings to a depth of 10ft., then perform SPT's at 5 ft. intervals.

4, Obtain 50-lb bag samples in each cohesive soil layer in each boring for laboratory testing in the upper 10 ft. for remainder of depth.

5, Obtain undisturbed soil samples using a Shelby tube, per ASTM D 1587, when cohesive soils are encountered.

6, Laboratory Testing shall consist of:

A) Natural water content - ASTM D2216
B) Percent passing the #200 sieve - D1140
C) Atterberg limits - D4318
D) Standard Proctor tests - D698
E) Permeability tests on samples compacted to 95% per ASTM D698 at a moisture content of +1% of optimum (D5084).
F) Unconfined compression tests on samples compacted to 95% per ASTM D698 at a moisture content of +1% of optimum (D2166).
G) Dry density per EM-1110-2-1906.
Unconfined compressive strength on undisturbed samples per ASTM D2166.

HANSON

Hanson Professional Services Inc.

Springfield, Illinois

OPERATOR: JPK

TEST DATE: 2/27/06

JOB NO.: 03S5010ap

LABORATORY SOIL TEST DATA

PROJECT NAME: Duck Creek Ash Pond

LOCATION: Canton, Illinois

CLIENT: AmerenCilco

SAMP.	DEPTH (ft)	ELEV. (ft)	N (blows/ft)	STRENGTH TESTS			WATER (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)	Special Tests	SAMPLE DESCRIPTION
				Qu (tsf)	Failure	P (tsf)					
BORING: B-01		Ground Surface Elevation (ft): 579.6					Balance: G09745				
SS-1	2.0	577.6	16			2.75	12				Brn. - gray clayey silt w/some crs sand & sm. gravel
SS-3	6.0	573.6	12			0.70	17				Gray silt w/some vf. sand
SS-4A	8.0	571.6	16			0.75	20				Gray - some brn. silt w/some vf. sand
SS-4B	8.0	571.6	16				21				Brn. silt/some vf. sand
SS-6	15.0	564.6	5	1.63	B	1.75	28				Brn. - yel. silt w/some clay & vf. sand
SS-7A	20.0	559.6	4	0.47	B	1.00	21				Brn. - yel. silt w/some f. - med. sand, tr. clay
SS-7B	20.0	559.6	4				20				Brn. - yel. silty f. - med. sand w/tr. clay
SS-9A	30.0	549.6	11	0.47	BSh	0.30	18				Brn. - yel. silty f. - med. sand w/tr. sm. gravel & clay
SS-9B	30.0	549.6	11				13				Brn. - yel. silty f. - med. sand w/tr. sm. gravel & clay

LABORATORY SOIL TEST DATA 03S5010AP.GPJ HANSON ENG.GDT 3/16/06

Reviewed by: VLM Date: 02/28/06

P = Penetrometer Reading

Water % - ASTM 2216-98

HANSON

Hanson Professional Services Inc.
Springfield, Illinois

OPERATOR: JPK
TEST DATE: 2/27/06
JOB NO.: 03S5010ap

LABORATORY SOIL TEST DATA

PROJECT NAME: Duck Creek Ash Pond
LOCATION: Canton, Illinois
CLIENT: AmerenCilco

SAMP.	DEPTH (ft)	ELEV. (ft)	N (blows/ft)	STRENGTH TESTS Qu (tsf)	Failure	P (tsf)	WATER (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)	Special Tests	SAMPLE DESCRIPTION
BORING: B-02		Ground Surface Elevation (ft): 575.4					Balance: G09745				
SS-1A	2.0	573.4	11				18				Brn. silt w/some vf. sand
SS-1B	2.0	573.4	11	1.55	Sh	1.25	21				Brn. silt w/some vf. sand
SS-3	6.0	569.4	12				16				Brn. & gray silt w/some vf. sand
SS-4	8.0	567.4	13			2.75	19				Brn. vf. sandy silt w/tr. clay
SS-6	15.0	560.4	3	0.23	B	0.20	32				Brn. & gray silt
SS-8	25.0	550.4	27	6.55	Sh	4.50	17				Dk. gray-blk. clayey silt, shale, & coal
SS-9	30.0	545.4	21				15				Gray - dk. gray shaley clay w/some coal

LABORATORY SOIL TEST DATA 03S5010AP.GPJ HANSON ENG.GDT 3/16/06

Reviewed by: VLM Date: 02/28/06

P = Penetrometer Reading
Water % - ASTM 2216-98

HANSON

Hanson Professional Services Inc.
Springfield, Illinois

OPERATOR: JPK
TEST DATE: 2/27/06
JOB NO.: 03S5010ap

LABORATORY SOIL TEST DATA

PROJECT NAME: Duck Creek Ash Pond
LOCATION: Canton, Illinois
CLIENT: AmerenCilco

SAMP.	DEPTH (ft)	ELEV. (ft)	N (blows/ft)	STRENGTH TESTS			WATER (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)	Special Tests	SAMPLE DESCRIPTION
				Qu (tsf)	Failure	P (tsf)					
BORING: B-03				Ground Surface Elevation (ft): 576.3				Balance: G09745			
SS-1	2.0	574.3	13	2.76	Sh	1.85	19				Brn. & gray silt w/some vf. sand
SS-3	6.0	570.3	7	1.38	Sh	1.25	25				Brn. & gray silt w/some vf. sand
SS-4A	8.0	568.3	8	0.92	Sh	0.08	24				Brn. & gray silt w/some vf. sand
SS-4B	8.0	568.3	8	1.75	Sh	1.25	26				Brn. silt w/some vf. sand
SS-5	10.0	566.3	9	1.92	Sh	1.25	24				Brn. silt w/some vf. sand
SS-7	20.0	556.3	19	5.43	B	4.50	11				Brn. silty f. - med sand w/tr. clay
SS-8	25.0	551.3	59				11				Gray silty f. - crs. sand w/some gravel
SS-9A	30.0	546.3	50/4"				12				Gray silty f. - crs. sand w/some gravel
SS-9B	30.0	546.3	50/4"				9				Gray silty f. - crs. sand w/some gravel

LABORATORY SOIL TEST DATA 03S5010AP.GPJ HANSON ENG.GDT 3/16/06

Reviewed by: VLM Date: 02/28/06

P = Penetrometer Reading
Water % - ASTM 2216-98

HANSON

Hanson Professional Services Inc.
Springfield, Illinois

LABORATORY SOIL TEST DATA

OPERATOR: JPK
TEST DATE: 2/28/06
JOB NO.: 03S5010ap

PROJECT NAME: Duck Creek Ash Pond
LOCATION: Canton, Illinois
CLIENT: AmerenCilco

SAMP.	DEPTH (ft)	ELEV. (ft)	N (blows/ft)	STRENGTH TESTS Qu (tsf)	Failure	P (tsf)	WATER (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)	Special Tests	SAMPLE DESCRIPTION
BORING: B-04			Ground Surface Elevation (ft): 575.7				Balance: G09745				
SS-1	2.0	573.7	9	1.84	Sh	1.50	20				Brn. silt w/some vf. sand
SS-3	6.0	569.7	9	1.61	Sh	1.00	21				Brn. silt w/some vf. sand
SS-4	8.0	567.7	12	1.38	Sh	1.75	27				Brn. & gray silt w/some vf. sand
SS-5	10.0	565.7	4	0.92	Sh	2.25	28				Gray & brn. silt w/some vf. sand
SS-7	20.0	555.7	3	0.55	B	0.25	20				Gray & brn. silt w/some vf. sand & tr. clay
SS-8A	25.0	550.7	78	6.33	Sh		16				Brn. silty f. - crs sand w/tr. sm. gravel
SS-8B	25.0	550.7	78				10				Gray silty f. - crs sand w/tr. sm. gravel & clay
SS-9	30.0	545.7	43	5.36	B	4.50	11				Gray clayey shaley silt w/some crs. sand

LABORATORY SOIL TEST DATA 03S5010AP.GPJ HANSON ENG.GDT 3/16/06

Reviewed by: VLM Date: 02/28/06

P = Penetrometer Reading
Water % - ASTM 2216-98

HANSON

Hanson Professional Services Inc.

Springfield, Illinois

OPERATOR: JPK

TEST DATE: 2/28/06

JOB NO.: 03S5010ap

LABORATORY SOIL TEST DATA

PROJECT NAME: Duck Creek Ash Pond

LOCATION: Canton, Illinois

CLIENT: AmerenCilco

SAMP.	DEPTH (ft)	ELEV. (ft)	N (blows/ft)	STRENGTH TESTS			WATER (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)	Special Tests	SAMPLE DESCRIPTION
				Qu (tsf)	Failure	P (tsf)					
BORING: B-05		Ground Surface Elevation (ft): 585.0					Balance: G09745				
SS-1	2.0	583.0	12	1.84	Sh		15				Brn. silt w/some vf. sand
SS-3	6.0	579.0	10	2.18	Sh	2.50	18				Brn. silt w/some vf. sand
SS-4	8.0	577.0	25			1.25	17				Brn. silt w/some vf. sand
SS-5	10.0	575.0	17				19				Brn. silt w/some vf. sand - cuttings
SS-7	20.0	565.0	5	2.62	Sh	2.00	27				Brn. silt w/some vf. sand
SS-8	25.0	560.0	6	2.62	Sh	2.00	24				Gray silt w/some vf. sand

LABORATORY SOIL TEST DATA 03S5010AP.GPJ HANSON ENG.GDT 3/16/06

Reviewed by: VLM Date: 02/28/06

P = Penetrometer Reading

Water % - ASTM 2216-98

HANSON

Hanson Professional Services Inc.
Springfield, Illinois

OPERATOR: JPK
TEST DATE: 2/28/06
JOB NO.: 03S5010ap

LABORATORY SOIL TEST DATA

PROJECT NAME: Duck Creek Ash Pond
LOCATION: Canton, Illinois
CLIENT: AmerenCilco

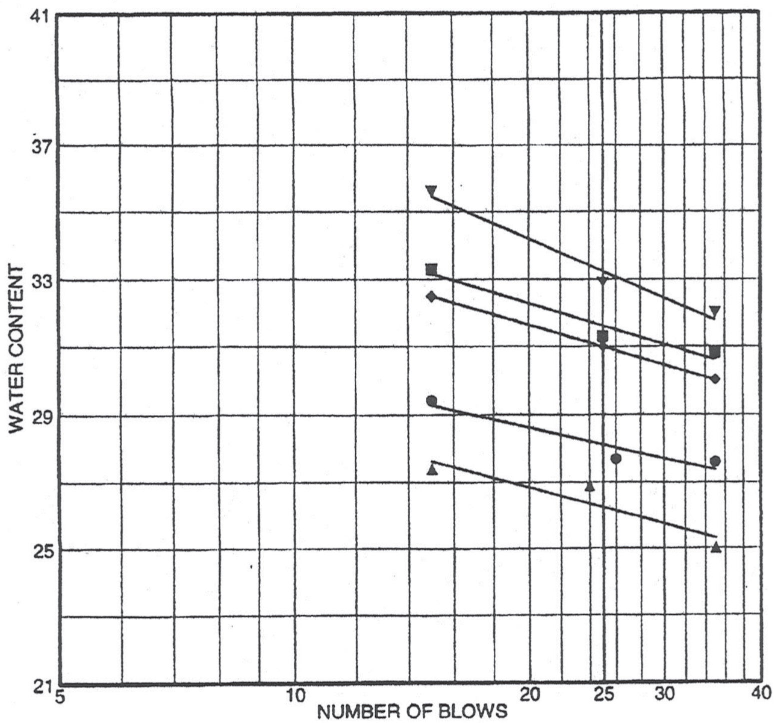
SAMP.	DEPTH (ft)	ELEV. (ft)	N (blows/ft)	STRENGTH TESTS Qu (tsf)	Failure	P (tsf)	WATER (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)	Special Tests	SAMPLE DESCRIPTION
BORING: B-06		Ground Surface Elevation (ft): 577.5					Balance: G09745				
SS-1	2.0	575.5	14			4.25	16				Brn. silt w/some vf. sand
SS-3	6.0	571.5	7	1.20	Sh	1.00	24				Brn. silt w/some vf. sand
SS-4	8.0	569.5	9	1.18	Sh	1.00	23				Gray - some brn. silt w/some vf. sand
SS-5	10.0	567.5	4	1.24	Sh	0.75	26				Gray - some brn. silt w/some vf. sand
SS-7A	20.0	557.5	4	1.18	B	0.75	23				Gray silt w/some vf. - med. sand
SS-7B	20.0	557.5	4	1.81	B	1.40	26				Gray sandy silt w/some clay
SS-8	30.0	547.5	8				23				Gray silty f. - med. sand w/tr. crs. sand

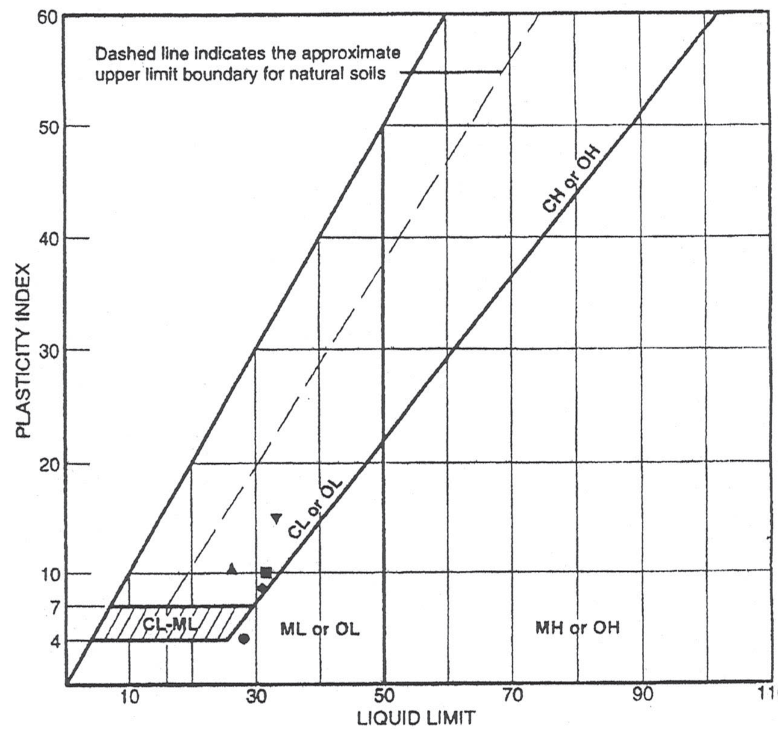
LABORATORY SOIL TEST DATA 03S5010AP.GPJ HANSON ENG.GDT 3/16/06

Reviewed by: VLM Date: 02/28/06

P = Penetrometer Reading
Water % - ASTM 2216-98

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318 / USCS SOIL





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-1 ST-2	2.0-4.0	3/10-06		Brn. & gray vf. sandy silt.	16.1	28.1	4.1
■		B-1 ST-5	8.0-10.0	3/10/06		Brn. vf. sandy silt.	23.0	31.6	10.0
▲		B-1 ST-8	23.0-25	3/10/06		Brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).	18.8	26.2	10.4
◆		B-2 SS-6	13.5-15.0	03-14-06		Brn. & gray silt.	22.4	31.0	8.6
▼		B-4 ST-6	13.0-15.0	3/10/06		Brn. & gray vf. sandy silt.	23	33.2	14.8

Client Sargent & Lundy

Project Duck Creek Ash Pond

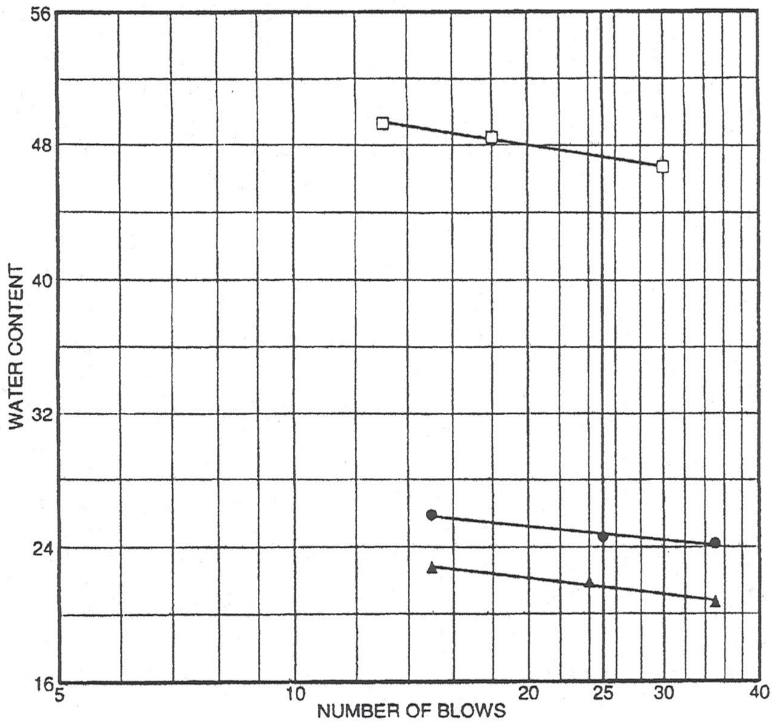
Duck Creek Ash Pond

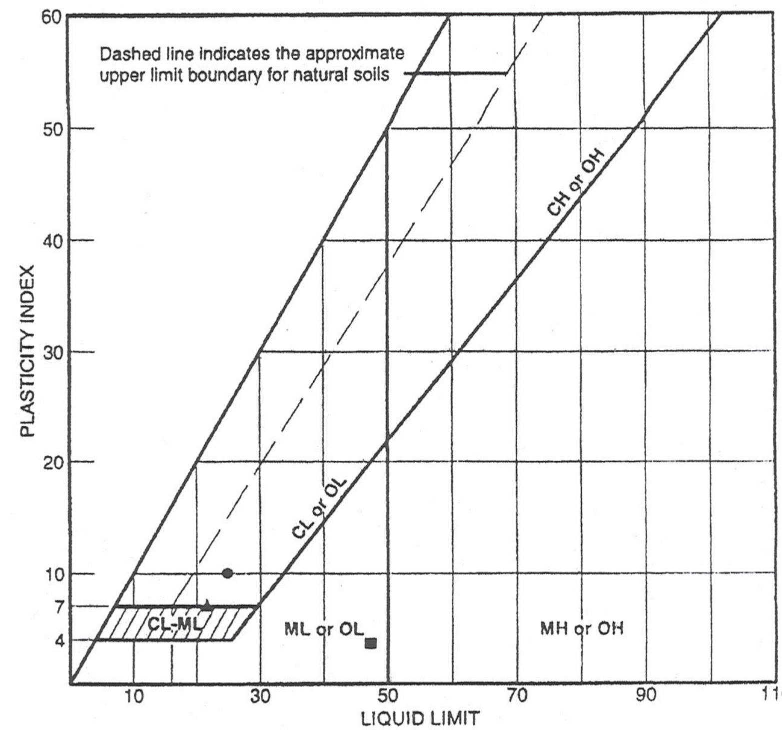
Project No. 03S5010 5000 Plate

HANSON
Hanson Professional Services Inc.

●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318 / USCS SOIL

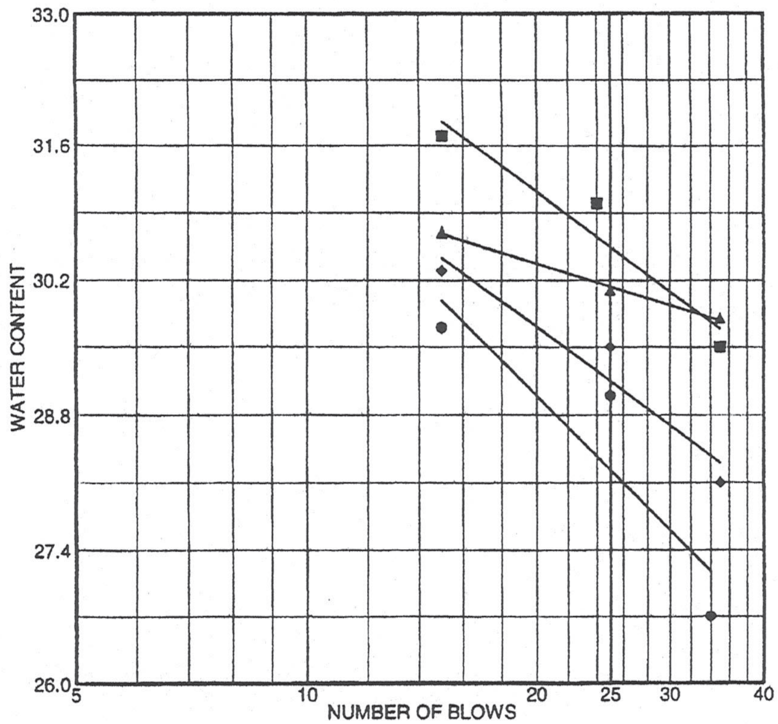


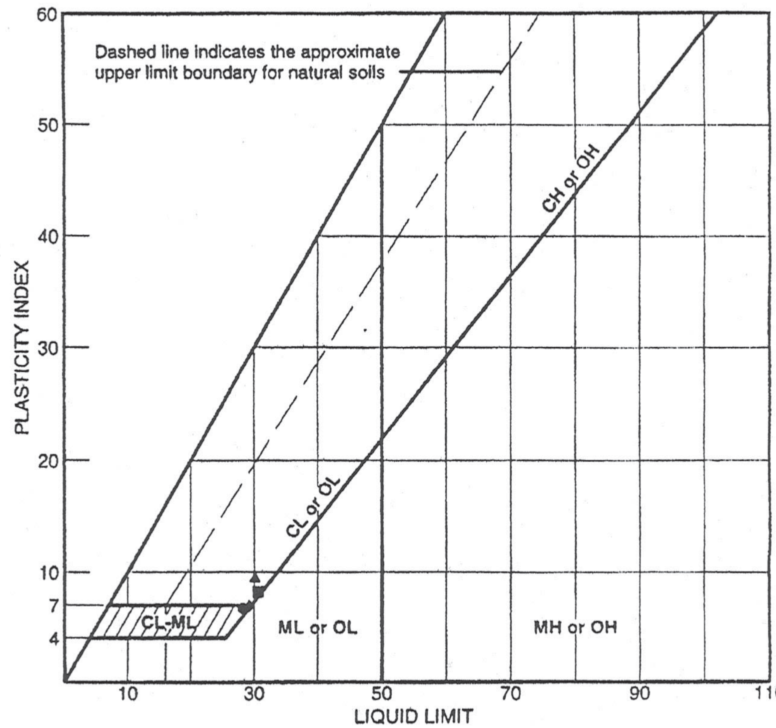


	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		B-4 SS-7	18.5-20.0	3/10/06		Gray & brn. silt / so. vf, sand & (tr. clay).	20	24.8	10.0
■		B-6 ST-6	13.0-15.0	3/10/06		Brn. & gray vf. sandy silt - organic.	48.7	47.3	3.6
▲		B-6 ST-8	23.0-25.0	3/10/06		Gray silty f.-m. sand / (tr. c. sand).	14.4	21.6	7.1

Client Sargent & Lundy		HANSON Hanson Professional Services Inc.	● ■ ▲
Project Duck Creek Ash Pond			
Duck Creek Ash Pond			
Project No. 03S5010 5000	Plate		

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318 / USCS SOIL





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●		Bag B-3	1.0-10.0	3/14/06		Yel. brn. vf. sandy silt.	15	28.2	6.7
■		Bag B-4	1.0-10.0	03/10/06		Yel. brn. vf. sandy silt.	18.4	30.6	8.2
▲		Bag B-5	1.0-10.0	03/14/06		Yel. brn. vf. sandy silt / so. clay.	13.7	30.1	9.6
◆		Bag B-6	1.0-10.0	3/10/06		Yel. brn. vf. sandy silt (tr. clay).	18.8	29.2	6.9

Client Sargent & Lundy

Project Duck Creek Ash Pond

Duck Creek Ash Pond

Project No. 03S5010 5000 Plate

HANSON

Hanson Professional Services Inc.

●
■
▲
◆

LIQUID AND PLASTIC LIMIT TEST DATA

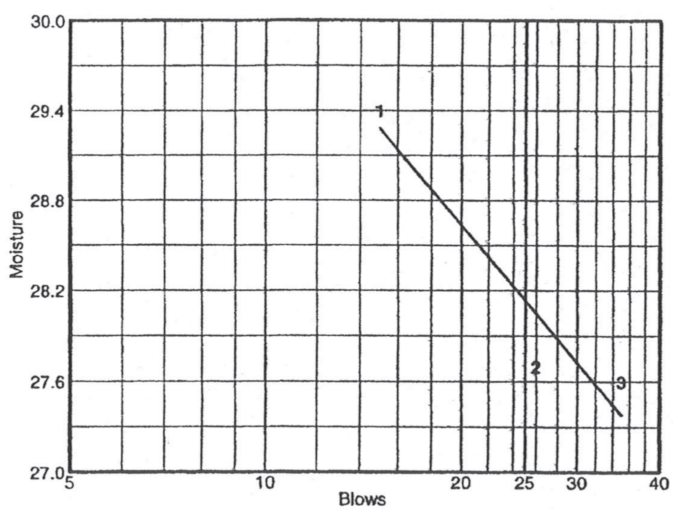
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-1 ST-2
Elev. or Depth: 2.0-4.0 **Sample Length (in./cm.):**
Location:
Description: Brn. & gray vf. sandy silt.
Date: 3/10-06 **Natural Moisture:** 16.1
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.63	29.83	28.92			
Dry+Tare	25.01	26.81	26.07			
Tare	16.11	15.92	15.75			
# Blows	15	26	35			
Moisture	29.4	27.7	27.6			



Liquid Limit= 28.1
Plastic Limit= 24.0
Plasticity Index= 4.1

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	25.16	26.28		
Dry+Tare	23.26	24.31		
Tare	15.39	16.10		
Moisture	24.1	24.0		

Hanson Professional Services, Inc.

LIQUID AND PLASTIC LIMIT TEST DATA

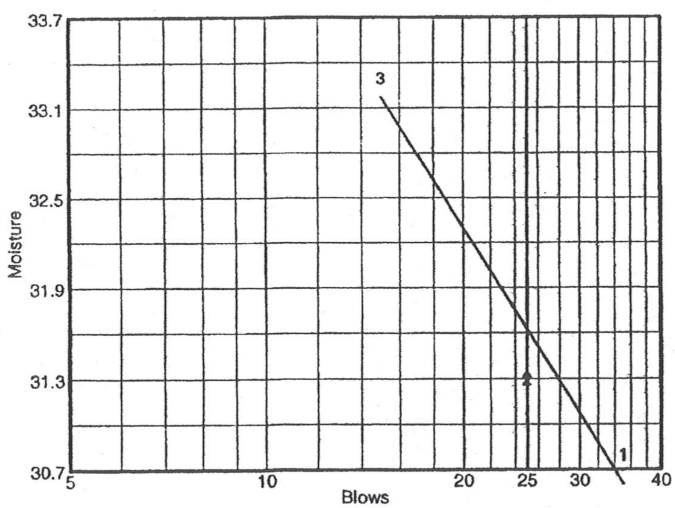
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-1 ST-5
Elev. or Depth: 8.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Brn. vf. sandy silt.
Date: 3/10/06 **Natural Moisture:** 23.0
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	26.50	26.32	25.97			
Dry+Tare	24.04	23.81	23.38			
Tare	16.06	15.80	15.61			
# Blows	35	25	15			
Moisture	30.8	31.3	33.3			



Liquid Limit= 31.6
Plastic Limit= 21.6
Plasticity Index= 10.0

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	24.50	25.88		
Dry+Tare	22.97	24.07		
Tare	15.80	15.81		
Moisture	21.3	21.9		

LIQUID AND PLASTIC LIMIT TEST DATA

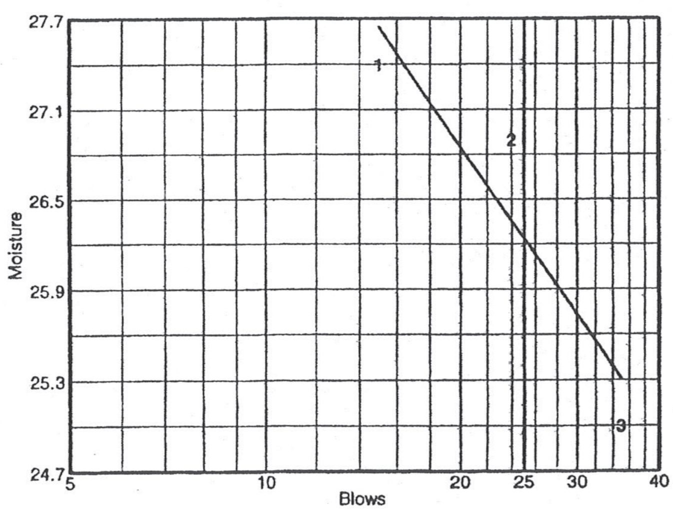
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-1 ST-8
Elev. or Depth: 23.0-25 **Sample Length (in./cm.):**
Location:
Description: Brn. vf.-f. sandy silt / so. clay (tr. c. sand & sm. gravel).
Date: 3/10/06 **Natural Moisture:** 18.8
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.83	28.21	27.39			
Dry+Tare	25.35	25.58	25.05			
Tare	16.31	15.82	15.68			
# Blows	15	24	35			
Moisture	27.4	26.9	25.0			



Liquid Limit= 26.2
Plastic Limit= 15.8
Plasticity Index= 10.4

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	24.84	27.38		
Dry+Tare	23.64	25.88		
Tare	16.14	16.25		
Moisture	16.0	15.6		

LIQUID AND PLASTIC LIMIT TEST DATA

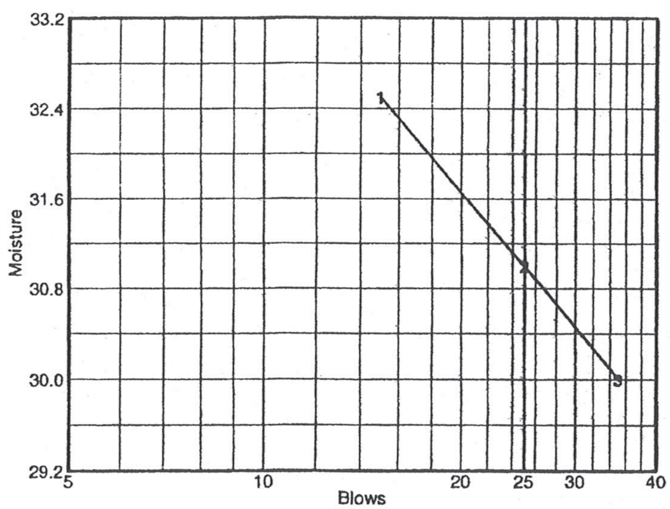
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-2 SS-6
Elev. or Depth: 13.5-15.0 **Sample Length (in./cm.):**
Location:
Description: Brn. & gray silt.
Date: 03-14-06 **Natural Moisture:** 22.4
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	25.81	26.66	26.94			
Dry+Tare	23.40	24.03	24.48			
Tare	15.99	15.54	16.29			
# Blows	15	25	35			
Moisture	32.5	31.0	30.0			



Liquid Limit= 31.0
Plastic Limit= 22.4
Plasticity Index= 8.6

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	25.08	23.45		
Dry+Tare	23.37	22.00		
Tare	15.76	15.46		
Moisture	22.5	22.2		

LIQUID AND PLASTIC LIMIT TEST DATA

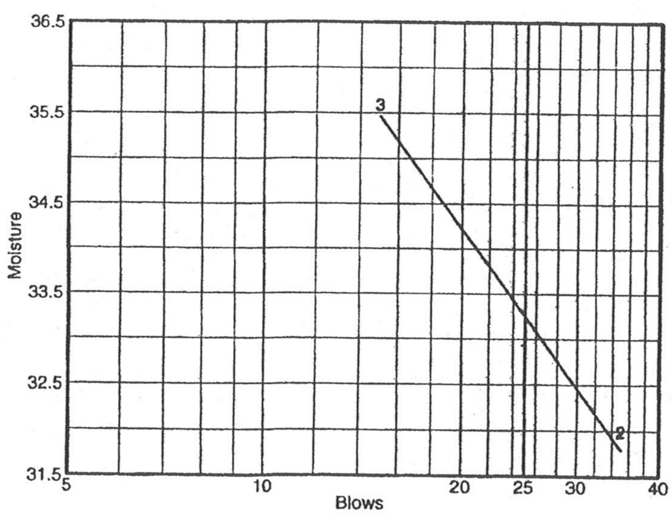
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-4 ST-6
Elev. or Depth: 13.0-15.0 **Sample Length (in./cm.):**
Location:
Description: Brn. & gray vf. sandy silt.
Date: 3/10/06 **Natural Moisture:** 23
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.60	30.62	27.64			
Dry+Tare	24.73	27.09	24.65			
Tare	16.01	16.06	16.26			
# Blows	25	35	15			
Moisture	32.9	32.0	35.6			



Liquid Limit= 33.2
Plastic Limit= 18.4
Plasticity Index= 14.8

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	22.71	24.25		
Dry+Tare	21.59	22.94		
Tare	15.58	15.76		
Moisture	18.6	18.2		

LIQUID AND PLASTIC LIMIT TEST DATA

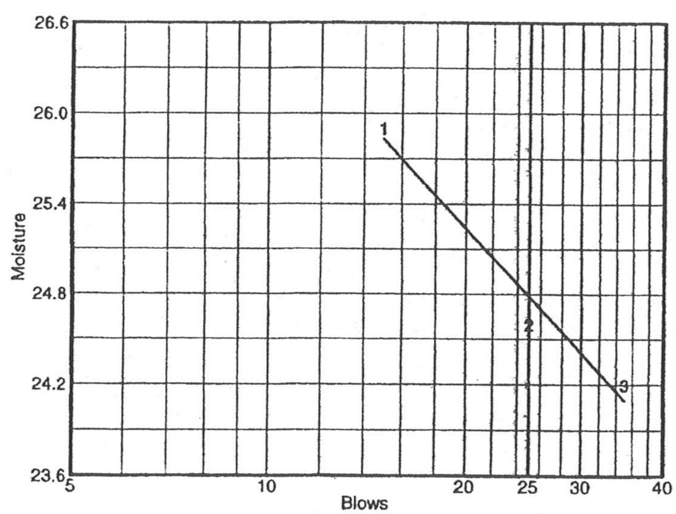
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-4 SS-7
Elev. or Depth: 18.5-20.0 **Sample Length (in./cm.):**
Location:
Description: Gray & brn. silt / so. vf. sand & (tr. clay).
Date: 3/10/06 **Natural Moisture:** 20
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	28.16	27.11	28.35			
Dry+Tare	25.74	24.89	25.85			
Tare	16.41	15.87	15.54			
# Blows	15	25	35			
Moisture	25.9	24.6	24.2			



Liquid Limit= 24.8
Plastic Limit= 14.8
Plasticity Index= 10.0

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	22.99	24.55		
Dry+Tare	22.10	23.44		
Tare	16.09	15.95		
Moisture	14.8	14.8		

LIQUID AND PLASTIC LIMIT TEST DATA

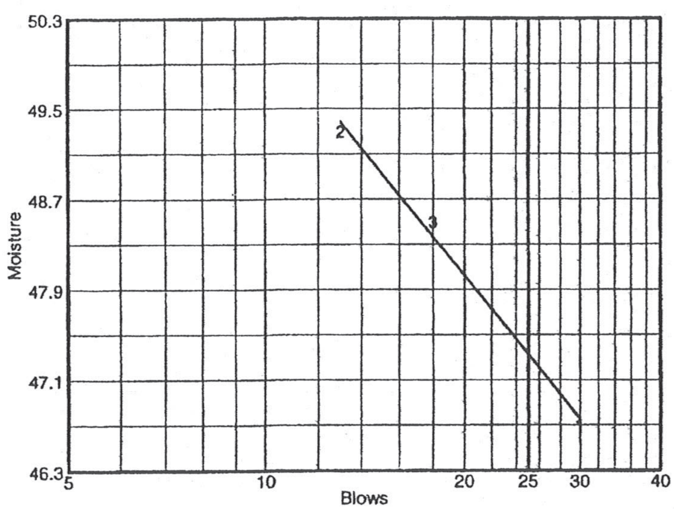
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-6 ST-6
Elev. or Depth: 13.0-15.0 **Sample Length (in./cm.):**
Location:
Description: Brn. & gray vf. sandy silt - organic.
Date: 3/10/06 **Natural Moisture:** 48.7
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.24	26.73	26.49			
Dry+Tare	24.84	23.03	22.72			
Tare	15.42	15.53	14.95			
# Blows	30	13	18			
Moisture	46.7	49.3	48.5			



Liquid Limit= 47.3
Plastic Limit= 43.7
Plasticity Index= 3.6

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	22.68	21.52		
Dry+Tare	20.75	19.65		
Tare	16.34.	15.35		
Moisture	43.8	43.5		

LIQUID AND PLASTIC LIMIT TEST DATA

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

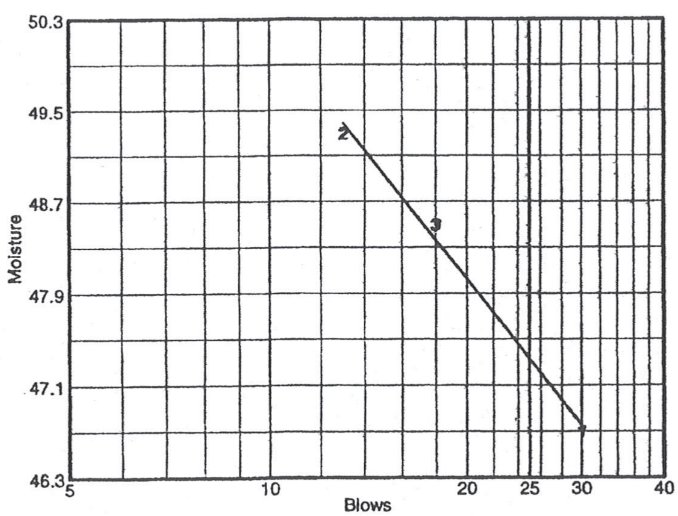
Source:
Sample No.: B-6 ST-6
Elev. or Depth: 13.0-15.0 **Sample Length (in./cm.):**
Location:
Description: Brn. & gray vf. sandy silt - organic.
Date: 3/10/06 **Natural Moisture:** 48.7
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.24	26.73	26.49			
Dry+Tare	24.84	23.03	22.72			
Tare	15.42	15.53	14.95			
# Blows	30	13	18			
Moisture	46.7	49.3	48.5			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.24	26.73	26.49			
Dry+Tare	24.84	23.03	22.72			
Tare	15.42	15.53	14.95			
# Blows	30	13	18			
Moisture	46.7	49.3	48.5			



Liquid Limit= 47.3
Liquid Limit (organics)= 47.3
Plastic Limit= 43.7
Plasticity Index= 3.6

LIQUID AND PLASTIC LIMIT TEST DATA

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.68	21.52			
Dry+Tare	20.75	19.65			
Tare	16.34.	15.35			
Moisture	43.8	43.5			

LIQUID AND PLASTIC LIMIT TEST DATA

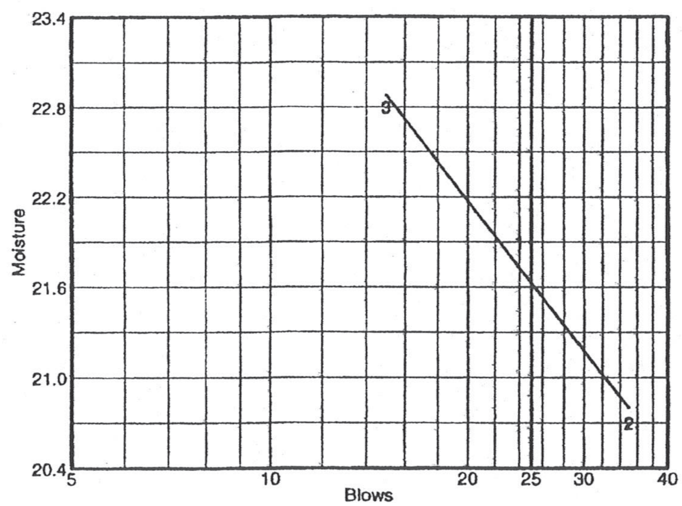
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: B-6 ST-8
Elev. or Depth: 23.0-25.0 **Sample Length (in./cm.):**
Location:
Description: Gray silty f.-m. sand / (tr. c. sand).
Date: 3/10/06 **Natural Moisture:** 14.4
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	26.76	30.04	28.76			
Dry+Tare	24.80	27.64	26.43			
Tare	15.86	16.02	16.20			
# Blows	24	35	15			
Moisture	21.9	20.7	22.8			



Liquid Limit= 21.6
Plastic Limit= 14.5
Plasticity Index= 7.1

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	23.90	23.53			
Dry+Tare	22.93	22.55			
Tare	16.09	15.91			
Moisture	14.2	14.8			

LIQUID AND PLASTIC LIMIT TEST DATA

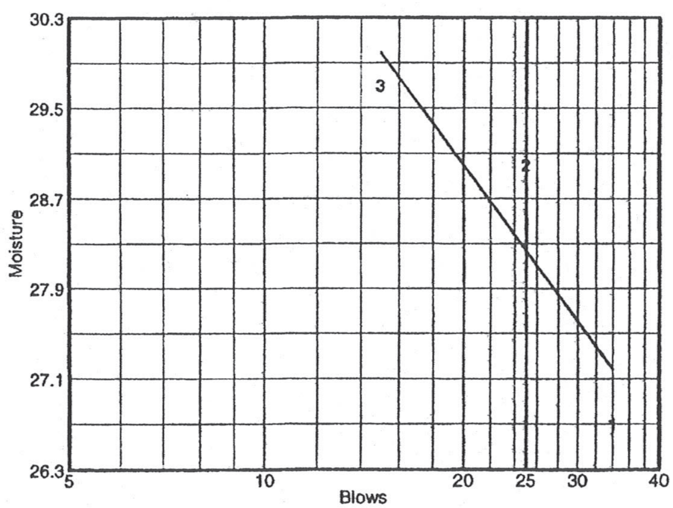
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: Bag B-3
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt.
Date: 3/14/06 **Natural Moisture:** 15
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	31.48	25.33	26.79			
Dry+Tare	28.27	23.23	24.29			
Tare	16.25	16.00	15.87			
# Blows	34	25	15			
Moisture	26.7	29.0	29.7			



Liquid Limit= 28.2
Plastic Limit= 21.5
Plasticity Index= 6.7

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.41	23.75			
Dry+Tare	21.24	22.32			
Tare	15.79	15.68			
Moisture	21.5	21.5			

LIQUID AND PLASTIC LIMIT TEST DATA

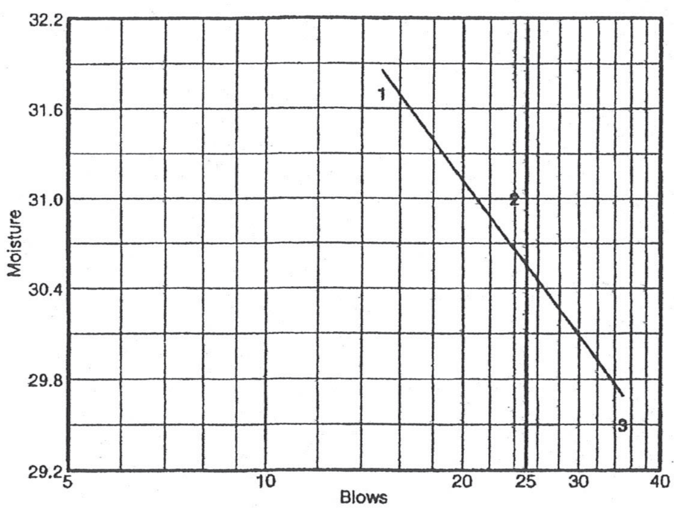
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: Bag B-4
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt.
Date: 03/10/06 **Natural Moisture:** 18.4
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	24.77	24.20	24.13			
Dry+Tare	22.60	22.22	22.25			
Tare	15.76	15.84	15.87			
# Blows	15	24	35			
Moisture	31.7	31.0	29.5			



Liquid Limit= 30.6
Plastic Limit= 22.4
Plasticity Index= 8.2

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	24.62	25.95		
Dry+Tare	23.0	24.13		
Tare	15.8	15.98		
Moisture	22.5	22.3		

LIQUID AND PLASTIC LIMIT TEST DATA

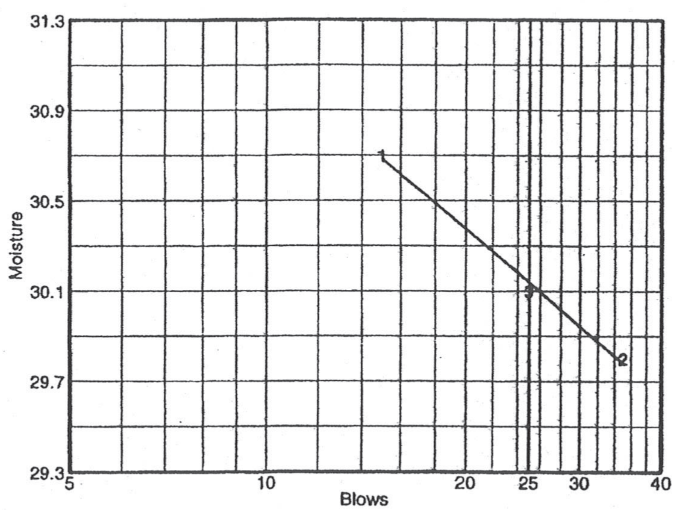
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: Bag B-5
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt / so. clay.
Date: 03/14/06 **Natural Moisture:** 13.7
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	26.52	24.16	26.63			
Dry+Tare	24.11	22.24	24.11			
Tare	16.25	15.8	15.75			
# Blows	15	35	25			
Moisture	30.7	29.8	30.1			



Liquid Limit= 30.1
Plastic Limit= 20.5
Plasticity Index= 9.6

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	23.30	23.53		
Dry+Tare	22.09	22.18		
Tare	16.28	15.52		
Moisture	20.8	20.3		

LIQUID AND PLASTIC LIMIT TEST DATA

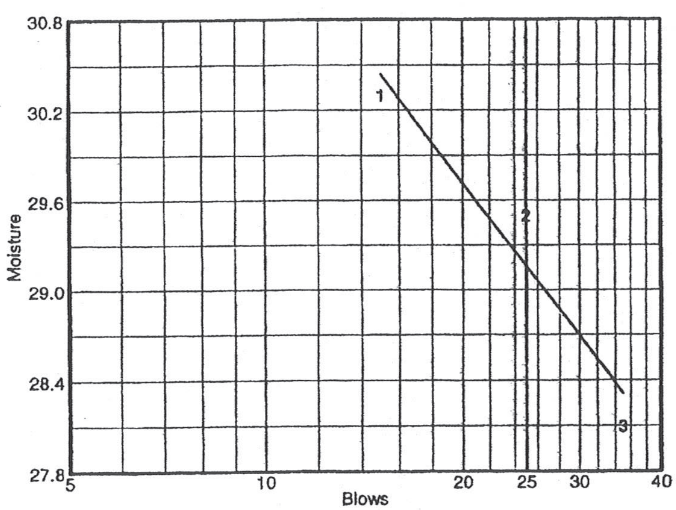
Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000

Sample Data

Source:
Sample No.: Bag B-6
Elev. or Depth: 1.0-10.0 **Sample Length (in./cm.):**
Location:
Description: Yel. brn. vf. sandy silt (tr. clay).
Date: 3/10/06 **Natural Moisture:** 18.8
USCS Class.: **AASHTO Class.:**
Testing Remarks:

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	24.12	24.63	25.01			
Dry+Tare	22.17	22.58	22.95			
Tare	15.74	15.62	15.61			
# Blows	15	25	35			
Moisture	30.3	29.5	28.1			

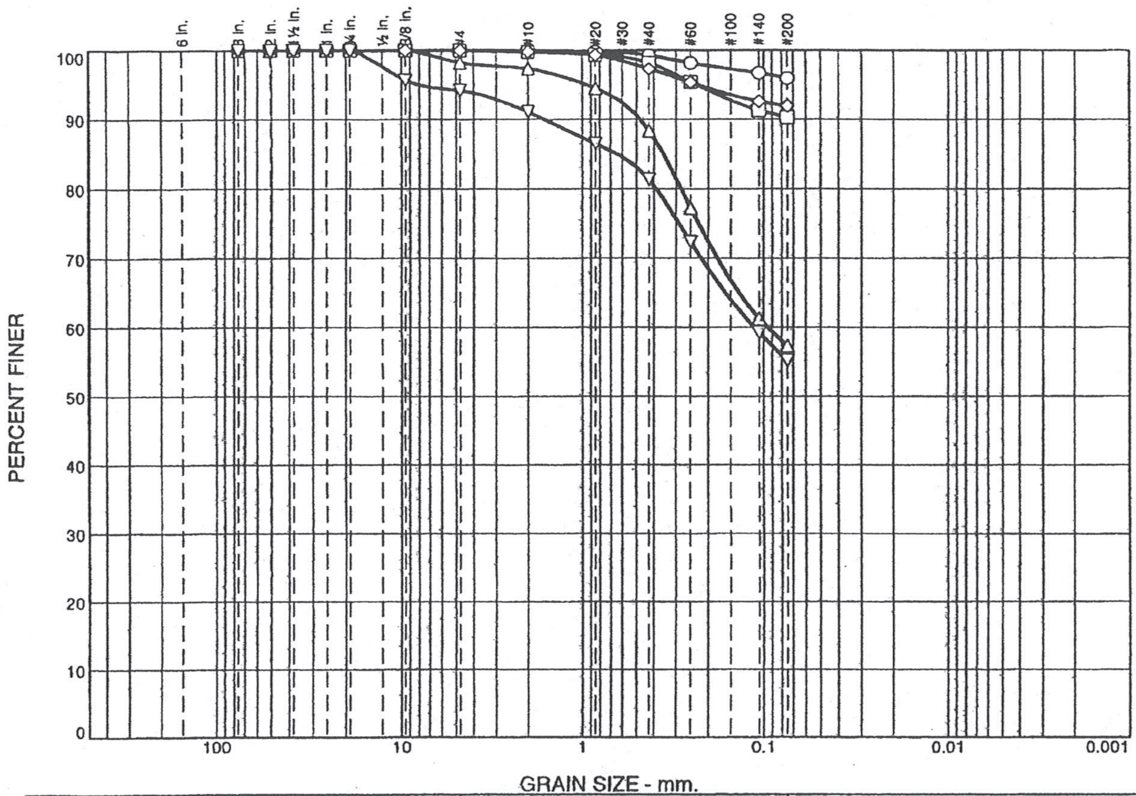


Liquid Limit= 29.2
Plastic Limit= 22.3
Plasticity Index= 6.9

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	22.43	22.01		
Dry+Tare	21.25	20.90		
Tare	15.98	15.88		
Moisture	22.4	22.1		

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.7	3.3	96.0	
□	0.0	0.0	0.0	0.2	1.6	7.9	90.3	
△	0.0	0.0	1.8	0.8	9.0	31.1	57.3	
◇	0.0	0.0	0.0	0.2	2.5	5.4	91.9	
▽	0.0	0.0	5.8	3.1	9.8	26.1	55.2	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○		B-2 SS-6	13.5-15.0	Brn. & gray silt.	
□		B-4 ST-6	13.0-15.0	Brn. & gray vf. sandy silt.	
△		B-4 SS-7	18.5-20.0	Gray & brn. silt / so. vf. sand & (tr. clay).	
◇		B-6 ST-6	13.0-15.0	Brn. & gray vf. sandy silt - organic.	
▽		B-6 ST-8	23.0-25.0	Gray silty f.-m. sand / (tr. c. sand).	

HANSON
Hanson Professional Services Inc.

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project No.: 03S5010 5000 **Plate**

Tested By: Rin **Checked By:** JCC

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 13.5-15.0
Sample Number: B-2 SS-6
Material Description: Brn. & gray silt.
Tested by: Rin
Checked by: JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
37.95	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.00	100.0
			#10	0.00	100.0
			#20	0.07	99.8
			#40	0.28	99.3
			#60	0.68	98.2
			#140	1.25	96.7
			#200	1.53	96.0

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.7	3.3	4.0			96.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}

Fineness Modulus
0.05

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 13.0-15.0
Sample Number: B-4 ST-6
Material Description: Brn. & gray vf. sandy silt.
Tested by: Rin
Checked by: JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
343.54	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.00	100.0
			#10	0.72	99.8
			#20	2.21	99.4
			#40	6.22	98.2
			#60	15.73	95.4
			#140	29.78	91.3
			#200	33.29	90.3

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	1.6	7.9	9.7			90.3

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
									0.2322

Fineness Modulus
0.12

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 18.5-20.0 **Sample Number:** B-4 SS-7
Material Description: Gray & brn. silt / so. vf. sand & (tr. clay).
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
54.13	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.95	98.2
			#10	1.42	97.4
			#20	2.99	94.5
			#40	6.28	88.4
			#60	12.31	77.3
			#140	20.96	61.3
			#200	23.09	57.3

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.8	1.8	0.8	9.0	31.1	40.9			57.3

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0957	0.2819	0.3538	0.4747	0.9524

Fineness Modulus
0.68

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 13.0-15.0 **Sample Number:** B-6 ST-6
Material Description: Brn. & gray vf. sandy silt - organic.
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
269.36	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.00	100.0
			#10	0.49	99.8
			#20	1.90	99.3
			#40	7.26	97.3
			#60	12.53	95.3
			#140	19.98	92.6
			#200	21.74	91.9

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	2.5	5.4	8.1			91.9

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
									0.2277

Fineness Modulus
0.12

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 23.0-25.0 **Sample Number:** B-6 ST-8
Material Description: Gray silty f.-m. sand / (tr. c. sand).
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
478.86	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	20.86	95.6
			#4	27.94	94.2
			#10	42.57	91.1
			#20	64.61	86.5
			#40	89.54	81.3
			#60	132.38	72.4
			#140	195.21	59.2
			#200	214.64	55.2

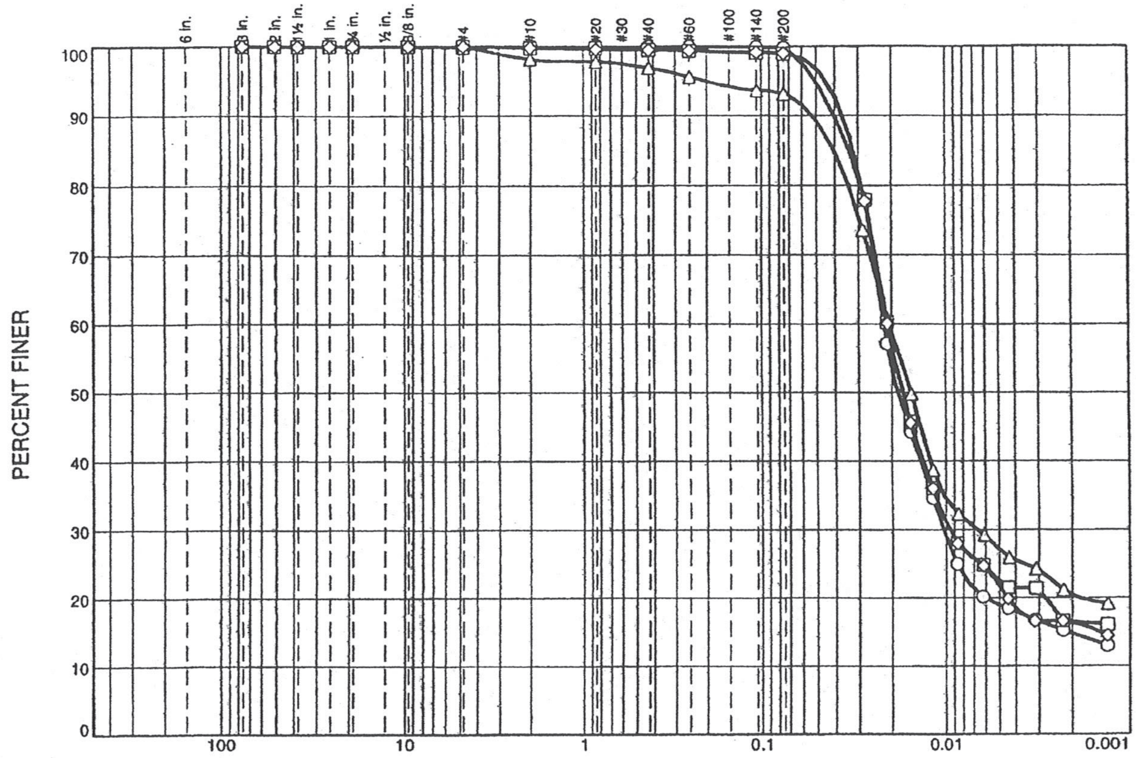
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	5.8	5.8	3.1	9.8	26.1	39.0			55.2

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.1126	0.3875	0.6410	1.6174	8.1744

Fineness Modulus
1.06

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.1	0.2	80.8	18.9
□	0.0	0.0	0.0	0.2	0.3	0.6	76.5	22.4
△	0.0	0.0	0.1	1.8	1.2	3.8	66.0	27.1
◇	0.0	0.0	0.0	0.2	0.3	0.5	77.3	21.7

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○		Bag B-3	1.0-10.0	Yel. brn. vf. sandy silt.	
□		Bag B-4	1.0-10.0	Yel. brn. vf. sandy silt.	
△		Bag B-5	1.0-10.0	Yel. brn. vf. sandy silt / so. clay.	
◇		Bag B-6	1.0-10.0	Yel. brn. vf. sandy silt (tr. clay).	

HANSON
Hanson Professional Services Inc.

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project No.: 03S5010 5000 **Plate**

Tested By: Rin **Checked By:** JCC

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 1.0-10.0 **Sample Number:** Bag B-3
Material Description: Yel. brn. vf. sandy silt.
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
491.25	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.00	100.0
			#10	0.17	100.0
49.42	0.00	0.00	#20	0.01	99.9
			#40	0.02	99.9
			#60	0.03	99.9
			#140	0.07	99.8
			#200	0.11	99.7

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =50
Hygroscopic moisture correction:
- **Moist weight and tare =** 50.58
- **Dry weight and tare =** 50.18
- **Tare weight =** 15.80
- **Hygroscopic moisture =** 1.2%

Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-3.7	-1.8

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.2	1.0270	1.0243	0.0129	27.0	9.2	0.0277	78.0
4.00	23.2	1.0205	1.0178	0.0129	20.5	10.9	0.0213	57.1
8.00	23.2	1.0165	1.0138	0.0129	16.5	11.9	0.0158	44.3
15.00	23.2	1.0135	1.0108	0.0129	13.5	12.7	0.0119	34.7
30.00	23.1	1.0105	1.0078	0.0129	10.5	13.5	0.0087	25.0
60.00	23.1	1.0090	1.0063	0.0129	9.0	13.9	0.0062	20.1
120.00	22.9	1.0085	1.0057	0.0130	8.5	14.0	0.0044	18.4
240.00	22.7	1.0080	1.0052	0.0130	8.0	14.2	0.0032	16.7
480.00	22.9	1.0075	1.0047	0.0130	7.5	14.3	0.0022	15.2
1440.00	21.8	1.0070	1.0040	0.0131	7.0	14.4	0.0013	12.9

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	80.8	18.9	99.7

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0021	0.0061	0.0104	0.0186	0.0222	0.0292	0.0339	0.0404	0.0506

Fineness Modulus
0.00

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 1.0-10.0 **Sample Number:** Bag B-4
Material Description: Yel. brn. vf. sandy silt.
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
425.15	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.00	100.0
			#10	0.91	99.8
49.31	0.00	0.00	#20	0.03	99.7
			#40	0.14	99.5
			#60	0.23	99.3
			#140	0.37	99.0
			#200	0.42	98.9

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.8
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 45.90
Dry weight and tare = 45.48
Tare weight = 15.69
Hygroscopic moisture = 1.4%
Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-3.2	-1.4

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.2	1.0265	1.0242	0.0129	26.5	9.3	0.0279	77.9
4.00	23.2	1.0210	1.0187	0.0129	21.0	10.7	0.0212	60.2
8.00	23.2	1.0165	1.0142	0.0129	16.5	11.9	0.0158	45.8
15.00	23.1	1.0135	1.0112	0.0129	13.5	12.7	0.0119	36.1
30.00	23.1	1.0110	1.0087	0.0129	11.0	13.4	0.0086	28.0
60.00	23.1	1.0100	1.0077	0.0129	10.0	13.6	0.0062	24.8
120.00	22.9	1.0090	1.0067	0.0130	9.0	13.9	0.0044	21.5
240.00	22.7	1.0090	1.0066	0.0130	9.0	13.9	0.0031	21.4
480.00	22.8	1.0075	1.0052	0.0130	7.5	14.3	0.0022	16.6
1440.00	21.8	1.0075	1.0050	0.0131	7.5	14.3	0.0013	16.0

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	0.3	0.6	1.1	76.5	22.4	98.9

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0028	0.0096	0.0174	0.0211	0.0289	0.0320	0.0364	0.0442

Fineness Modulus
0.02

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 1.0-10.0 **Sample Number:** Bag B-5
Material Description: Yel. brn. vf. sandy silt / so. clay.
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
455.56	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.63	99.9
			#10	8.44	98.1
49.21	0.00	0.00	#20	0.17	97.8
			#40	0.63	96.9
			#60	1.31	95.5
			#140	2.28	93.6
			#200	2.51	93.1

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 98.1
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 38.95
Dry weight and tare = 38.59
Tare weight = 16.29
Hygroscopic moisture = 1.6%
Table of composite correction values:

Temp., deg. C:	18.0	28.0
Comp. corr.:	-2.5	-1.1

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x **Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.2	1.0250	1.0232	0.0129	25.0	9.7	0.0284	73.6
4.00	23.2	1.0210	1.0192	0.0129	21.0	10.7	0.0212	60.9
8.00	23.2	1.0175	1.0157	0.0129	17.5	11.7	0.0156	49.8
15.00	23.1	1.0140	1.0122	0.0129	14.0	12.6	0.0119	38.7
30.00	23.1	1.0120	1.0102	0.0129	12.0	13.1	0.0086	32.4
60.00	23.1	1.0110	1.0092	0.0129	11.0	13.4	0.0061	29.2
120.00	22.9	1.0100	1.0082	0.0130	10.0	13.6	0.0044	25.9
240.00	22.7	1.0095	1.0077	0.0130	9.5	13.8	0.0031	24.3
480.00	22.8	1.0085	1.0067	0.0130	8.5	14.0	0.0022	21.1
1440.00	21.8	1.0080	1.0060	0.0131	8.0	14.2	0.0013	19.1

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.1	0.1	1.8	1.2	3.8	6.8	66.0	27.1	93.1

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0019	0.0067	0.0157	0.0207	0.0339	0.0405	0.0525	0.2082

Fineness Modulus
0.16

GRAIN SIZE DISTRIBUTION TEST DATA

3/16/2006

Client: Sargent & Lundy
Project: Duck Creek Ash Pond
Project Number: 03S5010 5000
Depth: 1.0-10.0 **Sample Number:** Bag B-6
Material Description: Yel. brn. vf. sandy silt (tr. clay).
Tested by: Rin **Checked by:** JCC

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
427.84	0.00	0.00	3	0.00	100.0
			2	0.00	100.0
			1.5	0.00	100.0
			1	0.00	100.0
			.75	0.00	100.0
			.375	0.00	100.0
			#4	0.00	100.0
			#10	0.84	99.8
49.41	0.00	0.00	#20	0.11	99.6
			#40	0.17	99.5
			#60	0.23	99.3
			#140	0.36	99.1
			#200	0.42	99.0

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.8
Weight of hydrometer sample =50
Hygroscopic moisture correction:
Moist weight and tare = 50.77
Dry weight and tare = 50.36
Tare weight = 15.54
Hygroscopic moisture = 1.2%
Table of composite correction values:
Temp., deg. C: 18.0 28.0
Comp. corr.: -3.2 -1.4
Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.2	1.0265	1.0242	0.0129	26.5	9.3	0.0279	77.7
4.00	23.2	1.0210	1.0187	0.0129	21.0	10.7	0.0212	60.1
8.00	23.1	1.0165	1.0142	0.0129	16.5	11.9	0.0158	45.6
15.00	23.2	1.0135	1.0112	0.0129	13.5	12.7	0.0119	36.0
30.00	23.1	1.0110	1.0087	0.0129	11.0	13.4	0.0086	28.0
60.00	23.0	1.0100	1.0077	0.0130	10.0	13.6	0.0062	24.7
120.00	22.9	1.0085	1.0062	0.0130	8.5	14.0	0.0044	19.8
240.00	22.7	1.0075	1.0051	0.0130	7.5	14.3	0.0032	16.5
480.00	22.8	1.0075	1.0052	0.0130	7.5	14.3	0.0022	16.6
1440.00	21.8	1.0070	1.0045	0.0131	7.0	14.4	0.0013	14.4

Fractional Components

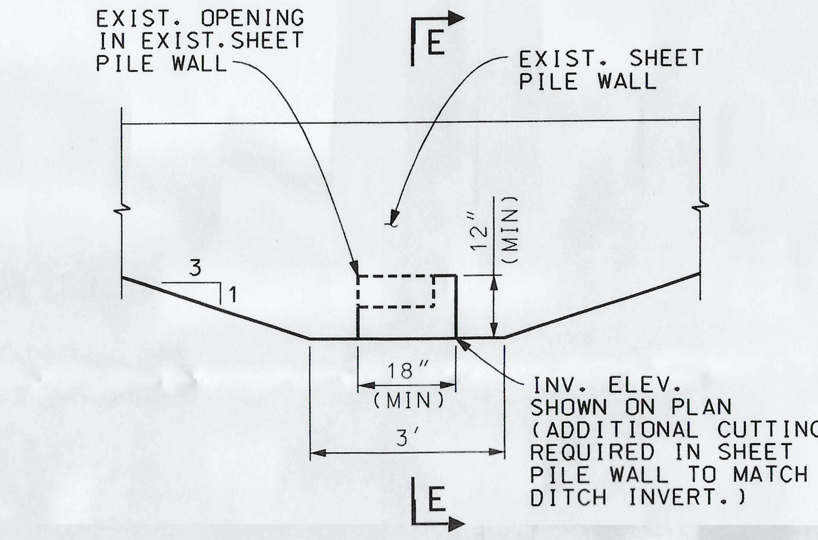
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	0.3	0.5	1.0	77.3	21.7	99.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0015	0.0045	0.0096	0.0175	0.0212	0.0290	0.0321	0.0366	0.0445

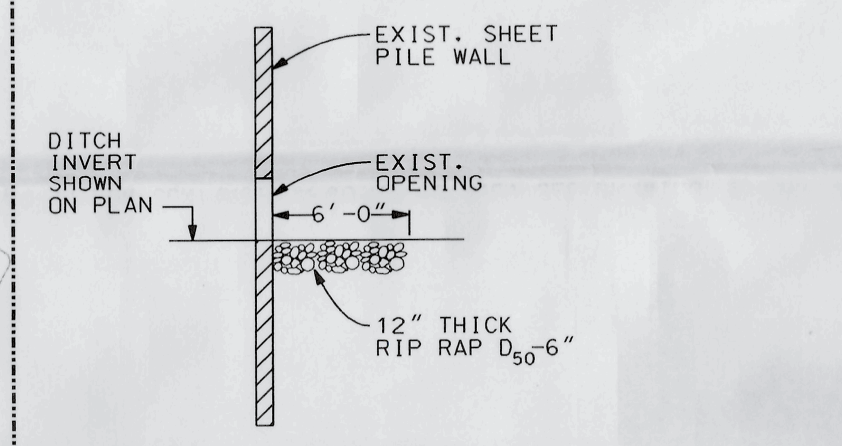
Fineness Modulus
0.02

ATTACHMENT 2

Bottom Ash Basin Design Drawings

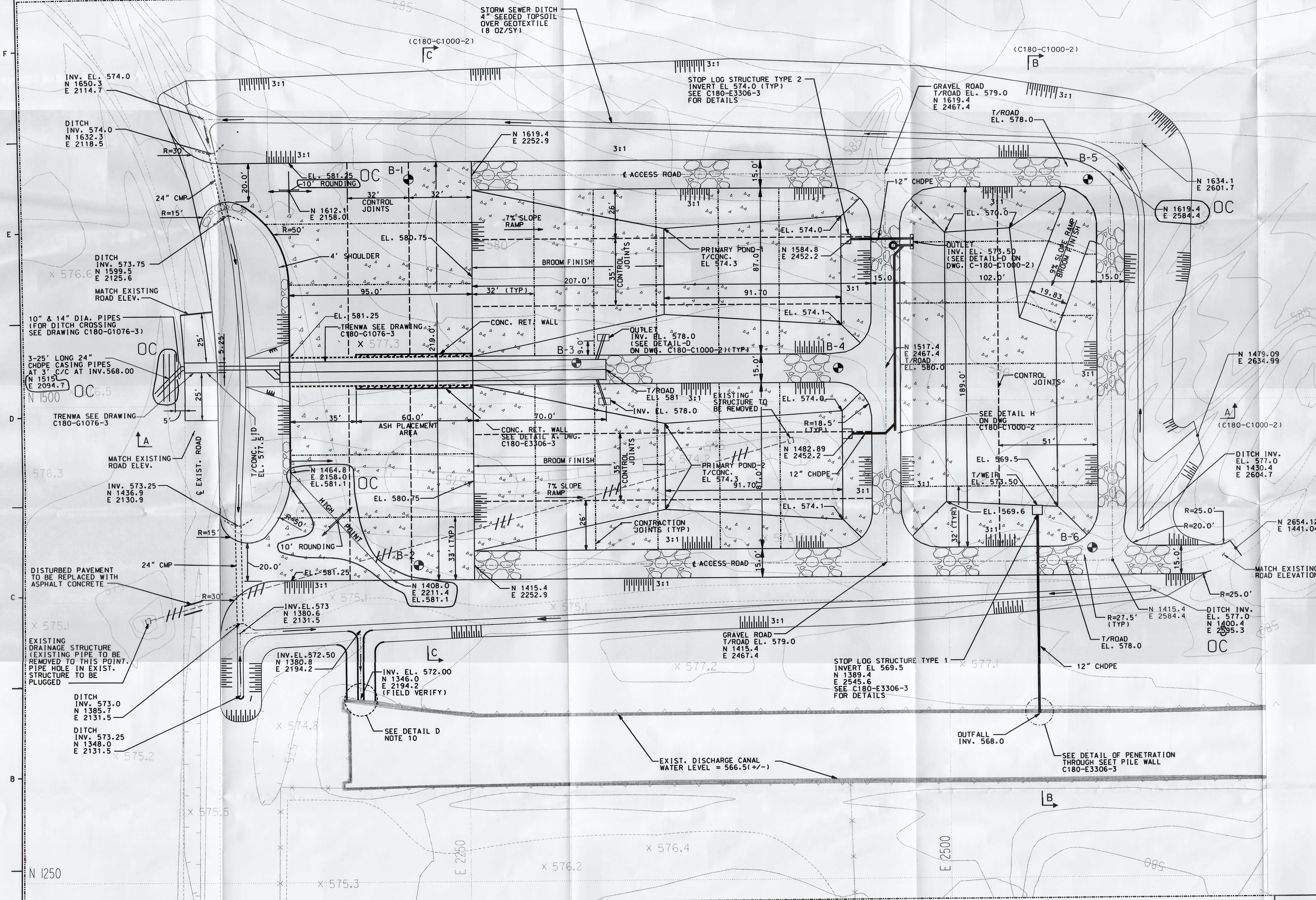


DETAIL D
N.T.S.



SECTION E
N.T.S.

(symbol)	GRAVEL ROADS
(symbol)	CONCRETE
(symbol)	BORE HOLE
------------	CONTRACTION JOINT
- - - - - -	CONTROL JOINT



1. ALL WORK DONE BY CONTRACTOR/INSTALLER PURSUANT TO THIS DRAWING SHALL: (A) CONFORM TO THE GOVERNING CONTRACT DOCUMENTS; (B) BE PERFORMED EXCLUSIVELY BY ITS TRAINED, COMPETENT PERSONNEL OR, WHERE PERMITTED, THAT OF ITS SUBCONTRACTOR(S); AND (C) COMPLY WITH ALL APPLICABLE SAFETY LAWS, REGULATIONS, PROGRAMS AND PRACTICES TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING THE CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.
2. UNDERGROUND OR EMBEDDED UTILITIES MAY BE LOCATED WITHIN OR ADJACENT TO THE AREA IN WHICH EXCAVATION, DEMOLITION, FOUNDATION, OR MODIFICATION WORK IS TO BE PERFORMED.
3. REFERENCES RELATING TO THE UNDERGROUND OR EMBEDDED UTILITIES ARE PROVIDED TO ASSIST THE CONTRACTOR/INSTALLER IN THE FIELD LOCATING THOSE UTILITIES AND OTHER POSSIBLE UNDERGROUND OR EMBEDDED INTERFERENCES WITH THE WORK.
4. THE CONTRACTOR/INSTALLER SHALL EXERCISE DUE CAUTION DURING ALL EXCAVATION/FOUNDATION/DEMOLITION WORK.
5. CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.
6. FOR PIPING DETAILS SEE DRAWINGS C180-G1902 SHEET 2 AND C180-G1076 SHEET 3/4.
7. FOR CONTRACTION JOINT DETAIL, SEE DRAWING C180-E3306-3.
8. FOR BORING LOGS, SEE SPEC. D-1007.
9. FOR CONCRETE NOTES SEE DRAWINGS C180-E3306-2.
10. NEW DRAINAGE DITCH WILL BE DISCHARGING THROUGH THE EXISTING OPENING IN THE SHEET PILE WALL.
11. THE LOCATION OF CONSTRUCTION JOINTS SHALL BE APPROVED BY OWNER BEFORE START OF CONSTRUCTION

FILE NO. C-1000SH1.DGN

GRAPHIC SCALE 20' 0 20' 40'

NORTH

AEC CAD GENERATED
DO NOT REVISE MANUALLY

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0A	04-21-06	A.S.	S. AHMED	GPW	FOR CLIENT COMMENTS, SPECIFICATION D-1007
0B	07-02-07	A.S.	S. AHMED	GPW	FOR BID, SPEC. D-1007
0C	09-21-07	A.S.	S. AHMED	——	FOR CONSTRUCTION, SPEC. D-1007

SARGENT & LUNDY LLC's ILLINOIS DEPARTMENT OF PROFESSIONAL REGULATION REGISTRATION NUMBER IS 184-000106

STATE OF ILLINOIS GARY WILLIAMS 81-4140 LICENSED STRUCTURAL ENGINEER

SCALE AS NOTED
PROJECT 1478-034
DRAFTER C.FLAMINI
DATE —

DRAWING TITLE

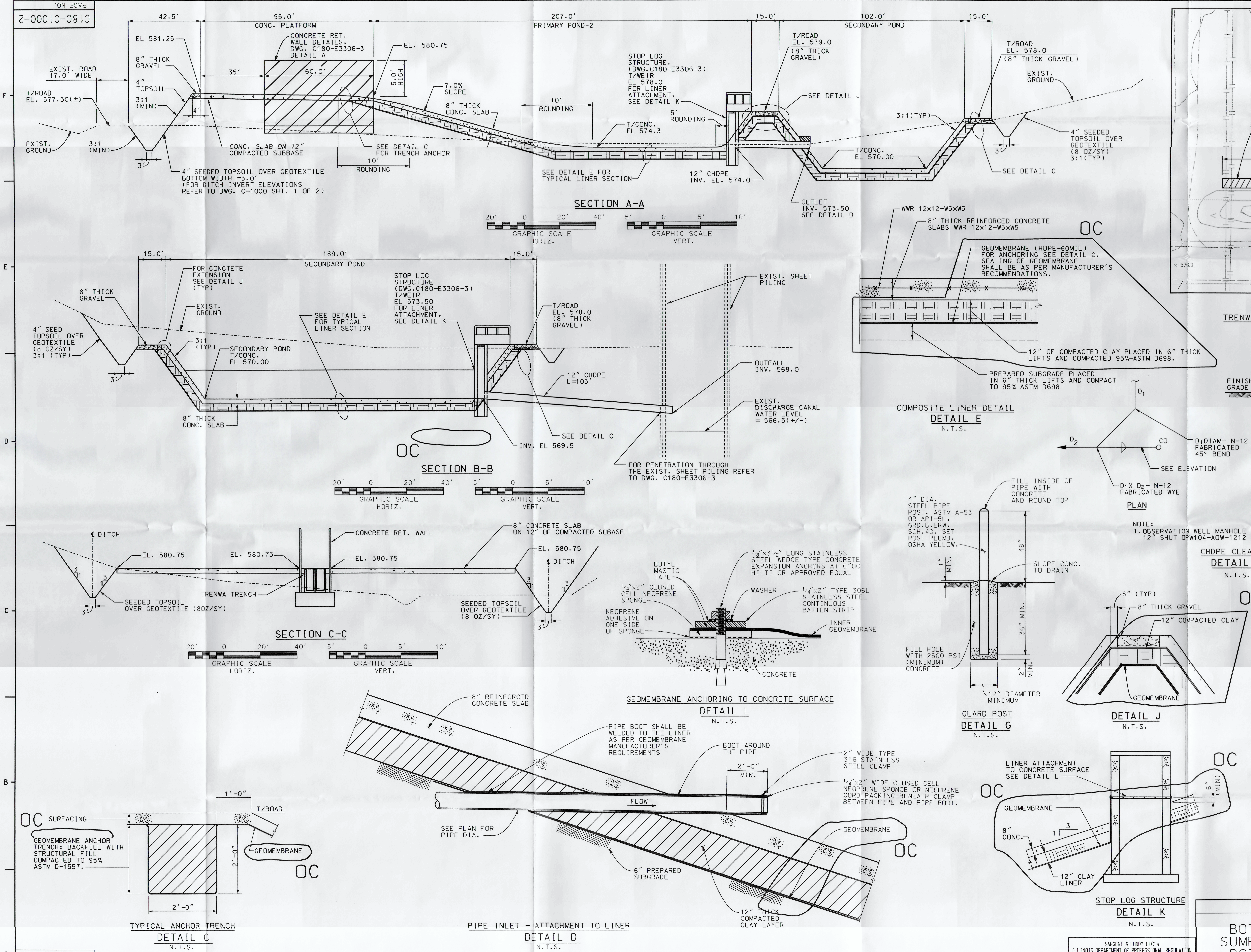
BOTTOM ASH AND LOW VOLUME SUMP WATER BASIN AND PIPING BOTTOM ASH BASIN SECTION DUCK CREEK POWER STATION UNIT 1 CANTON, ILLINOIS

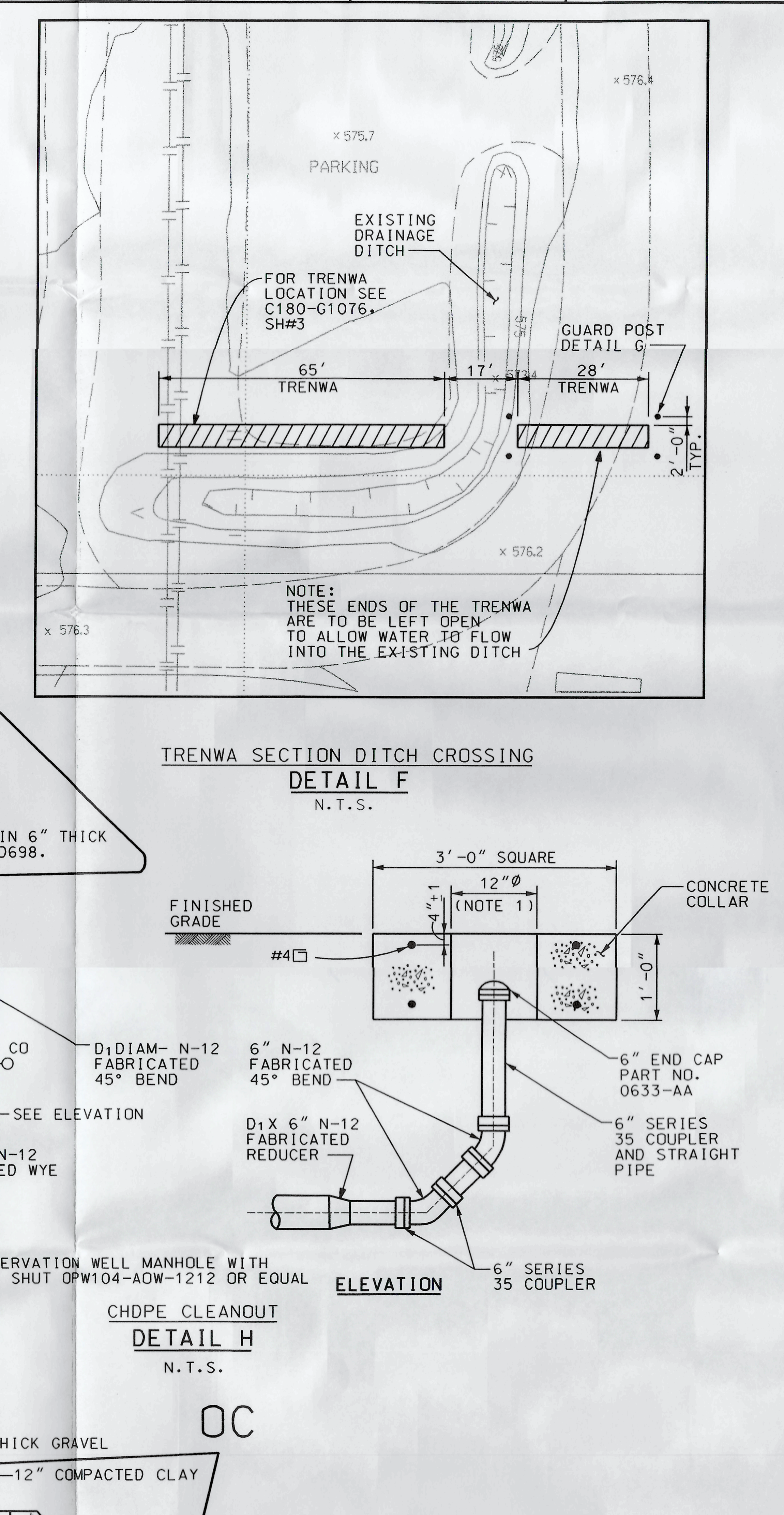
DUCK CREEK POWER STATION UNIT NO. —

Ameren Energy Resources Generating

DRAWING NUMBER	REV.
C180-C1000-1	0C

SHEET NO. 1





1. ALL WORK DONE BY CONTRACTOR/INSTALLER PURSUANT TO THIS DRAWING SHALL: (A) CONFORM TO THE GOVERNING CONTRACT DOCUMENTS; (B) BE PERFORMED EXCLUSIVELY BY ITS TRAINED, COMPETENT PERSONNEL OR, WHERE PERMITTED, THAT OF ITS SUBCONTRACTOR(S); AND (C) COMPLY WITH ALL APPLICABLE SAFETY LAWS, REGULATIONS, PROGRAMS AND PRACTICES TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING THE CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.
2. UNDERGROUND OR EMBEDDED UTILITIES MAY BE LOCATED WITHIN OR ADJACENT TO THE AREA IN WHICH EXCAVATION, DEMOLITION, FOUNDATION, OR MODIFICATION WORK IS TO BE PERFORMED.
3. REFERENCES RELATING TO THE UNDERGROUND OR EMBEDDED UTILITIES ARE PROVIDED TO ASSIST THE CONTRACTOR/INSTALLER IN THE FIELD LOCATING THOSE UTILITIES AND OTHER POSSIBLE UNDERGROUND OR EMBEDDED INTERFERENCES WITH THE WORK.
4. THE CONTRACTOR/INSTALLER SHALL EXERCISE DUE CAUTION DURING ALL EXCAVATION/FOUNDATION/DEMOLITION WORK.
5. CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.

FILE NO. C-1000SH2.DGN

DRAWING TITLE

BOTTOM ASH AND LOW VOLUME SUMP WATER BASIN AND PIPING BOTTOM ASH BASIN SECTIONS DUCK CREEK POWER STATION UNIT 1 CANTON, ILLINOIS

DUCK CREEK POWER STATION UNIT NO. –

SARGENT & LUNDY LLC's
ILLINOIS DEPARTMENT OF PROFESSIONAL REGULATION
REGISTRATION NUMBER IS 184-000106

STATE OF ILLINOIS · GARY WILLIAM · 81-4140 · LICENSED STRUCTURAL ENGINEER

AEG CAD GENERATED
DO NOT REVISE MANUALLY

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
OA	04-21-06	A.S.	S. AHMED	GPW	FOR CLIENT COMMENTS. SPECIFICATION D-1007
OB	07-02-07	A.S.	S. AHMED	GPW	FOR BID. SPEC. D-1007
OC	09-21-07	RST/ALS	S. AHMED	——	FOR CONSTRUCTION. SPEC. D-1007

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

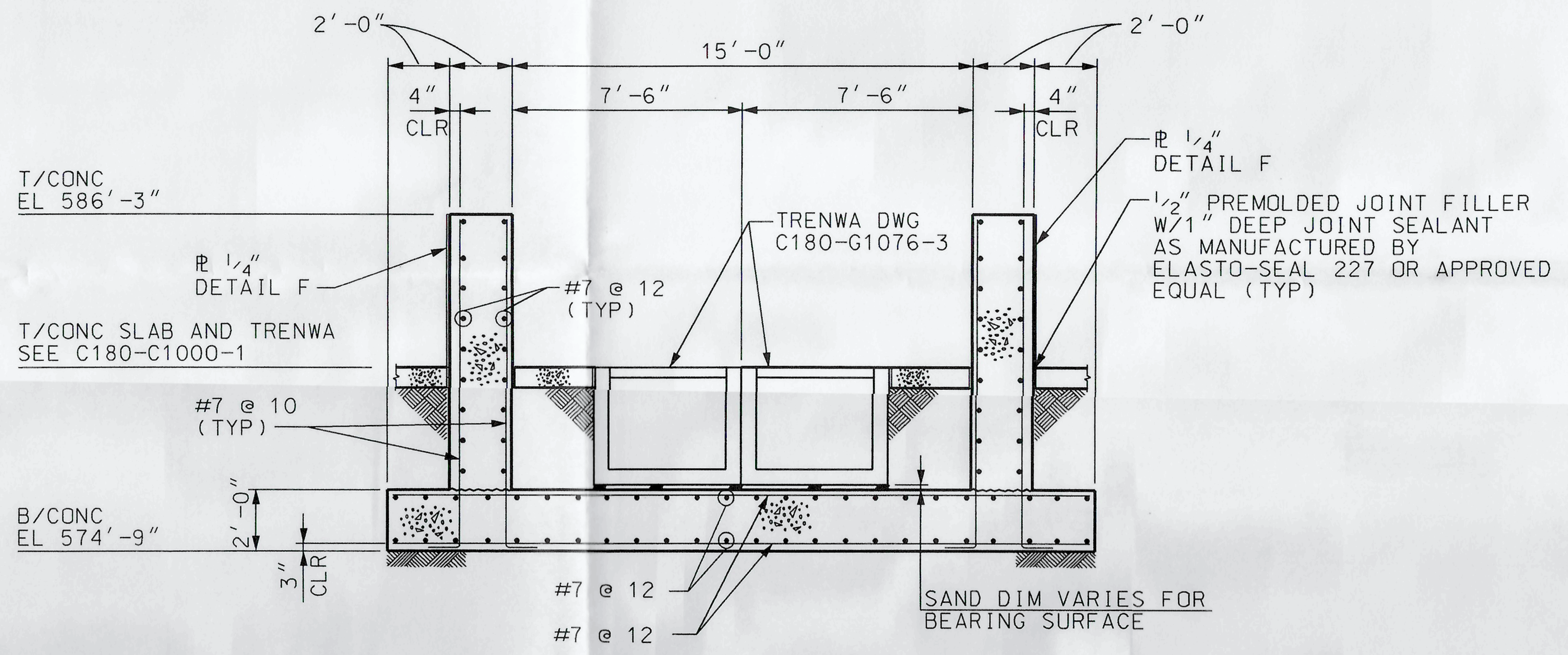
SCALE NONE
PROJECT 1478-034
DRAFTER CF
DATE –

Ameren Energy. Resources Generating

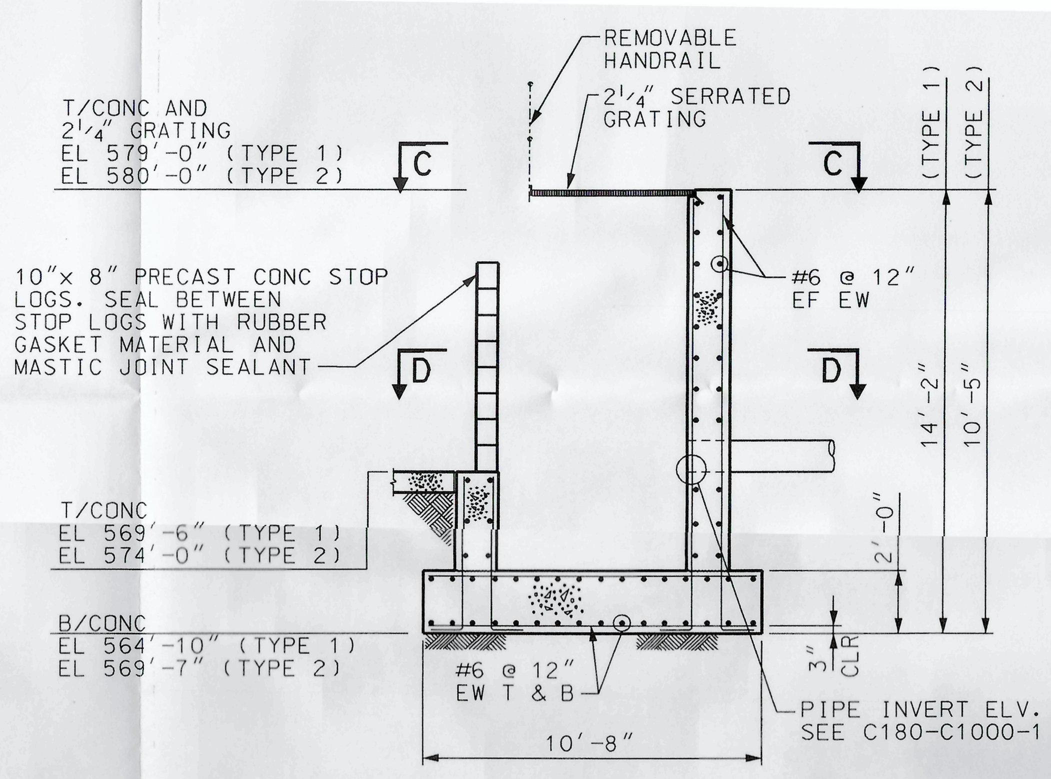
DRAWING NUMBER	REV.
C180-C1000-2	OC

SHEET NO. 2

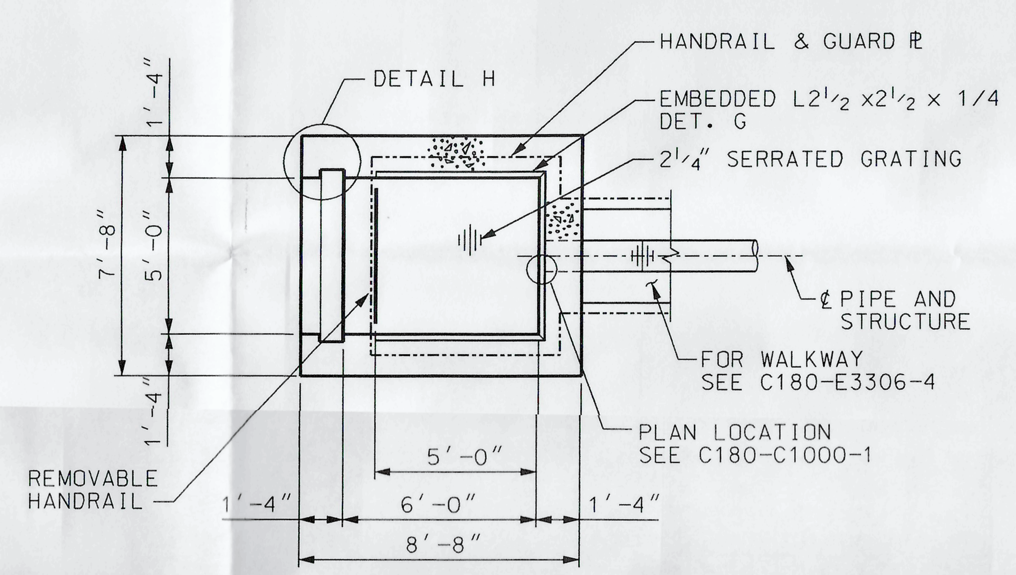
PAGE NO.
E3306-3



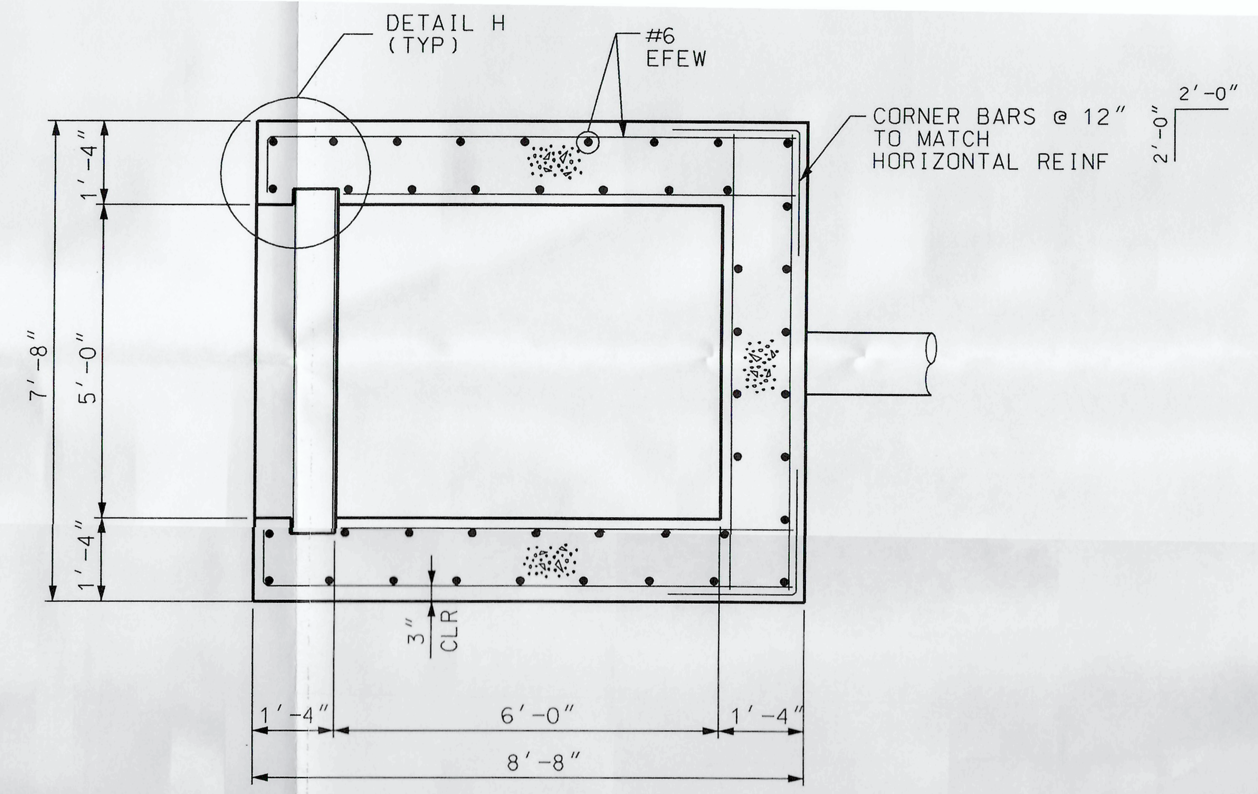
DETAIL A
(SEE DWG C180-C1000-1)



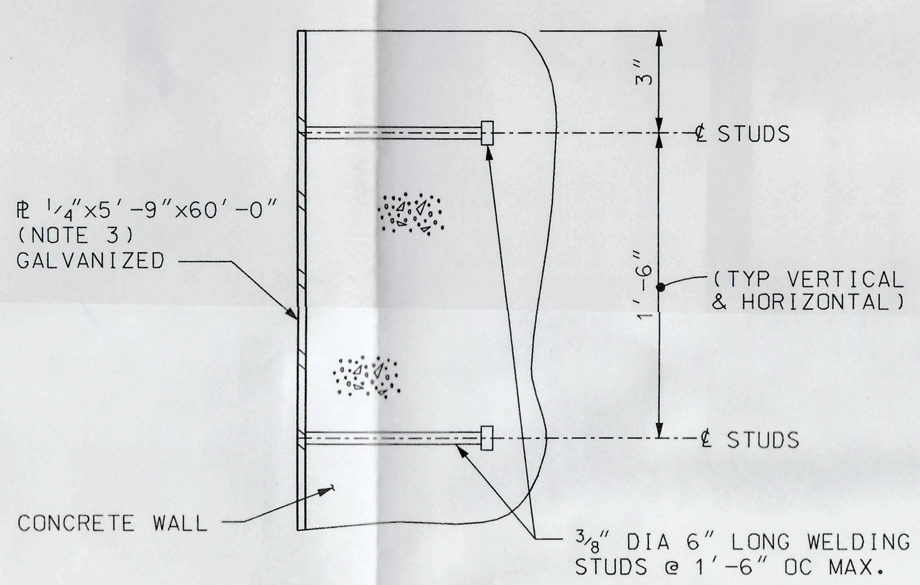
STOP LOG STRUCTURE TYPE 1 & TYPE 2
(SEE DWG C180-C1000-1)



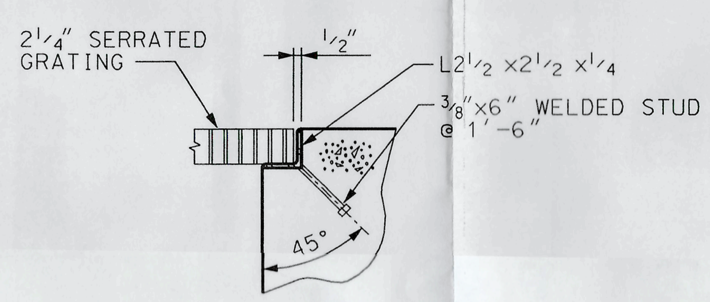
SECTION C



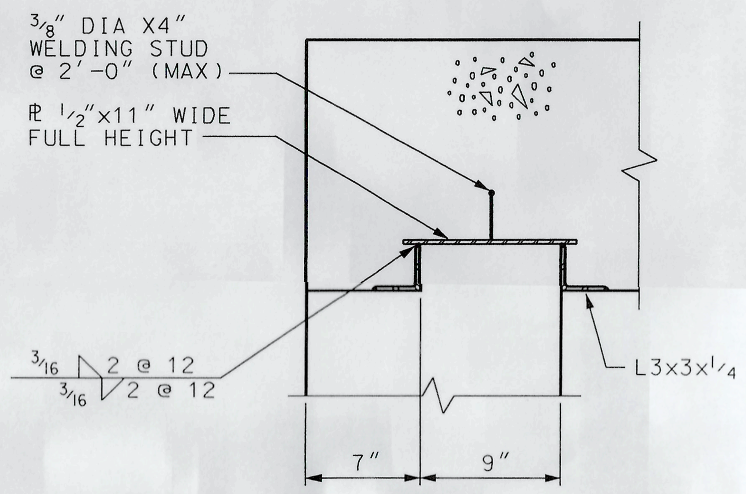
SECTION D
SCALE: 1/2"=1'-0"



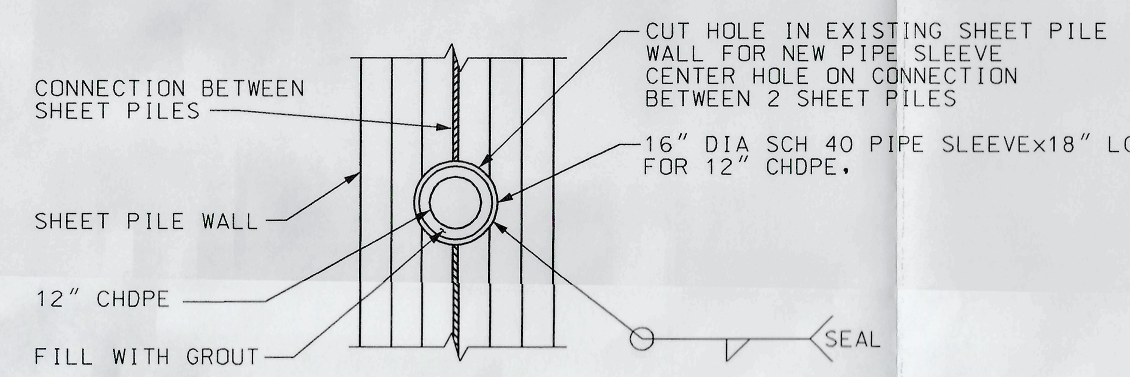
DETAIL F
SCALE: NONE



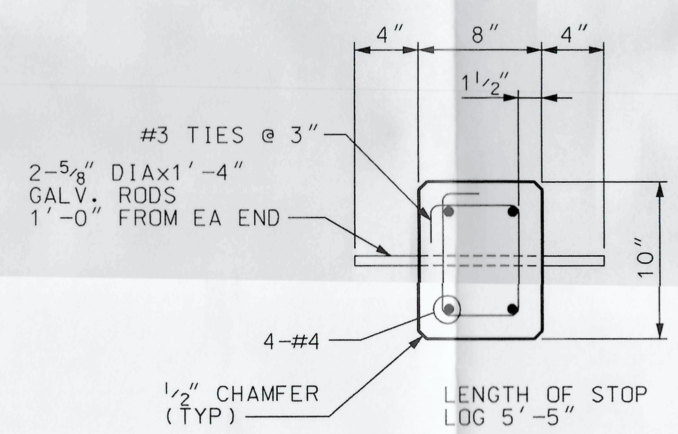
DETAIL G
SCALE: 1 1/2"=1'-0"



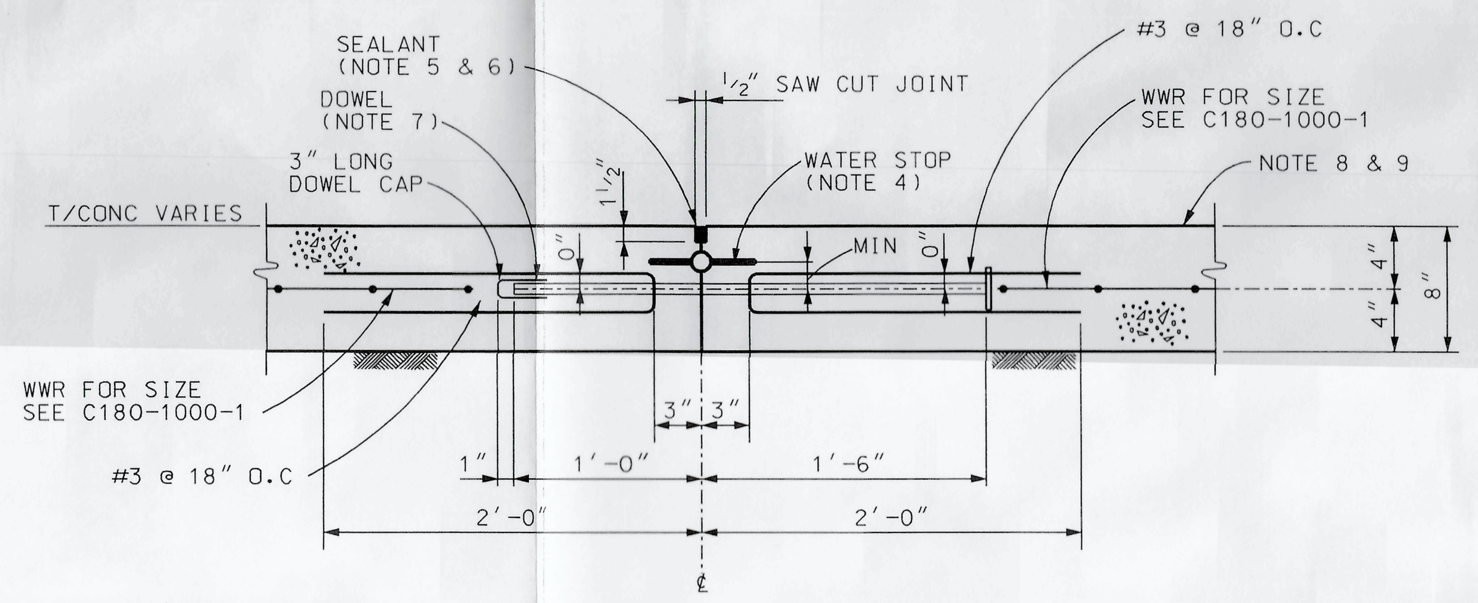
DETAIL H
SCALE: 1 1/2"=1'-0"



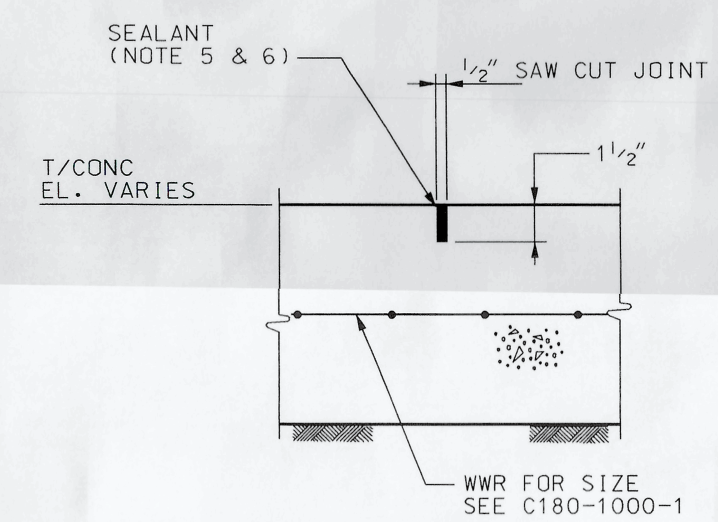
DETAIL PENETRATION THROUGH SHEET PILE WALL
SCALE: NONE



STOP LOG DETAIL
SCALE: 1 1/2"=1'-0"



DETAIL L
(TYPICAL SLAB CONTRACTION AND CONSTRUCTION JOINT)
FOR LOCATION OF CONTRACTION JOINTS SEE DWG C180-C1000-1
CONTRACTOR TO SUBMIT LOCATION OF CONSTRUCTION JOINTS
TO AMEREN FOR APPROVAL PRIOR TO REBAR PURCHASE
SCALE: 1 1/2"=1'-0"



DETAIL M
(TYPICAL SLAB CONTROL JOINT AT MAX. SPACING 20'-0" EACH WAY)
SCALE: NONE

NOTES

1. FOR CONCRETE GENERAL NOTES SEE DWG E3306-2.
2. ALL WORK ON THIS DRAWING SHALL BE FURNISHED AND INSTALLED IN ACCORDANCE WITH SPECIFICATION D-1007.
3. PLATE TO BE FABRICATED WITHOUT ANY HORIZONTAL FIELD JOINTS. THE NUMBER OF VERTICAL FIELD JOINTS SHALL BE MINIMIZED
4. WATERSTOPS SHALL BE PVC RIBBED TYPE, 9" WIDE BY 1/4" THICK WITH 1 1/4" O.D. CENTER BULB, AND SHALL CONFORM TO THE REQUIREMENTS OF THE ARMY CORPS OF ENGINEERS CRD-C 572.
5. JOINT SEALANT SHALL BE PREFORMED ELASTOMERIC JOINT SEALER CONFORMING TO ASTM-D2628. TOP OF SEAL TO BE 1/4" INCH BELOW SLAB SURFACE.
6. APPLY SEALANT IN STRICT ADHERENCE TO MANUFACTURER'S REQUIREMENTS.
7. DOWEL SLEEVES SHALL BE PLASTIC SPEED DOWELS WITH REMOVABLE CAPS OR APPROVED EQUAL. ALL DOWELS SHALL BE 3/4" DIA., ASTM A36 PLAIN BAR, @1'-6" O.C. AND 3"SQ.x1/2" THICK PLATE WELDED TO BAR WITH A 1/4" FILLET.
8. CONCRETE SLAB SHALL HAVE HEAVY-DUTY FINISH PROVIDED IN ACCORDANCE WITH ACI 301.
9. THE 8 INCH THICK CONCRETE SLAB IS ADEQUATE FOR 32 KIP AXIAL LOADING AND LIGHT DUTY FRONT END LOADERS.
10. PROVIDE 9 STOP LOGS FOR TYPE-1 STRUCTURE PROVIDE 4 STOP LOGS FOR EACH TYPE-2 STRUCTURE.

REFERENCE DRAWINGS

UNDERGROUND OR EMBEDDED UTILITIES MAY BE LOCATED WITHIN OR ADJACENT TO THE AREA IN WHICH EXCAVATION, DEMOLITION, FOUNDATION, OR MODIFICATION WORK IS TO BE PERFORMED.

REFERENCES RELATING TO THE UNDERGROUND OR EMBEDDED UTILITIES ARE PROVIDED TO ASSIST THE CONTRACTOR/INSTALLER IN THE FIELD LOCATING THOSE UTILITIES AND OTHER POSSIBLE UNDERGROUND OR EMBEDDED INTERFERENCES WITH THE WORK.

THE CONTRACTOR/INSTALLER SHALL EXERCISE DUE CAUTION DURING ALL EXCAVATION/FOUNDATION/DEMOLITION WORK.

FILE NO. C180-E3306-3.DGN

CONSTRUCTION NOTE: CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR (S)) PERFORMING THE WORK.

NOTICE OF LIMITED RESPONSIBILITY

Sargent & Lundy LLC

SARGENT & LUNDY LLC's ILLINOIS DEPARTMENT OF PROFESSIONAL REGULATION REGISTRATION NUMBER IS 184-000106

AEG CAD GENERATED
DO NOT REVISE MANUALLY

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
OA	04/21/06	GT	AN	——	FOR CLIENT COMMENTS
OB	07-02-07	S.R / A.C	GW	——	FOR BIDS SPECIFICATION D-1007
OC	09/21/07	D.ZIMA	GW	——	FOR CONSTRUCTION SPECIFICATION D-1007

STATE OF ILLINOIS — GARY WILLMAN — 81-4140 — LICENSED STRUCTURAL ENGINEER

SCALE 1/4"=1'-0"
PROJECT 11478-034
140M052
DRAFTER GT
DATE

DRAWING TITLE

FOUNDATION SECTION AND DETAILS

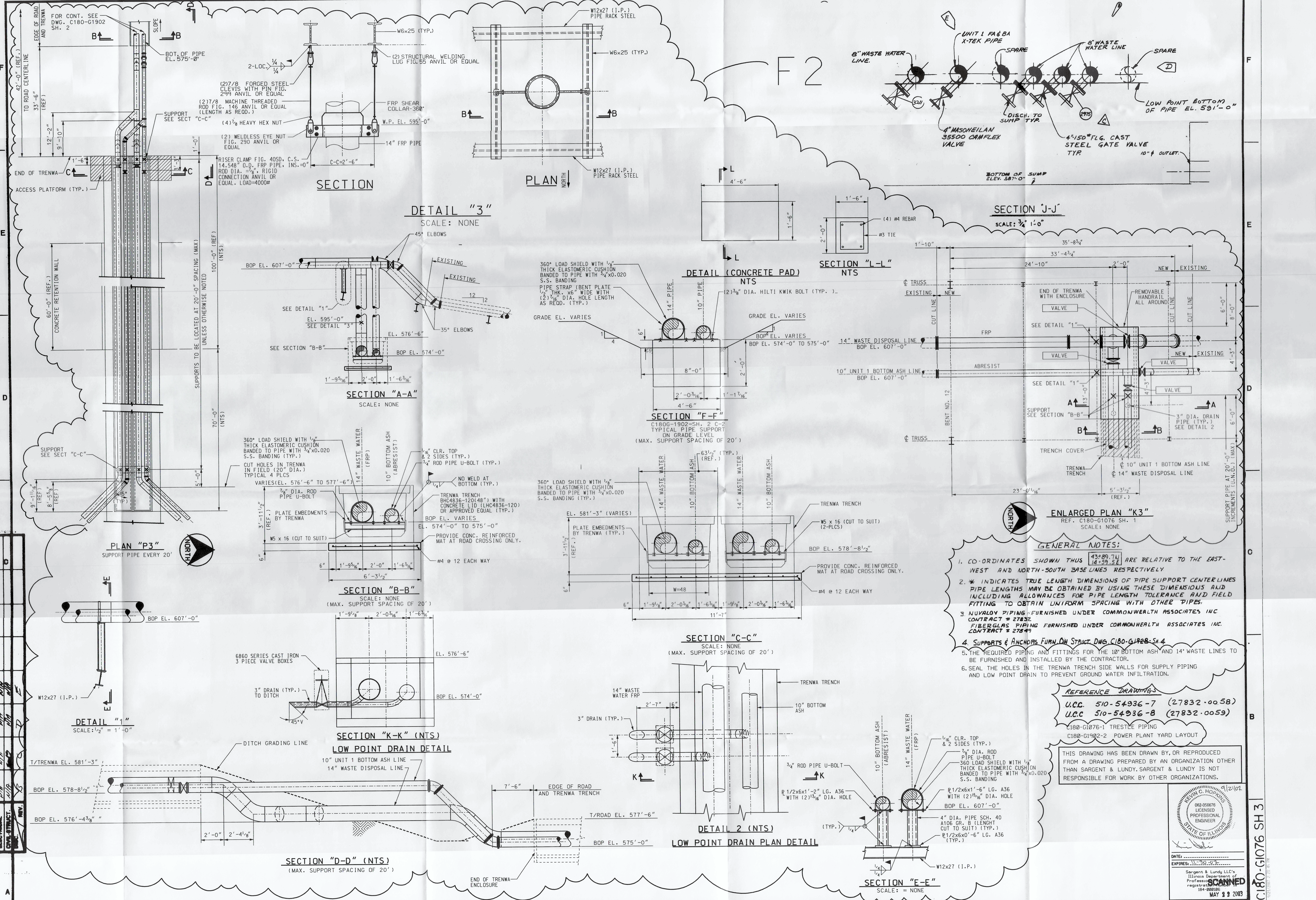
BOTTOM ASH AND LOW VOLUME SUMP WATER BASIN AND PIPING PROJECT
CANTON, ILLINOIS

DUCK CREEK POWER STATION UNIT NO. 1

Ameren Energy.
Resources Generating

DRAWING NUMBER	REV.
C180-E3306-3	OC

SHEET NO. 1



GENERAL NOTES:

1. CO-ORDINATES SHOWN THUS [43+89.74 / 14+59.5E] ARE RELATIVE TO THE EAST-WEST AND NORTH-SOUTH BASE LINES RESPECTIVELY
2. ✱ INDICATES TRUE LENGTH DIMENSIONS OF PIPE SUPPORT CENTERLINES PIPE LENGTHS MAY BE OBTAINED BY USING THESE DIMENSIONS AND INCLUDING ALLOWANCES FOR PIPE LENGTH TOLERANCE AND FIELD FITTING TO OBTAIN UNIFORM SPACING WITH OTHER PIPES.
3. NUVALOY PIPING FURNISHED UNDER COMMONWEALTH ASSOCIATES INC CONTRACT # 27832
FIBERGLAS PIPING FURNISHED UNDER COMMONWEALTH ASSOCIATES INC. CONTRACT # 27849
4. SUPPORTS & ANCHORS FURN. ON STRUCT. DWG. C180-G1928-SH.4
5. THE REQUIRED PIPING AND FITTINGS FOR THE 10" BOTTOM ASH AND 14" WASTE LINES TO BE FURNISHED AND INSTALLED BY THE CONTRACTOR.
6. SEAL THE HOLES IN THE TRENWA TRENCH SIDE WALLS FOR SUPPLY PIPING AND LOW POINT DRAIN TO PREVENT GROUND WATER INFILTRATION.

REFERENCE DRAWINGS

U.C.C. 510-54936-7 (27832-0058)
U.C.C. 510-54936-8 (27832-0059)
C180-G1076-1 TRESTLE PIPING
C180-G1902-2 POWER PLANT YARD LAYOUT

THIS DRAWING HAS BEEN DRAWN BY, OR REPRODUCED FROM A DRAWING PREPARED BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY. SARGENT & LUNDY IS NOT RESPONSIBLE FOR WORK BY OTHER ORGANIZATIONS.

KEVIN C. HOPKINS 062-056676 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

Sargent & Lundy LLC's Illinois Department of Professional Regulation registration 184-000186

SCANNED MAY 2 2 2003

REV.	DATE	DESCRIPTION	BY	APPROVED
F2	09/21/07	FOR CONSTRUCTION D-1007	M. MIOTTI	G. SWITAK
F2	06/08/07	FOR BIDS PER SPEC. D-1007		
F1	4/14/06	FOR CLIENT COMMENTS PER SPEC. D-1007		
E		RELOCATED 10" RAI BA LINE IN PLAN AND SECTION-REVISED DIMENSIONS TO AS BUILT CONDITIONS.	T. SEFFERNICK	
D		RELOCATED 8" & FRP WASTE WATER LINE	T. SEFFERNICK	
C		CHANGED "W8" LINKS ON PLAN ... ADDED TWO ...	K. NEUKAMM	
B		AS BUILT PER CILCO LETTER DC2 LOG 2558 DATED 1-23-81	J. KWIATKOWSKI	
A	10-31-76	ADDED SECTION "3-3"	T. SEFFERNICK	

DESIGN AND DRAFTING T L SEFFERNICK DATE 2-7-75
CHECKED DATE 11-3-75

RICHARD J. STOWE 31687 REGISTERED PROFESSIONAL ENGINEER

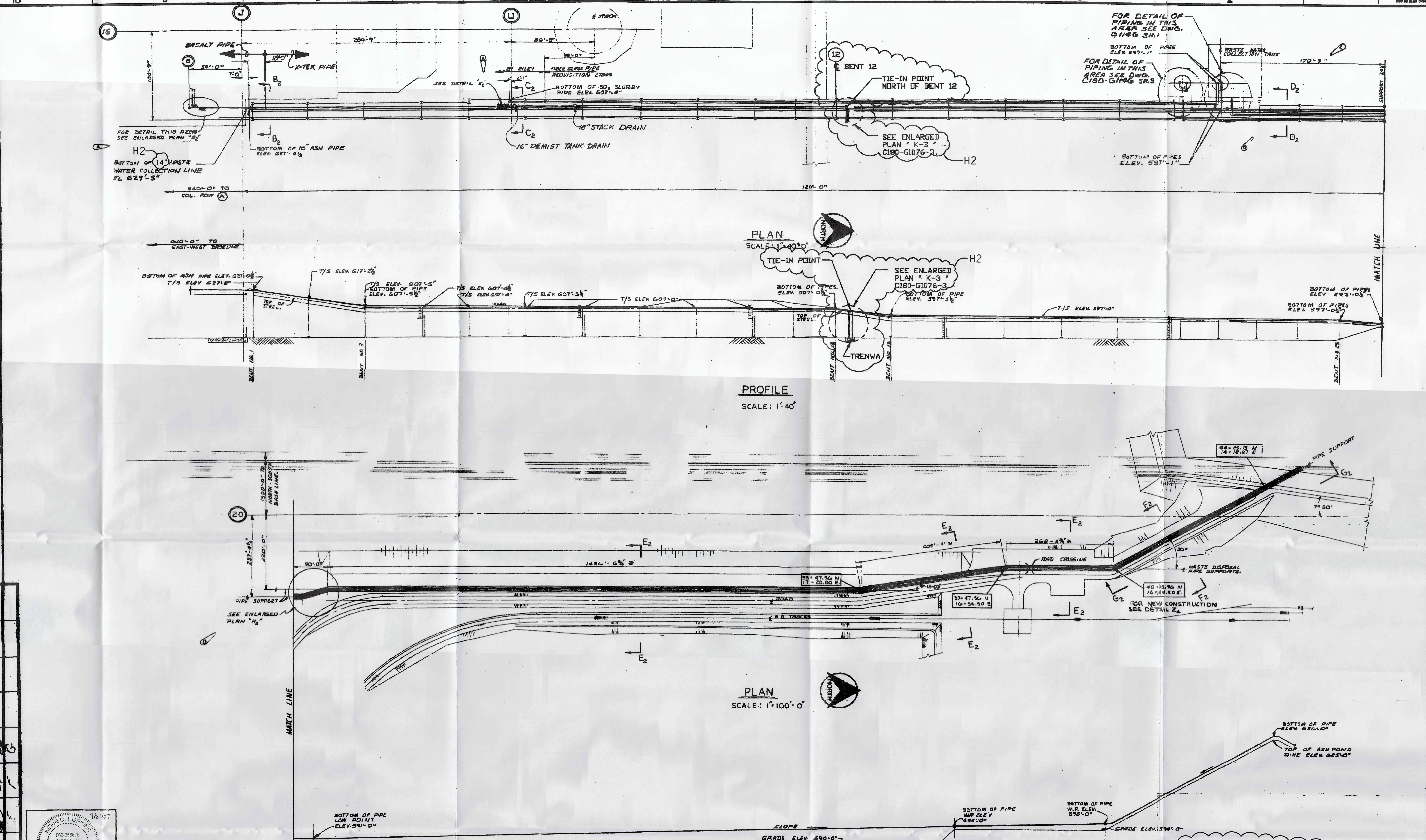
PREPARED UNDER RESPONSIBLE SUPERVISION OF RICHARD J STOWE P.E.
MICHIGAN PROFESSIONAL REGISTRATION NO. 16462
ILL. PROFESSIONAL REGISTRATION NO. 62-31687
AT OFFICES OF COMMONWEALTH ASSOCIATES INC.
209 E. WASHINGTON AVE., JACKSON, MICH.

OWNER AND LOCATION
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA, ILLINOIS
DUCK CREEK SITE UNIT 1

TITLE
TRESTLE PIPING
SECTIONS & DETAILS

JOB NO.	DRAWING NO.	SHEET	REV.
0002-126	C180-G1076	3/4	F2

C180-G1076 SH 3



REFERENCE DRAWINGS:

C180-G1902-2 POWER PLANT YARD LAYOUT

C180-G1076-3 TRESTLE PIPING SECTIONS AND DETAILS

H2

FOR GENERAL NOTES SEE SH. 3.

THIS DRAWING HAS BEEN DRAWN BY, OR REPRODUCED FROM A DRAWING PREPARED BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY. SARGENT & LUNDY IS NOT RESPONSIBLE FOR WORK BY OTHER ORGANIZATIONS.

SCANNED

DATE:
EXPIRES: 11-30-07

Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

REV.	DATE	DESCRIPTION	BY	APPROVED
H2	9/21/07	FOR CONSTRUCTION D-1007	M. MIOTTI	G. SWITAK
H2	6/29/07	FOR BIDS SPEC. D-1007	M. VILLANUEVA	R. KRONE
H1	4/14/06	FOR CLIENT COMMENTS PER SPEC. D-1007.		
G	4/1/85	REV. LOCATION OF FRP&A LINE. ADDED 18 STACK DRAIN & 16" DEMIST TANK DRAIN PER AS BUILT.	T SEFFERNICK	
F	4/29/83	REVISED PIPING TO PUMP HOUSE ADDITION REF. R.N. 12 J	T. SEFFERNICK	
E	7-22-80	ADDED RETURN WATER PUMPHOUSE ADDITION PIPING. ADDED NOTE ZONE C-8	K. NEUKAM	

REV.	DATE	DESCRIPTION	BY	APPROVED
D		AS BUILT PER CILCO LETTER DCZ LOG 2558 DATED 1-23-81	J. KWIATKOWSKI	GJP
C	3-8-76	DIMENSION 170'-9" WAS 177'-6 (DIM. ERROR)	T. SEFFERNICK	
B	10-31-75	REVISED TRESTLE PIPING ELEV.	T. SEFFERNICK	
A	3-10-75	REV. 8" INLETS INTO 18" WASTE WATER HEADER. ADDED SO2 LIMESTONE DISPOSAL LINES	T. SEFFERNICK	

DESIGN AND DRAFTING: T. L. SEFFERNICK, DATE 1-27-75
CHECKED, DATE 11-5-75
APPROVED, DATE 11-4-75

PREPARED UNDER RESPONSIBLE SUPERVISION OF
RICHARD J STOWE P.E.
MICHIGAN PROFESSIONAL REGISTRATION NO. 16462
ILL PROFESSIONAL REGISTRATION NO. 62 31687
AT OFFICES OF
COMMONWEALTH ASSOCIATES INC.
209 E. WASHINGTON AVE., JACKSON, MICH.

OWNER AND LOCATION
CENTRAL ILLINOIS LIGHT COMPANY
PEORIA, ILLINOIS
DUCK CREEK SITE
UNIT 1

TITLE
TRESTLE PIPING

JOB NO.	DRAWING NO.	SHEET	REV.
0002-126	C180-G1076	1/4	H2

TRESTLE PIPING SH 1

C180 G1076 SH1

SHEET NO. 1
E3306-2

1.0	GENERAL

1.1 **ABBREVIATIONS AND DEFINITIONS**

AB	= ANCHOR BOLT
AR	= ANCHOR ROD
BPL	= BASE PLATE
BM	= BEAM
BOTT	= BOTTOM
B/	= BOTTOM OF
℄	= CENTERLINE
C TO C	= CENTER TO CENTER
CHKD PL	= CHECKERED PLATE
CEA	= CONCRETE EXPANSION ANCHOR
CJ	= CONSTRUCTION JOINT
CLR	= CLEAR
COL	= COLUMN
CONC	= CONCRETE
CONT	= CONTINUOUS
DET	= DETAIL
DIA	= DIAMETER
Ø	= DIAMETER
DWLS	= DOWELS
DWG	= DRAWING
E	= ANCHOR BOLT EMBEDMENT LENGTH
EF	= EACH FACE
EL	= ELEVATION
EQ	= EQUAL
EW	= EACH WAY
FD	= FLOOR DRAIN
FDN	= FOUNDATION
FL	= FLOOR
FS	= FAR SIDE
Fy	= YIELD STRESS
GALV	= GALVANIZED
GL	= GIRT LINE
GPL	= GUARD PLATE
GR	= GRADE
GRTG	= GRATING
GWC	= GENERAL WORK CONTRACTOR
HP	= HIGH POINT
HR	= HANDRAIL
ID	= INSIDE DIAMETER
INV	= INVERT
IP	= IN PLACE
KSF	= KIPS PER SQUARE FOOT
KSI	= KIPS PER SQUARE INCH
LG	= LENGTH, LONG
LP	= LOW POINT
MAX	= MAXIMUM
MIN	= MINIMUM
NS	= NEAR SIDE
NTS	= NOT TO SCALE
OC	= ON CENTER
OD	= OUTSIDE DIAMETER
P	= ANCHOR BOLT PROJECTION ABOVE ROUGH CONCRETE
PL	= PLATE
PL	= PLATE
PSI	= POUNDS PER SQUARE INCH
PT	= POINT OF TANGENCY
R	= RADIUS
REF	= REFERENCE
REINF	= REINFORCEMENT
REM	= REMOVABLE
REQD	= REQUIRED
SECT	= SECTION
SIM	= SIMILAR
SPA	= SPACES
SS	= STAINLESS STEEL
STL	= STEEL
SYMM	= SYMMETRICAL
T & B	= TOP & BOTTOM
T/	= TOP OF
T/C	= TOP OF CONCRETE
T/G	= TOP OF GRATING
T/S	= TOP OF STEEL
TYP	= TYPICAL
UN	= UNLESS NOTED
VB	= VERTICAL BRACING
WP	= WORK POINT
WS	= WATER STOP
WWF	= WELDED WIRE FABRIC
WWR	= WELDED WIRE REINFORCMENT

1.2 **SYMBOLS**

12″ = ONE-WAY SLAB SPAN WITHOUT DECKING (NOTE 1.3.1)

8″+2″ / D-2 = INDICATES A NOMINAL 8″ CONCRETE SLAB AND 2″ OF SEPARATE FINISH WITH TOP OF CONCRETE ELEVATION AS NOTED ON PLAN. THE DIRECTION OF MAIN REINFORCING AND SPAN OF METAL DECK IS INDICATED BY THE DIRECTION OF THE ARROW. DEPTH OF DECKING FLUTE IS INDICATED BY D-2 (SEE NOTE 1.3.2).

72″+8″ = INDICATES 72″ THICK ROUGH CONCRETE SLAB AND 8″ OF SEPARATE FINISH WITH TOP OF CONCRETE ELEVATION AS NOTED ON PLAN AND THE DIRECTIONS OF THE MAIN REINFORCING.

P = PRECAST CONCRETE SLAB SPAN

SLOPE = DIRECTION OF DOWNWARD SLOPE

F = CONSTRUCTION OPENINGS TO BE FILLED WITH CONCRETE LATER WITH PRIOR APPROVAL OF THE ENGINEER.

1.3 **DESIGNATIONS**

1.3.1

GENERAL (CONTINUED)

1.3.2 METAL DECKING FLUTE DEPTHS
D = ROOF METAL DECKING
D-1 = $1^1/_2$″
D-2 = 2″
D-3 = 3″

1.3.3 CONCRETE BEAM DESIGNATIONS INDICATE A BEAM NUMBER, WHEN APPLICABLE, AND THE BEAM SIZE IN INCHES (WIDTH X DEPTH)

EXAMPLE: B-310
36″X54″

1.4 **STRUCTURAL DESIGN DATA**

1.4.1 STRUCTURAL DESIGN IS BASED ON THE APPLICABLE REQUIREMENTS OF THE UNIFORM BUILDING CODE (UBC 1997).

1.4.2 WIND LOAD:
1. BASIC WIND SPEED: 70 MPH
2. IMPORTANCE FACTOR, I_w = 1.0
3. EXPOSURE CATERGORY C

1.4.3 SEISMIC LOAD:
1. SEISMIC ZONE 1
2. IMPORTANCE FACTOR, I = 1.0
3. OCCUPANCY CATEGORY 3
4. SOIL PROFILE TYPE S_E

1.4.4 SNOW LOAD:
1. GROUND SNOW LOAD = 20 PSF
2. IMPORTANCE FACTOR, I = 1.0

1.4.5 FLOOR LIVE LOAD AT GRADE IS 350 PSF, UNLESS NOTED

2.0	CONCRETE WORK

2.1 **TYPICAL DETAIL DRAWINGS**

2.1.1 FOR STANDARD PILE DETAILS SEE DRAWING S-10001.

2.1.2 FOR MAT FOUNDATION DETAILS SEE DRAWINGS S-10002 AND S-10003.

2.1.3 FOR EQUIPMENT ANCHOR ROD DETAILS SEE DRAWING S-10004.

2.1.4 FOR CONCRETE WALL DETAILS SEE DRAWINGS S-10005.

2.1.5 FOR CONCRETE EDGE DETAILS SEE DRAWING S-10007.

2.1.6 FOR SLAB SUPPORTED BY METAL DECK DETAILS SEE DRAWING S-10008.

2.1.7 FOR REMOVABLE SLAB DETAILS SEE DRAWING S-10009.

2.1.8 FOR CONCRETE REINFORCED DUCT BANK DETAILS SEE DRAWING S-10010.

2.2 **CONCRETE COVER REQUIREMENTS**

REINFORCING BARS ADJACENT TO THE FACE OF CONCRETE SHALL HAVE THE FOLLOWING MINIMUM CONCRETE COVER UNLESS NOTED ON DESIGN DRAWINGS:

2.2.1 CONCRETE CAST AGAINST EARTH OR OTHER SURFACE NOT FORMED .... 3″

2.2.2 FORMED CONCRETE SURFACES PERMANENTLY IN CONTACT WITH SOIL OR EXPOSED TO WEATHER: .... 2″

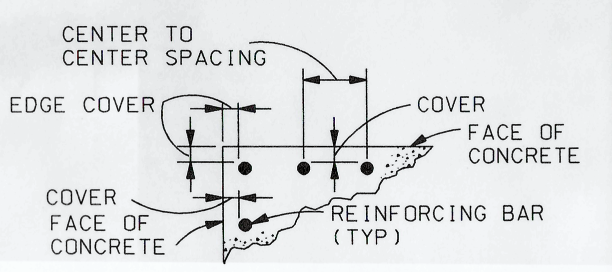
2.2.3 TOP BARS OF CONCRETE MATS AT GRADE. .... 2″

2.2.4 CONCRETE SURFACES NOT PERMANENTLY EXPOSED TO WEATHER:
a. SLABS, WALLS, JOIST #3 THROUGH #11 .... 3/4″
b. BEAMS AND COLUMNS .... $1^1/_2$″

2.2.5 ALL OTHER CONDITIONS .... $1^1/_2$″

2.3 **REINFORCING LAP SPLICE, DEVELOPMENT LENGTH AND STANDARD HOOK REQUIREMENTS**

FOR STANDARD HOOKS SEE NOTE 2.3.5. FOR STRAIGHT BARS, LAP SPLICE AND DEVELOPMENT LENGTH REQUIREMENTS, GIVEN IN THE TABLES FOR NOTES 2.3.1, ARE BASED ON THE FOLLOWING PARAMETERS:
- REINFORCING STEEL STRENGTH Fy=60,000 PSI
- BARS NOT BUNDLED
- BARS UNCOATED (β =1.0)
- NORMAL WEIGHT AGGREGATE (λ =1.0)
- CLASS B SPLICES (LST=1.3xELT AND LSO=1.3xELO)
- CONCRETE STRENGTH, f′c, AS NOTED IN THE TABLES
- REINFORCING CLEAR COVER AND CENTER TO CENTER SPACING EQUAL TO, OR GREATER THAN, MINIMUM VALUES IN TABLES. THE CLEAR COVER SHALL BE THE SMALLER OF THE COVER TO THE FACE OR EDGE OF THE CONCRETE AS SHOWN IN THE SKETCH.



WHERE CONDITIONS LISTED ABOVE ARE NOT MET, LENGTHS IN THE TABLES SHALL BE ADJUSTED WITH THE APPROVAL OF THE ENGINEER.

CONCRETE WORK (CONTINUED)

2.3.1 LAP AND DEVELOPMENT LENGTHS FOR CONCRETE STRENGTH f′c = 4,000 PSI OR f′c = 4,500 PSI

CONCRETE STRENGTH:
f′c = 4,000 PSI OR 4,500 PSI
REINFORCING STEEL CLEAR COVER: 3/4″ MINIMUM
REINFORCING STEEL STRENGTH: Fy = 60,000 PSI
LENGTHS GIVEN IN INCHES

BAR SIZE	LAP SPLICE LENGTH			DEVELOPMENT LENGTH		
	TOP BARS LST	OTHER BARS LSO	MIN. BAR SPAC	TOP BARS ELT	OTHER BARS ELO	MIN. BAR SPAC
3	16	16	2.3	12	12	1.9
4	24	19	2.5	19	15	2.0
5	36	28	2.8	28	21	2.2
6	48	37	3.0	37	29	2.3
7	78	60	3.3	60	46	2.4
8	96	74	3.5	74	57	2.5
9	117	90	3.8	90	69	2.7
10	140	108	4.1	108	83	2.8
11	165	127	4.4	127	98	3.0

CONCRETE STRENGTH:
f′c = 4,000 PSI OR 4,500 PSI
REINFORCING STEEL CLEAR COVER: $1^1/_2$″ MINIMUM
REINFORCING STEEL STRENGTH: Fy = 60,000 PSI
LENGTHS GIVEN IN INCHES

BAR SIZE	LAP SPLICE LENGTH			DEVELOPMENT LENGTH		
	TOP BARS LST	OTHER BARS LSO	MIN. BAR SPAC	TOP BARS ELT	OTHER BARS ELO	MIN. BAR SPAC
3	16	16	2.3	12	12	1.9
4	20	16	3.0	15	12	2.5
5	24	19	3.8	19	15	3.2
6	29	22	4.5	22	17	3.8
7	48	37	4.8	37	28	3.9
8	60	47	5.0	47	36	4.0
9	74	57	5.3	57	44	4.2
10	91	70	5.6	70	54	4.3
11	109	84	5.9	84	64	4.5

CONCRETE STRENGTH:
f′c = 4,000 PSI OR 4,500 PSI
REINFORCING STEEL CLEAR COVER: 2″ MINIMUM
REINFORCING STEEL STRENGTH: Fy = 60,000 PSI
LENGTHS GIVEN IN INCHES

BAR SIZE	LAP SPLICE LENGTH			DEVELOPMENT LENGTH		
	TOP BARS LST	OTHER BARS LSO	MIN. BAR SPAC	TOP BARS ELT	OTHER BARS ELO	MIN. BAR SPAC
3	16	16	2.3	12	12	1.9
4	20	16	3.0	15	12	2.5
5	24	19	3.8	19	15	3.2
6	29	22	4.5	22	17	3.8
7	42	33	5.3	33	25	4.4
8	48	37	6.0	37	29	5.0
9	60	46	6.3	46	36	5.2
10	74	57	6.6	57	44	5.3
11	89	68	6.9	68	53	5.5

CONCRETE STRENGTH:
f′c = 4,000 PSI OR 4,500 PSI
REINFORCING STEEL CLEAR COVER: 3″ MINIMUM
REINFORCING STEEL STRENGTH: Fy = 60,000 PSI
LENGTHS GIVEN IN INCHES

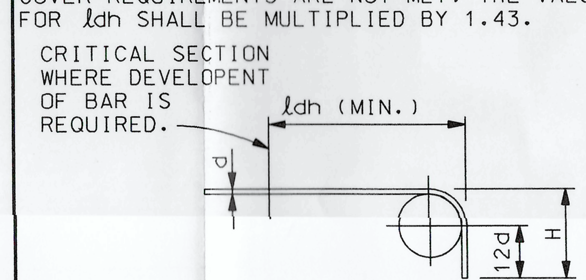
BAR SIZE	LAP SPLICE LENGTH			DEVELOPMENT LENGTH		
	TOP BARS LST	OTHER BARS LSO	MIN. BAR SPAC	TOP BARS ELT	OTHER BARS ELO	MIN. BAR SPAC
3	16	16	2.3	12	12	1.9
4	20	16	3.0	15	12	2.5
5	24	19	3.8	19	15	3.2
6	29	22	4.5	22	17	3.8
7	42	33	5.3	33	25	4.4
8	48	37	6.0	37	29	5.0
9	55	42	6.8	42	32	5.7
10	61	47	7.7	47	36	6.4
11	68	52	8.5	52	40	7.1

2.3.2 - NOT USED -

2.3.3 WHERE REINFORCING BARS OF THE DIFFERENT SIZES ARE SPLICED, THE SPLICE LENGTH SHALL BE THE REQUIRED LAP SPLICE LENGTH FOR THE SMALLER BAR, BUT NOT LESS THAN THE DEVELOPMENT LENGTH FOR THE LARGER BAR.

2.3.4 ANY HORIZONTAL REINFORCING BAR, OR BAR BENT LESS THAN 45° FROM HORIZONTAL REGARDLESS OF LOCATION, WITH MORE THAN 12″ OF CONCRETE CAST BELOW THE BAR SHALL BE CONSIDERED AS A "TOP BAR" VERTICAL BAR AND HORIZONTAL REINFORCING BAR WITH LESS THAN 12″ OF CONCRETE CAST BELOW THE BAR SHALL BE CONSIDERED AS AN "OTHER BAR"

2.3.5 FOR A STANDARD HOOK, THE SCHEDULE BELOW IS BASED ON A SIDE COVER OF NOT LESS THAN $2^1/_2$″ AND THE COVER OVER THE BAR EXTENSION BEYOND THE HOOK OF NOT LESS THAN 2″. IF THESE COVER REQUIREMENTS ARE NOT MET, THE VALUES FOR ℓdh SHALL BE MULTIPLIED BY 1.43.



CONCRETE WORK (CONTINUED)

STANDARD HOOK LENGTHS
REINFORCING STEEL Fy=60,000 PSI
LENGTHS GIVEN IN INCHES

BAR SIZE	CONCRETE STRENGTH f′c = 4000 PSI f′c = 4500 PSI	
	H	ℓdh
3	6	6
4	8	7
5	10	9
6	12	10
7	14	12
8	16	14
9	20	15
10	22	17
11	24	19

2.4 **DETAILING, FABRICATION & CONSTRUCTION REQUIREMENTS**

2.4.1 ALL CONCRETE WORK, REINFORCING BAR, EMBEDMENTS IN CONCRETE AND GROUT WORK SHALL BE INSTALLED BY THE GENERAL WORK CONTRACTOR IN ACCORDANCE WITH THE APPLICABLE CONSTRUCTION SPECIFICATION.

2.4.2 THE MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE FOR EACH PORTION OF THE STRUCTURE SHALL BE AS FOLLOWS UNLESS NOTED.

COMPRESSIVE STRENGTH AREA/BUILDING

2000psi...........MUD MATS AND LEAN CONCRETE BACKFILL
4000psi...........ALL BUILDINGS AND STRUCTURES UNLESS NOTED
4500psi...........BUILDINGS AND STRUCTURES DESIGNATED AS USING CONCRETE CATEGORY E

2.4.3 - NOT USED -

2.4.4 ALL WELDING STUD ANCHORS SHALL BE COLD DRAWN STEEL CONFORMING TO ASTM A108 WITH A MINIMUM YIELD STRENGTH OF 50 ksi AND SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S GUIDELINES.

2.4.5 ALL LAP SPLICES FOR REINFORCING BARS #11 AND SMALLER SHALL BE AS INDICATED IN NOTE 2.3.5 AND SHALL BE STAGGERED AS INDICATED IN DETAIL 6.1.2 UNLESS OTHERWISE APPROVED BY THE ENGINEER.

2.4.6 MECHANICAL SPLICES SHALL BE USED FOR SPLICES OF REINFORCING BARS #14 TO #18 IN ACCORDANCE WITH THE APPLICABLE CONSTRUCTION SPECIFICATIONS. MECHANICAL SPLICES ON ADJACENT BARS OF THE SAME LAYER OR ADJACENT BARS OF PARALLEL LAYERS SHALL HAVE A MINIMUM STAGGER OF 2′-0″ UNLESS NOTED OTHERWISE ON DESIGN DRAWINGS.

2.4.7 LAP SPLICES SHALL BE USED ONLY WHERE IT IS NOT PRACTICAL TO USE CONTINUOUS BARS.

2.4.8 PROVIDE A STANDARD 90° HOOK LENGTH AS INDICATED IN NOTE 2.3.5 WHEN STRAIGHT BAR DEVELOPMENT LENGTH IS NOT OBTAINABLE. THE ℓdh DIMENSION SHALL BE ADJUSTED AS SHOWN ON DESIGN DRAWINGS SO THAT THE HOOK CAN BE TIED TO THE FAR FACE BARS UNLESS NOTED OTHERWISE.

2.4.9 THE MINIMUM CLEAR DISTANCE BETWEEN TWO PARALLEL BARS (EXCEPT IN COLUMNS AND BETWEEN MULTIPLE LAYERS OF BARS IN BEAMS) OR BETWEEN A PARALLEL BAR AND AN EMBEDDED CONDUIT OR PIPE SHALL NOT BE LESS THAN ONE BAR DIAMETER OR 1 1/3 TIMES THE MAXIMUM SIZE OF COARSE AGGREGATE OR 1″WHICHEVER IS THE GREATER.

2.4.10 UNLESS NOTED OTHERWISE, THE MINIMUM CLEAR DISTANCE BETWEEN PARALLEL BARS IN COLUMNS SHALL NOT BE LESS THAN 1.5BAR DIAMETERS OR 1 1/3 TIMES THE MAXIMUM SIZE OF COARSE AGGREGATE OR $1^1/_2$″, WHICHEVER IS THE GREATER. FOR BUNDLED BARS, THE DIAMETER SHALL BE THE DIAMETER OF A SINGLE BAR WITH THE EQUIVALENT CROSS-SECTION AREA.

2.4.11 WHERE PARALLEL REINFORCING BAR IS PLACED IN TWO OR MORE LAYERS, THE BARS IN THE UPPER LAYERS SHALL BE PLACED DIRECTLY ABOVE THOSE IN THE BOTTOM LAYER WITH CLEAR DISTANCE BETWEEN BARS NOT LESS THAN 1″.

2.4.12 FOR MULTIPLE LAYERS OF PARALLEL REINFORCING BARS, THE CONTRACTOR SHALL FURNISH SPACER BARS AS REQUIRED TO SATISFY THE REQUIREMENTS OF NOTES 2.4.9, 2.4.10 AND 2.4.11. REINFORCING BARS SHALL NOT BE BUNDLED UNLESS SPECIFICALLY NOTED ON THE DESIGN DRAWINGS.

2.4.13 - NOT USED -

2.4.14 OPENINGS IN METAL DECKING SHALL BE CUT AFTER THE CONCRETE IS PLACED AND SET. THE CUT EDGES OF METAL DECK SHALL BE GROUND SMOOTH ON A 45° BEVEL AND COATED PER THE APPLICABLE CONSTRUCTION SPECIFICATION.

2.4.15 ALL EXPOSED PROJECTING CORNERS OF CONCRETE WORK SHALL BE BEVELED 1″ UNLESS NOTED. CONCRETE WALL OPENINGS FOR HVAC FIRE DAMPERS SHALL NOT HAVE BEVELED EDGES UNLESS APPROVED ON A PROJECT UNIQUE BASIS.

CONCRETE WORK (CONTINUED)

2.4.16 DRAWINGS INDICATING LOCATION OF CONSTRUCTION JOINTS REQUIRED IN ADDITION TO OR DIFFERENT FROM THOSE INDICATED ON THE DESIGN DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW. THESE DRAWINGS SHALL BE SUBMITTED AND ACCEPTED BY THE ENGINEER BEFORE REBAR DETAILS ARE SUBMITTED FOR REVIEW. ALL CHANGES INCLUDING REQUIRED WATERSTOP, IF ANY, SHALL BE AT CONTRACTOR'S EXPENSE. FOR TYPICAL CONSTRUCTION JOINT DETAILS SEE DRAWING S-10002.

2.4.17 ALL CONSTRUCTION JOINTS SHALL BE ROUGHENED TO A MINIMUM AMPLITUDE OF 1/4″ UNLESS NOTED OTHERWISE. ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED AND MOISTENED BEFORE PLACING FRESH CONCRETE.

2.4.18 AT ALL HORIZONTAL CONSTRUCTION JOINTS A 1″ MINIMUM TO 3″ MAXIMUM LAYER OF MORTAR OF THE SAME STRENGTH OR GREATER AS THAT OF THE ADJACENT CONCRETE SHALL BE PLACED ON THE JOINT SURFACE IMMEDIATELY PRIOR TO PLACEMENT OF FRESH CONCRETE.

2.4.19 VERTICAL CONSTRUCTION JOINTS IN SHEAR WALLS SHALL BE STAGGERED BETWEEN FLOOR LEVELS AND LOCATED SIX TIMES THE WALL THICKNESS FROM THE CORNERS OF WALLS UNLESS NOTED.

2.4.20 - NOT USED -

2.4.21 IT IS NOT A REQUIREMENT THAT THE WATERSTOP BE PLACED AT THE CENTERLINE OF THE STRUCTURAL ELEMENT. AT THE CONTRACTOR'S OPTION THE WATERSTOP MAY BE PLACED ANYWHERE BETWEEN THE CENTERLINE OF THE STRUCTURAL ELEMENT AND A POINT LOCATED A MINIMUM OF 2″ FROM THE FACE OF THE REINFORCING BARS ON THE WATER SIDE OF THE JOINT.

2.4.22 - NOT USED -

2.4.23 NONSHRINK GROUT SHALL BE USED UNDER EQUIPMENT BASES, UNDER COLUMN BASE PLATES AND WHERE SPECIFICALLY INDICATED IN THE EQUIPMENT MANUFACTURER'S INSTRUCTION MANUAL. ANY DEVIATION FROM THIS REQUIREMENT SHALL BE APPROVED BY THE OWNER.

2.4.24 BEFORE APPLYING NONSHRINK GROUT, ALL SURFACES SHALL BE ROUGHENED TO A MINIMUM AMPLITUDE OF 1/8″ TO EXPOSE THE AGGREGATE, THOROUGHLY CLEANED AND MOISTENED.

2.4.25 ALL GROUT SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH OF 5000 PSI AT 28 DAYS AND SHALL ATTAIN A MINIMUM COMPRESSIVE STRENGTH OF 3500 PSI AFTER 1 DAY.

2.4.26 THE FOLLOWING TYPES OF CONCRETE FINISH SHALL BE PROVIDED FOR THE SURFACES INDICATED UNLESS NOTED OTHERWISE. SEE ACI-301 AND THE APPLICABLE CONSTRUCTION SPECIFICATIONS FOR A DESCRIPTION OF THE SURFACE FINISH TYPES.

A. SCRATCHED FINISH
- TOP OF ROUGH CONCRETE SURFACES THAT WILL BE COVERED WITH SEPARATE CONCRETE FLOOR FINISH.
- TOP OF CONCRETE DUCT RUNS

B. SCRATCHED FINISH - INTENTIONALLY ROUGHENED TO A FULL AMPLITUDE OF 1/4″
- TOP OF AN INTERMEDIATE LIFT IN MULTILIFT POURS OF SLABS, WALLS, OR MATS(E.G., CONSTRUCTION JOINTS).

C. FLOATED FINISH
- TOP OF WALLS, FLOORS OF TUNNELS, INTAKE STRUCTURES, MANHOLES,SUMP PITS, VALVE PITS AND MISCELLANEOUS PITS.
- FOR SURFACES RECEIVING ROOFING OR WATER PROOFING MEMBRANES.

D. TROWELLED FINISH
- FOR FLOORS AND THE TOP SURFACES OF CURBS, PIERS, PLINTHS AND PEDESTALS.
- SWITCHYARD AND OTHER EQUIPMENT FOUNDATIONS WHERE THE TOP SURFACES WILL BE EXPOSED AFTER COMPLETION OF THE WORK.

E. BROOM OR BELT FINISH
- FOR EXTERIOR FLATWORK INCLUDING DRIVEWAYS AND SIDEWALKS.

F. NONSLIP FINISH
- FOR EXTERIOR AND INTERIOR PLATFORMS STEPS AND LANDINGS OF BOTH FORMED CONCRETE AND METAL PAN STAIRS.
- FOR EXTERIOR AND INTERIOR RAMPS.

2.4.27 SPECIAL CONCRETE FINISHES OTHER THAN THOSE SPECIFIED IN NOTE 2.4.26 ARE SPECIFIED ON THE DESIGN DRAWINGS.

2.4.28 WATERPROOFING SHALL BE APPLIED IN ACCORDANCE WITH THE APPLICABLE CONSTRUCTION SPECIFICATION AND AS INDICATED BELOW:

A. EXTERIOR SURFACES OF ALL WALLS BELOW FINISH GRADE UNLESS NOTED OTHERWISE. SEE DRAWING "LATER" FOR SITE PLAN OF PLANT GRADING.

B. SIDE SURFACES OF BASE MATS UNLESS NOTED.

C. ALL SURFACES OF TUNNELS AND OTHER MISCELLANEOUS STRUCTURES UNLESS NOTED.

2.4.29 SLEEVE PENETRATIONS OR EMBEDDED PIPES SHALL BE ROTATED TO PROVIDE MAXIMUM SPACE BETWEEN THE FIN LUGS OF ADJACENT SLEEVES.

CONCRETE WORK (CONTINUED)

2.4.30 IN CASES WHERE EMBEDMENT PLATES ARE PROVIDED IN ROUGH CONCRETE AND THE FINISH CONCRETE IS POURED PRIOR TO INSTALLING ANY ATTACHMENTS TO THE PLATE, A BLOCK OUT SHALL BE PROVIDED IN THE FINISH CONCRETE AS PER DETAIL 6.1.11 ON DRAWING S-10002.

2.4.31 IF CONCRETE PLACEMENT MUST BE STOPPED RESULTING IN A COLD JOINT,PROVIDE A CONSTRUCTION JOINT AS FOLLOWS:
A. NO.8 SHEAR DOWELS SHALL BE PROVIDED PERPENDICULAR TO THE CONSTRUCTION JOINT AND SPACED AS SHOWN ON DETAIL 6.1.19 ON DRAWING S-10002.
B. THE CONSTRUCTION JOINT SHALL BE PREPARED BY THE METHODS DESCRIBED IN THE APPLICABLE CONSTRUCTION SPECIFICATION.

2.4.32 ALL REINFORCING BARS SHALL BE CONTINUOUS ON OUTSIDE CORNERS OF WALLS OR CORNER BARS SHALL BE PROVIDED.

2.4.33 - NOT USED -

2.4.34 FOR TYPICAL REINFORCING AROUND OPENINGS SEE DRAWING S-10003

2.4.35 ALL WATERSTOPS SHALL BE SPLICED TO FORM A CONTINUOUS WATERTIGHT SEAL. ALL WATERSTOPS SHALL BE 6″x3/8″ PVC OR STEEL AS INDICATED IN THE PROJECT SPECIFICATION, UNLESS NOTED. WATERSTOPS USED FOR CONTAINMENT AT ALL TRANSFORMERS SHALL BE PVC (DUMBBELL TYPE) OR APPROVED EQUAL.

2.4.36 FOR REINFORCING BARS AT COLUMN POCKETS, SEE TYPICAL COLUMN POCKET REINFORCEMENT DETAIL ON DRAWING S-10002.

2.4.37 NAIL HOLES SHALL BE PROVIDED FOR ALL EMBEDDED PLATES TO SECURE THEM TO FORMWORK. ALL NAIL HOLES SHALL BE INDICATED ON SHOP DRAWINGS.

2.4.38 - NOT USED -

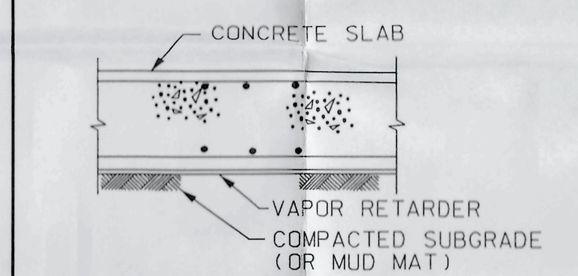
2.4.39 ALL ALUMINUM SURFACES EMBEDDED IN OR IN CONTACT WITH CONCRETE SHALL BE COATED IN ACCORDANCE WITH THE PROJECT SPECIFICATION.

2.4.40 - NOT USED -

2.4.41 WHERE CONCRETE SLAB IS INDICATED AS SLOPED (TO DRAIN) SPECIFIED CONCRETE THICKNESS SHALL BE MEASURED AT THE HIGH POINT. REINFORCING COVER REQUIREMENTS SHALL BE MAINTAINED AT THE LOW POINT OF CONCRETE.

2.4.42 PROVIDE SADDLES ON SLOPED FLOORS AT ALL EQUIPMENT PADS TO PREVENT WATER ACCUMULATION.

2.4.43 ALL FLOOR SLABS IN CONTACT WITH GROUND IN INHABITED BUILDINGS OR THAT RECEIVE ANY FORM OF FLOOR COVERING OR COATING SHALL BE INSTALLED WITH A VAPOR RETARDER BELOW THE SLAB IN ACCORDANCE WITH THE REQUIREMENTS THE SPECIFICATION.



TYPICAL VAPOR RETARDER DETAIL

2.4.44 DOWELS AND POST-INSTALLED ANCHOR RODS SHALL BE INSTALLED USING HILTI HIT HY-150 INJECTION ADHESIVE OR APPROVED EQUAL UNLESS NOTED. THE HOLE SIZE AND DRILLING REQUIREMENTS SHALL BE PER THE MANUFACTURER'S RECOMMENDATIONS UNLESS NOTED.

2.4.45 WHEN DRILLING INTO EXISTING CONCRETE, CUTTING OF EXISTING REBAR IS NOT ALLOWED. CONTRACTOR SHALL DRILL PILOT HOLES AND/OR MAP EXISTING REBAR AS REQUIRED. CONTRACTOR MAY RELOCATE NEW DOWELS ±2″ IN ANY DIRECTION TO AVOID HITTING ANY EXISTING REBAR.

2.4.46 ALL EXPANSION ANCHORS SHALL BE WEDGE TYPE, HILTI-KWIK BOLT 3 OR EQUAL. INSTALLATION SHALL BE PER MANUFACTURER'S RECOMMENDATION.

2.5 MATERIALS

2.5.1 REINFORCING STEEL
A. WELDED WIRE REINFORCEMENT SHALL BE PLAIN TYPE, ASTM A185: IN FLAT SHEETS AND UNCOATED.
B. REINFORCING STEEL SHALL BE ASTM A615, GRADE 60 BILLET STEEL DEFORMED BARS AND UNCOATED.

2.5.2 CONCRETE
CONCRETE SHALL BE IN ACCORDANCE WITH THE SPECIFICATION D-1060

CONCRETE WORK (CONTINUED)

UNDERGROUND OR EMBEDDED UTILITIES MAY EXIST WITHIN THE AREA OF AND ADJACENT TO THE LIMITS OF THE WORK. THE LOCATION OR IDENTIFICATION OF SUCH UTILITIES HAS NOT BEEN VERIFIED BY OWNER OR BY S&L. CONTRACTOR/INSTALLER IS RESPONSIBLE FOR FIELD LOCATING AND IDENTIFYING UNDERGROUND OR EMBEDDED UTILITIES AND ANY OTHER UNDERGROUND OR EMBEDDED UTILITY DIMENSIONS.

REFERENCES USED HAVE BEEN IDENTIFIED ON EXCAVATION/FOUNDATION/DEMOLITION DRAWINGS AND HAVE BEEN PROVIDED TO ASSIST THE CONTRACTOR/INSTALLER IN THE FIELD LOCATING EXISTING UTILITIES AND OTHER POTENTIAL UNDERGROUND OR EMBEDDED INTERFERENCES. THESE REFERENCES ONLY SHOW THE APPROXIMATE LOCATION OF POTENTIAL UNDERGROUND OR EMBEDDED UTILITIES AND MAY NOT INDICATE OR REFLECT ALL EXISTING UNDERGROUND OR EMBEDDED UTILITIES OR THEIR ACTUAL LOCATIONS.

REFERENCES IDENTIFIED SHALL NOT SUBSTITUTE FOR THE CONTRACTOR'S/INSTALLER'S OBLIGATION TO FIELD LOCATE ANY UNDERGROUND OR EMBEDDED UTILITIES OR INTERFERENCES THAT MAY AFFECT THE WORK.

DUE CAUTION SHALL BE TAKEN DURING ANY EXCAVATION/FOUNDATION/DEMOLITION WORK WITHIN THE AREA OF AND ADJACENT TO THE LIMITS OF THE WORK DUE TO POSSIBLE INTERFERENCES THAT MAY NOT BE REFLECTED ON THE REFERENCES IDENTIFIED.

ALL WORK DONE BY CONTRACTOR/INSTALLER PURSUANT TO THIS DRAWING SHALL: (A) CONFORM TO THE GOVERNING CONTRACT DOCUMENTS; (B) BE PERFORMED EXCLUSIVELY BY ITS TRAINED, COMPETENT PERSONNEL OR, WHERE PERMITTED, THAT OF ITS SUBCONTRACTOR(S); AND (C) COMPLY WITH ALL APPLICABLE SAFETY LAWS, REGULATIONS, PROGRAMS AND PRACTICES TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING THE CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.

NOTE:
THIS ELECTRONIC FILE CONTAINS INFORMATION WHICH MAY BE COPIED IN WHOLE OR IN PART FOR PREPARATION OF PROJECT DELIVERABLES. PROJECT PERSONNEL ARE RESPONSIBLE FOR REVIEW AND APPROVAL OF RESULTANT DELIVERABLES IN ACCORDANCE WITH S&L STANDARD OPERATING PROCEDURES (SOP).

FILE NO. C180-E3306-2.DGN

CONSTRUCTION NOTE:
CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR (S)) PERFORMING THE WORK.

NOTICE OF LIMITED RESPONSIBILITY
THE RESPONSIBILITY OF THE UNDERSIGNED ENGINEER IS LIMITED TO THE DESIGN WORK SHOWN ON PROJECT DRAWINGS AND DOCUMENTS BEARING HIS/HER SEAL, SIGNATURE OR INITIALS. HE/SHE DOES NOT HAVE AUTHORITY OVER THE PROJECT AS A WHOLE. THE UNDERSIGNED DISCLAIMS ANY RESPONSIBILITY FOR WORK DONE UNDER SUBSEQUENT REVISIONS AND ANY OTHER DOCUMENTS ASSOCIATED WITH THE PROJECT WHICH DO NOT BEAR HIS/HER SEAL, SIGNATURE OR INITIALS.

SARGENT & LUNDY LLC's
ILLINOIS DEPARTMENT OF PROFESSIONAL REGULATION
REGISTRATION NUMBER IS 184-000106

AEG CAD GENERATED
DO NOT REVISE MANUALLY

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION

DRAWING RECORD

REV.	DATE	PREPARED	REVIEWED	APPROVED	DESCRIPTION
0A	04/21/06	GT	AN	———	FOR CLIENT COMMENTS
0B	07-02-07	S.R. / A.	GW	———	FOR BIDS SPECIFICATION D-1007
0C	09/21/07	D.ZIMA	GW	———	FOR CONSTRUCTION SPECIFICATION D-1007

Sargent & Lundy LLC

STATE OF ILLINOIS
GARY WILLMAN
81-4140
EXP. 11-30-2008
CHICAGO, ILLINOIS
LICENSED STRUCTURAL ENGINEER

SCALE 1/4″=1-0″
PROJECT 11478-034
140M052
DRAFTER DDC
DATE -

DRAWING TITLE

CONCRETE GENERAL NOTES

BOTTOM ASH AND LOW VOLUME SUMP WATER BASIN AND PIPING PROJECT
CANTON, ILLINOIS

DUCK CREEK POWER STATION UNIT NO. 1

Ameren Energy Resources Generating

DRAWING NUMBER	REV.
C180-E3306-2	0C

SHEET NO. 1

ATTACHMENT 3

Hydrologic and Hydraulic Assessments

AECOM

Submitted to
Illinois Power Resources
Generating, LLC
17751 North Cilco Road
Canton, IL 61520

Submitted by
AECOM
1001 Highlands Plaza Drive West,
Suite 300
St. Louis, MO 63110

October 2016

CCR Certification Report: Initial Structural Stability Assessment, Initial Safety Factor Assessment, and Initial Inflow Design Flood Control System Plan

For

Bottom Ash Basin

At Duck Creek Power Station

Table of Contents

Executive Summary **1**
1 Introduction **1-1**
2 Facility Description and Location Map **2-1**
2.1 Overview of Existing Surface Impoundments 2-1
3 Initial Structural Stability Assessments **3-1**
4 Initial Safety Factor Assessments **4-1**
5 Initial Inflow Design Flood Control System Plan **5-1**
5.1 Inflow Design Flood Control Systems (§257.82(a)(1), (2), (3)) 5-1
5.2 Discharge from the CCR Unit (§257.82(b)) 5-2
6 Conclusions **6-1**
7 References **7-1**
8 Appendices **8-1**

Tables
Table ES-1 – Certification Summary

Figures
Figure 1 – Duck Creek Power Station Location Map
Figure 2A – Duck Creek Power Station Site Plan
Figure 2B – Duck Creek Power Station Bottom Ash Basin Area Plan

Appendix
Appendix A – Hydrologic and Hydraulic Report

Executive Summary

The initial structural stability assessment, initial safety factor assessment, and initial inflow design flood control system plan for the Bottom Ash Basin at the Duck Creek Power Station have been prepared in accordance with the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule 40 Code of Federal Regulations (CFR) §257.73(d), §257.73(e), and §257.82, respectively. These regulations require that the specified structural stability, safety factor, and hydrologic and hydraulic (supporting the inflow design flood control system plan) assessments for an existing CCR surface impoundment be completed by October 17, 2016. The Bottom Ash Basin is an incised CCR surface impoundment, as defined by 40 CFR §257.53. Per §257.73(b), the requirements of §257.73(d) (structural stability assessment) and §257.73(e) (safety factor assessment) are not applicable to incised CCR surface impoundments.

The engineering investigations, analyses, and evaluations determined that the Bottom Ash Basin meets all requirements for hydrologic and hydraulic analysis, as summarized in Table ES-1.

Table ES-1 – Certification Summary

Report Section	CCR Rule Reference	Requirement Summary	Requirement Met?	Comments
Initial Structural Stability Assessment				
3	§257.73(d)(1)(i)	Stable foundations and abutments	Not Applicable	The Bottom Ash Basin is an incised CCR surface impoundment and does not meet the criteria in §257.73(b); thus, the requirement to perform a structural stability assessment does not apply.
	§257.73(d)(1)(ii)	Adequate slope protection		
	§257.73(d)(1)(iii)	Sufficiency of dike compaction		
	§257.73(d)(1)(iv)	Presence and condition of slope vegetation		
	§257.73(d)(1)(v)(A) and (B)	Adequacy of spillway design and management		
	§257.73(d)(1)(vi)	Structural integrity of hydraulic structures		
	§257.73(d)(1)(vii)	Stability of downstream slopes inundated by water body		
Initial Safety Factor Assessment				
4	§257.73(e)(1)(i)	Maximum storage pool safety factor must be at least 1.50	Not Applicable	The Bottom Ash Basin is an incised CCR surface impoundment and does not meet the criteria in §257.73(b); thus, the requirement to perform a safety factor assessment does not apply.
	§257.73(e)(1)(ii)	Maximum surcharge pool safety factor must be at least 1.40		
	§257.73(e)(1)(iii)	Seismic safety factor must be at least 1.00		
	§257.73(e)(1)(iv)	For dikes constructed of soils that have susceptibility to liquefaction safety factor must be at least 1.20		
Initial Inflow Design Flood Control System Plan				
5.1	§257.82(a)(1), (2), (3)	Adequacy of inflow design flood control system	Yes	Flood control system adequately manages inflow and peak discharge during the 25-year, 24-hour Inflow Design Flood.
5.2	§257.82(b)	Discharge from the CCR Unit	Yes	Discharge from CCR Unit is routed through a NPDES-permitted outfall during both normal and 25-year, 24-hour Inflow Design Flood conditions.

1 Introduction

This report documents that the inflow design flood control system plan meets the requirements specified in 40 CFR §257.82 to support the certification required under the regulatory provision for the Duck Creek Power Station Bottom Ash Basin. The Bottom Ash Basin is an existing CCR surface impoundment as defined by 40 CFR §257.53. The CCR Rule requires that the specified initial structural stability assessment, initial safety factor assessment, and initial inflow design flood control system plan (i.e., hydrologic and hydraulic analysis) for an existing CCR surface impoundment be completed by October 17, 2016.

The Bottom Ash Basin is an incised CCR surface impoundment, as defined by 40 CFR §257.53, that is used to manage sluiced bottom ash. Under 40 CFR §257.73(b), structural stability assessments (§257.73(d)) and safety factor assessments (§257.73(e)) must be performed for an existing CCR surface impoundment that:

1. *Has a height of five feet or more and a storage volume of 20 acre-feet or more; or*

2. *Has a height of 20 feet or more.*

The Bottom Ash Basin does not satisfy the criteria because the incised basin does not have dikes. Therefore, the Bottom Ash Basin is not subject to the structural stability assessment (§257.73(d)) and safety factor assessment (§257.73(e)) requirements.

The requirements for hydrologic and hydraulic assessments specified in §257.82 are applicable to the incised Bottom Ash Basin and are addressed herein.

The Bottom Ash Basin has been evaluated to determine whether the inflow design flood control system plan requirements are met. The following sections describe the evaluations performed and the results from the analyses, as supported by the underlying data and analyses included in the appendix.

2 Facility Description and Location Map

2.1 Overview of Existing Surface Impoundments

The Duck Creek Power Station is a coal-fired power plant located near Canton, Illinois in Fulton County. The station is located west of the Illinois River and Duck Creek Reservoir, and the Bottom Ash Basin is located approximately 0.1 miles northeast of the station. A site location map showing the Duck Creek Power Station is in **Figure 1. Figure 2A** presents the Duck Creek Power Station site plan, and **Figure 2B** presents the site plan in the vicinity of the Bottom Ash Basin.

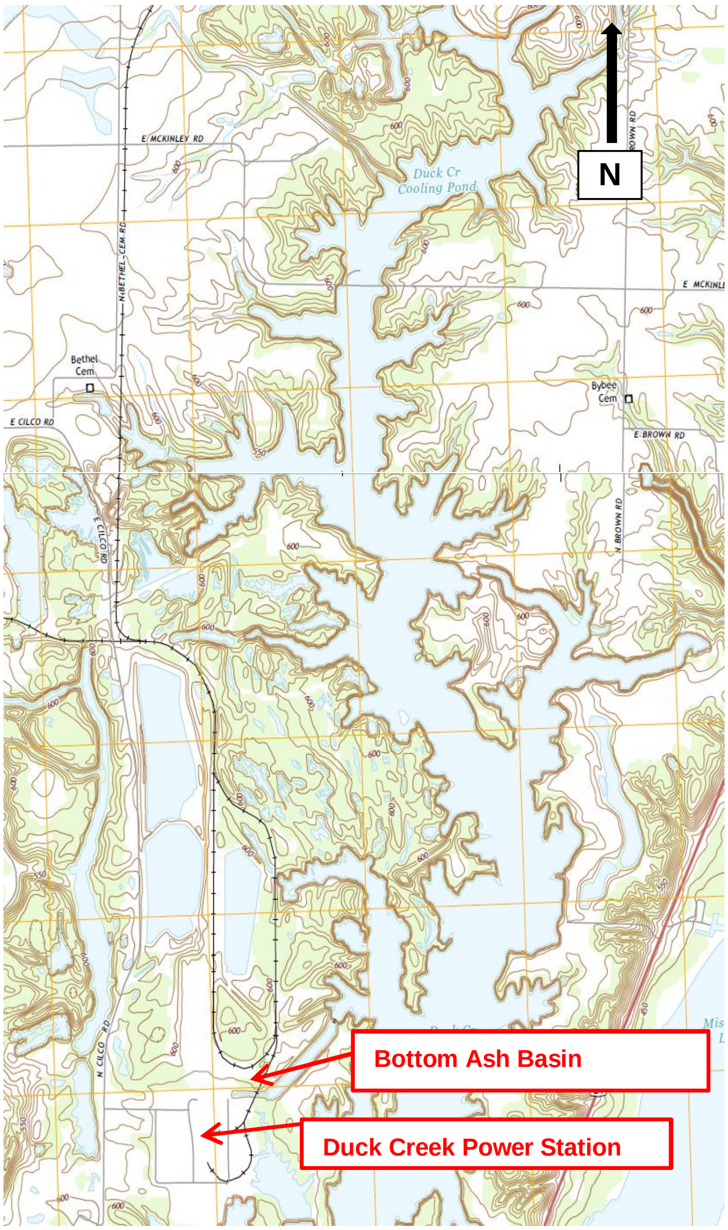


Figure 1 – Duck Creek Power Station Location Map
(from United States Geological Survey Banner and Duck Island 7.5' Topographic Maps, 2015)

Two active CCR surface impoundments – the GMF Pond and the Bottom Ash Basin – are utilized for managing CCRs generated by the Duck Creek Power Station. This certification report only pertains to the Bottom Ash Basin. Per §257.73, a hazard potential classification assessment is not required for incised CCR surface impoundments.

The Bottom Ash Basin, which is sub-divided into Primary Pond 1, Primary Pond 2 and the Secondary Settlement Pond, serves as the wet bottom ash impoundment basin. Within the Bottom Ash Basin, Primary Ponds 1 and 2 are essentially identical in design and construction and receive sluiced bottom ash from the Duck Creek Power Station. The Secondary Settlement Pond sub-basin operates as a polishing pond before discharging water into the station's discharge channel, which leads to the Duck Creek Reservoir and a NPDES-permitted outfall. The Bottom Ash Basin consists of incised trapezoidal basins that were constructed in 2009. Primary Pond 1 and Primary Pond 2 operate alternately with each sub-basin operating for approximately one week at a time. While one sub-basin is receiving bottom ash, the other sub-basin is dewatered and the ash is removed.

Sluiced bottom ash enters the Bottom Ash Basin through Trenwa precast modular trenches. Overflow water from the Primary Pond sub-basins flows into the Secondary Settlement Pond sub-basin through a stop-log weir. Outflow from the Bottom Ash Basin is transmitted from the Secondary Settlement Pond through a stop-log structure into a 12-inch diameter corrugated high-density polyethylene (HDPE) pipe which flows by gravity into the discharge channel.

Figure 2A – Duck Creek Power Station Site Plan
(Imagery from Google Earth Pro, 2016)

The Bottom Ash Basin is lined with, from bottom to top, a 60-mil geomembrane, 12-inches of compacted clay, and an 8-inch reinforced concrete slab. The interior side slopes of the Bottom Ash Basin are graded at a 7% slope and were constructed to a sidewall heights ranging from 5.7 to 9 feet (basin sidewalls below current existing grade).

As currently operated, the maximum operating pool of Bottom Ash Basin Primary Ponds 1 and 2 is El. 577.3 feet (all elevations listed in this report are in the NAVD88 datum, unless stated otherwise), and the normal pool elevation of the Secondary Settlement Pond is 573.5 feet. The pool elevation in each sub-basin is controlled by the stop log overflow weirs. The Bottom Ash Basin is approximately 1.9 acres in size and the perimeter (crest length) is approximately 1,100 feet. The minimum crest elevation of the Bottom Ash Basin is 579.0 feet for Primary Pond 1 and Primary Pond 2 and 578.0 feet for the Secondary Settlement Pond. Additional details about the geometry and configuration of the Bottom Ash Basin and each sub-basin is provided in the Hydrologic and Hydraulic Report in **Appendix A**.

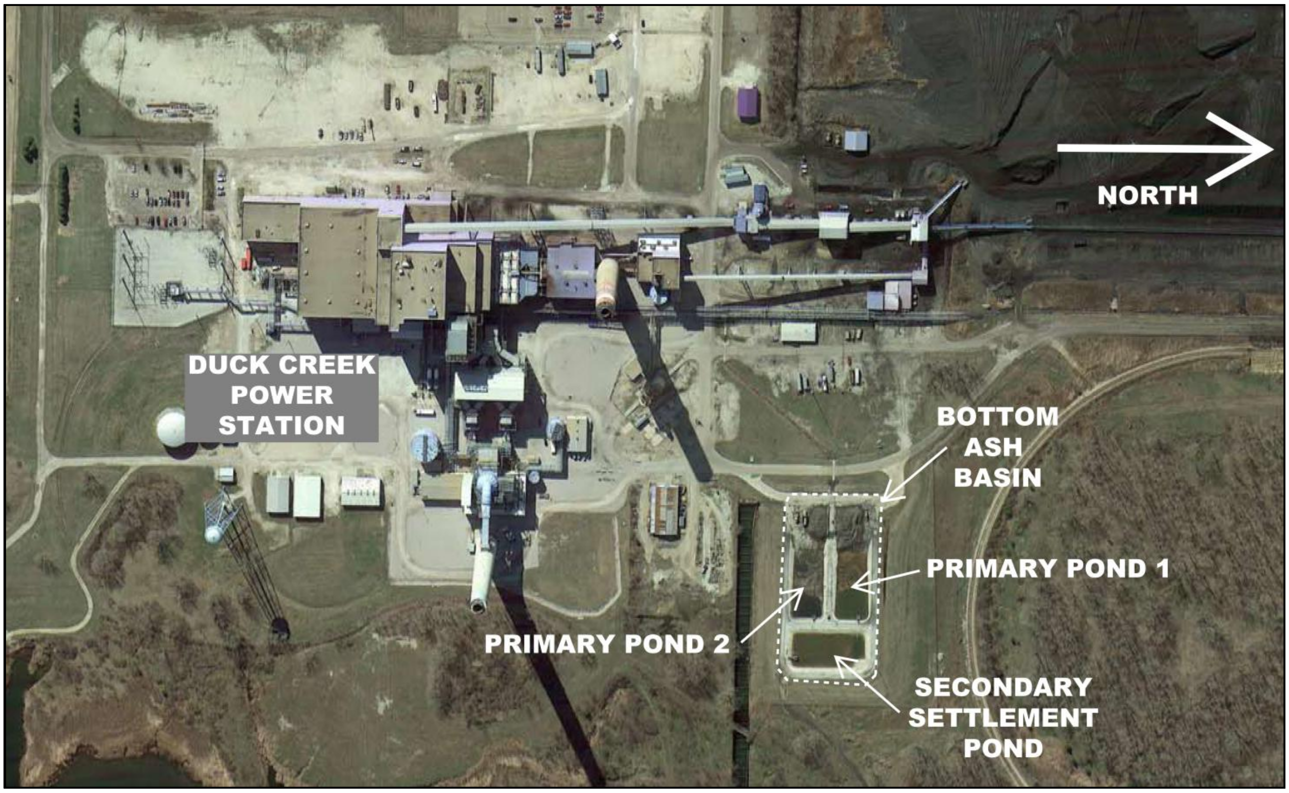


Figure 2B – Duck Creek Power Station Bottom Ash Basin Area Plan

(Imagery from Google Earth Pro, 2016)

3 Initial Structural Stability Assessment

40 CFR §257.73(d)(1)
The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein. The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with [the standards in (d)(1)(i)-(vii)].

According to §257.73(b), structural stability assessments are required for existing CCR surface impoundments that have a height of five feet or more. The requirements of §257.73(d) are not applicable to the incised Bottom Ash Basin at the Duck Creek Power Station because dikes are not present.

4 Initial Safety Factor Assessment

40 CFR §257.73(e)(1)
The owner or operator must conduct initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

According to §257.73(b), safety factor assessments are required for existing CCR surface impoundments that have a height of five feet or more. The requirements of §257.73(e) are not applicable to the incised Bottom Ash Basin at the Duck Creek Power Station because dikes are not present.

5 Initial Inflow Design Flood Control System Plan

40 CFR §257.82
(a) The owner or operator of an existing … CCR surface impoundment … must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.
(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.
(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.
(3) The inflow design flood is:
(i) For a high hazard potential CCR surface impoundment, …, the probable maximum flood;
(ii) For a significant hazard potential CCR surface impoundment, …, the 1,000-year flood;
(iii) For a low hazard potential CCR surface impoundment, …, the 100-year flood; or
(iv) For an incised CCR surface impoundment, the 25-year flood.
(b) Discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.

Analyses completed for the initial inflow design flood control system plan of the Bottom Ash Basin are described in the following subsections. Data and analysis results in the following subsection are based on spillway design information shown on design drawings, construction information, topographic surveys, information about operational and maintenance procedures provided by IPRG and field measurements collected by AECOM. The analysis approach and results of the hydrologic and hydraulic analyses are presented in the following subsections. A detailed presentation of the analyses performed can be found in **Appendix A**.

The Bottom Ash Basin is an “incised CCR surface impoundment” as defined by 40 CFR *§*257.53. Therefore, the inflow design flood (IDF) is the 25-year flood per *§*257.82(a)(3)(iv).

5.1 Initial Inflow Design Flood Control Systems (§257.82(a))

An initial inflow design flood control system plan, supported by a hydraulic and hydrologic analysis, was developed for the Bottom Ash Basin by evaluating the effects of a 24-hour duration design storm for the 25-year IDF using a hydraulic HydroCAD (Version 10) computer model and a starting water surface elevation of 577.3 feet in the Primary Pond 1 and 2 sub-basins and 573.5 feet in the Secondary Settlement Pond sub-basin. These starting water surface elevations are based on the characteristics of the outfall structures for each sub-basin, which, in their current configuration, would allow for normal pool elevations up to 577.3 feet in Primary Ponds 1 and 2 and 573.5 feet in the Secondary Settlement Pond when all stop logs are in place. The computer model evaluated the Bottom Ash Basin’s ability to collect and control the 25-year IDF under existing operational and maintenance procedures. Rainfall data for the 25-year IDF was obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14. The NOAA Atlas 14 rainfall depth is 5.25 inches.

The HydroCAD model results for the Bottom Ash Basin indicate that the CCR unit has sufficient storage capacity and spillway structures to adequately manage (1) flow into the CCR unit during and following the peak discharge of the 25-year IDF and (2) flow from the CCR unit to collect and control the peak discharge resulting from the 25-year IDF. The peak water surface elevation is 577.8 feet during the IDF in Primary Pond 1, 577.7 feet in Primary Pond 2, and 574.2 feet in the Secondary Settlement Pond. The minimum crest elevation is 579.0 feet for Primary Ponds 1 and 2 and 578.0 feet for the Secondary Settlement Pond. Therefore, overtopping is not expected.

Based on this evaluation, the Bottom Ash Basin meets the requirements in §257.82(a), and the hydrologic and hydraulic analysis is presented in **Appendix A**.

5.2 Discharge from the CCR Unit (§257.82(b))

40 CFR §257.82(b) provides that the discharge from the CCR unit must be handled in accordance with the surface water requirements under 40 CFR §257.3-3, which states the following:

> *(a) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act, as amended.*
>
> *(b) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.*
>
> *(c) A facility or practice shall not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or Statewide water quality management plan that has been approved by the Administrator under section 208 of the Clean Water Act, as amended.*
>
> *(d) Definitions of the terms Discharge of dredged material, Point source, Pollutant, Waters of the United States, and Wetlands can be found in the Clean Water Act, as amended, 33 U.S.C. 1251 et seq., and implementing regulations, specifically 33 CFR part 323 (42 FR 37122, July 19, 1977).*

The handling of discharge was evaluated by reviewing design drawings, operational and maintenance procedures, conditions observed in the field by AECOM, and the inflow design flood control system plan developed per §257.82(a).

Based on this evaluation, outflow from the Bottom Ash Basin is ultimately routed through a NPDES-permitted outfall into the Duck Creek Reservoir, via the discharge channel. Hydraulic and hydrologic analyses performed as part of the initial inflow design flood control system plan found the Bottom Ash Basin adequately manages outflow during the 25-year IDF, as overtopping of the Bottom Ash Basin is not expected.

Therefore, discharge in pollutants in violation of the NPDES permit is not expected as discharge s routed and controlled through the existing spillway system and NPDES permitted outfall during both normal and IDF conditions. Based on this evaluation, the Bottom Ash Basin meets the requirements in §257.82(b).

6 Conclusions

The Bottom Ash Basin at the Duck Creek Power Station is an incised CCR surface impoundment; therefore, it is not required to meet the structural stability assessment (§257.73(d)) and safety factor assessment (§257.73(e)) requirements of the CCR Rule. The Bottom Ash Basin was evaluated relative to the CCR Rule requirements for the initial inflow design flood control system plan (§257.82). Based on the evaluations presented herein, the initial inflow design flood control system plan requirements are satisfied.

7 References

AECOM (2016). *Hydrologic and Hydraulic Summary Report-Duck Creek Power Station, Bottom Ash Basin.* Canton, Illinois.

National Oceanic and Atmospheric Administration (NOAA) (2013) Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 13, http://hdsc.nws.noaa.gov/hdsc/pfds/index.html.

Sargent & Lundy (2009). *Bottom Ash and Low Volume Sump Water Basin* design drawings. May 8, 2009.

U.S. Environmental Protection Agency [USEPA]. (2015). *Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.* 40 CFR Part 257, Subpart D. 80 Fed. Reg. 21468 April 17, 2015.

8 Appendix

A. Hydrologic and Hydraulic Report

Appendix A. Hydrologic and Hydraulic Report

AECOM

AECOM
1001 Highlands Plaza Drive West
Suite 300
St. Louis, MO 63110-1337
www.aecom.com

314.429.0100 tel
314.429.0462 fax

October 7, 2016

Mr. Matt Ballance, PE
Senior Project Engineer
Dynegy Inc.
1500 Eastport Plaza Drive
Collinsville, IL 62234

RE: Hydrologic and Hydraulic Summary Report
Duck Creek Station
Bottom Ash Basin

Dear Mr. Ballance:

AECOM is pleased to provide this Summary Report of Hydrologic and Hydraulic Modeling for the Illinois Power Resources Generating, LLC (IPRG) Duck Creek Bottom Ash Basin Coal Combustion Residual (CCR) Unit. This analysis was performed to document that the facility meets the requirements of 40 CFR § 257.82(a) with regard to the Inflow Design Flood Control Plan. Based on AECOM's analysis, the Bottom Ash Basin meets all hydraulic requirements for certification per 40 CFR § 257.82(a).

AECOM looks forward to providing continued support to IPRG and working together on this important program. Please do not hesitate to call Ron Hager at 314-429-0100 (office) / 440-591-7868 (mobile), if you have any questions.

Sincerely,
AECOM

Brian Linnan, PE
Site Manager
brian.linnan@aecom.com

Ronald H. Hager

Ron Hager
Program Manager
ronald.hager@aecom.com

cc: Mark Rokoff, PE – AECOM

Attachments:

A. Location Plan
B. Hydrologic and Hydraulic Analysis

1. INTRODUCTION

1.1. *Purpose of this Memorandum*

This report presents the results of the hydrologic and hydraulic analysis prepared by AECOM for the Illinois Power Resources Generating, LLC (IPRG)[1] Bottom Ash Basin Coal Combustion Residual (CCR) unit at the Duck Creek Power Station, located southeast of Canton, Illinois in Fulton County (see Attachment A, Location Plan). This analysis was completed in accordance with the Environmental Protection Agency (EPA) 40 CFR Part §257, Subpart D, regulations for the disposal of CCR. As required by §257.82(a), by October 17, 2016 owners and operators of existing CCR surface impoundments must develop an Inflow Design Flood Control Plan that documents how the inflow design flood control system had been designed and constructed to meet the following requirements:

- *40 CFR 257.82 (a)(1)* - The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood.
- *40 CFR 257.82 (a)(2)* - The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood.

The Duck Creek Station Bottom Ash Basin is an “incised CCR surface impoundment” as defined in 40 CFR §257.53. In accordance with §257.82(a)(3)(iv), the inflow design flood for an incised CCR surface impoundment is the 25-year storm event. This event is the basis for AECOM certification.

1.2. *Brief Description of Impoundments*

The Duck Creek Power Station is located southeast of Canton in Fulton County, Illinois (see Attachment A, Location Plan). The Bottom Ash Basin is located directly northeast of the generating station, as shown on the Location Plan. Design drawings for the Bottom Ash Basin were prepared by Sargent and Lundy and are dated 2009. The Bottom Ash Basin is comprised of several internal sub-basins, which are Primary Pond 1, Primary Pond 2, and Secondary Settlement Pond. The two Primary Ponds are essentially identical. They are each approximately 0.73 acres in size and each discharges outflow over a weir into a stop-log structure and through a 12-inch corrugated high-density polyethylene (HDPE) transfer pipe into the approximately 0.48-acre Secondary Settlement Pond.

The Secondary Settlement Pond discharges through a stop-log structure to the discharge channel through a 105-foot long, 12-inch diameter HDPE pipe. The top of the stop-log weir is at elevation 573.5 feet (all elevations in this report are listed in the NAVD 88 datum unless otherwise noted). The 12-inch HDPE pipe has an invert elevation of 569.5 feet at the upstream end and an invert elevation of 568.0 feet at the outfall. The discharge channel also collects stormwater runoff from a stormwater

[1] Although the Duck Creek Power Station and Bottom Ash Basin are owned and operated by IPRG, Dynegy Administrative Services Company (*Dynegy*) contracted AECOM to develop this Hydrologic and Hydraulic Summary Report on behalf of IPRG). Therefore, “Dynegy” is referenced in materials attached to this hydraulic and hydrologic report.

channel that discharges into storm sewer pipe system that runs along the north and east side of the Bottom Ash Basin. The stormwater channel is incised below natural ground elevation.

The Primary Ponds are each operated for a week at a time, with ash being deposited and dewatered in one pond while in the other pond the dewatered ash is being removed. The normal water elevation in the discharge channel is 1.5 feet lower than the Secondary Settlement Pond outfall. AECOM assumed the water level in the discharge channel stays below the Secondary Settlement Pond outfall invert elevation during and after the design storm and that the discharge channel has free discharge to Duck Creek Reservoir.

2. POND CAPACITY / IMPOUNDMENT COMPUTATIONS

The elevation/areas for the hydraulic modeling of the Bottom Ash Basin Primary Ponds 1 and 2 and Secondary Settlement Pond were evaluated using the design documents provided by IPRG including plans and details (Sargent and Lundy, 2009). Detailed pond storage and discharge infrastructure data are provided in Attachment B. The normal operational pool water surface elevation at the beginning of the design storm was determined for the Bottom Ash Basin based on running a “sunny day” analysis, assuming plant process flow into the Bottom Ash Basin and assuming that all stop logs are in place on the outfall structures. This is intended to represent conditions where Primary Ponds 1 and 2 are filled to the maximum operating level with either CCR material or free water. Aerial photography was also examined for the site to estimate approximate volumes of CCR placed above the maximum operating level, and these volumes were accounted for in the capacity calculations for the Bottom Ash Basin.

The Bottom Ash Basin was analyzed to determine whether the sub-basins overtop and run into the run-on diversion channel during operations and the design storm.

The stormwater channel and storm sewer pipe system north and east of the Bottom Ash Basin was analyzed to evaluate the potential for run-on into the Bottom Ash Basin from this system and surrounding areas during the Inflow Design Flood.

3. HYDROLOGIC AND HYDRAULIC ANALYSIS

3.1. ***Rainfall Data***

The rainfall information used in the HydroCAD modeling was based on the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 2, Version 3 (Reference 2) which provides rainfall data for storm events with average recurrence intervals ranging from 1 to 1,000 years and durations ranging from 5 minutes to 60 days. The design storm rainfall depth, obtained from the NOAA website, is 5.25 in for the 24-hour, 25-year storm. The Soil Conservation Service (SCS) Type II storm used by AECOM is appropriate to use for storms up to the 1,000-year flood at the project site.

3.2. ***Runoff Computations***

The HydroCAD Version 10.0 computer model, by HydroCAD Software Solutions, LLC, was used to model the Duck Creek Bottom Ash Basin collection and control system, for the runoff calculations, and storage and discharge structure evaluations. The model evaluated pond capacities, hydraulics of the sub-basins considering details of the between-pond discharge structures, and the final outlet structure during peak discharges.

During normal operations, the water level in each of the sub-basins is controlled by the stop-log outlet structure in each sub-basin. The beginning water elevations in each pond would be at the lowest elevation if no stop-logs are in place and the highest elevations if all of the stop-logs are in place. The starting water surface elevation (WSE) in Primary Ponds 1 and 2 is based on the top of stop-logs elevation of 577.3 feet and the starting WSE in the Secondary Settlement Pond is based on the top of stop-log structure elevation of 573.5 feet. The flow from the plant, as provided by IPRG, was assumed to be approximately 1.37 cubic feet per second discharging to one of the Primary Ponds at a time. After setting the starting WSE for each sub-basin, the model determines the final WSE in all of the sub-basins based on the constant base flow and the 25-year, 24-hour design flood event.

Please refer to Attachment B.2 for further details and modeling results.

3.3. ***Hydraulics***

HydroCAD does not calculate the minor losses through a pipe network, so in order to determine the capacity of the storm sewer pipe system that collects flow from the stormwater channel and runs along the north and east side of the Bottom Ash Basin, it was modeled with AutoCAD Civil 3D Hydraflow Storm Sewers extension (Hydraflow). AECOM used Hydraflow to model the pipe system based on design drawings provided by IPRG. Hydraflow takes into account all of the minor head losses throughout the system due to friction, junctions, and angle changes. A rating curve was developed for the pipe system by inputting known inflows for several different storms ranging from the 1-year recurrence interval to the 50-year recurrence interval. For each known inflow, Hydraflow would calculate the necessary headwater elevation at the inlet. Using this information, a rating curve was constructed and input into the HydroCAD model to accurately account for minor losses throughout the system.

Please refer to Attachment B.3 for Run-on Drainage Basins and Attachment B.4 for Civil 3D Hydraflow Storm Sewers Output.

4. CONCLUSIONS

The inflow design flood control system of the Duck Creek Bottom Ash Basin adequately manages flow into and out of the unit during and following the peak discharge of the 25-year storm event inflow design flood while flow from the plant is discharging 1.37 cfs into Primary Pond 1. Results of the model are summarized in Table 4.1.

Table 4.1
Duck Creek Summary of Hydrologic and Hydraulic Analysis, 25-Year, 24-Hour Storm

CCR Unit Sub-basin	Beginning WSE[1] (ft)	Peak WSE (ft)	Crest Elevation (ft)
Primary Pond 1	577.3	577.8	579.0
Primary Pond 2	577.3	577.7	579.0
Secondary Settlement Pond	573.5	574.2	578.0

- There is no anticipated overtopping of the Bottom Ash Basin crest during the inflow design flood.
- Run-on from the surrounding areas does not flow into the Bottom Ash Basin during the inflow design flood.
- The Bottom Ash Basin meets the hydraulic requirements for certification.

5. LIMITATIONS

Background information, design basis, and other data, which AECOM has used in preparing this report, have been furnished to AECOM by IPRG. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

The conclusions presented in this report are intended only for the purpose, site location, and project indicated. The recommendations presented in this report should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by IPRG. Changes in any of these operations or procedures may invalidate the findings in this report until AECOM has had the opportunity to review the changes, and revise the report if necessary.

This hydrologic and hydraulic analysis was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the engineering profession. The conclusions presented in this report are professional opinions based on the indicated project criteria and data available at the time this report was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

6. REFERENCES

Design Drawings, Sargent & Lundy, Inc. (May 8, 2009) – "Bottom Ash and Low Volume Sump Water Basin."

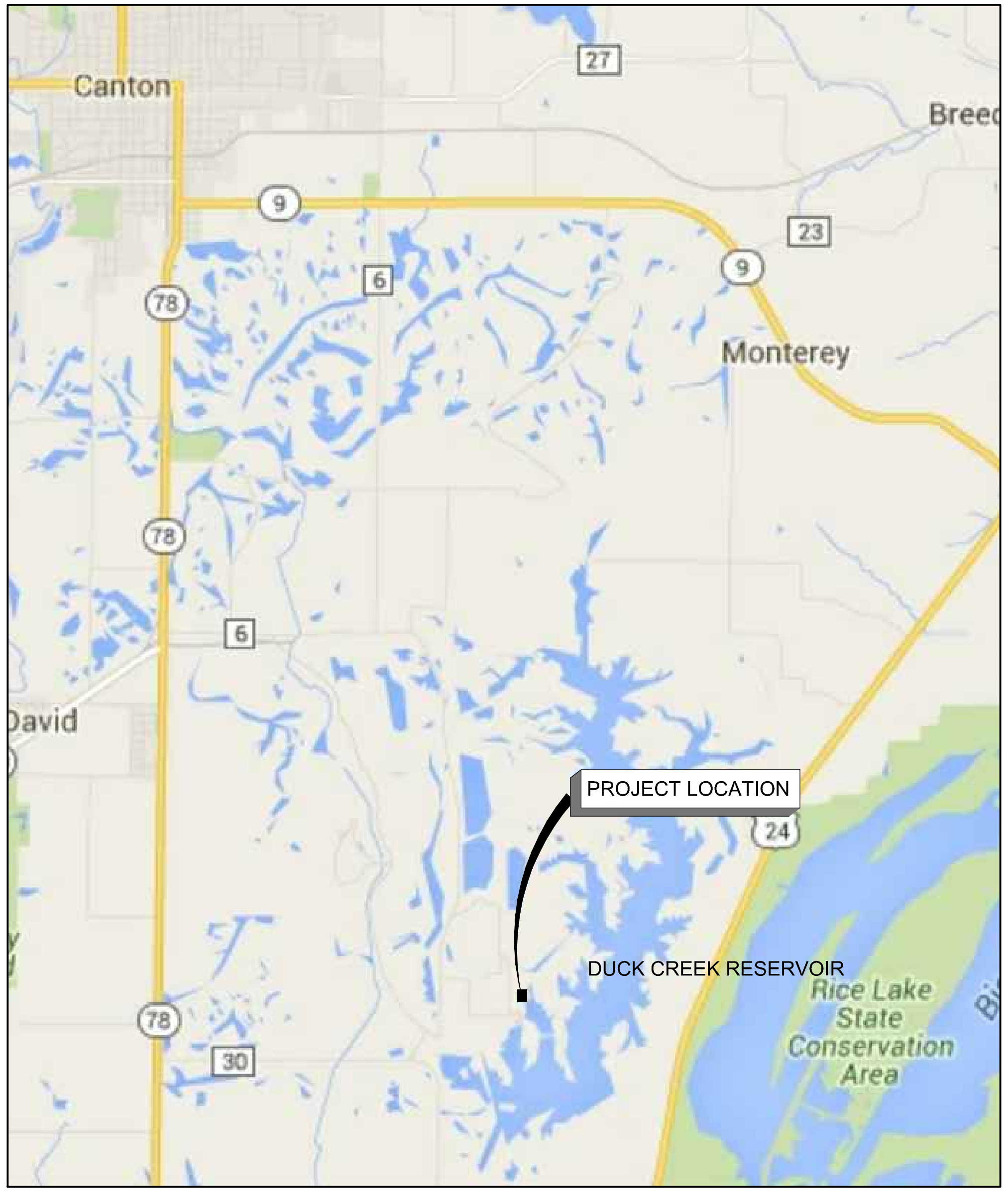
National Oceanic and Atmospheric Administration (NOAA) (2013) Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 13, http://hdsc.nws.noaa.gov/hdsc/pfds/index.html.

Attachment A

Location Plan

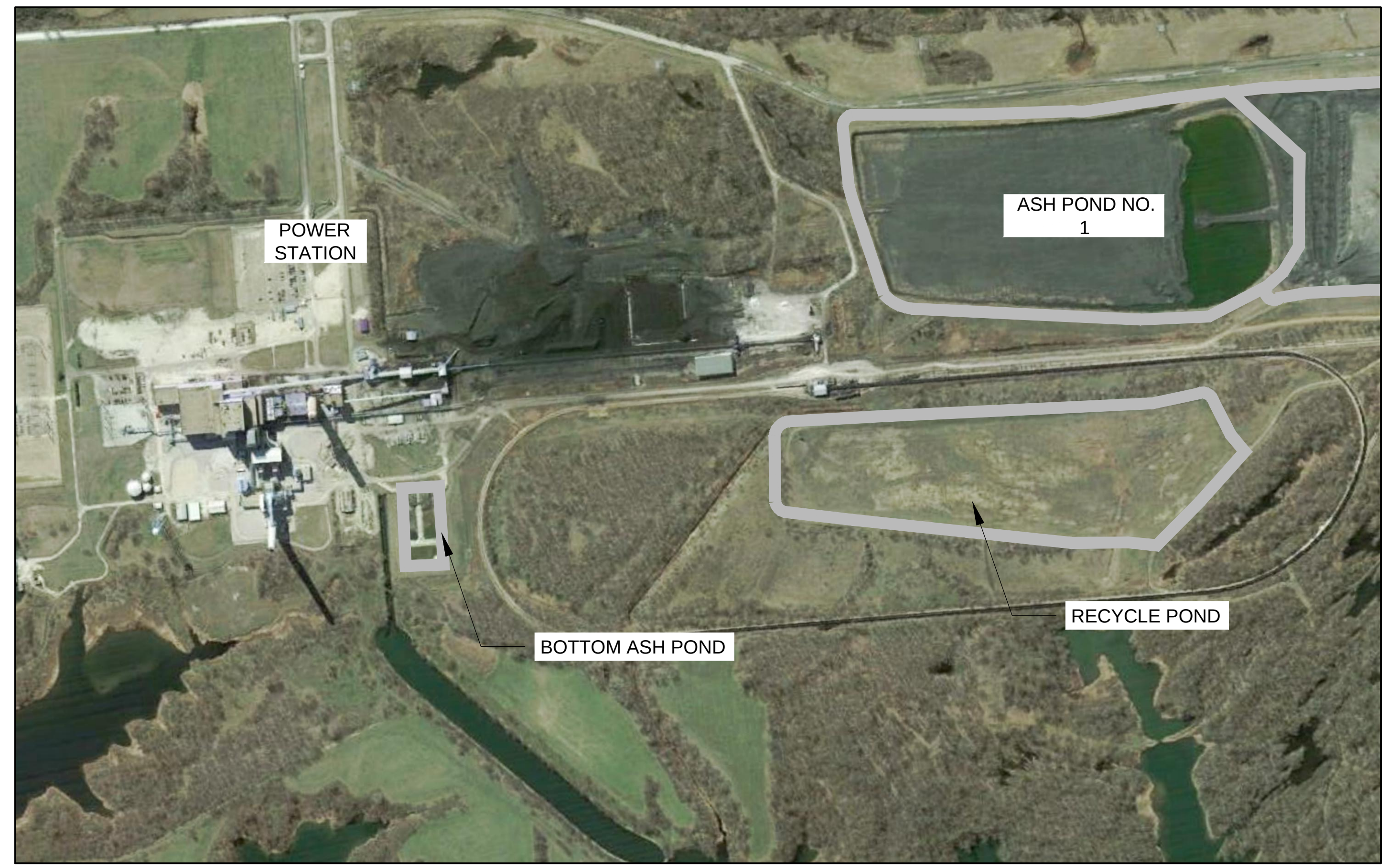
STUCKER, SARAH, 4/12/2016 11:28 AM

AECOM DRAWING PATH: J:\Dynegy Duck Creek Station CCR Designation\CAD\Plan Sheets\FIG\Location Map and Vicinity Map Figure 1.dwg



LOCATION MAP

NOT TO SCALE



VICINITY MAP

1" = 1000'

AECOM

8300 College Boulevard, Suite 200
Overland Park, Kansas 66210
913-344-1000 (phone)
913-344-1011 (fax)

DYNEGY

Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

CCR RULE ASSESSMENT OF PLANTS

DUCK CREEK POWER PLANT
FULTON COUNTY, IL

GEOTECHNICAL REPORT

ISSUED FOR BIDDING	DATE	BY
ISSUED FOR CONSTRUCTION	DATE	BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

AECOM PROJECT NO:	60439301
DRAWN BY:	SMS
DESIGNED BY:	WDS
CHECKED BY:	BDL
DATE CREATED:	2016-02-22
PLOT DATE:	2016-02-22
SCALE:	
ACAD VER:	2014

SHEET TITLE

LOCATION MAP &
SITE VICINITY MAP

FIGURE 1

Attachment B

Hydrologic and Hydraulic Analysis

Objective: **This analysis describes the independent investigation and design calculations and considerations of the on-site hydrology and hydraulics for certification of the Bottom Ash Basin CCR Unit, as required by the Environmental Protection Agency's (EPA's) Final Coal Combustion Residuals (CCR) Rule. In particular, the analysis investigates the performance of the existing impoundments, spillways, and outlet structures for the Bottom Ash Basin during the 25-Yr, 24- hr storm event, as required by the aforementioned CCR rule. AECOM investigated the Bottom Ash Basin CCR Unit as it relates to concerns about stormwater overtopping the perimeter berm during the design storm event while the Duck Creek Plant is discharging to the Bottom Ash Basin.**

I. Overview

The Bottom Ash Basin is an incised CCR surface impoundment as defined by 40 CFR §257.53. Per 40 CFR §257.82(a)(3)(iv), the inflow design flood is the 25-year flood. The rainfall depth for the 25-yr, 24-hr storm event for the site is 5.25 in as determined from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 2, Version 3. (See Point Precipitation Frequency Estimates for Canton, Illinois in Attachment B.1.) The SCS Type II storm distribution was used. Maximum plant inflow of 1.37 cfs was used, as determined from the Site Water Balance Diagram, provided by Dynegy. The HydroCAD model was used to simulate the pond system.

II. Selected Methods:

- HydroCAD 10.0-12 was used to model the routing, storage, and conveyance of stormwater and process water through the impoundments and discharge structures and into the discharge channel.
- Within the HydroCAD program, runoff was calculated using the SCS TR-20 method and the routing was completed using the Dynamic Simultaneous Reach Routing method, where the stage-discharge and storage-indication curves are re-evaluated at each time step, based on the current elevation of any downstream nodes. This allows the routing to respond to ongoing tailwater changes, rather than assuming static tailwater conditions. This results in a more accurate representation of controls on the system throughout a flood event.
- AutoCAD Civil 3D Hydraflow Storm Sewers Extension was used to construct a rating curve for the storm sewer pipe system north and east of the Bottom Ash Basin, as this system is used to collect stormwater adjacent to the Bottom Ash Basin, and therefore the capacity of this system needs to considered for evaluating potential run-on into the Bottom Ash Basin. This rating curve was then input into AECOM's HydroCAD model to accurately account for minor head losses throughout the system.

III. Design Criteria:

- Certification criteria are based on whether the Bottom Ash Basin CCR Unit can pass the 24-hour, 25-year storm event without overtopping the impoundment crest.

IV. Data & Assumptions:

The following is a list of assumptions and determining factors used for the HydroCAD modeling effort:

- The two Primary Ponds receive the bottom ash (alternately) and act to settle the bottom ash. One pond is cleaned out while the other is operated.
- The Secondary Settlement Pond (Secondary Pond) accepts outflow from the Primary Ponds. The water discharges from the Secondary Pond after passing over the weir in the stop-log structure. It flows to the discharge channel through a 12-inch HDPE pipe.
- The configurations of the three sub-basins that make up the Duck Creek Bottom Ash Basin CCR Unit, such as crest elevations, control structure dimensions and inverts, and other relevant hydraulic controls were obtained from historic documents including design drawings.
- Perimeter channels run along the east and north sides of the Bottom Ash Basin and into an underground storm sewer pipe system. Both the channels and pipe system were assumed to be constructed as shown in the design drawings provided by Dynegy.
- The maximum base flow of 1.37 cfs of bottom ash/slurry water was provided by Dynegy and input into the model for flow into the Primary Ponds (one at a time, per the operating plan).

V. Hydrology

The following chart shows the rainfall depth and duration for the storm modeled, in addition to the rainfall intensity distribution applied to the storm event. The source of the design storm data is included in Attachment B.1.

Storm Event	Rainfall Depth (Inches)	Duration (Hours)	Rainfall Distribution
25-Year	5.25	24	SCS Type II

VI. Hydraulics Calculations

All hydraulic modeling was done using HydroCAD hydraulic Modeling Software and AutoCAD Civil 3D Hydraflow Storm Sewers Extension. The information included in the model was provided by Dynegy. Storage areas were based on the plan drawing of the ponds. Inverts, widths, heights, and other details for inlet and outlet structures were taken from design drawings. The following information formed the basis for the HydroCAD calculations:

Primary Pond 1 and Primary Pond 2

- The Primary Ponds are identical
- The Primary Ponds discharge water over stop-log structures into transfer pipes which flow into the Secondary Pond.
- The only inflow into the Primary Ponds is the rainfall that falls directly into them and the maximum plant flow, which is assumed to be entering Primary Pond 1.
- The Primary Ponds were modeled to account for approximate limits of ash shown in aerial photography.
- Each Primary Pond has an area of approximately 0.73 acres.
- The two Primary Ponds discharge through stop-log structures with the top weir assumed to be at elevation 577.33. The width of the weirs is 5 ft according to the detail drawing provided by

Dynegy. The water flows into the Secondary Pond through 12-in CHDPE pipes which leave the stop-log structures at elevation 574.0 and discharge into the Secondary Pond at elevation 573.5. The discharge pipes are defined as "CHDPE." We assume they are corrugated on the inside. The length and slope of the discharge pipes varies, depending on which Primary Pond they exit from. During the design storm event, there may be tailwater at the outfalls of the discharge pipes.

Secondary Settlement Pond

- The only inflow into the Secondary Pond comes from the Primary Ponds and the rainfall that falls directly into it. It has an area of 0.48 acres.
- The Secondary Pond was modeled as though no bottom ash is in the pond above the permanent pool elevation which appears to be accurate, based on review of a site aerial photo.
- Discharge from the Secondary Pond is through the stop-log structure.
- The top weir is assumed to be at elevation 573.5. The weir is 5 ft wide. The discharge pipe is a 105-ft long CHDPE pipe sloped at 1.43%.
- Normal water elevation in the discharge channel is 566.5 via a 12-inch HDPE pipe. It was assumed that the discharge channel has free discharge to Duck Creek Reservoir and that this water elevation does not rise as much as 1.5 ft during the design storm. Therefore, there is no tailwater on the outfall pipe coming from the Secondary Pond.

Off-Site Flow to Perimeter Channels and Storm Sewer Pipes

- Perimeter channels constructed per design drawings with 3 ft bottom width and 3:1 (H:V) sideslopes.
- Storm sewer pipe system consists of a 24-in CMP and an 18-in CMP discharging into a 24-in CMP pipe system that outlets into the discharge channel.
- Minor head losses due to friction, junctions, and angle changes were modeled in AutoCAD Civil 3D Hydraflow Storm Sewers Extension.

VII. Results

HydroCAD H&H Model Output

Table 2 below summarizes the results of the AECOM HydroCAD model for the Bottom Ash Basin CCR Unit. The associated detailed HydroCAD output reports are included in Attachment B.2.

Table 2 – 25-Year, 24-Hour Design Flood Pond Responses

Storage Area	Q_{peak} in (cfs)	Qpeak out (cfs)	Max WSE[2] (ft)	Primary Spillway Elevation (ft)	Top of Crest Elevation (ft)
Primary Pond 1	6.95	4.72	577.8	577.3	579.0
Primary Pond 2	5.58	2.93	577.7	577.3	579.0
Secondary Pond	10.43	4.73	574.2	573.5	578.0

[1]The storage is the volume of water stored in the area upstream of the outlet structure.
[2]WSE = Water Surface Elevation.

Conclusions

The following conclusions are based on the HydroCAD model of the Bottom Ash Basin CCR Unit.

- Run-on does not cause backup of the storm sewer piping system or overtopping of the run-on channels into the Bottom Ash Basin.
- There is no anticipated overtopping of the CCR Unit Bottom Ash Basin during the design flood.
- The Bottom Ash Basin meets the hydraulic requirements for certification.

Attachment B.1

NOAA – Canton, Illinois
Point Precipitation Frequency Estimates

NOAA Atlas 14, Volume 2, Version 3
Location name: Canton, Illinois, US*
Latitude: 40.5044°, Longitude: -89.9888°
Elevation: 619 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.413** (0.378–0.453)	**0.493** (0.451–0.541)	**0.588** (0.537–0.645)	**0.662** (0.603–0.725)	**0.756** (0.686–0.827)	**0.828** (0.749–0.906)	**0.899** (0.809–0.984)	**0.973** (0.870–1.07)	**1.07** (0.950–1.18)	**1.15** (1.01–1.2
10-min	**0.642** (0.587–0.704)	**0.770** (0.704–0.845)	**0.914** (0.835–1.00)	**1.02** (0.932–1.12)	**1.16** (1.05–1.26)	**1.26** (1.14–1.37)	**1.35** (1.22–1.48)	**1.45** (1.30–1.59)	**1.58** (1.40–1.73)	**1.67** (1.47–1.8
15-min	**0.787** (0.720–0.863)	**0.942** (0.861–1.03)	**1.12** (1.03–1.23)	**1.26** (1.15–1.38)	**1.43** (1.30–1.56)	**1.55** (1.41–1.70)	**1.68** (1.51–1.84)	**1.81** (1.62–1.98)	**1.97** (1.74–2.16)	**2.09** (1.84–2.3
30-min	**1.04** (0.952–1.14)	**1.26** (1.15–1.38)	**1.54** (1.40–1.69)	**1.75** (1.59–1.91)	**2.02** (1.83–2.21)	**2.22** (2.01–2.43)	**2.43** (2.18–2.66)	**2.64** (2.36–2.89)	**2.91** (2.58–3.20)	**3.13** (2.75–3.4
60-min	**1.27** (1.16–1.39)	**1.55** (1.41–1.70)	**1.93** (1.76–2.11)	**2.22** (2.03–2.43)	**2.62** (2.37–2.86)	**2.93** (2.65–3.20)	**3.25** (2.92–3.55)	**3.58** (3.20–3.92)	**4.03** (3.57–4.42)	**4.39** (3.87–4.8
2-hr	**1.48** (1.35–1.62)	**1.80** (1.65–1.98)	**2.26** (2.07–2.48)	**2.63** (2.39–2.88)	**3.13** (2.83–3.42)	**3.52** (3.18–3.85)	**3.93** (3.53–4.30)	**4.37** (3.90–4.78)	**4.97** (4.39–5.44)	**5.46** (4.78–5.9
3-hr	**1.59** (1.46–1.74)	**1.93** (1.77–2.12)	**2.44** (2.24–2.68)	**2.84** (2.59–3.11)	**3.40** (3.08–3.71)	**3.85** (3.48–4.20)	**4.32** (3.88–4.71)	**4.82** (4.30–5.26)	**5.53** (4.87–6.03)	**6.11** (5.34–6.6
6-hr	**1.88** (1.73–2.06)	**2.29** (2.10–2.50)	**2.88** (2.65–3.15)	**3.36** (3.07–3.67)	**4.02** (3.66–4.38)	**4.55** (4.12–4.95)	**5.12** (4.61–5.57)	**5.72** (5.10–6.22)	**6.57** (5.79–7.16)	**7.27** (6.34–7.9
12-hr	**2.18** (2.01–2.37)	**2.64** (2.43–2.88)	**3.31** (3.05–3.60)	**3.84** (3.52–4.17)	**4.56** (4.17–4.95)	**5.15** (4.68–5.59)	**5.77** (5.21–6.25)	**6.42** (5.75–6.96)	**7.33** (6.50–7.96)	**8.08** (7.10–8.8
24-hr	**2.49** (2.31–2.69)	**3.01** (2.79–3.26)	**3.78** (3.51–4.10)	**4.40** (4.07–4.76)	**5.25** (4.84–5.69)	**5.94** (5.47–6.43)	**6.67** (6.10–7.21)	**7.43** (6.76–8.04)	**8.50** (7.68–9.20)	**9.37** (8.42–10
2-day	**2.91** (2.71–3.12)	**3.51** (3.27–3.77)	**4.38** (4.08–4.70)	**5.06** (4.70–5.43)	**5.99** (5.55–6.43)	**6.74** (6.22–7.23)	**7.51** (6.90–8.07)	**8.31** (7.61–8.95)	**9.43** (8.57–10.2)	**10.3** (9.33–11
3-day	**3.09** (2.88–3.31)	**3.72** (3.48–4.00)	**4.63** (4.32–4.97)	**5.34** (4.97–5.73)	**6.30** (5.85–6.76)	**7.06** (6.54–7.58)	**7.85** (7.23–8.43)	**8.66** (7.95–9.31)	**9.77** (8.91–10.5)	**10.7** (9.67–11
4-day	**3.27** (3.05–3.50)	**3.94** (3.68–4.23)	**4.89** (4.56–5.25)	**5.62** (5.24–6.03)	**6.61** (6.14–7.09)	**7.39** (6.85–7.93)	**8.19** (7.56–8.79)	**9.00** (8.29–9.67)	**10.1** (9.26–10.9)	**11.0** (10.0–11
7-day	**3.82** (3.58–4.07)	**4.58** (4.30–4.90)	**5.62** (5.27–6.00)	**6.40** (6.00–6.84)	**7.44** (6.95–7.95)	**8.24** (7.68–8.81)	**9.05** (8.41–9.69)	**9.87** (9.14–10.6)	**11.0** (10.1–11.8)	**11.8** (10.8–12
10-day	**4.35** (4.08–4.63)	**5.21** (4.89–5.56)	**6.34** (5.95–6.76)	**7.18** (6.72–7.65)	**8.28** (7.74–8.84)	**9.13** (8.52–9.75)	**9.98** (9.28–10.7)	**10.8** (10.0–11.6)	**11.9** (11.0–12.8)	**12.8** (11.8–13
20-day	**5.94** (5.57–6.34)	**7.11** (6.68–7.59)	**8.57** (8.05–9.15)	**9.64** (9.04–10.3)	**11.0** (10.3–11.8)	**12.1** (11.3–12.9)	**13.1** (12.2–14.0)	**14.1** (13.1–15.1)	**15.4** (14.3–16.5)	**16.4** (15.2–17
30-day	**7.36** (6.92–7.82)	**8.78** (8.27–9.33)	**10.5** (9.87–11.1)	**11.7** (11.0–12.4)	**13.3** (12.4–14.1)	**14.4** (13.5–15.3)	**15.5** (14.5–16.5)	**16.6** (15.5–17.7)	**18.0** (16.8–19.3)	**19.1** (17.7–20
45-day	**9.27** (8.74–9.82)	**11.0** (10.4–11.7)	**13.1** (12.3–13.8)	**14.5** (13.7–15.3)	**16.3** (15.3–17.2)	**17.6** (16.5–18.6)	**18.9** (17.7–20.0)	**20.1** (18.8–21.3)	**21.6** (20.2–23.0)	**22.8** (21.3–24
60-day	**11.1** (10.5–11.8)	**13.2** (12.5–14.0)	**15.5** (14.6–16.4)	**17.2** (16.2–18.2)	**19.2** (18.1–20.3)	**20.7** (19.4–21.9)	**22.1** (20.7–23.4)	**23.4** (22.0–24.9)	**25.1** (23.5–26.7)	**26.4** (24.7–28

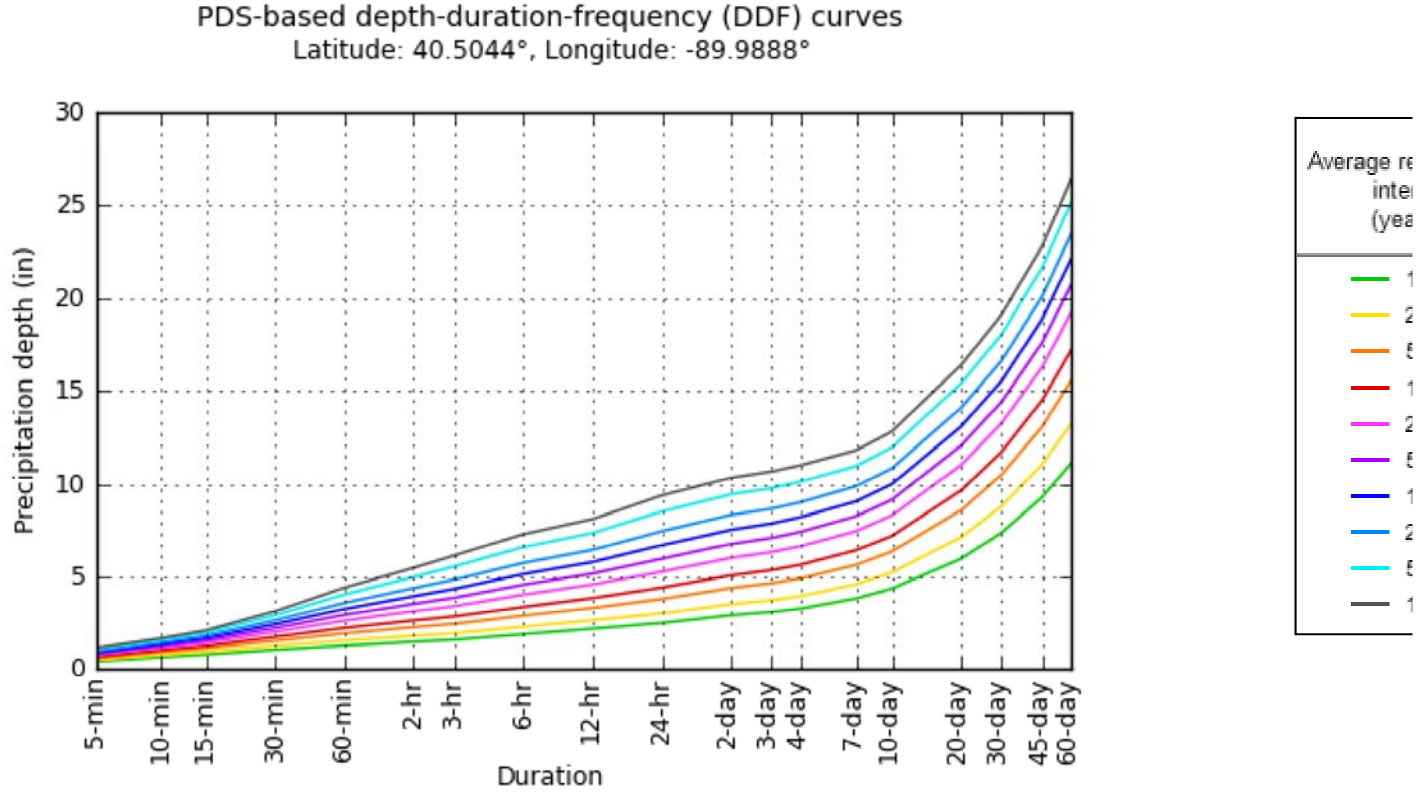
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

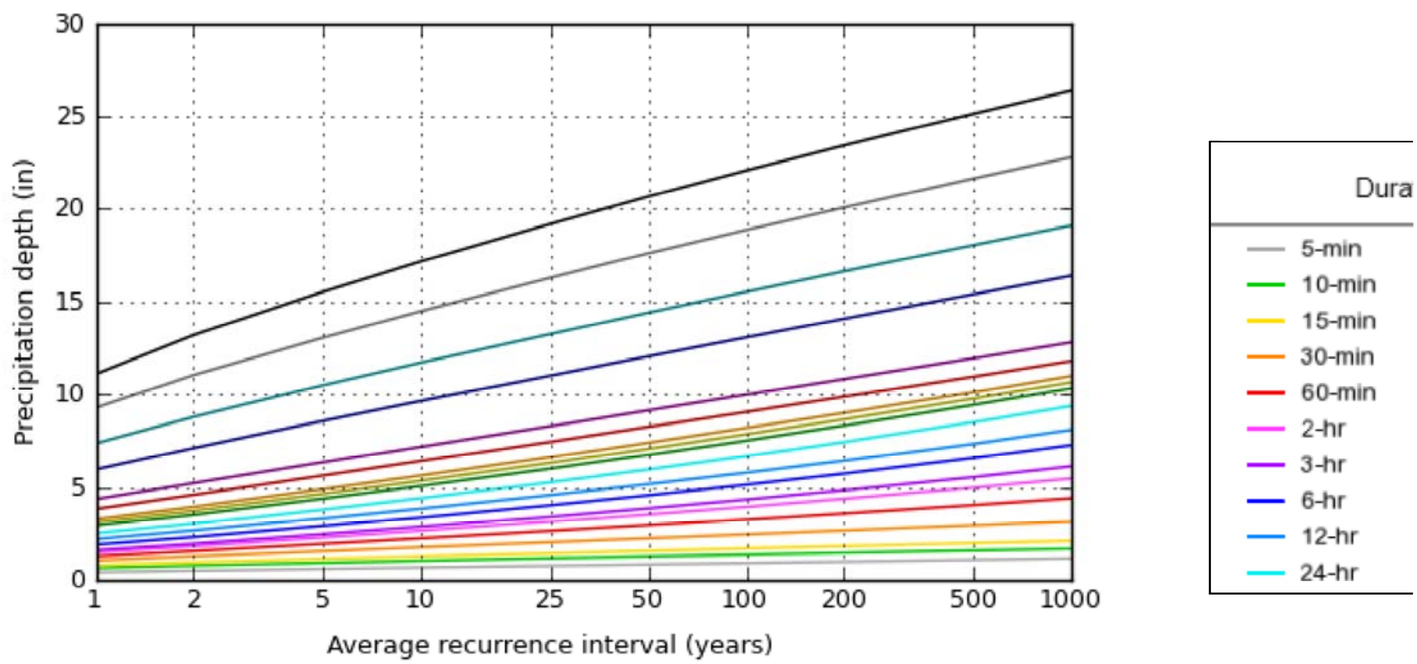
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

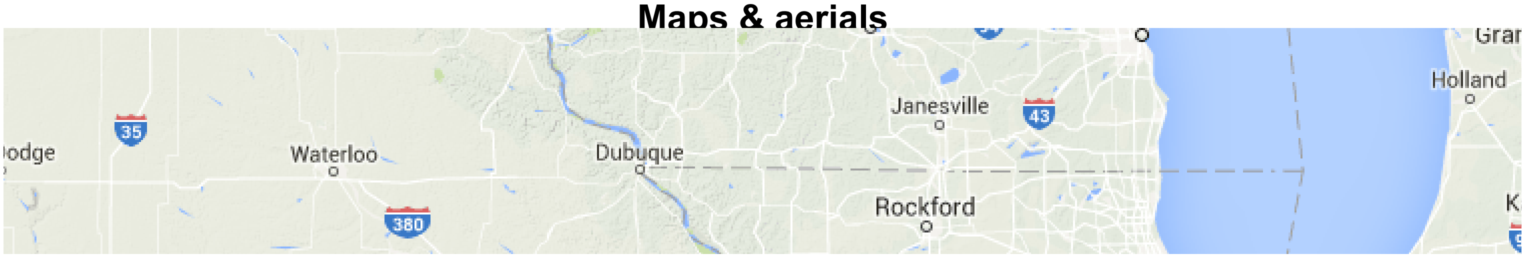


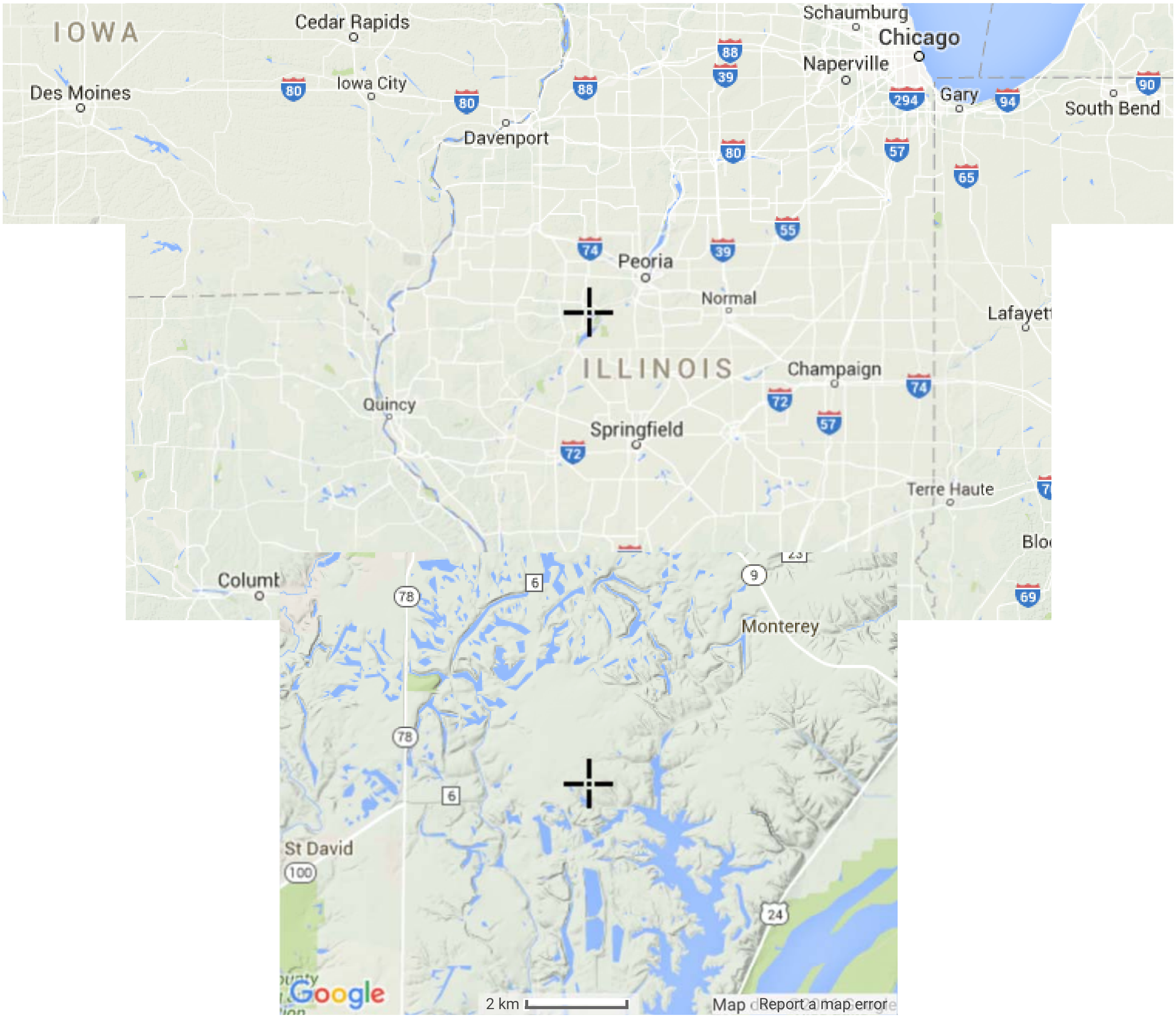


NOAA Atlas 14, Volume 2, Version 3 Created (GMT): Mon Feb 29 19:23:03 2016

Back to Top

Maps & aerials





Large scale map

Large scale aerial

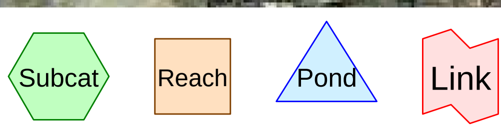
Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Attachment B.2

HydroCAD Model Output



Drainage Diagram for Dynegy Duck Creek Bottom Ash CCR Ponds2B
Prepared by AECOM, Printed 3/30/2016
HydroCAD® 8.50 s/n 000800 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.600	65	Woods/grass comb., Fair, HSG B (7S)
3.200	69	Pasture/grassland/range, Fair, HSG B (8S)
0.725	98	Top of Berm Primary Pond 1 (4S)
0.725	98	Top of Berm Primary Pond 2 (5S)
0.482	98	Top of Berm Secondary Pond (6S)
11.732		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points x 3
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 4S: Primary Pond 1 Runoff Area=0.725 ac 100.00% Impervious Runoff Depth=5.01"
Tc=5.0 min CN=98 Runoff=5.59 cfs 0.303 af

Subcatchment 5S: Primary Pond 2 Runoff Area=0.725 ac 100.00% Impervious Runoff Depth=5.01"
Tc=5.0 min CN=98 Runoff=5.59 cfs 0.303 af

Subcatchment 6S: Secondary Pond Runoff Area=0.482 ac 100.00% Impervious Runoff Depth=5.01"
Tc=5.0 min CN=98 Runoff=3.72 cfs 0.201 af

Subcatchment 7S: 24" CMP Catchment Runoff Area=6.600 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=1,100' Slope=0.0100 '/' Tc=28.4 min CN=65 Runoff=10.24 cfs 1.002 af

Subcatchment 8S: 18" CMP Catchment Runoff Area=3.200 ac 0.00% Impervious Runoff Depth=2.14"
Flow Length=1,000' Slope=0.0100 '/' Tc=34.8 min CN=69 Runoff=5.22 cfs 0.571 af

Reach 6R: South ditch Avg. Depth=0.98' Max Vel=2.63 fps Inflow=15.26 cfs 1.573 af
n=0.022 L=50.0' S=0.0028 '/' Capacity=70.63 cfs Outflow=15.25 cfs 1.573 af

Pond 1P: Primary Pond 1 Peak Elev=577.76' Storage=0.112 af Inflow=6.96 cfs 3.701 af
Outflow=4.65 cfs 3.701 af

Pond 2P: Primary Pond 2 Peak Elev=577.65' Storage=0.081 af Inflow=5.59 cfs 0.303 af
Outflow=2.93 cfs 0.302 af

Pond 3P: Secondary Ash Settlement Pond Peak Elev=574.22' Storage=0.222 af Inflow=10.50 cfs 4.205 af
Outflow=4.72 cfs 4.148 af

Pond 4P: North perimeter stormwater pond Peak Elev=575.43' Storage=881 cf Inflow=10.24 cfs 1.002 af
Outflow=10.09 cfs 1.002 af

Pond 5P: Discharge Channel Peak Elev=566.84' Storage=0.143 af Inflow=19.97 cfs 5.721 af
Outflow=19.14 cfs 5.712 af

Pond 6P: 18" CMP Peak Elev=580.32' Inflow=5.22 cfs 0.571 af
Outflow=5.22 cfs 0.571 af

Total Runoff Area = 11.732 ac Runoff Volume = 2.380 af Average Runoff Depth = 2.43"
83.53% Pervious = 9.800 ac 16.47% Impervious = 1.932 ac

Summary for Subcatchment 4S: Primary Pond 1 Catchment

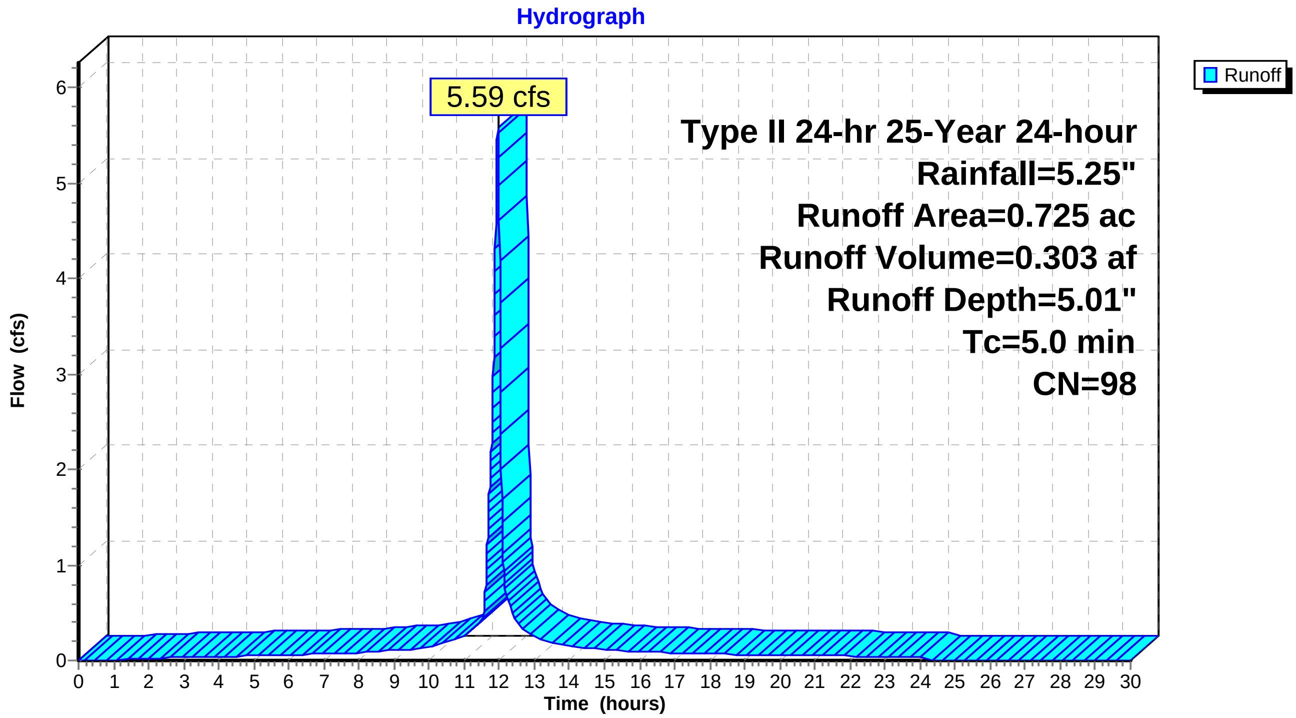
Runoff = 5.59 cfs @ 11.96 hrs, Volume= 0.303 af, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year 24-hour Rainfall=5.25"

	Area (ac)	CN	Description
*	0.725	98	Top of Berm Primary Pond 1
	0.725		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Rainfall onto Primary Pond 1**

Subcatchment 4S: Primary Pond 1 Catchment



Summary for Subcatchment 5S: Primary Pond 2 Catchment

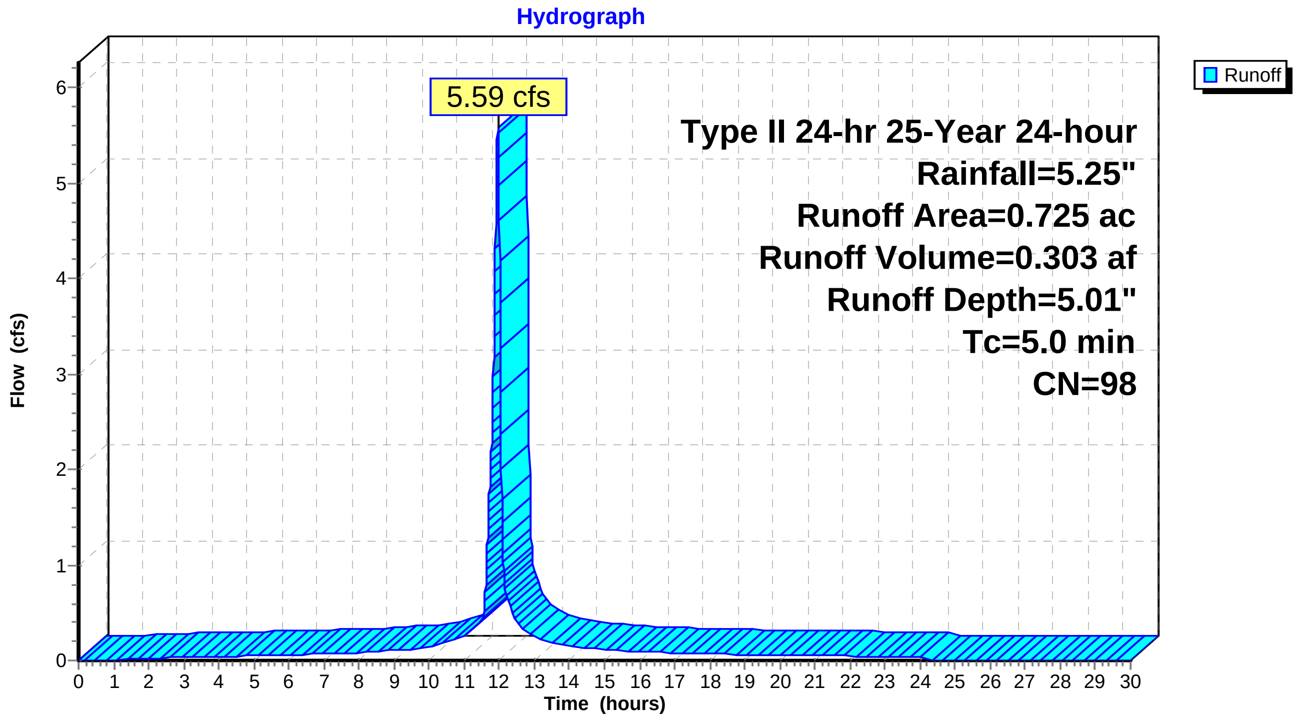
Runoff = 5.59 cfs @ 11.96 hrs, Volume= 0.303 af, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year 24-hour Rainfall=5.25"

	Area (ac)	CN	Description
*	0.725	98	Top of Berm Primary Pond 2
	0.725		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Rainfall Falling in Primary Pond 2**

Subcatchment 5S: Primary Pond 2 Catchment



Summary for Subcatchment 6S: Secondary Pond Catchment

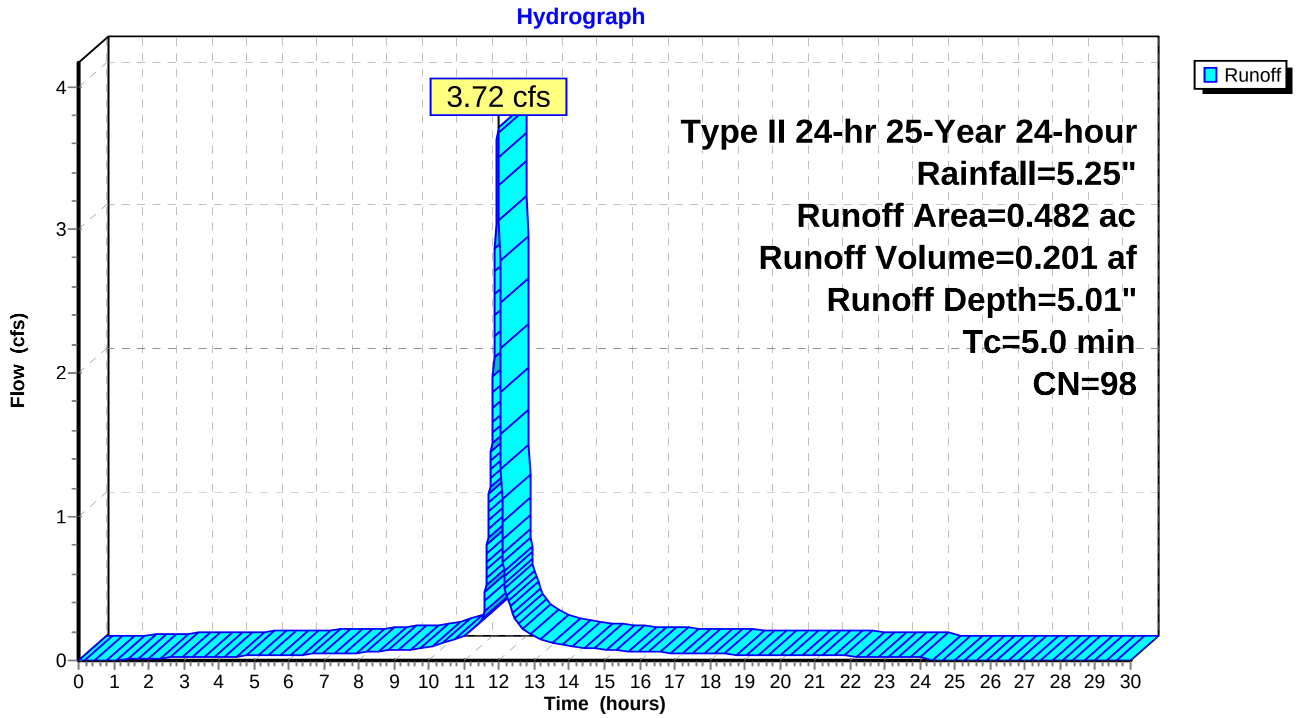
Runoff = 3.72 cfs @ 11.96 hrs, Volume= 0.201 af, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year 24-hour Rainfall=5.25"

	Area (ac)	CN	Description
*	0.482	98	Top of Berm Secondary Pond
	0.482		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Rainfall on Secondary Pond**

Subcatchment 6S: Secondary Pond Catchment



Summary for Subcatchment 7S: 24" CMP Catchment

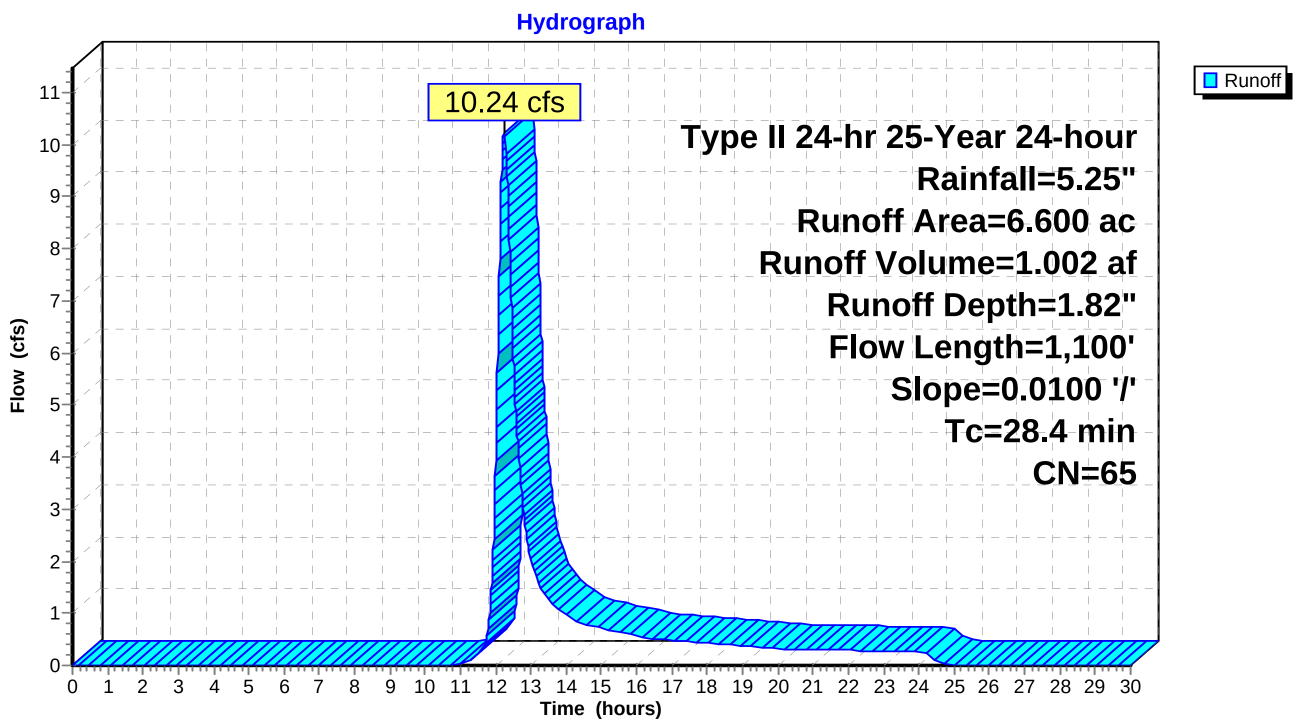
Runoff = 10.24 cfs @ 12.24 hrs, Volume= 1.002 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year 24-hour Rainfall=5.25"

Area (ac)	CN	Description
6.600	65	Woods/grass comb., Fair, HSG B
6.600		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.4	100	0.0100	0.12		**Sheet Flow, shallow** Grass: Short n= 0.150 P2= 3.00"
14.3	600	0.0100	0.70		**Shallow Concentrated Flow, shallow conc** Short Grass Pasture Kv= 7.0 fps
0.7	400	0.0100	10.01	640.45	**Trap/Vee/Rect Channel Flow, channel** Bot.W=4.00' D=4.00' Z= 3.0 '/' Top.W=28.00' n= 0.025 Earth, grassed & winding
28.4	1,100	Total			

Subcatchment 7S: 24" CMP Catchment



Summary for Subcatchment 8S: 18" CMP Catchment

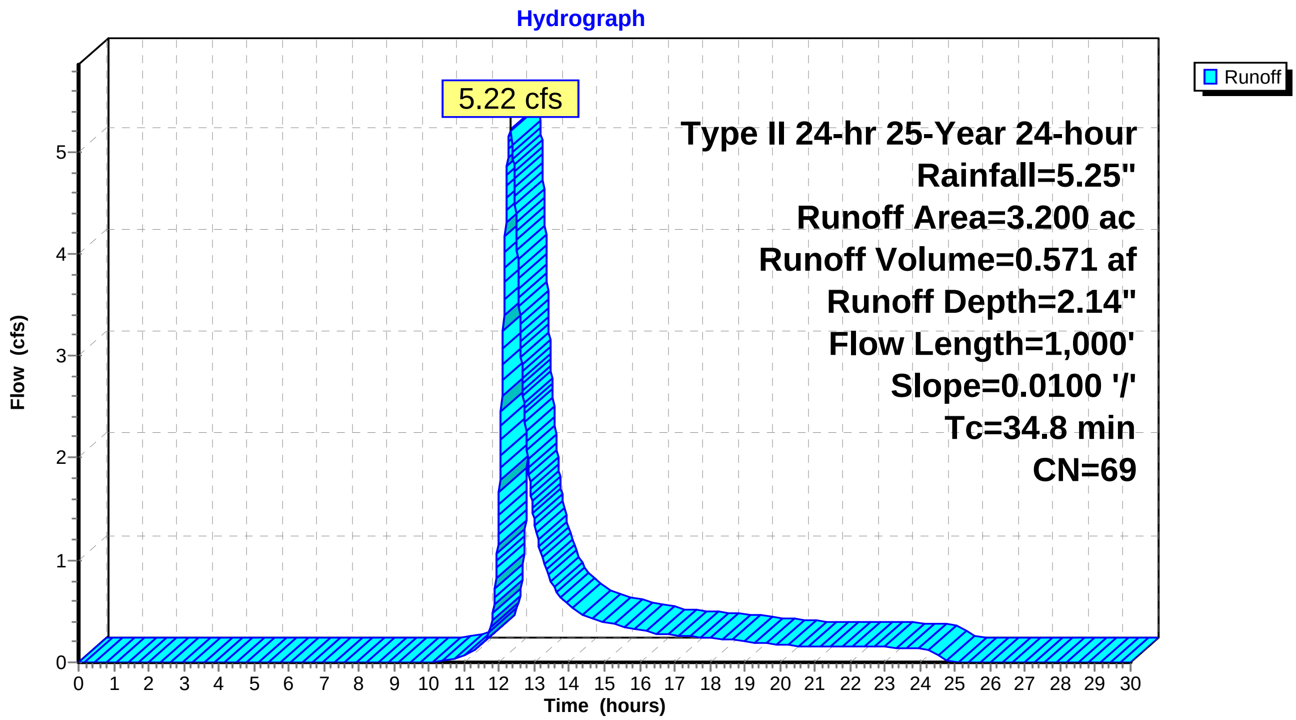
Runoff = 5.22 cfs @ 12.33 hrs, Volume= 0.571 af, Depth= 2.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year 24-hour Rainfall=5.25"

Area (ac)	CN	Description
3.200	69	Pasture/grassland/range, Fair, HSG B
3.200		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.4	100	0.0100	0.12		**Sheet Flow, sheet** Grass: Short n= 0.150 P2= 3.00"
21.4	900	0.0100	0.70		**Shallow Concentrated Flow, shallow conc** Short Grass Pasture Kv= 7.0 fps
34.8	1,000	Total			

Subcatchment 8S: 18" CMP Catchment



Summary for Reach 6R: South ditch

[78] Warning: Submerged Pond 4P Primary device # 1 by 0.98'
[78] Warning: Submerged Pond 6P Primary device # 1 by 0.98'

Inflow Area = 9.800 ac, 0.00% Impervious, Inflow Depth = 1.93" for 25-Year 24-hour event
Inflow = 15.26 cfs @ 12.29 hrs, Volume= 1.573 af
Outflow = 15.25 cfs @ 12.29 hrs, Volume= 1.573 af, Atten= 0%, Lag= 0.2 min

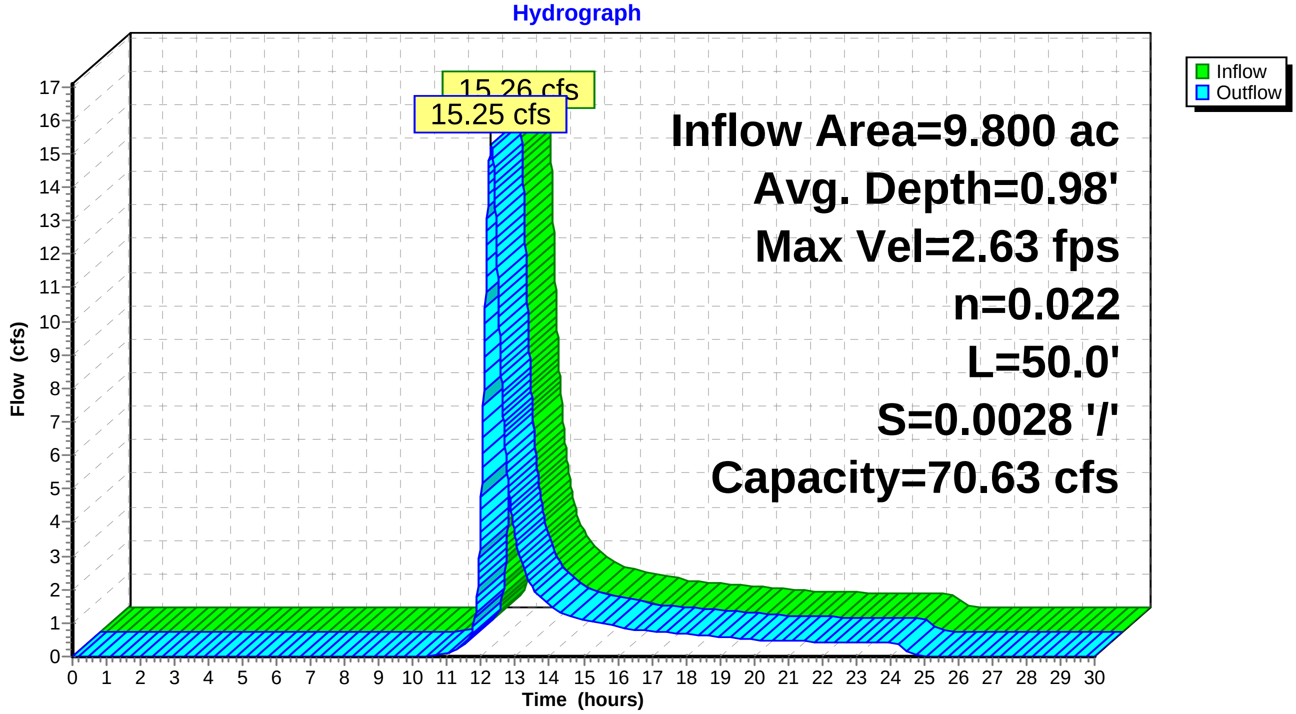
Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.63 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 0.8 min

Peak Storage= 290 cf @ 12.29 hrs, Average Depth at Peak Storage= 0.98'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 70.63 cfs

3.00' x 2.00' deep channel, n= 0.022
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 50.0' Slope= 0.0028 '/'
Inlet Invert= 572.14', Outlet Invert= 572.00'

‡

Reach 6R: South ditch



Summary for Pond 1P: Primary Pond 1

Inflow Area =	0.725 ac,100.00% Impervious, Inflow Depth > 61.25"		for 25-Year 24-hour event
Inflow =	6.96 cfs @ 11.96 hrs, Volume=	3.701 af,	Incl. 1.37 cfs Base Flow
Outflow =	4.65 cfs @ 12.03 hrs, Volume=	3.701 af,	Atten= 33%, Lag= 4.4 min
Primary =	4.65 cfs @ 12.03 hrs, Volume=	3.701 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 577.52' Surf.Area= 0.257 ac Storage= 0.048 af
Peak Elev= 577.76' @ 12.03 hrs Surf.Area= 0.271 ac Storage= 0.112 af (0.064 af above start)

Plug-Flow detention time= 24.7 min calculated for 3.651 af (99% of inflow)
Center-of-Mass det. time= 1.3 min (888.4 - 887.1)

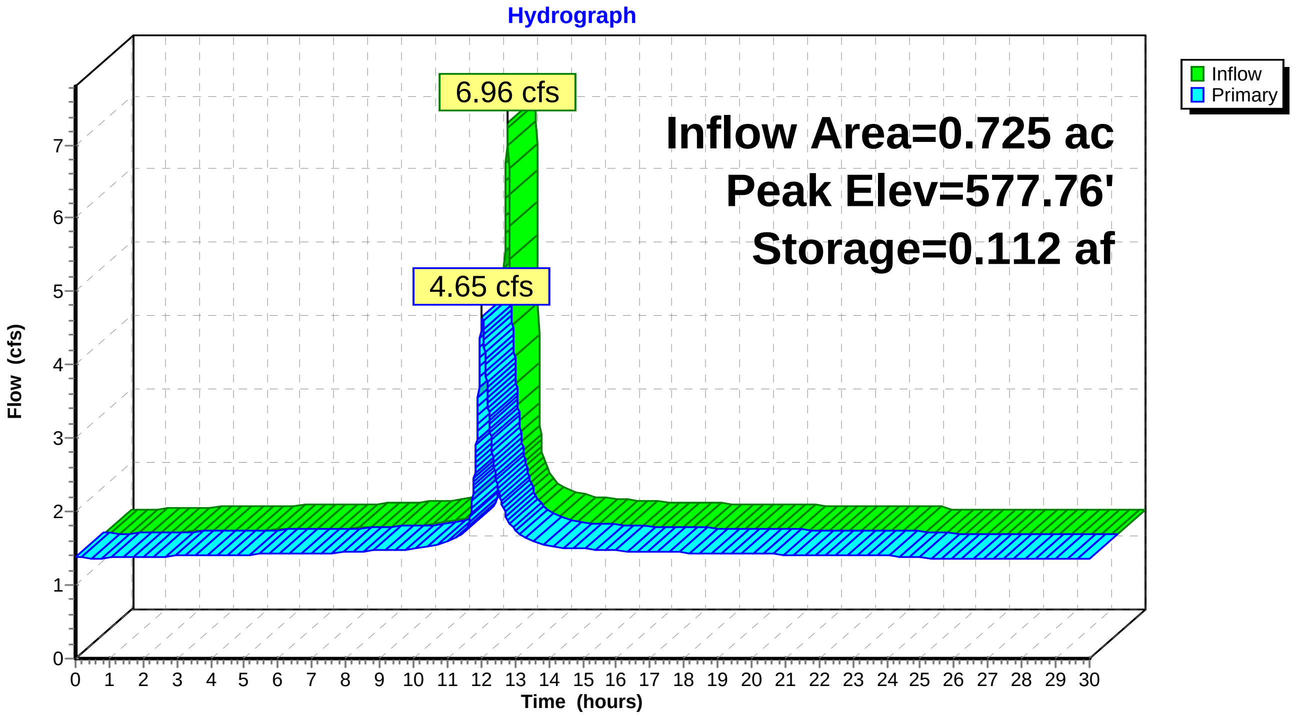
Volume	Invert	Avail.Storage	Storage Description
#1	577.33'	0.494 af	**Pimary Pond 1 Storage (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
577.33	0.245	0.000	0.000
579.00	0.347	0.494	0.494

Device	Routing	Invert	Outlet Devices
#1	Primary	574.00'	**12.0" x 44.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 573.50' S= 0.0114 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Device 1	577.33'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.3' Crest Height

Primary OutFlow Max=4.65 cfs @ 12.03 hrs HW=577.76' TW=574.08' (Dynamic Tailwater)
└─**1=Culvert** (Passes 4.65 cfs of 5.21 cfs potential flow)
  └─**2=Sharp-Crested Rectangular Weir** (Weir Controls 4.65 cfs @ 2.19 fps)

Pond 1P: Primary Pond 1



Summary for Pond 2P: Primary Pond 2

Inflow Area = 0.725 ac,100.00% Impervious, Inflow Depth = 5.01" for 25-Year 24-hour event
Inflow = 5.59 cfs @ 11.96 hrs, Volume= 0.303 af
Outflow = 2.93 cfs @ 12.04 hrs, Volume= 0.302 af, Atten= 48%, Lag= 4.9 min
Primary = 2.93 cfs @ 12.04 hrs, Volume= 0.302 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 577.65' @ 12.04 hrs Surf.Area= 0.265 ac Storage= 0.081 af

Plug-Flow detention time= 42.9 min calculated for 0.302 af (100% of inflow)
Center-of-Mass det. time= 41.8 min (784.0 - 742.2)

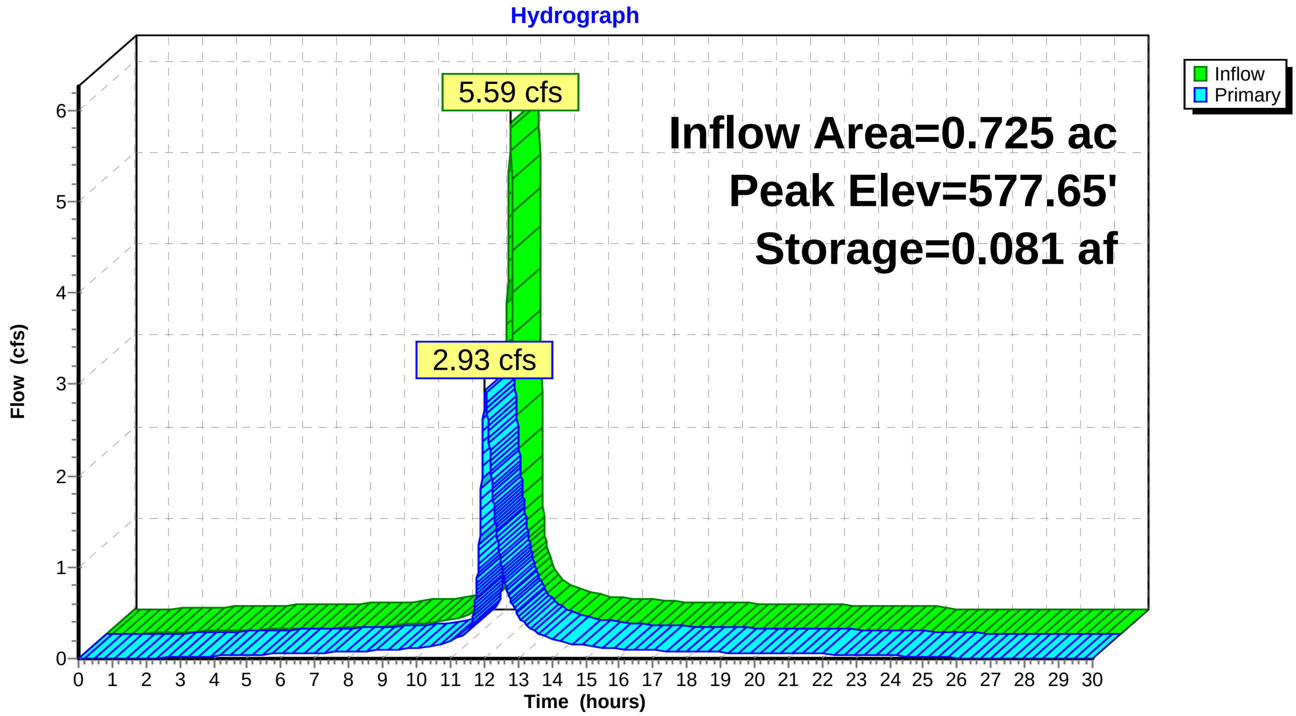
Volume	Invert	Avail.Storage	Storage Description
#1	577.33'	0.494 af	**Primary Pond 2 Storage (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
577.33	0.245	0.000	0.000
579.00	0.347	0.494	0.494

Device	Routing	Invert	Outlet Devices
#1	Primary	574.00'	**12.0" x 176.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 573.50' S= 0.0028 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Device 1	577.33'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.3' Crest Height

Primary OutFlow Max=2.93 cfs @ 12.04 hrs HW=577.65' TW=574.09' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.93 cfs @ 3.73 fps)
  └─**2=Sharp-Crested Rectangular Weir** (Passes 2.93 cfs of 2.95 cfs potential flow)

Pond 2P: Primary Pond 2



Summary for Pond 3P: Secondary Ash Settlement Pond

Inflow Area = 1.932 ac,100.00% Impervious, Inflow Depth > 26.12" for 25-Year 24-hour event
Inflow = 10.50 cfs @ 11.99 hrs, Volume= 4.205 af
Outflow = 4.72 cfs @ 12.33 hrs, Volume= 4.148 af, Atten= 55%, Lag= 20.4 min
Primary = 4.72 cfs @ 12.33 hrs, Volume= 4.148 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 574.22' @ 12.33 hrs Surf.Area= 0.322 ac Storage= 0.222 af

Plug-Flow detention time= 28.9 min calculated for 4.147 af (99% of inflow)
Center-of-Mass det. time= 16.1 min (890.0 - 873.9)

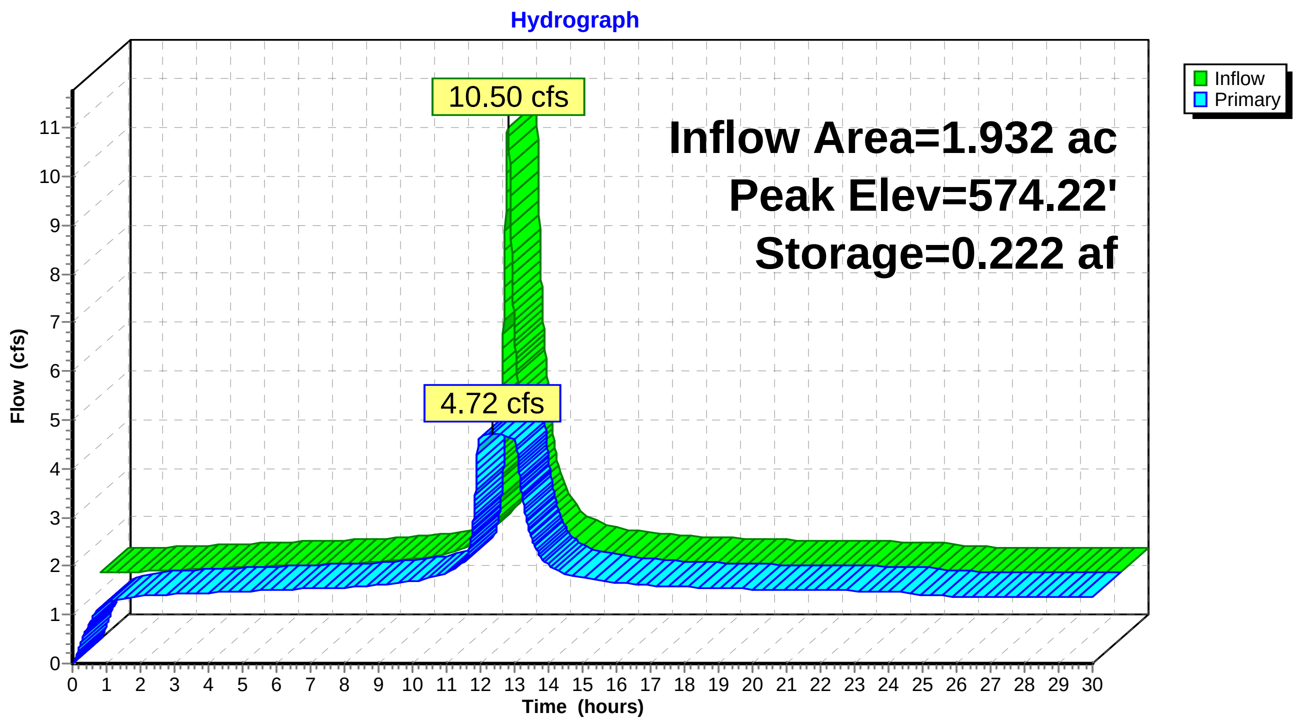
Volume	Invert	Avail.Storage	Storage Description
#1	573.50'	1.728 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
573.50	0.293	0.000	0.000
577.00	0.433	1.270	1.270
578.00	0.482	0.457	1.728

Device	Routing	Invert	Outlet Devices
#1	Primary	569.50'	**12.0" x 105.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 568.00' S= 0.0143 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior
#2	Device 1	573.50'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 4.0' Crest Height

Primary OutFlow Max=4.72 cfs @ 12.33 hrs HW=574.22' TW=566.83' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 4.72 cfs @ 6.01 fps)
  └─**2=Sharp-Crested Rectangular Weir** (Passes 4.72 cfs of 9.98 cfs potential flow)

Pond 3P: Secondary Ash Settlement Pond



Summary for Pond 4P: North perimeter stormwater pond w/ 24" CMP

Inflow Area =	6.600 ac,	0.00% Impervious,	Inflow Depth = 1.82"	for 25-Year 24-hour event
Inflow =	10.24 cfs @	12.24 hrs, Volume=	1.002 af	
Outflow =	10.09 cfs @	12.28 hrs, Volume=	1.002 af,	Atten= 1%, Lag= 2.2 min
Primary =	10.09 cfs @	12.28 hrs, Volume=	1.002 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 575.43' @ 12.28 hrs Surf.Area= 1,791 sf Storage= 881 cf

Plug-Flow detention time= 0.7 min calculated for 1.002 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (876.0 - 875.3)

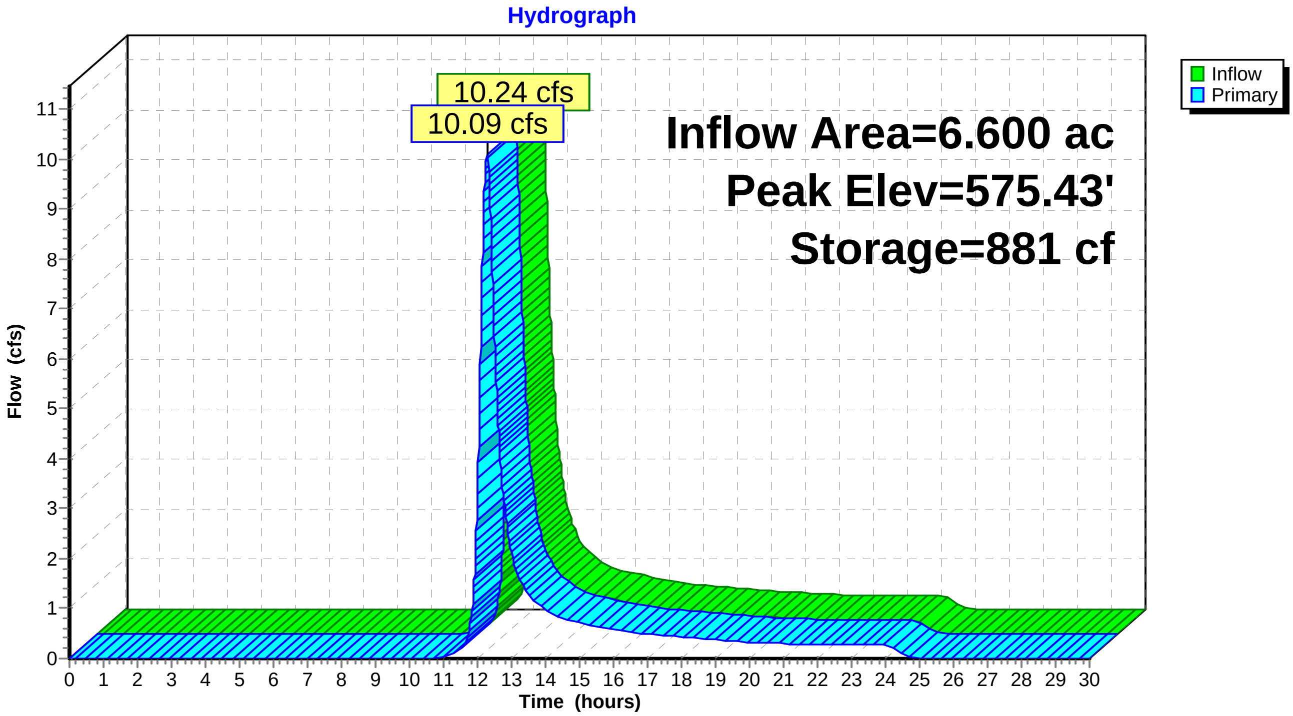
Volume	Invert	Avail.Storage	Storage Description
#1	574.25'	26,528 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
574.25	0	0	0
575.00	830	311	311
576.00	3,040	1,935	2,246
577.00	6,434	4,737	6,983
578.00	9,813	8,124	15,107
579.00	13,030	11,422	26,528

Device	Routing	Invert	Outlet Devices
#1	Primary	572.14'	**24" CMP rating curve** Head (feet) 0.00 2.72 3.09 3.79 5.17 8.24 11.33 Disch. (cfs) 0.000 1.000 2.200 4.600 6.800 10.000 13.300
#2	Primary	574.25'	**24.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=10.08 cfs @ 12.28 hrs HW=575.43' TW=573.12' (Dynamic Tailwater)
├─**1=24" CMP rating curve** (Custom Controls 2.90 cfs)
└─**2=Orifice/Grate** (Orifice Controls 7.18 cfs @ 3.71 fps)

Pond 4P: North perimeter stormwater pond w/ 24" CMP



Summary for Pond 5P: Discharge Channel

Inflow Area = 11.732 ac, 16.47% Impervious, Inflow Depth > 5.85" for 25-Year 24-hour event
Inflow = 19.97 cfs @ 12.29 hrs, Volume= 5.721 af
Outflow = 19.14 cfs @ 12.37 hrs, Volume= 5.712 af, Atten= 4%, Lag= 4.5 min
Primary = 19.14 cfs @ 12.37 hrs, Volume= 5.712 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 566.84' @ 12.37 hrs Surf.Area= 0.504 ac Storage= 0.143 af

Plug-Flow detention time= 5.2 min calculated for 5.712 af (100% of inflow)
Center-of-Mass det. time= 3.9 min (889.7 - 885.8)

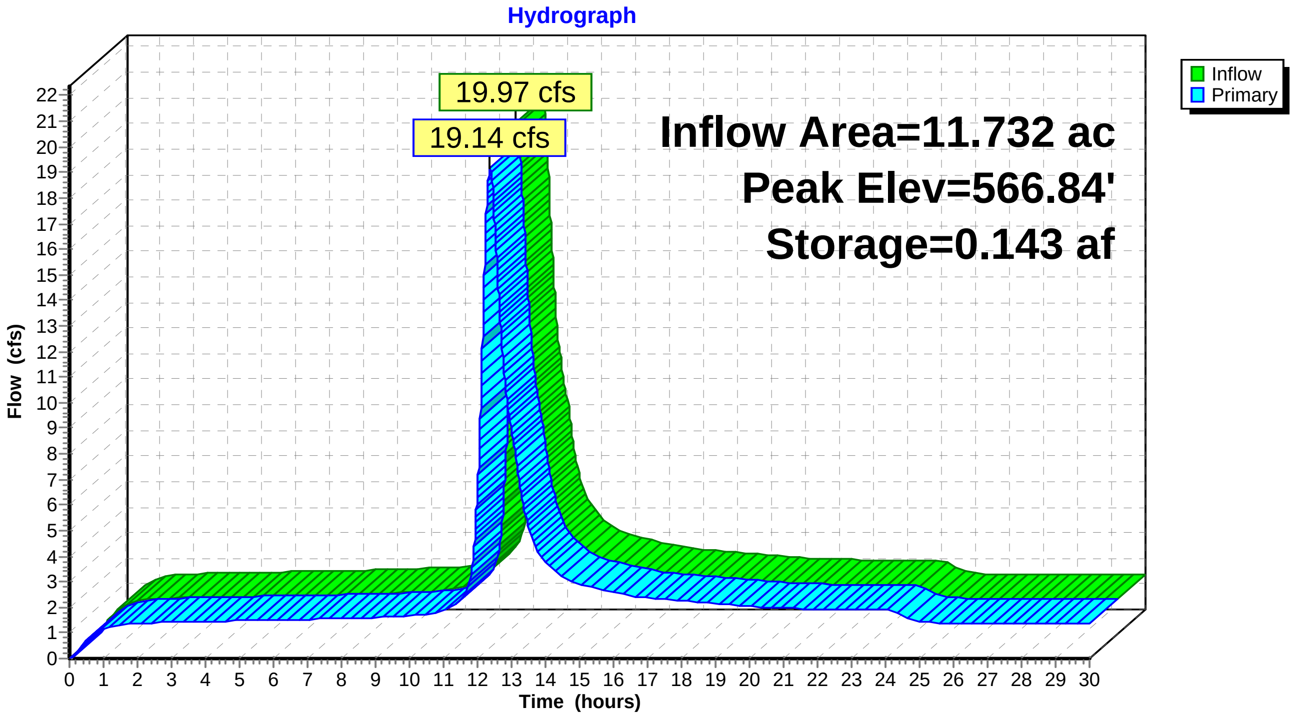
Volume	Invert	Avail.Storage	Storage Description
#1	566.50'	2.995 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
566.50	0.000	0.000	0.000
566.60	0.500	0.025	0.025
572.00	0.600	2.970	2.995

Device	Routing	Invert	Outlet Devices
#1	Primary	566.50'	**Custom Weir/Orifice, C= 2.62** Head (feet) 0.00 5.50 Width (feet) 30.00 31.00

Primary OutFlow Max=19.14 cfs @ 12.37 hrs HW=566.84' (Free Discharge)
└─**1=Custom Weir/Orifice** (Weir Controls 19.14 cfs @ 1.90 fps)

Pond 5P: Discharge Channel



Summary for Pond 6P: 18" CMP

[57] Hint: Peaked at 580.32' (Flood elevation advised)

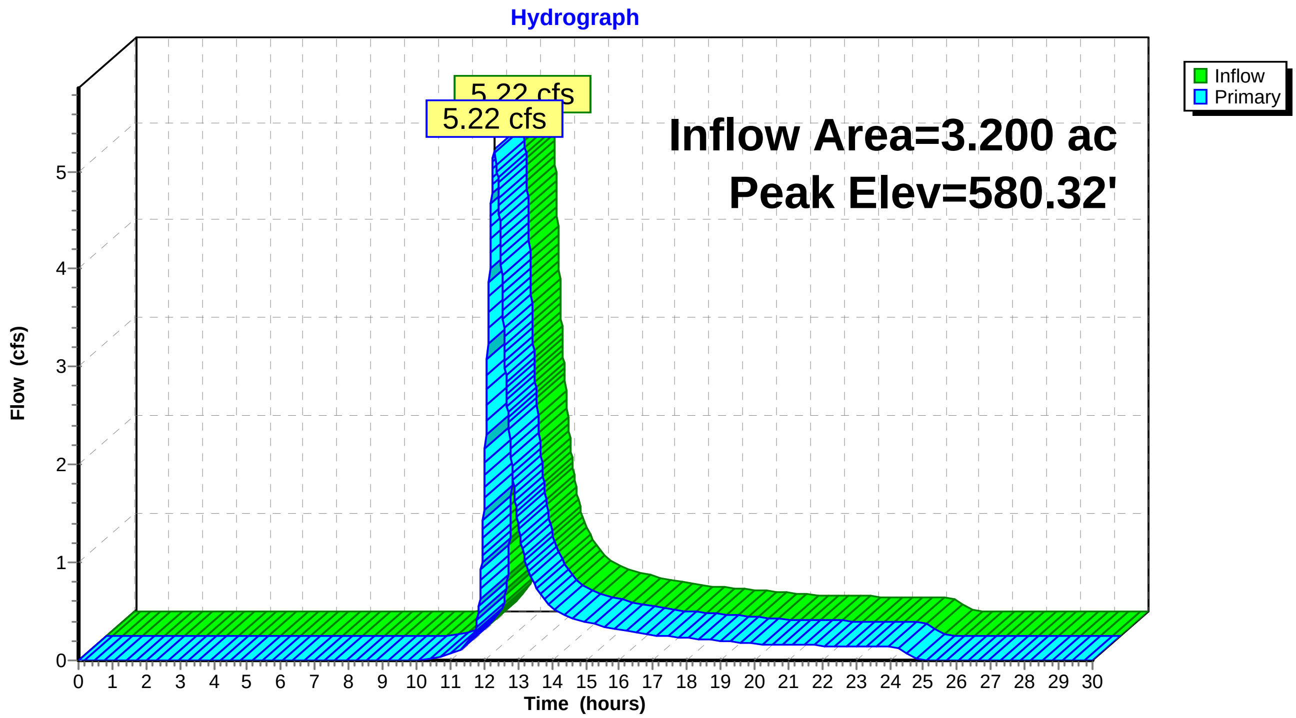
Inflow Area =	3.200 ac,	0.00% Impervious, Inflow Depth = 2.14"	for 25-Year 24-hour event	
Inflow =	5.22 cfs @	12.33 hrs, Volume=	0.571 af	
Outflow =	5.22 cfs @	12.33 hrs, Volume=	0.571 af,	Atten= 0%, Lag= 0.0 min
Primary =	5.22 cfs @	12.33 hrs, Volume=	0.571 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 580.32' @ 12.33 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	572.14'	**18" CMP rating curve** Head (feet) 0.00 3.19 3.36 3.84 5.13 8.13 11.33 Disch. (cfs) 0.000 0.730 1.400 2.600 3.600 5.200 6.600
#2	Device 1	575.00'	**18.0" Vert. Orifice/Grate** C= 0.600

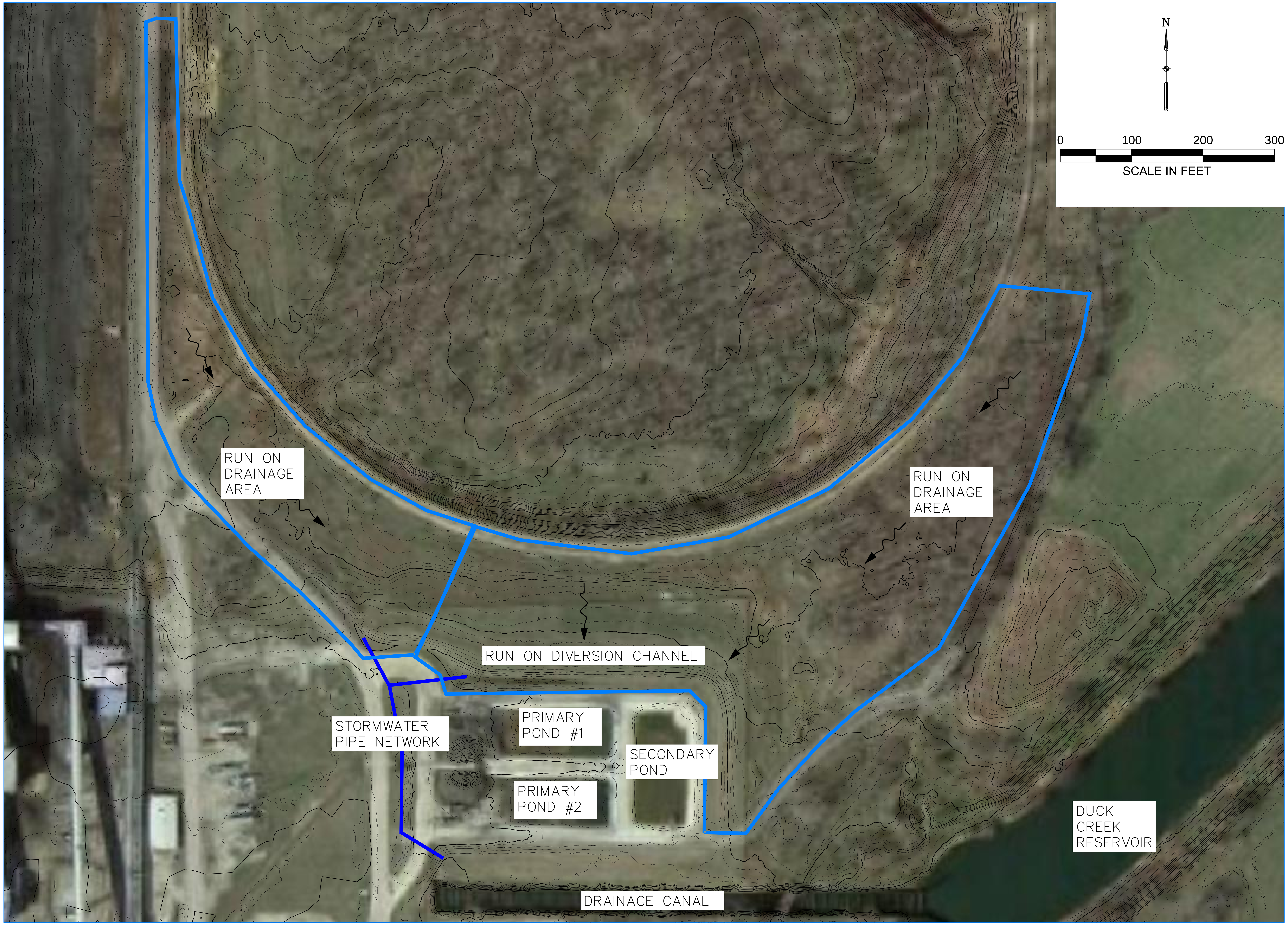
Primary OutFlow Max=5.22 cfs @ 12.33 hrs HW=580.32' TW=573.11' (Dynamic Tailwater)
└─**1=18" CMP rating curve** (Custom Controls 5.22 cfs)
  └─**2=Orifice/Grate** (Passes 5.22 cfs of 18.19 cfs potential flow)

Pond 6P: 18" CMP



Attachment B.3

Run-on Drainage Basins



AECOM
564 White Pond Dr.
Akron, OH 44320
330-836-9111 (phone)
330-836-9115 (fax)

DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

DUCK CREEK
POWER PLANT
FULTON COUNTY, IL

DRAFT

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
1		

AECOM PROJECT NO:	60440115
DRAWN BY:	LEH
DESIGNED BY:	LEH
CHECKED BY:	RHH
DATE CREATED:	2016-02-04
PLOT DATE:	2016-02-04
SCALE:	1" = 100'
ACAD VER:	2015

SHEET TITLE

BOTTOM ASH
POND
CERTIFICATION

FIGURE B.3

SHEET 1 OF 1

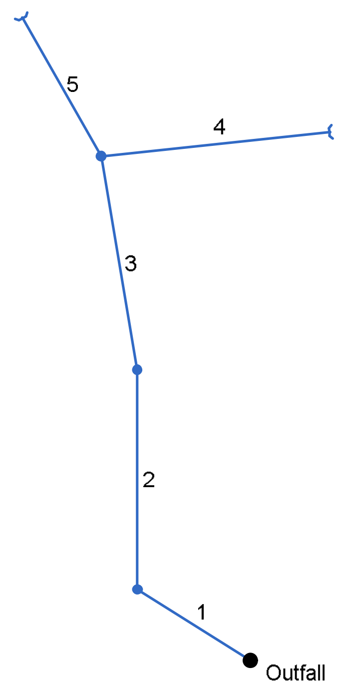
FISCHER, NICHOLAS, 4/12/2016 2:35 PM

AECOM DRAWING PATH: H:\DuckCreekReview\Bottom ash pond\Duck Creek Contours.dwg

Attachment B.4

Civil 3D Hydraflow Storm Sewers Output

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: DuckCreekHydraflow.stm	Number of lines: 5	Date: 3/30/2016

Storm Sewers v10.30

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
5	3	80.019	-20.000	Hdwl	6.60	0.00	0.00	0.0	574.00	1.25	575.00	18	Cir	0.025	1.00	3.59	Pipe - (43)
4	3	115.288	93.481	Hdwl	13.30	0.00	0.00	0.0	574.00	0.22	574.25	24	Cir	0.025	1.00	577.84	Pipe - (39)
3	2	109.161	-9.518	MH	0.00	0.00	0.00	0.0	573.60	0.37	574.00	24	Cir	0.025	1.00	577.84	Pipe - (40)
2	1	110.713	57.684	MH	0.00	0.00	0.00	0.0	573.00	0.54	573.60	24	Cir	0.025	0.20	577.84	Pipe - (41)
1	End	67.237	-147.726	MH	0.00	0.00	0.00	0.0	572.14	1.28	573.00	24	Cir	0.025	0.87	577.84	Pipe - (42)

Project File: DuckCreekHydraflow.stm	Number of lines: 5	Date: 3/30/2016

`

1001 Highlands Plaza Drive West, Suite 300
St. Louis, MO 63110
1-314-429-0100

About AECOM

AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With nearly 100,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and collaborative technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments. A Fortune 500 company, AECOM serves clients in more than 100 countries and has annual revenue in excess of $19 billion.

More information on AECOM and its services can be found at www.aecom.com.

ATTACHMENT 4

Concrete Specifications

DIVISION 5 – STRUCTURAL REQUIREMENTS

501. **GENERAL**

501.1 Scope of Work

a. This division covers the civil and structural requirements applicable to the procurement, fabrication, installation, erection, excavation and demolition activities as indicated by the Specification and as shown on the Design Drawings.

b. Scope of work is defined in Section 102 of this specification

501.2 Reference Documents

a. Related standard specifications are referenced in this Division. The work performed shall comply with the referenced and applicable requirements of the latest issue date of these documents, in addition to Federal, State, or local codes having jurisdiction.

b. A list of agencies with applicable codes and standards is given in Section 112 of this Specification.

502. **CONCRETE WORK**

502.1 Extent

a. Concrete construction shall conform to the requirements of this Section and to the requirements indicated on the design drawings. The work shall include, but not be limited to, the following:

a1. Furnishing, erecting and removing formwork.

a2. Furnishing and placing reinforcing steel, including stirrups, spirals, and other reinforcement materials with all necessary wire ties, bar supports, spacers, block supports and other devices required to install and secure reinforcement properly.

a3. Setting miscellaneous steel embedments, inserts and anchor bolts, including pipe sleeves, piping and conduit for mechanical and electrical work and Purchaser furnished building column anchor bolts.

a4. Furnishing, placing, finishing and curing of all concrete.

a5. Furnishing of miscellaneous accessories required to properly execute the work.

a6. Furnishing and placing joint filler.

502.2 Quality Assurance

a. Inspection Before Erection: Examine the areas and conditions under which concrete work is to be installed and notify Purchaser of any quality concerns.

b. The Purchaser will engage an independent testing and inspection agency to inspect the concrete work in progress and to perform tests and prepare test reports.

c. Materials and fabrication procedures may be subject to inspection and tests in the shop and in the field, and will be conducted by an independent qualified inspection agency hired by the Purchaser. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements. The Purchaser reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

d. Correct deficiencies in concrete work which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any noncompliance of the original work, and as may be necessary to show compliance of corrected work.

e. Tolerances for concrete construction, including tolerances on structure dimensions, concrete finishing tolerances and tolerances on placing reinforcing and embedded materials, shall be in accordance with the applicable chapters of ACI 301.

f. Errors or flaws in the concrete materials, components and accessories discerned during construction and which prevent the proper assembly, fit-up, and/or alignment of components shall be corrected promptly. Contractor shall make immediate substitution of the non-complying component or shall make field changes to make the non-complying component acceptable. Whether the correction is made by substitution or field correction, it shall be performed at no cost to Purchaser.

g. Reinforcing steel with rust, mill scale, or a combination of both shall be considered satisfactory, provided the minimum dimensions, including height of deformations and weight of a hand-wire-brushed test specimen are not less than ASTM A-615 requirements.

502.3 Formwork

a. Conform to the applicable requirements of ACI 301.

b. Plywood Forms: Plywood shall be water-resistant and shall be treated to prevent raising of the grain. If a lining is used it shall consist of accepted nonabsorptive fiberboard plastic coated to resist moisture and with a hard smooth surface on contact side.

c. Steel Forms: Provide minimum gauge thickness, stiffened to support weight of concrete with minimum deflection.

d. Glass Fiber Reinforced Resin Type: Preformed shape, stiffened to support weight of concrete with minimum deflection.

e. Form Ties:

e1. Factory fabricated, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent the spalling of concrete surfaces upon their removal.

e2. Provide ties so that the portion remaining within concrete after removal is at least 1-1/2 inches inside concrete, and which will not leave holes larger than one-inch diameter in concrete surface for concrete exposed above grade.

f. Form Release Agent: Nonstaining type. Contractor shall select with acceptance of the Purchaser.

502.4 Reinforcing Steel

a. Welded Steel Wire Fabric: Plain type, ASTM A 185; in flat sheets and uncoated. Spacing and gauge of wires as indicated on the design drawings.

b. Reinforcing Steel: ASTM A 615, Grade 60 billet steel, deformed bars, uncoated. Bar spacing and size as indicated on the design drawings.

c. Reinforcement Support: Provide bolsters, chairs, spacers, etc., required for spacing and support of reinforcement in accordance with CRSI Manual of Standard Practice Class C. Wood and brick

ARE NOT PERMITTED. Use precast concrete blocks of the same strength as the concrete to support reinforcing steel placed on soil.

502.5 Concrete

a. Cement: Per ASTM C 150, Type I/II.

b. Fly ash: If fly ash is used, it shall conform to ASTM C 618, Class C or Class F, with loss on ignition not to exceed six percent.

c. Aggregates: Per ASTM C 33, and as herein specified:

c1. Fine: Use only graded natural sand.

c2. Coarse Aggregate: Use only graded crushed stone or gravel. For concrete 12 inches or less in thickness the coarse aggregate shall be graded from 3/4" to No. 4 (Size No. 67). For all other concrete work the coarse aggregate shall be graded from 1-1/2" to No. 4 (Size No. 467).

d. Water: Clean, fresh, free from oils, acid, organic matter or other matter deleterious to concrete. Potable water is preferred.

e. Air-entraining admixture: Per ASTM C 260. Type and manufacturer as follows:

e1. Darex AEA: W. R. Grace & Co., Cambridge, MA, 617-876-1400

e2. MB-VR: Master Builders Inc., Cleveland, OH, 216-831-5500

e3. Sika AER: Sika Corp., Lynhurst, NJ, 800-631-7270

e4. Toxement AEA: Toch Div., Carboline Co., St. Louis, MO, 314-644-1000

e5. Others as accepted by the Purchaser.

f. Water-reducing admixture: Per ASTM C 494, Type A. Type and manufacturer as follows:

f1. WRDA with Hycol (nonair-entraining): W. R. Grace & Co.

f2. Pozzolith-Normal Set (nonair-entraining): Master Builders Inc.

f3. Plastocrete 161 (nonair-entraining): Sika Corp.

f4. Others as accepted by the Purchaser.

g. Accelerating admixture: Per ASTM C 494 Type C or E. Non-chloride type only. The use of calcium chloride IS NOT PERMITTED. See use restrictions in this Section. Type and manufacturer as follows:

g1. Pozzutec 20: Master Builders, Inc.

g2. Gilco: Cormix, Inc. (Gifford-Hill), Des Plaines, IL, 800-621-5506.

g3. Lubricon NCA: Cormix, Inc. (Gifford-Hill).

g4. Daraset: W. R. Grace & Co.

g5. Prokrete NCA: Prokrete Industries, Denver CO, 501-227-7580.

g6. Others as accepted by the Purchaser.

h. Retarding admixture: Per ASTM C 494 Type B (retarding) or Type D (retarding and water reducing). Non-chloride type only. See use restrictions in this Section. Type and manufacturer as follows:

h1. Pozzolith 100-XR: Master Builders, Inc.

h2. PSI-R Series: Cormix, Inc. (Gifford-Hill).

h3. Daratard: W. R. Grace & Co.

h4. Eucan Retarder: Euclid Chemical Company, Cleveland, OH, 216-531-9222.

h5. Others as accepted by the Purchaser.

502.6 Concrete Strength And Proportions

a. General: Proposed concrete proportions shall be subject to acceptance by the Purchaser and Consulting Engineer based on demonstrated ability to produce concrete meeting all requirements of the Specification.

b. Proportions of materials for concrete shall be established to provide:

b1. Adequate workability and proper consistency to permit concrete to be worked readily into the forms and around reinforcement without excessive segregation or bleeding under conditions of placement to be employed.

b2. Resistance to freezing and thawing and other aggressive actions.

b3. Conformance with strength test requirements specified in this Section.

c. Concrete proportions shall be established on the basis of previous field experience, laboratory trial batches as specified in Section 3.9, ACI 301 with the materials to be employed in the work, or using empirical data as specified in Section 3.10, ACI 301.

d. The procedure as given in Appendix 3, ACI Standard 211.1, Recommended Practice for Selecting Proportions for Normal and Heavy-weight Concrete, may be used as a guide in performing concrete trial mixes.

e. Prepare design mixes for 4,000 psi concrete (28-day strength) for all concrete work unless otherwise specified. 2,000 psi concrete (28-day strength) may be used for mud slab concrete. Develop the design mixes using the services of the Testing Laboratory furnished by Purchaser. Submit the design mixes to the Engineer for approval. If fly ash is used, it shall not exceed 25% of the cement plus fly ash by weight.

f. Water-Cement Ratio: Not more than 0.50, including free surface moisture on aggregates.

g. Fine Aggregate: In accordance with ASTM C 33 and as specified in this Section.

h. Coarse Aggregate: In accordance with ASTM C 33 and as specified in this Section.

i. Proportions and Slump:

i1. The proportions of cement to coarse aggregate shall be at least that which will produce a plastic mix of suitable workability for each portion of the WORK so as to result in uniformly dense concrete free from aggregate pockets or honeycomb.

i2. Slump limits: Proportion and design mixes to result in concrete slump at point of placement of not less than two inches nor more than five inches.

i3. Proportions to meet these requirements are established by design mixes as set forth herein. All concrete for the WORK shall be in strict conformance with these design mixes.

j. Admixture Use:

j1. Add air-entraining admixture at manufacturer's prescribed rate so that concrete at point of placement has an air content not less than two percent nor more than six percent of the volume of the concrete. The admixture shall be added as a solution in a portion of the mixing water, using a suitable mechanically activated dispenser.

j2. A water-reducing admixture may be used at the Contractor's option. When used a water-reducing admixture shall meet the requirements of this Section and shall be added at rates recommended by the manufacturer.

j3. The use of an accelerating admixture requires the written authorization of the Purchaser. When so authorized, the accelerating admixture shall meet the requirements of this Section and shall be added at rates recommended by the manufacturer.

j4. The use of a retarding admixture requires the written authorization of the Purchaser. When so authorized, the retarding admixture shall meet the requirements of this Section and shall be added at rates recommended by the manufacturer.

502.7 Concrete Testing And Job Control Of Concrete

a. Contractor shall furnish Testing Laboratory with sufficient quantities of cement, fly ash, and aggregates, from same sources as will be used for the WORK, for testing of these materials and preparation of 6 test cylinders for each design mix. Materials thus furnished shall be used for the entire Project without changes.

b. Contractor shall make all concrete test cylinders, as specified in Table 03315-1, from fresh samples of concrete taken on Project Site from discharge of stationary mixers, pumpcrete machines, truck mixers or truck agitators. Locations for taking samples shall be acceptable to the Purchaser. Making of test cylinders shall include slump tests, taking temperatures, curing, storing, packing, and delivery to Testing Laboratory of test cylinders and all required data as to materials, name and quality of air-entraining admixtures, water-cement ratio, proportions, slumps, air contents, temperatures, etc., as referenced on the approved mix design.

Table 03315-1, Schedule of Concrete Test Cylinders

Total Cylinders Required from Each 100 cubic yards of Concrete, or from Each Day's Pour if Less than 100 cubic yards	Cylinders For Strength Test At		
	7 Days	28 Days	Spare
3 Sets of 2 Each - Total, 6	2	2	2

Notes:
1. One set of 2 cylinders comprises a strength test.
2. If one cylinder in a strength test shows evidence of improper sampling, molding, or testing, discard the specimen and use the other to determine the strength. Spare cylinders may be used only when authorized by the purchaser.

c. Unless otherwise indicated, Contractor shall furnish equipment for and shall check the slump of concrete and air content of air-entrained concrete by direct measurement of fresh samples of concrete taken on Project Site from discharge of stationary mixers, pumpcrete machines, truck mixers or truck agitators. Locations of samples for testing slump and air entrainment shall be the same as for samples for test cylinders. At least one air test shall be made for each 100 yards of concrete, provided further that no less than 2 air tests shall be made for each day's pour if less than 100 cubic yards.

d. Concrete shall be sampled and tested at time of placement, as follows:

d1. Sampling of fresh concrete: Per ASTM C 172; except that requirements shall be modified to comply with the requirements of ASTM C 94.

d2. Slump: Per ASTM C 143; one test for each set of compressive strength test specimens made.

d3. Air content: Per ASTM C 231, pressure method, one test for each set of compressive strength specimens.

d4. Temperature of concrete: Test at point of discharge, hourly when ambient temperature if 40°F or below, and when 80°F and over; and each time a set of compressive strength test specimens is made.

e. The data collected shall be forwarded to the Purchaser's Testing Laboratory along with the cured concrete cylinders to be tested.

f. If the results of strength tests indicate that concrete does not meet specified requirements, the following steps shall be taken:

f1. The Testing Laboratory will be directed to visit Project Site and set up proper controls and inspection of job concrete, and Contractor shall pay entire costs of such services.

f2. Contractor may be directed to take concrete cores and/or make load tests, at his own expense, of any work that he has installed with concrete not meeting specified strength requirements. If cores and/or load tests established that such work in place does not meet requirements, Contractor shall correct the work as requested without cost to Purchaser.

502.8 Ready-Mixed Concrete

a. Ready-mixed concrete shall conform to the requirements of this specification in addition to the applicable requirements of ASTM C 94.

b. Ready-mixed concrete shall be mixed and delivered in accordance with applicable requirements of ASTM C 94, except that only trucks equipped with a rotary drum or agitator may be used.

c. When using ready mix concrete per ASTM C 94, delete the reference which allows additional water to be added for concrete with insufficient slump. Addition of water in excess of design quantity is NOT PERMITTED.

502.9 Detailing And Fabrication Of Reinforcement

a. Prepare setting plans and bar lists of the reinforcing steel bars to be fabricated in accordance with the design drawings. The setting drawings shall show the quantity, grade, size, length, mark, location, and bending diagrams for all reinforcing steel in accordance with the applicable requirements of ACI 315. These shop detail drawings which include the setting plans, bending details and bar lists shall be submitted to the Purchaser and Consulting Engineers for review and acceptance prior to fabrication. Do not start fabrication until these shop drawings have been reviewed and accepted.

b. Fabricate reinforcing bars in accordance with the reviewed and accepted shop drawings prepared from the design drawings.

c. Field fabrications when required shall be accomplished by cold bending. Heat bending is NOT PERMITTED. Welding of reinforcing steel is NOT PERMITTED. Bending of reinforcing bars in hardened concrete is NOT PERMITTED.

d. Splicing of reinforcing steel shall conform to the applicable requirements of ACI 318 unless otherwise indicated on the Design Drawings. Splice by the cadweld method shall be in accordance with the manufacturer's requirements.

e. All materials shall be new and in accordance with the ASTM specification or other recognized standards specified.

f. Bending and Concrete Cover Requirements: Bending and concrete cover requirements for reinforcing bars shall be as indicated on the design drawings, and in accordance with the applicable requirements of ACI 318 and CRSI Manual of Standard Practice, unless otherwise indicated.

502.10 Construction Details

a. Construction Joints:

a1. Major construction joints are indicated on the design drawings. Drawings indicating location of construction joints required in addition to or different from those indicated in the design drawings shall be submitted to the Purchaser and Consulting Engineers for review. These drawings shall be submitted and accepted by the Purchaser and Consulting Engineers before rebar details are submitted for review.

a2. If Contractor desires to revise locations of the accepted construction joints or to add or delete construction joints as the work progresses, then drawings showing proposed changes shall be submitted for review by the Purchaser and Consulting Engineers. No changes shall be made until acceptance is received. All changes, including required waterstops, if any, shall be made at no cost to Purchaser.

a3. Provide keyways at least 1-1/2 inches deep in construction joints in walls, slabs, and between walls and footings unless the Design Drawings indicate otherwise when smooth forms are used for the construction joints. Acceptable prefabricated bulkheads designed for this purpose may be used for slabs. As an alternate, expanded metal of sufficient strength may be used as a bulkhead material.

a4. Concrete for turbine-generator foundation, and for supporting foundation structures and foundation slabs for pulverizers, pumps, fan and similar equipment subject to vibration and/or impact operating loads shall have only those construction joints indicated on the design drawings.

b. Beveled Corners:

b1. Bevel all exposed projecting corners of concrete work, such as piers, columns, beams, equipment foundations, switchyard foundations, etc., 1" by 1" unless otherwise indicated. For exposed vertical corners in contact with ground, extend bevels 1'-0" below finish grade.

b2. Bevel all projecting corners of turbine foundations 2" by 2" unless otherwise indicated on the design drawings.

b3. The foregoing specified dimensions refer to the horizontal and/or vertical legs of the bevels.

c. Openings in Concrete:

c1. Provide openings, pockets, chases, recesses, slots, etc., in walls, piers, floors or other portions of concrete Work for structural steel, conduit, pipe, building sewers, sleeves, and similar items, as indicated on the design drawings.

c2. Fill all such openings, pockets, chases, etc., with concrete when indicated on the design drawings after preceding items, whether they are by Contractor or are by others, are installed as the WORK progresses. Finish exposed surfaces of such concrete fills to match adjoining concrete work.

502.11 Connecting to Existing Concrete:

a. Connections of new concrete to existing concrete shall include all necessary cutting, patching and fitting required for a neat and workmanlike job. All exposed surfaces shall be cut true and smooth and shall be patched and finished to match adjoining concrete surfaces.

b. Existing reinforcing uncovered in removing concrete and which is not indicated to be retained shall be cut back 1" from new surfaces before patching. Existing reinforcing indicated to be retained shall be stripped clean and lapped into new concrete a minimum of the specified lap length for the bar size involved unless otherwise indicated on the design drawings.

502.12 Accessories

a. Joint filler material:

a1. For expansion joints in concrete paving and concrete structures use preformed expansion joint filler per ASTM D 1752.

a2. For expansion joints in concrete slabs on grade and non-building structures use preformed expansion joint filler per ASTM D 1752 or ASTM D 1751.

a3. For non-expansion control joints use preformed expansion joint filler per ASTM D 1751.

b. Curing Compound: Membrane forming per ASTM C 309. Type 1, for concrete floors and stair treads. Type 1-D with fugitive dye for all other work (wax base not permitted). Type and manufacturer as follows:

b1. Burke Res-X or Cure-Seal-Hardener: The Burke Company, San Mateo, CA, 800-423-9140

b2. Clear Seal Standard. Code 2802, Dekote T-130 or Horncure 30D: A. C. Horn, Inc., Beltsville, MD, 800-654-0402

b3. Masterseal MB-429: Master Builders Inc.

b4. Sealtight AR-30-D or CS-309: W. R. Meadows, Inc., Elgin, IL, 708-683-4500

b5. Kure-N-Seal: Hydrocide Curing (Resin Base): Sonneborn Building Products/ChemRex, Inc., Minneapolis, MN, 612-835-3434

b6. Cure and Seal (High Solids): Symons Corp., Des Plaines, IL, 708-298-3200

b7. Thorocure: Thoro System Products, Miami, FL, 800-327-1570

b8. Others as accepted by the Purchaser.

502.13 Installation Of Formwork

a. General Requirements: Conform to the applicable requirements of ACI 301.

502.14 Placing Reinforcement

a. Reinforcing Bars:

a1. Comply with CRSI Manual for details and methods for reinforcing bar support and placement, as indicated on the design drawings and as specified herein.

a2. Clean reinforcement free of loose rust, mill scale, oil, grease, mud, dirt, ice and other foreign material which could reduce or destroy the bar's bond with concrete.

a3. Accurately position, support and secure reinforcement against displacement by construction activities and placement of concrete by metal supports or spacers, except use precast concrete blocks to support reinforcement placed on soil.

a4. Place reinforcement to obtain the minimum concrete coverage as indicated on the design drawings. Set wire ties so that ends are directed into concrete and not toward exposed concrete surfaces.

a5. Bending of reinforcing bars in hardened concrete will not be permitted.

a6. Heating and welding of reinforcing bars for any purpose WILL NOT BE PERMITTED.

b. Placing of Welded Wire Fabric: Carefully place fabric in position indicated on the design drawings, and maintain in this position before and during placing of concrete.

c. Anchoring Dowels: Securely anchor all dowels in place by wire tieing, etc., before starting placement of concrete.

d. Coating Dowels for Future Extensions: Exposed reinforcing bars for bonding with future work shall be protected from corrosion with two coats of "Bitumastic No. 50" as made by Koppers Company, Inc., Tar Products Division. Before coating the dowels, apply two coats of Bitumastic Concrete Penetrant on the concrete surface adjacent to the dowels. When the dowels are coated, the coated concrete surface shall be included as an integral part of the dowel coating.

502.15 Installation Of Embedded Items

a. Build in reglets and install anchors, building column anchor bolts, equipment anchor bolts, dowels, inserts, hangers, nailing strips, grounding, sleeves, conduit, and other items furnished by Contractor, other Subcontractors or the Purchaser. Use setting drawings, diagrams, instructions and directions provided by suppliers of the items to be installed. Maintain items plumb, in alignment and in proper position. Use care in placing concrete so as not to dislodge any of these installations.

b. Electrical conduit and piping embedded in concrete shall be located by the Contractor between the bottom and top reinforcement. Joints and ends of conduit and piping shall be sealed to prevent concrete from entering them. Where conduit or piping crossovers are necessary, they shall not displace reinforcement from its required positions.

c. Embedded conduit or piping parallel the main reinforcing steel shall be installed so that at least 2 in. of concrete can completely surround the main reinforcing steel.

d. Embedded items shall be sufficiently anchored to maintain their position during concrete placement and to prevent their flotation.

502.16 Concrete Mixing

a. All concrete shall be mixed until there is a uniform distribution of materials. Production of concrete shall be in accordance with the applicable requirements of ACI 301.

b. Site-mixed concrete shall be mixed in a batch mixer. Mixer shall be rotated at a speed recommended by manufacturer, and mixing shall be continued for not less than 1-1/2 minutes after all materials are in drum. For batches larger than 1 cubic yard, mixing time shall be in-creased 15 seconds for each additional cubic yard or fraction thereof. Where site-mixed concrete is conveyed by trucks from a central batch plant, trucks shall be equipped with an approved rotary drum or agitator. The mixer shall be discharged completely before recharging.

502.17 Conveying Concrete

a. Convey concrete from mixer to place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients.

b. Chutes or other equipment for conveying concrete shall be of such size and design as to insure a continuous flow of concrete at delivery end without separation of ingredients, and shall be thoroughly cleaned before each run. If use of pumping equipment to convey concrete is accepted, aluminum pipe shall not be used.

c. Concrete shall not be allowed to drop freely more than 5 ft. For drops which exceed 5 ft., use a hopper and drop chute. For all walls, use a hopper for any depth, with addition of a drop chute for drops which exceed 5 ft.

502.18 Preparations For Placing Concrete

a. Before concrete is placed, clean the forms and reinforcing of dirt and debris, remove snow and ice, and do all necessary trenching, damming, draining and pumping so that all concrete can be placed in the dry. Do not place any concrete until forms and reinforcing have been inspected and approved by Purchaser.

b. Before fresh concrete is placed on or against hardened new concrete or old concrete, thoroughly clean surfaces of all laitance, soft or loose materials and deleterious substances. The surfaces shall then be washed clean and thoroughly moistened. Where concrete has dried out, it shall be saturated for at least 24 hours. Immediately before fresh concrete is deposited, horizontal surfaces shall be thoroughly covered with a sand/water/cement mortar of same mix as concrete to be poured. Fresh concrete shall then be placed before cement mortar has obtained its initial set.

502.19 Placing Concrete

a. General:

a1. Comply with ACI 301 and as herein specified.

a2. Place all concrete in a continuous and uninterrupted operation in such manner as to form a monolithic structure, the component parts of which are securely bonded together. No concrete shall be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within a given section. If a section cannot be placed continuously, provide construction joints as specified in this Section. Do not deposit segregated concrete or concrete that has partially hardened or been contaminated by foreign materials, nor use retempered concrete. Time interval between placing of successive batches of concrete shall not be greater than 30 minutes.

a3. Deposit all concrete in forms within 1-1/2 hours after introduction of mixing water to cement and aggregates.

a4. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing.

a5. All concrete in vertical members, such as columns, caissons and walls, shall be in place not less than 2 hours before any concrete is placed in girders, beams or slabs supported thereon. Place concrete for beams, girders, brackets, column caps, caisson caps and haunches monolithic with floor slabs.

a6. Massive concrete (concrete components greater than 18 inches in thickness) shall be placed in layers approximately 18 inches thick, in accordance with ACI 301.

a7. Thoroughly compact all concrete work by means of mechanical vibrators.

a8. The temperature limitations of plastic concrete shall be according to ACI 301.

b. Cold Weather Placement:

b1. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 301 and as herein specified.

b2. The use of frozen materials or materials containing ice or snow IS NOT PERMITTED. Do not place concrete on frozen subgrade, or on subgrade containing frozen materials.

b3. Do not use calcium chloride, salt or other materials containing antifreeze agents. The use of an accelerating admixture requires the written approval of the Purchaser as noted in this Section.

c. Hot Weather Placement:

c1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 301 and as herein specified.

c2. The use of a retarding admixture requires the written approval of the Purchaser as noted in this Section.

502.20 Finishing Formed Surfaces

a. All formed concrete surfaces shall be finished in accordance with ACI 301 and as follows:

a1. Exposed Surface Finish:

- Upon removal of forms, all fins and other projections shall be removed and offsets leveled. All voids, holes, honeycomb or other damaged surfaces shall be cleaned back to solid concrete, saturated with water and filled with cement mortar of same composition as that used in the concrete. The concrete shall be finished free from streaks, discoloration or other imperfections as to produce an extremely smooth, dense and true finish of uniform color.
- This finish shall be used for all formed surfaces exposed to view.

a2. Unexposed Surface Finish:

- Upon removal of forms, all voids, holes, honeycomb or other damaged surfaces shall be cleaned back to solid concrete, saturated with water and filled with cement mortar of same composition as that used in the concrete.

- This finish shall be used for all formed surfaces unexposed to view.

502.21 SLAB Finishes

a. All concrete slab surfaces shall be finished in accordance with Chapter 11 of ACI 301.

b. Top surface of structural concrete slabs and equipment foundations shall be level unless otherwise indicated. Screeds shall be used for all structural slabs and shall be securely and accurately set to elevations indicated. After concrete has been compacted by vibrating, it shall be screeded to required level.

c. Floated Finish: Provide in accordance with Paragraph 11.7.2 of ACI 301 and as follows:

c1. Surface shall first be screeded, and then be bull floated to a smooth, compact surface. After bull floating, surface shall be floated after concrete has hardened sufficiently to retain the float finish and water sheen has disappeared.

c2. Uses:

- Structural concrete roof slabs. Finish shall be free of all depressions or projections which would prevent proper application of roofing.
- Structural floor slabs only where specifically indicated on the design drawings.
- Top of concrete walls, curbs, piers, pads, pedestals and switchyard and equipment foundations.
- Floors of tunnels, crib houses, manholes, sump pits, elevator pits, valve pits, miscellaneous pits, etc. Roofs, if any, of these structures shall also have a float finish, except that where such roofs are integral with other concrete work, the roofs shall have the same finish as the other concrete work.

d. Troweled Finish: Provide in accordance with Paragraph 11.7.3 of ACI 301 and as follows:

d1. Surface shall first be screeded, and then be floated to a smooth, compact surface. After floating, the surface of concrete shall be steel troweled to a smooth, slate-like surface. Final troweling shall be done after concrete is so hard that no mortar accumulates on trowel and a ringing sound is produced as trowel is drawn over surface. Finish surface shall not be brushed off or scored in any manner.

d2. Uses:

- Structural concrete floor slabs where monolithic finish is indicated. A monolithic finish is one produced on structural concrete slabs which are poured all at one time with one concrete mix. Concrete for structural slabs with monolithic finish shall be of the driest consistency possible to work with a sawing motion of screed.
- Floor areas where resilient tile finishes (asphalt, rubber, vinyl, etc.) are indicated.
- Stair treads.

e. Broom Finish: Provide in accordance with Paragraph 11.7.4 of ACI 301 and as follows:

e1. The surface shall first be screeded, and shall then be bull floated to a smooth, compact surface. Following the bull floating, the surface shall be broomed with a medium-stiff bristled broom only after the concrete has hardened sufficiently to retain the scoring. The strokes shall be square across the surface and shall be so made as to produce regular scoring without tearing the surface or exposing any aggregate. The scoring shall run transverse to the direction of traffic.

e2. This finish shall be used for sidewalks and driveways. It shall be used for other surfaces only if specifically indicated.

502.22 Concrete Curing And Protection

a. Concrete shall be cured and protected in accordance with the requirements of Chapter 12 of ACI 301. Curing should start as soon as the concrete has hardened sufficiently to prevent surface damage. Cure for the minimum periods herein specified before subjecting concrete to live loads, earth loads, traffic, etc.

b. Protect freshly placed concrete from premature drying, excessive heat or cold, and maintain at a relatively constant temperature for the period of time required for the hydration of cement and proper hardening.

c. All concrete shall be protected so as to prevent the temperature at the surface from going below 50°F or loss of moisture from the surface.

d. Curing shall continue for at least 7 days.

e. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be discontinued when the average compressive strength has reached 70% of the specified strength. Moisture retention measures may also be discontinued when the temperature of the concrete is maintained at least at 50°F for the same length of time that laboratory-cured cylinders, representative of the concrete-in-place, require to achieve 85% of the specified *f'c*.

f. When the temperature of surrounding air is 40°F, or below, or is expected to drop to 40°F or below in the next 12 hours, provide adequate means for maintaining the temperature of the concrete between 50°F and 70°F for the required curing period.

g. The housing or covering of concrete for cold weather protection and the means of providing artificial heat shall be in accordance with industry practice. Such housing or covering shall remain in place and intact for at least 24 hours after artificial heating is discontinued.

h. The mass of concrete contained in a mat foundation thicker than 30" generates enough heat in the process of hydration that use of artificial heating may not be required. Insulation blankets of sufficient thickness shall be provided to maintain the surface temperature of the concrete above 40°F for a period of 7 days or until the average compressive strength of the concrete conforms to requirements above.

i. Avoid rapid drying at the end of the final curing period.

j. Curing Methods:

j1. Provide membrane curing by applying membrane forming curing compound to damp concrete surfaces as soon as water film has disappeared. Apply uniformly in a two-coat continuous operation by means of power spray equipment in accordance with manufacturer's directions. Re-coat areas which are subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period. Liquid membrane forming curing compounds shall conform to the requirements and shall be applied in accordance with the manufacturer's recommendations.

j2. Do not use membrane forming curing compounds on surfaces against which additional concrete or other materials such as waterproofing, membrane roofing, flooring, painting or other coatings will be bonded unless the Contractor can prove that the curing compound will not prevent bond, or unless the Contractor takes positive measures to remove the curing compound completely from those areas. If the Contractor cannot comply with this provision, he shall select one of the other curing methods specified in Section 12.2.1 of ACI 301.

j3. Where forms are left in place for entire period for which curing is specified, the use of curing compound may be omitted, provided that in warm weather, temperatures above 80°F, the forms are kept wet until they can be safely removed.

j4. Where forms are stripped before completion of specified curing period, apply curing compound to such surfaces immediately after completion of specified surface treatment.

k. Protection of Concrete: Fully protect all concrete from damage or injury during construction operations. Protect exposed external corners of concrete with wood strips securely fastened in place.

l. Cleaning of Surfaces: After concrete is placed, all exposed surfaces which have been contaminated by concrete splashing, dripping, etc., caused by such concrete work shall be cleaned to restore these surfaces to their original condition.

502.23 Removal of Forms

a. Do not remove forms from any concrete work until the concrete has acquired sufficient strength to safely carry its own weight and any construction loads that may be imposed on it. Methods used for removal of formwork shall be such as to prevent marring, breakage or other damage to concrete. Removal of formwork shall conform to the applicable requirements of ACI 301.

503. **GROUT WORK**

503.1 Intent

a. This section covers the material and procedures for grouting of the following unless otherwise indicated on the Design Drawings:

a1. Column base plates.

a2. Conduit, piping, etc., through concrete floors or walls.

a3. Anchor bolts in drilled holes in concrete.

a4. Grouting of equipment

b. Grouting shall be performed using non-shrink grout, unless otherwise indicated on the Design Drawings.

503.2 Quality Assurance

a. Purchaser may engage an independent testing laboratory to inspect the grout work in progress and to perform test to verify compliance with the requirements specified herein. Such inspections and tests shall not relieve Contractor of responsibility for providing materials and procedures in compliance with the specified requirements.

ATTACHMENT 5

Earthwork Specifications

SECTION 319005

EARTHWORK AND CLAY LINING FOR A CLAY/GEOMEMBRANE COMPOSITE LINED POND

PART 1 - GENERAL

101. EXTENT

101.1 The intent of this Section is to define the material and installation requirements for earthwork and clay lining for ponds in accordance with the Design Drawings and as specified herein.

101.2 Work Included:

101.3 The work shall include, but not be limited to, the following items:

a. Installation of sediment and erosion control facilities prior to the start of construction and maintenance of the facilities during construction.

b. Dust Control during the construction period.

c. Earth excavation.

d. Preparation of the subgrade to receive fill, including clearing and grubbing.

e. Placement and compaction of general and structural fills.

f. Placement and compaction of dike fills.

g. Supply of clay liner materials from an offsite or onsite (if available) borrow area.

h. Placement and compaction of the clay liner.

i. Preparation of the clay liner to be geomembrane lined.

j. Excavation and backfill of anchor trenches for geomembrane lining.

k. Fine finishing of completed slopes and embankments.

l. Disposal of excess or unsuitable excavated material if required.

m. Placement and seeding of topsoil on exterior slopes.

n. Placement of rock surfacing on the top of the dikes.

o. Closure and seeding of borrow areas.

p. Offsite disposal of excess or unsuitable excavated earthen material and debris.

102. RELATED WORK SPECIFIED IN OTHER SECTIONS

102.1 Section 014362 – Quality Assurance for Installation of Earthwork and Clay Lining for a Clay Lined Pond

102.2 Section 329219 – Temporary and Permanent Seeding (Illinois)

102.3 Section 321124 – Crushed Stone Surfacing for Unpaved Roads, Parking Lots and Laydown Areas

102.4 Section 015713 – Temporary Sediment Control During Construction

102.5 Section 311101 – Site Clearing and Grubbing

103. REFERENCE DOCUMENTS

103.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state or local codes having jurisdiction.

103.2 References to these documents are to the latest issue of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of the Contract for the Work.

103.3 Abbreviations listed indicate the form used to identify the reference documents in the Specification.

103.4 ASTM - American Society for Testing and Materials:

a. ASTM D422 - Test Method for Particle Size Analysis of Soils.

b. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

c. ASTM D1140 - Test Method for Amount of Material in Soils finer than the No. 200 Sieve.

d. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

e. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

f. ASTM D5084 - Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter.

104. SUBMITTALS

104.1 Contractor shall submit drawings and data as specified. Contractor's Drawings and Data shall be submitted via electronic medium in a format compatible for importing into the Purchaser's information systems specified by the Purchaser.

104.2 Data required to be submitted by the CQA Engineer is specified in Section 014362 – Quality Assurance for Installation of Earthwork and Clay Lining for a Clay Lined Pond.

104.3 The Contractor shall submit for the Purchaser's review catalog data on all compaction equipment and proofrolling equipment he plans to use on the project.

105. QUALITY ASSURANCE

105.1 Inspection Before Working: The Contractor shall examine the areas and conditions under which earthwork is to be done and notify the Purchaser in writing of conditions detrimental to the proper and timely completion of the Work.

105.2 Material, placing procedures and installations are subject to inspection and tests conducted by an Independent Testing Service hired by Purchaser. Such inspections and tests shall not relieve Contractor of responsibility for providing material and placement in compliance with this specification. The Purchaser reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

105.3 The Contractor shall correct all deficiencies in earthwork and liner installation which inspections and laboratory and field tests have indicated are not in compliance with the specifications. The Contractor shall perform additional tests, at his expense, as may be necessary to reconfirm any noncompliance of the original work, and as may be necessary to show compliance of corrected work.

105.4 The Contractor shall promptly correct errors or flaws in the work or material identified during construction and which prevent proper installation. The Contractor shall make immediate substitution of the noncomplying material or shall make field changes to make the noncomplying material acceptable. The correction or substitution shall be performed at no cost to the Purchaser.

106. GEOTECHNICAL DATA AND TOPOGRAPHY

106.1 Geotechnical Data:

a. Reference drawings in the geotechnical report indicate location of the borings taken at the Project Site and the boring logs indicate the character of the soil. This information is available and, on request, will be furnished to the Contractor for his convenience and use. The Purchaser assumes no responsibility for the accuracy of information provided.

106.2 The Contractor may be permitted to make his own soil investigations. If permitted, investigations shall be performed at no cost to the Purchaser.

106.3 Topography:

a. A topographical survey is available with Purchaser. The Design Drawings indicate contour lines, elevations and dimensions of existing ground. This information is furnished for Contractor's convenience and use. The Purchaser assumes no responsibility for the accuracy of information provided.

b. The Contractor may be permitted to make his own topography assessment or check the existing survey data. Any additional surveying of the project site shall be at no cost to the Purchaser.

107. LINE AND GRADES

107.1 The Contractor shall lay out lines and grades from the existing monuments and bench marks on the Project Site.

107.2 The Purchaser reserves the right to verify correctness of lines and grades during progress of the Work. Such verification by Purchaser shall not relieve the Contractor of responsibility as herein specified.

107.3 The Contractor shall notify the Purchaser of any difference in location of existing construction and conditions from those indicated wherever such difference may affect his work.

107.4 The Contractor shall preserve and maintain bench marks and reference points established on the Project site. Should Contractor, during prosecution of the Work, destroy or remove any bench mark or reference point established by the Purchaser, the cost of reestablishing the bench mark or reference point shall be borne by the Contractor.

108. DUST CONTROL

108.1 The Contractor shall be responsible for controlling dust caused by the grading operation in compliance with any dust control permit obtained by the Purchaser. Water shall be applied uniformly and lightly to prevent muddy, slippery or other hazardous conditions. The application shall be frequent enough to adequately control the dust nuisance. However, excessive application that would affect compacting operations shall be avoided.

109. TEMPORARY SEDIMENT CONTROL DURING CONSTRUCTION

109.1 The Contractor shall be responsible for providing temporary facilities for the control of sediment in site area runoff during construction.

109.2 Silt fences, straw bale dikes and other temporary facilities shall be provided as required.

110. EROSION CONTROL

110.1 The Contractor shall be responsible for temporary protection of graded areas against erosion and for correction of erosion, which occurs.

110.2 Temporary seeding or application of topsoil and permanent seeding or other erosion control measures specified on the Design Drawings shall be applied to completed slopes, ditches and other disturbed areas not subject to additional construction activities within 30 days of completion of the grading activity.

110.3 Slopes, ditches or other disturbed areas, which will be exposed for more than 30 days without a permanent cover because they will be subject to additional future construction activities, shall be provided with temporary seeding. Included are cut and fill slopes, pond dikes, and spoils disposal areas.

PART 2 - PRODUCTS

201. DESCRIPTION OF EARTHWORK

201.1 Earthwork for the ponds includes constructing dikes, excavating the pond area, and lining the interior of the dikes with clay obtained from a borrow area. The clay liner will be covered with a geomembrane. The top of the dikes shall be surfaced with crushed rock. The exterior slope of exterior dikes shall be covered with topsoil and seeded.

202. MATERIAL FOR DIKES AND GENERAL AND STRUCTURAL FILLS

202.1 Definitions:

a. "Dike Fill" is fill for pond dikes.

b. "General Fill" is fill, which does not support structures. "General Fill" includes fill around the inlet and discharge structure where it is not part of the dikes.

c. "Structural Fill" is fill placed beneath equipment, walls, retaining walls, inlet and outlet structures, pump stations, and other similar structures sensitive to settlement. "Structural Fill" is also fill placed in the upper 3 feet beneath roads, fill supporting buried structures such as drainage manholes, electrical manholes and vaults where they are not incorporated in the dikes.

202.2 Satisfactory Fill Material:

a. Granular Material:

a1. Granular material is suitable for use as "General Fill" and "Structural Fill" if it contains not more than 1 percent organic or other deleterious material, is free of excess moisture and has a maximum particle size of 3 inches.

a2. Acceptable granular material comes from soils which are classified as coarse-grained soils in the Unified Soil Classification System, ASTM D2487. Classifications are GW, GP, GM, GC, SW, SP, SM or SC, or combinations of these such as SP-SC.

a3. Restrictions on the use of poorly graded sand (SP) or silty sand (SM) material are as follows: No material with a silt content of greater than 15 percent shall be used for "Dike Fill" or "Structural Fill" nor shall it be used for fill behind retaining walls or within 12 inches of the surface of ditches or slopes.

b. Cohesive Material:

b1. Cohesive material is suitable for use as "Dike Fill", "General Fill" and "Structural Fill" if it contains not more than 1 percent organic or other deleterious material, has a maximum particle size of 3 inches, has a liquid limit of less than 45 and a plasticity index of less than 25.

b2. Acceptable cohesive material comes from soils which are classified as fine-grained soils in the Unified Soil Classification System, ASTM D2487. Classification is CL.

202.3 Unsatisfactory Fill Material:

a. Material unsatisfactory for use as either a "General Fill" or a "Structural Fill" are as follows:

a1. Soils classified as silt or organic soils in the Unified Soil Classification System, ASTM D2487. Classifications are ML, MH, PT, OL and OH.

a2. Clay soils classified as CH with a liquid limit greater than 50.

a3. Rock material without a soil matrix in which nesting of rocks could occur.

b. Material classified as CL-ML (Plasticity Index of 4 to 7) shall not be used to construct Pond Dikes. However, limited amounts of that material may be blended with CL material to meet the limits of cohesive material listed above and used for "General Fill."

203. <u>MATERIAL FOR CLAY LINER</u>

203.1 Satisfactory Material:

a. Materials for the clay liner shall be clay, silty clay, sandy clay, or clayey sand classified as CL soils in the Unified Soil Classification System, ASTM D2487. Clay liner material shall meet requirements shown below.

No.	Test	Item	ASTM	Requirement
1	Atterberg Limits	Liquid Limit Plasticity Index	D 4318 D 4318	30% minimum 15% minimum 40% maximum
2	Gradation	Passing No. 200 sieve (0.074mm size) Passing 2 micron (0.002mm) size Retained on the 3/8 inch sieve	D1140 D 422 D 422	50% minimum 30% minimum 10% maximum
3	Permeability	Permeability	D 5084	$1x10^{-6}$ cm/sec maximum

b. Clay shall be free from trash, vegetation, organic matter, hard lumps of earth, and frozen, corrosive or perishable material.

c. Clay shall not contain any earth particles or pieces of rock greater than 3/4 inch in any dimension.

d. Soils amended with additives such as bentonite, cement, or asphalt shall not be used as liner materials.

203.2 Source of Liner Material:

a. Clay for use as liner material shall be obtained from an approved borrow source.

b. Materials shall not be borrowed from any source until it has been qualified for use by the Purchaser.

204. RESTRICTIONS ON THE USE OF MATERIAL FOR ANY PURPOSE

204.1 Any material, which is frozen, contains an excessive amount of organic material or trash, or contains large rocks, shall be considered unsatisfactory for use as fill.

204.2 Fill and backfill soils placed by previous construction shall be considered unsatisfactory for use as fill unless they meet the requirements for satisfactory material.

205. TOPSOIL

205.1 Topsoils are friable sandy-loam surficial soils suitable to sustain the growth of vegetation. See Section 329219, Temporary and Permanent Seeding (Illinois). Topsoil shall be used only for surfacing of exterior side slopes of dikes and ditches.

PART 3 - EXECUTION

301. DEMOLITION, CLEARING, GRUBBING AND STRIPPING

301.1 General:

a. The work required is shown on the Design Drawings. No work shall be performed outside of the designated area without prior written approval of the Purchaser.

b. All work incidental to excavation or fill work will not be specifically indicated on the Design Drawings but shall be performed as part of the work.

301.2 Demolition:

a. No demolition of any structures is required.

b. Demolition and removal of minor items which are incidental to the earthwork may be required. The Contractor shall identify any such items during his pre-bid walkdown. The Contractor shall demolish such items as required as part of the performance of the work.

c. All waste resulting from demolition work shall be disposed of by the Contractor in an offsite disposal area.

301.3 Clearing and Grubbing:

a. All areas to be excavated or receive fill shall be cleared and grubbed, stripped of topsoil and debris and shall be inspected and approved by the Purchaser prior to beginning the earthwork operations.

301.4 Topsoil Stripping:

a. Areas designated for excavation or fill shall be stripped of all topsoil. Striped topsoil shall be placed in an onsite stockpile and used to cover finished ditches, slopes and other designated areas.

302. EXCAVATION

302.1 Classification of Excavation:

a. Excavation is classified as follows:

a1. Earth Excavation.

a2. Rock Excavation.

b. Earth excavation shall consist of removal of all material encountered which can be excavated using common earthmoving equipment.

c. Rock excavation shall consist of the excavation of boulders 1/2 cubic yard in volume or greater, all rock in ledges, and bedded and conglomerated deposits so firmly cemented that they cannot be removed by common earthmoving equipment.

302.2 Earth Excavation:

a. After topsoil removal has been completed, excavation within the limits of grading shall be performed to the lines and grades indicated on the Design Drawings.

b. Excavated material shall be used for fill unless it is classified as unsatisfactory.

c. Excavations shall not be carried below grades indicated on the Design Drawings without approval of the Purchaser. Over excavations shall be refilled with compacted satisfactory fill material to the proper grade at the Contractor's expense.

d. If unsatisfactory material is encountered at the bottom of an excavation, this material shall be removed to a depth as directed by the Purchaser and backfilled to the proper grade with compacted satisfactory fill material.

e. Excavation shall be performed in a sequence which will provide proper drainage at all times. Excavations shall be kept free of standing water while construction is in progress.

302.3 Rock Excavation:

a. No rock excavation is anticipated for this project.

302.4 Excavation of Drainage Facilities:

a. Drainage ditches, gutters, swales and channels shall be cut accurately to the cross section and grades indicated on the Design Drawings.

b. Roots, stumps, rocks and foreign material in the sides and bottom of drainage facilities shall be removed and the facility trimmed and dressed.

c. Care shall be taken not to excavate ditches and channels below the grades indicated. Excessive excavation shall be backfilled with compacted satisfactory backfill material.

d. Drainage facilities shall be maintained until final acceptance of the work by the Purchaser.

e. Material excavated from the drainage facilities shall be used as fill or transported to a designated stockpile or disposal area.

302.5 Stockpile of Select Material:

a. Stockpiling of excavated material suitable for use shall be as directed directed by the Purchaser.

302.6 Disposal of Excess Material:

a. Excess excavated material shall be placed in a designated onsite stockpile or disposal area as directed by Purchaser. Material may be removed from the stockpile or disposal area as directed by the Purchaser.

b. After completion of earthwork operations, all disposal and stockpile areas shall be dressed to drain properly and control erosion and seeded or removed from the site as directed by the Purchaser.

303. <u>PREPARATION OF SUBGRADE TO RECEIVE FILL</u>

303.1 Removal of Unsatisfactory Material Beneath Dikes:

a. Any material which is unsatisfactory for use for dike construction shall be removed and placed in a disposal area. The subgrade soils shall be inspected and approved by the Purchaser prior to the start of dike construction.

303.2 Preparation of Sloping Areas and Hillsides:

a. If fill is to be placed on an original hillside or an existing embankment with a slope of between 5 and 20 percent, the original ground shall be scarified to provide a bond between the ground and the fill to be placed thereon and the first layer of fill shall be placed, blended and compacted.

b. If fill is to be placed on an existing hillside or embankment which has a slope of greater than 20 percent, the fill shall be keyed at the toe of the slopes of the original hillside or existing fill and shall be continuously benched to key the fill to the underlying ground to ensure that new work is constructed on a firm foundation free of loose or disturbed material.

c. Keys at the toe shall be approximately 10 feet wide by 1 foot deep.

d. Benches on the slope shall be a minimum of 1 foot deep normal to the slope and about 10 feet wide. Benches shall slope 2 percent downhill and shall be horizontal longitudinally following the natural contours. Material excavated from benches may be mixed with new fill and compacted.

303.3 Compaction and Proofrolling:

a. Extent: The subgrade of areas to receive fill shall be compacted and proofrolled prior to placing the fill. The subgrade shall be compacted to a minimum degree of compaction specified in Table 1. Compaction shall be performed using suitable equipment for the type of soil present. Proofrolling shall consist of furnishing and operating heavy pneumatic tired compaction equipment for testing the stability of subgrade prior to receiving the fill. The intent is to locate any unstable areas. Compaction and proofrolling shall be performed in the presence of the Testing Service to allow for observation of unstable areas.

b. Proofrolling Equipment: The compaction equipment used for proofrolling shall be equipment such as a fully loaded water wagon having a gross weight of not less than 25 tons or a pneumatic-tired roller having not less than 4 pneumatic wheels. Under working conditions the roller shall deliver a compression of not less than 150 pounds per square inch of tire tread.

c. Operation: Compact the surface of the subgrade to be proofrolled. Proofroll the surface by making a minimum of two coverages with the compaction equipment at a speed of not greater than 5 mph. Each succeeding trip of the proofroller shall be offset by not greater than one tire width. Make additional passes over areas of suspected instability.

d. Failure: The subgrade shall be considered failed if, under the action of proofrolling, the subgrade yields, pumps, or is otherwise unstable. Yielding is defined as rutting of more than 1 inch measured from the top of the construction grade to the bottom of the rut.

e. Remedial Action: Remove all failed areas a minimum depth of 1 foot or deeper as directed by the Purchaser and replace with satisfactory fill compacted as specified in Table 1.

304. <u>PLACEMENT OF GENERAL AND STRUCTURAL FILLS</u>

304.1 Material Sources:

a. Borrow material from an onsite cut on an onsite borrow area shall be used for obtaining material for this purpose unless an offsite borrow area is identified by the Purchaser.

304.2 Moisture Content of Fill Material:

a. If the material is too dry, cut areas shall be pre-wetted to raise the moisture content. If the material is too wet, both cut and fill areas may require wind rowing or blending to dry the material. The moisture content of dike fill shall be within the range of (-) 1 to (+) 3 percent of optimum moisture content at the time of compaction. The moisture content of structural fill material shall be within ±2 percent of optimum moisture content at the time of compaction. The moisture content of general fill material shall be within ±3 percent of optimum moisture content at the time of compaction.

b. Fill material, which contains excessive moisture, shall not be compacted unless the material has dried and the moisture content is within the specified limits.

c. Fill material, which is too dry, shall have moisture added and then be blended so that the moisture content is uniform throughout the thickness prior to compaction.

d. Moisture control shall be applied to the upper 6 inches of the undercut subgrade soils.

304.3 Thickness:

a. Fill shall be placed in horizontal layers in thicknesses compatible with the material being placed, equipment being used and the compaction requirements.

b. Unless otherwise approved by the Purchaser the loose thickness shall not exceed the following:

b1. 8 inches maximum loose lift thickness for compaction by self-propelled equipment.

b2. 3 inches maximum loose lift thickness for compaction by hand-operated equipment.

b3. These lift thicknesses may be increased if the results of a test section prove that a thicker loose lift can be compacted to the required specified densities. The maximum loose lift thickness shall be 12 inches.

304.4 Placement of General and Structural Fills:

a. Each layer of fill shall be evenly spread and moistened or aerated as required to achieve the required moisture content.

b. Large continuous areas shall be uniformly filled to cover the entire length and width of the area to be filled before the next higher layer of material is placed.

c. The top surface of each layer shall be approximately level but shall have sufficient crown or cross fall to provide adequate drainage of water at all times during the construction period. The crown or crossfall shall be at least 1 in 50 (2 percent) but no greater than 1 in 20 (5 percent).

d. Fill slopes steeper than 20 percent (i.e., 5 horizontal to 1 vertical) shall be overfilled a minimum of 6 inches beyond the face of the slope, measured horizontally, and then cut back and trimmed to the required line and grade to expose a smooth surface uniformly compacted to the required density.

Installing the fill slope to lines and grades shown on the Design Drawings and then running over the surface with compaction equipment is not acceptable.

304.5 Placement of Dike Fills:

a. The fill material shall be brought to the required moisture content prior to being placed as dike fill.

b. The fill material shall be placed in horizontal lifts with a 2 percent cross slope. The entire length of the dike shall be uniformly raised for the entire length and width of the dike before the next higher layer of material is placed.

c. The width of a lift shall be the entire width of the finished dike at the height of the lift plus 6 inches beyond the face of each slope, measured horizontally to the slope. After compaction is complete the face of each slope shall be trimmed back to a uniformly compacted surface meeting density requirements. Compacting a slope by running up and down the slope is not acceptable.

304.6 Compacting Fills:

a. Equipment:

a1. Each layer of fill shall be compacted by tamping, sheepsfoot roller, pneumatic-tired roller, smooth drum steel-wheeled roller or other mechanical means acceptable to the Purchaser that will produce the specified compaction.

a2. At locations where it would be impractical because of inaccessibility to use self-propelled compacting equipment, fill layers shall be compacted using hand directed compaction equipment.

a3. When soils are used that develop a densely packed surface as a result of spreading or compacting equipment, the surface of each layer of fill shall be sufficiently roughened after compaction to ensure bonding of the succeeding layer.

b. Inspection and Testing:

b1. All work is subject to inspection and testing by an Independent Testing Service. The Testing Service shall have access to the work at all times. Testing shall be in accordance with Section 014362, "Quality Assurance for Installation of Earthwork and Clay Lining for a Clay Lined Pond".

b2. Each layer of compacted fill shall be tested before proceeding with the next layer.

b3. It is the Contractor's responsibility to request inspection prior to proceeding with further work that would make parts of the work inaccessible for inspection.

b4. If the fill material fails to meet the required density, the material shall be removed and replaced or reworked, altering the construction method as necessary to obtain the required density and compaction. Sufficient time shall be allotted between lifts for the necessary testing of the soils.

c. Compaction Densities:

c1. The degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained at optimum moisture content in accordance with ASTM D698.

c2. Compaction requirements are specified in Table 1.

305. PLACEMENT OF THE CLAY LINER

305.1 Excavation:

a. In-Place Material:

a1. Acceptable in-place liner materials SHALL NOT be compacted in-place. They shall be excavated and stockpiled or conditioned as specified herein before being placed and compacted.

a2. Liner material to be excavated from within the area to be lined may be stockpiled within the area to be lined as determined by the Contractor. Stockpiles outside of the area to be lined shall be approved by the Purchaser prior to stockpiling.

a3. Stockpile areas shall be properly prepared by clearing, grubbing and stripping.

a4. The Contractor shall provide and maintain suitable drainage in stockpile areas to prevent excessive wetting of the material. Stockpiled material shall be placed with a sufficient slope to assure rapid runoff of rainfall.

b. Borrow:

b1. Borrow areas shall first be cleared, grubbed and stripped before proceedings with borrow excavation of the liner material.

b2. The Contractor shall be responsible for maintenance of proper drainage and erosion control within the borrow area until the area is closed.

b3. Upon closure, all borrow areas shall be graded to drain and seeded or surfaced in accordance with final landscaping plans.

305.2 Blending and Conditioning of Material:

a. Selection and Blending:

a1. Selective use of material or blending of clay materials may be required to produce the required quality and uniformity. The soil shall be mixed and blended as it is excavated to produce as homogeneous a soil as possible. Methods such as cutting across zones of stratification and sieving out and crushing large clods shall be followed as necessary during excavation.

b. Conditioning:

b1. If a change in moisture content is required then conditioning shall be as follows:

b1.1 If a change of less than 2% is required then the change may be accomplished after the soil is in-place at the site, but before it is compacted.

b1.2 If a change of more than 2% is required then conditioning to adjust the moisture content to within 2% of moisture content required for compaction shall be done at the borrow source. Corrective moisture content of more than 2% IS NOT PERMITTED at the site.

b2. If a substantial change in moisture content is required it shall be done so that moistening or drying occurs uniformly throughout the soil. Materials shall be mixed and blended with discs or harrows as necessary so that the soil is uniform and homogeneous as to material and moisture content and so that clods are thoroughly wetted.

305.3 Preparation of the Subgrade to Receive Clay Liner Material:

a. The top 12 inches of subgrade shall be compacted to the degree of compaction specified in Table 1 and then proofrolled using equipment specified in Paragraph 303.3 to determine suitability of the subgrade. Proofrolling shall be performed in the presence of the Purchaser to allow for observance of deflection, pumping, or rutting. The Purchaser shall make the determination of unsuitable areas. Soft spots shall be excavated a minimum depth of 1 foot by the Contractor and backfilled with suitable material compacted to a minimum of 95% of maximum dry density as determined by ASTM D 698.

b. Prior to placement of the liner, the Contractor and the Purchaser shall inspect the subgrade for the following:

b1. Moisture seeps in the base or side slopes of the ponds.

b2. Side slope or base softening or failure due to moisture seeps.

b3. Presence of zones of high permeability that could present a pathway to seepage. Zones of high permeability can be fissures or fractures in the base or side slope or pockets of high permeability gravel or rock.

c. The Purchaser shall define the regions of high permeability requiring sealing. The Contractor shall seal all regions of high permeability identified by the Purchaser by over excavating a minimum of 2 feet and backfilling the over excavation with material meeting the requirements for satisfactory clay liner material compacted to a minimum of 95% of maximum dry density as determined by ASTM D 698. This type of work shall be performed in the presence of the Purchaser.

d. The Purchaser shall define and work required to eliminate moisture seeps and/or repair damage due to moisture seeps.

305.4 Weather Related Restrictions on Placement:

a. Placement and compaction operations during periods of rainfall, snowfall, high winds, or when the air temperature drops below 30°F IS NOT PERMITTED.

b. Liner material shall not be placed on frozen ground or on surfaces having visual signs of ponded water, frost or snow.

c. Frozen material shall not be incorporated into liner fill.

d. Before resumption or liner placement after freezing weather the surfaces to receive liner fill shall be scarified to the depth of frost penetration and recompacted to the specification requirements. The surfaces to receive fill shall be approved by the Purchaser prior to placement of a new lift.

e. After a prolonged shutdown the surfaces to receive liner fill shall be scarified and moistened to a minimum depth of 6 inches or as directed by the Purchaser and recompacted to the required density.

305.5 Placement of Lifts:

a. On the bottom crowned or sloped sections, the liner material shall be placed and compacted in nearly horizontal lifts.

b. On side slopes 2-1/2 horizontal to 1 vertical and flatter, the liner material shall be placed and compacted in lifts parallel to the slope.

c. On slopes steeper than 2-1/2 to 1, the liner material shall be placed and compacted in horizontal lifts. The width of a lift shall be a minimum of 12 feet or the width of the largest piece of construction equipment in use whichever is greater. After compaction, the face of the slope shall be trimmed. The width of trimming shall be a minimum of 12 inches, measured horizontally.

305.6 Material Placement and Conditioning:

a. Prior to compaction, the moisture content of the clay shall be adjusted to between +1% and +6% WET of the optimum moisture content.

b. Changes in moisture content of up to 2% may be accomplished at the site. If substantial changes are required, see Paragraph 305.2.

c. The maximum size of hard clods prior to compaction shall be 3/4 inch. This shall be determined by visual inspection. If the maximum clod size exceeds 3/4 inch, additional mixing and blending shall be provided as required to reduce clods to that size or the larger clods shall be sieved out.

d. The maximum loose thickness of a lift shall be 9 inches or the length of the compaction sheepsfoot roller feet, whichever is less. The maximum thickness of a compacted lift shall be 6 inches.

305.7 Compacting Clay Liner Material:

a. Compaction Equipment:

a1. Sheepsfoot Roller: The Contractor shall use sheepsfoot rollers of adequate weight to achieve compaction densities specified herein and to achieve the kneading action necessary to breakdown clods blended in liner materials, and eliminate interclod voids. Sheepsfoot rollers shall conform to the following:

a1.1 Have long thin feet capable of fully penetrating a loose lift and blending and compacting the bottom of the lift directly into the top of the previous lift. The minimum preferable length of the feet is 8 inch.

a1.2 Have a roller weight of not less than 50,000 lb. and a minimum weight of 3000 lb. per linear foot of roller. A roller with a weight of 4,000 to 5,000 lb./linear foot is preferred.

a1.3 The area of each foot shall be such that the foot contact pressure is not less than 300 psi, preferably 400-500 psi.

a2. Breakdown Roller: The Breakdown Roller used for fine finishing shall be a heavy wheel roller with 18,000 to 25,000 lb. wheel loads and tire inflation pressures in excess of 65 psi.

a3. Smooth Drum Roller: The Smooth Drum Roller used for compaction and fine finishing shall be a 3-axle tandem roller with a minimum weight in the range of 15 to 20 tons. Heavy rollers with a weight over 20 tons are acceptable.

b. Compaction:

b1. Compaction shall be accomplished using heavy sheepsfoot rollers.

b2. Compaction equipment shall pass over the soil liner a sufficient number of times to maximize compaction. Each lift shall receive a minimum of 5 passes of a footed roller. Additional passes shall be made as necessary to blend the soil, break up clods, and obtain the specified degree of compaction.

b3. The clay shall be compacted to at least the minimum dry density specified in Table 1.

b4. If a compacted lift fails to meet the specified density, the clay shall either be compacted further or removed and replaced. If a density moisture content test of the clay fails to meet specifications, the clay shall be scarified, the moisture content adjusted, and the material recompacted for an area extending from the failed test to one-half the distance to the nearest passed tests, in all directions. The Contractor shall alter compaction methods of subsequent work as necessary to obtain the specified compaction. The recompacted area shall then be retested for conformance with specifications.

b5. Compaction of bottom crowned sections shall start by rolling at the sides and proceed toward the center of the crowned section.

b6. Compaction of sloped areas shall start longitudinally at the low side and proceed toward the high side.

b7. Alternate trips of rollers shall be slightly different in length and shall overlap on successive trips by at least one-half of the width of the roller unit.

b8. After compaction of a lift is completed, the surface shall be smoothed using a rubber-tired breakdown roller or a heavy steel smooth drum roller to provide protection against over moistening during a rainfall and provide a smooth surface so that Construction Quality Control Tests can be made.

305.8 Fine Finishing of the Lining Surface:

a. After the lining has been brought to its final thickness and lift compaction is complete, the surface of the lining shall be fine finished as follows:

a1. Visually inspect the surface, remove clods and stones that would be retained on a 3/4 in sieve.

a2. Irregularities such as desiccation cracks and holes shall be corrected. Soil from irregularities, which cannot be corrected in-place, shall be removed and replaced with acceptable material.

a3. Shape the lining and form a flat uniform working surface free of bumps, ridges, gullies, holes, ruts, desiccation cracks or pockets of non-cohesive material.

a4. Compact the surface using a heavy rubber-tired roller or a heavy smooth steel drum roller to obtain a smooth, uniform surface. The last two passes of the surface shall be made using a heavy smooth steel drum roller.

b. The finished compacted surface of the clay liner shall be placed to the locations and elevations shown on the Design Drawings. Tolerances shall be as shown in Table 2.

305.9 Protection of Liner:

a. The Contractor shall make provisions to protect the liner until the geomembrane is in place. Protection shall be provided against over-moistening or erosion during rainfall or cracking resulting from desiccation or freezing.

b. If soft spots, subsidence or cracks larger than 1 inch wide or 2 inches deep occur in the clay liner prior to placement of the protective cover, the Contractor shall be responsible for blading down the lining material to the unaffected soil and then preparing and recompacting the disturbed soil to meet the requirements specified herein.

306. <u>PREPARATION OF SUBGRADE BENEATH GEOMEMBRANE LINER</u>

306.1 Intersections Between Planes:

a. Intersections between planes shall be rounded as specified below to provide a firm bearing without abrupt change:

	Intersection of Slope	Radius of Rounding
a1.	Side slope and bottom plane..	3 feet minimum

a2.	Side slope and top of dike or grade..	6 inch minimum
a3.	Intersection of 2 bottom planes (planes sloped at 10% or less).....	Straight line is acceptable

306.2 Responsibility:

a. The Contractor shall be responsible for preparing the surface of the subgrade beneath a geomembrane liner prior to placement of the liner. The subgrade is subject to inspection and acceptance by the Purchaser and the Geomembrane Liner Contractor prior to installation of the liner.

306.3 Inspection:

a. When requested by the Contractor, the Purchaser and the Geomembrane Liner Contractor shall inspect and document the following:

a1. Lines, grades and slopes are in conformance with the Design Drawings.

a2. Surface has been graded and rolled such that it is free of irregularities, protrusions, loose soil and abrupt changes in grade.

a3. The surface is free of debris, clods, stones, roots and organic material.

a4. That no settlement has occurred.

a5. That there are no side slope failures.

a6. That there are no moisture seeps, puddling or ponding.

a7. That there are no soft spots.

306.4 Certification:

a. The Geomembrane Liner Contractor shall provide written certification that the surface is acceptable. The acceptance shall be recorded and copies of the certification given to both the Contractor and the Purchaser.

b. Only as much surface as will be lined the following day shall be inspected, certified and documented as acceptable.

306.5 Geomembrane Liner Contractor's Responsibility:

a. After the surface has been accepted by the Geomembrane Liner Contractor, it becomes its responsibility and changes or repair work are the Geomembrane Liner Contractor's responsibility. Requests for changes or repair work to the subgrade by the Geomembrane Liner Contractor may be made through the Purchaser. The expense of such work shall be by the Geomembrane Liner Contractor.

307. <u>PREPARATION OF CONCRETE SURFACES</u>

307.1 All portions of concrete walls, curbs and foundation that will come in contact with a geomembrane shall be free of sharp edges or rough spots that can puncture or abrade the geomembrane. Where necessary, the concrete shall be ground smooth. Where specified on the plans, a geomembrane scuff strip shall be placed between the concrete and the geomembrane to act as a protective layer for the liner.

308. ANCHOR TRENCH EXCAVATION AND BACKFILLING

308.1 Excavation and Shaping:

a. The anchor trench shall be excavated by the Contractor to the lines and widths shown on the Design Drawings, prior to geomembrane liner system placement.

b. A slightly rounded corner shall be provided in the trench where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. The radius of rounding is shown on the Design Drawings. No loose soil shall be allowed to underlie the geomembrane in the anchor trench.

c. The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open.

308.2 Backfilling:

a. The anchor trench shall be backfilled by the Contractor after the geomembrane is in place.

b. Backfilling of the anchor trench shall occur during the morning or during extended periods of overcast skies when the liner is at its most contracted state.

c. Backfill shall be placed in layers not exceeding 6 inches loose thickness and compacted using hand compaction equipment to 95 percent of maximum density as determined by ASTM D698 at a recommended moisture content of optimum water content ±3%.

d. The material used for backfilling the first 8 inches of the anchor trench may be screened material from an onsite stockpile or material excavated from the trench which has a maximum size stone of 2 inches. The material used to backfill the remainder of the trench shall be material excavated from the trench which has a maximum size stone of 2 inches.

309. GRADING TOLERANCES

309.1 The acceptable deviation from lines and grades indicated on the Design Drawings shall be as shown in Table 2.

309.2 Slopes shall be finished in conformance with the lines and grades shown on the Design Drawings. When completed, the average plane of a slope shall conform to the slope indicated on the Design Drawings and no point on the completed slope shall vary from the designated plane by more than 6 inches measured at right angles to the slope.

310. CLEAN-UP

310.1 All waste, excess materials and debris shall be disposed of in an onsite or offsite disposal area as directed by the Purchaser.

TABLE 1

MINIMUM DEGREE OF COMPACTION	
AREA	**ASTM D698 (percent)**
Subgrade beneath fills, Dikes and Clay Lining	95
Pond Dike	95
Clay Liner	95
General Site Fills	95
Structural Fills	
Fills supporting structures (1)	98
Upper 3 feet of fills supporting roads or pavement	98
Deeper fills supporting roads or pavement	95
Drainage facilities (ditches, etc.)	95

Notes:

(1) Structures include items such as equipment, buildings, pump structures, inlet and outlet structures, walls, and retaining walls and any other structures or equipment that are sensitive to settlement.

TABLE 2

ACCEPTABLE DEVIATION		
Type of Installation Excavation or Fill	**Maximum Acceptable Deviation From Line (Feet)**	**Maximum Acceptable Deviation From Grade(l) (Feet)**
General Earthwork		
Pond Dike and Top Edge of Excavated Ponds	±0.5	+0.25 to -0.0
Pond Bottom (Top of Liner) (2)	±0.3	±0.0 to ±0.1
General Site Area	±0.3	±0.2
Roads		
Road Embankment or Subgrade	±0.2	+0.1 to -0.0
Drainage Facilities		
Permanent Drainage Channel	±0.3	0.0 to - 0.1
Slope Drainage Benches and Drainage Diversion Dikes	±0.5	±0.1

Notes:

(1) After initial settlement has taken place. Initial settlement is that settlement that will occur up to the time of determination and acceptance of final grade elevation as approved by Purchaser.

(2) Zero minus tolerance for thickness.

END OF SECTION

ATTACHMENT 6

Geomembrane Specifications

SECTION 319022

HIGH DENSITY POLYETHYLENE GEOMEMBRANE LINER

PART 1 - GENERAL

101. EXTENT

101.1 The intent of this specification is to define the minimum requirements for material and installation of High Density Polyethylene (HDPE) Non-Textured and Textured Geomembrane to be used as a liner for the bottom and side slopes of a pond, all in accordance with the Design Drawings and as specified herein.

101.2 Work Included:

101.3 The work shall include, but not be limited to, the following items:

a. Manufacture, shipping, handling, and storage of geomembrane materials.

b. Inspection and approval of surfaces to be lined.

c. Placement and field seaming of geomembrane.

d. Crest anchorage and attachment of the geomembrane to structures and penetrations.

e. Non-destructive field testing of geomembrane seams.

f. Removal of samples of geomembrane seams and transportation to an independent third party laboratory for destructive testing.

g. Repair of defective geomembrane seams.

h. Repair of defects in the geomembrane and locations where samples were taken.

i. Visual inspection of the completed geomembrane liner.

101.4 Definition of Terms:

a. The following definition of terms shall apply throughout this section.

a1. Purchaser: Ameren Resource Generation Company

a2. Earthwork Contractor: The Contractor who will be responsible for earthwork for the facility and for excavation and backfill of crest anchorage trenches.

a3. Geomembrane Contractor (Contractor): The Contractor who is responsible for supply and installation of all geomembrane and geotextile materials and unloading and storage of the materials.

a4. Construction Quality Assurance (CQA) Contractor: The Contractor who is responsible for all CQA work.

a5. Construction Quality Assurance (CQA) Geomembrane Inspector: An inspector who works for the CQA Contractor and is responsible for inspection of the Geomembrane Contractor's work.

a6. Manufacturer: The Manufacturer who is responsible for manufacture of materials and for transporting materials to the site.

101.5 Qualifications:

a. Manufacturer:

a1. The Manufacturer shall be approved by the Purchaser.

b. Geomembrane Contractor:

b1. The Geomembrane Contractor shall be approved by the geomembrane Manufacturer for installation of the Manufacturer's products.

b2. The Geomembrane Contractor shall be approved by the Purchaser.

102. <u>RELATED WORK SPECIFIED IN OTHER SECTIONS</u>

102.1 Section 319040 – Geotextiles for Lined Ponds.

102.2 Section 319005 – Earthwork and Clay Lining for a Clay/Geomembrane Composite Lined Pond.

103. <u>REFERENCE DOCUMENTS</u>

103.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state or local codes having jurisdiction.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 Abbreviations listed indicate the form used to identify the reference documents in the Specification text.

103.4 ASTM - American Society for Testing and Materials:

a. A276 Specification for Stainless and Heat Resisting Steel Bars and Shapes.

b. B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

c. D638 Test Method for Tensile Properties of Plastic.

d. D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

e. D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

f. D1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

g. D1505 Test Method for Density of Plastics by the Density-Gradient Technique.

h. D1603 Test Method for Carbon Black in Olefin Plastics.

i. D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Colorimetry.

j. D4218 Standard Test Method for Determination of Carbon Black Content of Polyethylene Compounds by the Muffle-Furnace Technique.

k. D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

l. D5199 Test Method for Measuring Normal Thickness of Geotextiles and Geomembranes.

m. D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

n. D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

o. D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

p. D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

q. D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

r. D5885 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Colorimetry.

s. D5994 Test Method for Measuring Core Thickness of Textured Geotextile.

t. D6392 Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

103.5 GRI – Geosynthetic Research Institute:

a. GM 6 Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembrane.

b. GM 10 Specification for the Stress Crack Resistance of Geomembrane Sheet.

c. GM 11 Accelerated Weathering of Geomembranes Using a Fluorescent UVA-Condensation Exposure Device.

d. GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage.

e. GM 13 Standard Specification for Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

f. GM 14 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.

g. GS 7 Determining the Index Friction Properties of Geosynthetics.

104. SUBMITTALS

104.1 Contractor shall submit the drawings and data as specified below within 30 days prior to use. Contractor's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Purchaser's information systems specified by the Purchaser.

104.2 Contractor shall submit status reports at regular intervals as specified by the Purchaser. The reports shall indicate the status of the schedule. The reports shall be submitted via electronic medium in a format compatible for importing into the Purchaser's information system specified by the Purchaser.

104.3 Submittals with the Bid Proposal:

a. HDPE Geomembrane Material:

a1. Certification of Compliance from the Manufacturer of the HDPE geomembrane sheeting signed by its authorized representative, indicating that the material meets the criteria specified herein.

a2. One representative sample of each type of geosynthetic material.

a3. Manufacturer's Quality Control and Quality Assurance Policies and Procedures.

b. Warranty:

b1. Written warranties from the Manufacturer and the Geomembrane Contractor covering the quality of the material and workmanship as applicable.

b2. The minimum period of warranty for materials shall be 20 years with first year non-prorated. The minimum period of warranty for installation shall be 5 years with the first year non-prorated.

b3. Warranty conditions proposed, including limits of liability, will be evaluated by the Purchaser in approving the liner Manufacturer and the Geomembrane Contractor.

c. Geomembrane Contractor:

c1. Geomembrane Contractor's name, address and telephone number.

c2. Geomembrane Contractor's qualifications.

c3. Installer's qualifications if the Geomembrane Contractor is proposing to subcontract installation work.

d. Testing Laboratory:

d1. Name, address, and telephone number of the off-site, independent third party laboratory that will perform destructive testing on cut samples of field seams.

d2. Laboratory's qualifications.

104.4 Submittals After Award of the Contract:

a. Geomembrane Resin:

a1. Manufacturer's signed Certificate that the resin meets specification requirements.

a2. Manufacturer's signed Certification of the origin of the resin and that all resin is from the same manufacturer (Contractor's name, identification brand name, and number).

a3. Copies of Manufacturer and resin suppliers' QA/QC certificates. Certificates shall include a summary report of test results conducted to verify the quality of the resin used in each batch used to manufacture geomembrane for this project. As a minimum, the report shall include tests on specific gravity, melt flow index and percent carbon black.

b. Geomembrane Sheeting:

b1. Signed certification that the properties of the manufactured sheeting meet specification requirements and are guaranteed by the Manufacturer.

b2. Statement certifying that no post consumer resin (PCR) has been added to the formulation.

b3. Copy of all of the geomembrane Manufacturer's Quality Assurance certificates. The certificates shall include documents of test results.

c. Extrudate Resins or Rod for Seaming Geomembranes:

c1. Certification that all extrudate is the same resin type as the geomembrane and was obtained from the same resin supplier as the resin used to manufacture the geomembranes.

d. Installation Data:

d1. Manufacturer's proposed geomembrane panel layout for each installation.

d2. Manufacturer's recommended procedures for making and testing seams if different from this specification.

d3. Manufacturer's recommended procedures for repairing damaged geomembrane sections and seams if different from this specification.

d4. Manufacturer's details of geomembrane liner anchorage, and attachment to structures and penetrations if different from this specification and the details on the Design Drawings.

104.5 Submittals After Construction is Complete:

a. Geomembrane Contractor:

a1. As-built panel layout.

a2. Drawing showing location of repairs and type of repairs made.

a3. Location of destructive tests.

a4. Results of destructive tests.

a5. Results of non-destructive tests.

105. QUALITY ASSURANCE

105.1 Materials and construction procedures shall be subject to inspection by a Construction Quality Assurance (CQA) Testing Service employed by the Purchaser.

PART 2 - PRODUCTS

201. HIGH DENSITY POLYETHYLENE GEOMEMBRANE

201.1 Manufacturers of HDPE Geomembrane Products:

a. The products of the following manufacturers meeting the requirements herein are acceptable:

a1. Agru/America Manufacturing, Inc., 500 Garrison Road, Georgetown, SC 29440, Tel.: 800-373-2478.

a2. Polyflex, 2000 W. Marshall Drive, Grand Prairie, TX 75051, Tel.: 888-765-9359.

a3. GSE Lining Technology, Inc., 19103 Gundle Road, Houston, TX 77073, Tel.: 281-443-8564 or 800-435-2008.

a4. Other as approved by the Purchaser.

201.2 HDPE Geomembrane - General Requirements:

a. The HDPE geomembrane shall be manufactured from first quality, virgin resin. Blending of resins shall not be allowed. No recycled or reworked geomembrane may be used except edge trim generated during the manufacturing process (no more than 10%). No post consumer resin (PCR) of any type shall be added to the formulation.

b. The resin used to produce the geomembrane shall be formulated to be resistant to chemical and ultraviolet degradation.

c. The geomembrane shall be free of plasticizers.

d. The geomembrane shall be free of leachable additives.

e. During manufacture, each roll of geomembrane shall be continuously monitored across the width to assure uniformity of thickness. Thickness measurements shall meet the requirements of Table 1 for Non-Textured Geomembrane and Table 2 for Textured Geomembrane.

f. The geomembrane shall be free of factory seams.

g. The geomembrane shall be free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, blisters, pits, tears, holes, pores, pinholes, voids, undispersed raw material, any sign of contamination or other defects that may affect serviceability, and shall be uniform in color, thickness and surface texture.

h. The geomembrane shall be capable of being seamed in the field to yield seams that are as resistant to waste liquids as the sheeting.

i. The geomembrane shall be manufactured in the United States or Canada.

201.3 HDPE Non - Textured Geomembrane:

a. HDPE Non-Textured Geomembrane shall meet the requirements of Table 1.

b. The location of HDPE Non-Textured Geomembrane to be used for each installation shall be as shown on the Design Drawings.

201.4 HDPE Textured Geomembrane:

a. HDPE Textured Geomembrane shall meet the requirements of Table 2.

b. The location of HDPE Textured Geomembrane to be used for each installation shall be as shown on the Design Drawings.

c. The textured liner shall be manufactured using a co-extrusion process.

d. The textured coating shall be applied to both sides of the base sheet.

e. Textured geomembrane shall have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

f. Each roll shall have 6 inch wide smooth edges to provide suitable seaming surfaces. Textured geomembrane without smooth edges may be provided if approved by the Purchaser.

TABLE 1

HIGH DENSITY POLYETHYLENE NON-TEXTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	GEOMEMBRANE MINIMUM AVERAGE ROLL VALUE				Testing Frequency
Nominal thickness, mil	--	--	40	60	80	100	---
Resin Properties							
Oxidative Induction Time (OIT), minimum average minutes							
Standard OIT or	D3895	100	--	--	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D3895	55	--	--	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 Hrs	D5885	50	--	--	--	--	one per formulation
Analytical Properties							
Density of base resin, g/cc minimum	D1505/D792	0.940	--	--	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	--	--	45,000 lbs. .of Resin
Mechanical Properties							
Thickness, mils	D5199	--	--	--	--	--	One per roll
Average		--	40	60	80	100	
Lowest individual of 10 values		--	36	54	72	90	
Tensile properties, in each direction (minimum):	D638 (Type IV Specimen at 2 ipm)						
Tensile stress at yield, ppi minimum		--	84	126	168	210	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	152	228	304	380	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	700	700	700	700	20,000 lbs. of Resin
Tear resistance, lb (minimum avg)	D1004	--	28	42	56	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	72	108	144	180	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	--	--	
Shear strength, ppi		--	81	121	162	203	
Peel adhesion (fusion), ppi		--	65	98	130	162	
Peel adhesion (extrusion), ppi		--	52	78	104	200	
Environmental and Aging Effect on Properties							
Stress Crack Resistance, hours (min)	D5397	--	200	200	200	200	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, adopted June 17, 1997 except for bonded seam strength.
2. Seam requirements.

TABLE 2

HIGH DENSITY POLYETHYLENE TEXTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	GEOMEMBRANE MINIMUM AVERAGE ROLL VALUE				Testing Frequency
Nominal thickness, mil	--	--	40	60	80	100	---
Resin Properties							
Oxidative Induction Time (OIT), minimum average minutes			--	--	--	--	
Standard OIT or	D3895	100					200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D3895	55	--	--	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 hrs.	D5885	50	--	--	--	--	one per formulation
Analytical Properties							
Density of base resin, g/cc minimum	D1505/D792	0.932	--	--	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	--	--	45,000 lbs. of Resin
Mechanical Properties							
Thickness, mils	D5994	--	--	--	--	--	One per roll
Minimum Average		--	38	51	76	95	
Lowest individual for 8 out of 10 values		--	36	54	72	90	
Lowest individual for 10 out of 10 values		--	34	51	68	85	
Asperity Height, mils (min avg)	GM 12	--	10	10	10	10	Every second roll
Tensile properties, in each direction (minimum average)	D638 (Type IV Specimen at 2 ipm)						
Tensile stress at yield, ppi minimum		--	84	126	168	210	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	60	90	120	150	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	100	100	100	100	20,000 lbs. of Resin
Tear resistance, lb. (minimum avg)	D1004	--	28	42	56	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	60	90	120	150	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	--	--	
Shear strength, ppi		--	81	121	162	203	
Peel adhesion (fusion), ppi		--	65	98	130	162	
Peel adhesion (extrusion), ppi		--	52	78	104	130	
Environmental and Aging Effect on Properties							
Stress Crack Resistance, hours (min)	D5397	--	200	200	200	200	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, adopted June 17, 1997 except for bonded seam strength.
2. Seam requirements.

201.5 Panel Layout:

a. Prior to manufacture of the geomembrane, a panel layout of the surface to be lined shall be made. Each panel to be used for the installation shall be given a numeric or alphanumeric identification number.

b. The panel identification number shall be related in writing to the manufacturing roll number that identifies the resin type, batch number, and date of manufacturer.

c. The panel layout shall be made considering the following requirements:

c1. Panel lengths shall include slope gain and anchorage.

c2. Perpendicular tie-ins shall be made a minimum of 5 feet beyond the toe of the slope.

c3. A minimum of 6 inch overlap shall be allowed at double fusion welded seams.

c4. All field seams on slopes shall be oriented parallel to the slope (oriented along, not across the slope).

c5. The number of seams in corners or odd shaped geometric locations shall be minimized.

201.6 Packaging and Shipping:

a. The geomembrane shall be shipped to the project site in rolls. No material shall be folded.

b. A label shall be attached or adhered to each roll of the geomembrane identifying the following:

b1. Manufacturer.

b2. Product Identification, which can be traced back to the origin of the base material (resin supplier's name, resin production plant, resin brand name type, resin brand number, and production date of the resin).

b3. Date of manufacture of the geomembrane.

b4. Roll identification number.

b5. Geomembrane thickness and type.

b6. Roll dimensions (length and width).

b7. Batch number.

b8. Order number.

b9. Panel number.

201.7 Packaging and Transportation:

a. Packaging and transportation shall be the responsibility of the Manufacturer, who shall retain responsibility until the geomembrane is accepted at the site by the Geomembrane Contractor.

202. MATERIALS FOR ATTACHMENT OF GEOMEMBRANE TO CONCRETE

202.1 Batten Strip:

a. Batten strip material shall be hot rolled, annealed and pickled Type 306 L stainless steel in accordance with ASTM A276.

b. Strips shall be 1/4 inch thick by 2 inches wide. Random lengths are acceptable.

202.2 Expansion Anchors:

a. Expansion anchors shall be stud type with a single piece three section wedge and zinc plated in accordance with ASTM B633. Wedges shall be manufactured from ANSI Type 304 stainless steel. Hilti Kwik Bolt 3 Expansion Anchors, or equal, are acceptable.

b. Minimum yield strength of 60,000 psi for wedge-type anchors and a minimum tensile strength of 65,000 psi for stud type anchors.

c. Anchors shall be 3/8 inch diameter x 3 1/2 inch long.

d. Washers for anchors shall be Type 18-8 stainless steel flat washers for 3/8 inch bolt size.

202.3 Neoprene Gasket:

a. Neoprene gaskets shall be 1/4 inch thick x 2 inches wide closed cell neoprene sponge sealing strips. Operating temperature range of neoprene shall be –40° F to +220° F.

b. Neoprene gaskets placed against concrete shall have a pressure sensitive adhesive on the side of the gasket placed against the concrete.

202.4 Mechanical Anchorage:

a. Extruded HDPE mechanical anchorage, set in cast-in-place concrete structures for liner attachment, shall be per Manufacturer's standard.

PART 3 - EXECUTION

301. ONSITE HANDLING AND STORAGE

301.1 Receipt/Unloading:

a. Unloading and storage of materials shall be the responsibility of the Manufacturer.

b. The unloading and other handling of materials shall be performed by the Manufacturer to ensure that the material is handled with care and not damaged.

301.2 Storage:

a. The Purchaser shall provide on-site storage space in a location near the area to be lined such that on-site transportation and handling are minimized. The Contractor shall be responsible for protecting stored material from theft and vandalism.

b. The rolls of geomembrane shall be placed on a smooth surface free of rocks and standing water.

301.3 Inspection:

a. Upon delivery of the material to the project site, the Geomembrane Contractor shall conduct a visual inspection of all rolls of geomembrane for damage or defects. This inspection shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

b. Any damage or defects shall be noted and immediately reported to the Purchaser, the Manufacturer and to the carrier that transported the material. Any roll or portion thereof, which, in the judgement of the Purchaser, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Purchaser.

302. PREPARATION OF SURFACES TO BE LINED

302.1 General:

a. The Earthwork Contractor shall be responsible for preparing and maintaining the surfaces to be lined as specified in Section 319005, "Earthwork and Clay Lining for a Clay/Geomembrane Composite Lined Pond" prior to placement of the geomembrane.

b. The Geomembrane Contractor shall confirm the conditions of the finished surfaces to be lined prior to placement of the liner.

302.2 Grading Requirements:

a. The subgrade surface on which a lining is to be placed shall be graded to elevations shown on the Design Drawings. Tolerances shall be as specified in Section 319005, "Earthwork and Clay Lining for a Clay/Geomembrane Composite Lined Pond".

302.3 Preparation of Concrete Surfaces:

a. All portions of concrete walls, curbs and foundations that will come in contact with a geomembrane shall be free of sharp edges or rough spots that can puncture or abrade the geomembrane. Where necessary, the concrete shall be ground smooth by the Earthwork Contractor. Where specified on the Design Drawings, one or more layers of geomembrane scuff strips shall be placed between the concrete and the geomembrane to act as a protective layer for the liner.

302.4 Subgrade Acceptance:

a. See Section 319005, "Earthwork and Clay Lining for a Clay/Geomembrane Composite Lined Pond" regarding inspection and acceptance of surfaces to be lined.

302.5 Geotextile:

a. See Section 319040, "Geotextiles for Lined Ponds" regarding installation, inspection, and acceptance of a geotextile used to protect the geomembrane liner.

303. FIELD PLACEMENT OF THE GEOMEMBRANE LINER

303.1 General Requirements:

a. Placement Procedure: The placement procedure used for the geomembrane liner shall include the conditions listed below.

b. Weather:

b1. Geomembrane shall not be placed when the air temperature is above 104°F or below 41°F unless it can be demonstrated to the approval of the Purchaser by trial welds that acceptable welds can be made at the prevailing temperature. Trial welds shall be as described in Paragraph 303.2.c.

b2. Geomembrane shall not be placed when there is any rainfall or snowfall, in the presence of excessive moisture due to fog or dew, in ponded water, on a frozen subgrade, or during high winds.

c. Panel Layout:

c1. The panels shall be placed in accordance with the Manufacturer's panel layout drawing to ensure that they are placed in the proper direction for seaming.

c2. If panels are installed in a location other than indicated on the panel layout drawing, the revised location shall be indicated on an "as-built" layout drawing. The "as-built" record drawing shall be submitted to the Purchaser at the completion of the project.

d. Panel Deployment:

d1. Only the panels that can be anchored and seamed together in one shift shall be unrolled.

d2. Unroll and layout panels in as close to the final position as possible. Pulling geomembrane panels should be minimized to reduce the chance of permanent tension.

d3. The methods and equipment used to deploy the panels shall not damage the geomembrane or the supporting surface.

d4. Wrinkles shall be minimized. However, enough slack shall be provided in both directions so that there will be no tension in the geomembrane at the lowest expected operating temperature.

e. Precautions to Prevent Wind Damage:

e1. If possible, work shall be oriented in the direction of the prevailing wind.

e2. Provide adequate temporary loading and/or anchoring of the geomembrane by the use of sandbags, tires or other means which will not damage the geomembrane, to prevent uplift of the geomembrane by wind.

f. Other Precautions to Prevent Damage:

f1. Protection of the geomembrane from damage due to foot traffic on the slopes shall be provided.

f2. Provisions of facilities for safe entrance and egress of employees from sloped depressions is required.

g. Replacement of Damaged Geomembrane:

g1. Any area of a panel, which, in the judgement of the Purchaser, becomes seriously damaged (torn, twisted, or crimped permanently) shall be replaced at no additional cost to the Purchaser.

303.2 Field Seaming:

a. Method of Seaming:

a1. The primary welding procedure for seams shall be double wedge fusion welding.

a2. Extrusion welding shall be used only for repairs, detail work, and for seaming where double wedge fusion welding is not possible.

a3. The rods used for extrusion welding shall be the same type of resin as the geomembrane, unless otherwise approved by the Purchaser.

a4. The use of solvents or adhesives is NOT PERMITTED.

b. General Requirements for Seaming:

b1. On slopes steeper than 10 horizontal to 1 vertical, seams shall be oriented parallel to the line of maximum slope (oriented up and down, not across the slope) when possible. No seams oriented across the slope shall be used unless approved by the Purchaser.

b2. Seams parallel to the toe of the slope shall be located a minimum of 5 feet from the toe.

b3. Seams parallel to the crest of the slope shall be located a minimum of 2 feet from the crest.

b4. Seams on the floor of the pond shall be overlapped so that the upslope sheet is positioned above the downslope sheet.

b5. Seaming shall extend to the outside edge of panels to be placed in the anchor trench. Seams at sheet corners of three or four sheets shall be completed with a patch having a minimum dimension of 24 inches, and extrusion welded to the parent sheets.

b6. All cross seams between the two rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of geomembrane.

c. Trial Welds Prior to Beginning Seaming:

c1. Trial welds are required for pre-qualification of personnel, equipment and procedures for making seams on identical geomembrane material under the same climatic conditions as the actual field production seams will be made.

c2. Trial welds shall be made as follows:

c2.1 Prior to each seaming period.

c2.2 Every 4 to 5 hours (i.e., at the beginning of the work shift and after the lunch break).

c2.3 Whenever personnel or equipment are changed.

c2.4 When climatic conditions result in wide changes in geomembrane temperature.

c2.5 When requested by CQA Geomembrane Inspector for any seaming crew or piece of welding equipment if problems are suspected.

c3. Once qualified by passing a trial weld, welding technicians shall not change parameters without performing another trial weld.

c4. Trial welds shall be made on both double wedge fusion welds and on extrusion welds.

c5. A test strip shall be prepared by joining two pieces of geomembrane, each piece shall be at least 6 inches wide. The length of double wedge fusion welded seams shall be a minimum of 10 feet long. The length of an extrusion welded seam shall be a minimum of 4 feet long. The CQA Geomembrane Inspector shall witness the fabrication of each test strip.

c6. All test welds shall be tested by destructive testing. Testing can be done as soon as the seam cools.

c7. A minimum of three (3) one (1) inch wide sample strips shall be cut from each test strip, one from each end and one from the middle. The location of each sample shall be selected by the CQA Geomembrane Inspector. The test strips shall be tested in peel at 2 inches per minute using a field tensiometer. The CQA Geomembrane Inspector shall witness all tests.

c8. If any of the test specimens fail, a new test strip shall be fabricated and the tests repeated for the new strip. If additional specimens fail, the seaming apparatus and the seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and successful trial welds have been achieved.

c9. The trial weld is considered acceptable if, when tested for peel adhesion using the field tensiometer, all three specimens meet the criteria specified in Tables 1 and 2, respectively, for both the peel and shear under Bonded Seam Strength, or the three specimens exhibit Film Tear Bond

(FTB) (yielding of the parent material before seam failure). In the case of double wedge fusion welded seams, both welds must pass in order to be considered acceptable.

c10. If the specimens pass the tests, production seaming operations can begin.

c11. The Contractor shall document all data on each trial weld, including:

c11.1 Date.

c11.2 Time.

c11.3 Operator.

c11.4 Machine number.

c11.5 Ambient temperature.

c11.6 Operating temperature.

c11.7 Speed setting.

c11.8 Pass/Fail designation.

d. Preparation for Seaming:

d1. Prior to seaming, the surface of the geomembrane shall be wiped with a clean cloth to ensure that it is clean and free from moisture, grease, dust, dirt, and debris of any kind before seam welding is started.

d2. The panels shall be adjusted so that the seams are aligned to eliminate wrinkles and fish mouths. Where necessary, fish mouths and wrinkles shall be cut to achieve flat overlap.

e. Seaming:

e1. Seaming shall be performed in accordance with the Manufacturer's accepted procedure.

e2. Double Wedge Fusion Welds:

e2.1 The panels shall be overlapped a minimum of 4 inches prior to welding.

e2.2 Vehicle mounted automated hot wedge welding apparatus shall be used to make the seam.

e3. Extrusion Fillet Welding:

e3.1 Geomembrane overlap shall be a minimum of 3 inches for extrusion welding.

e3.2 Geomembrane panels shall be temporarily bonded using a hot air device prior to extrusion welding.

e3.3 The edge of the geomembrane to be fillet welded shall be pre-beveled before heat-tacking the seam in place.

e3.4 The seam overlap shall be ground (abraded) no more than one hour prior to welding.

e3.5 Grinding shall be performed in accordance with the Manufacturer's instructions in a manner that does not damage the geomembrane.

e3.6 Grinding shall not extend more than 1/4 inch past the area to be covered with extrudate during welding.

e3.7 All grind marks shall be covered with extrudate.

e3.8 Geomembrane overlap shall be a minimum of 3 inches for extrusion welding.

303.3 Non-Destructive Field Testing – Geomembrane:

a. General:

a1. All non-destructive field testing shall be performed and documented by the Geomembrane Contractor.

a2. The CQA Geomembrane Inspector shall observe all non-destructive test procedures.

a3. One hundred (100) percent of the seam length shall be tested using non-destructive procedures to check the continuity of the field seams. Non-destructive testing is not meant to qualify seam strength.

a4. Air pressure testing shall be performed in accordance with ASTM D5820 and GRI GM 6.

a5. Vacuum Box testing shall be performed in accordance with ASTM D5641 and as specified herein.

a6. Continuity testing shall be performed as seaming progresses or as soon as a suitable length of seam is available, not at the completion of all field seaming.

b. Double Wedge Fusion Welded Seams:

b1. Double fusion welded seams shall be tested using air pressure testing.

b2. The procedure for testing shall be as specified in GRI GM 6 for the type and thickness of geomembrane in use.

b3. The following test pressures are applicable to both smooth and textured HDPE. After an initial 2 minute pressure stabilization period, the pressure shall be maintained between 24 and 30 psi for 40 mil HDPE, 27 and 30 psi for 60 mil HDPE, and 30 and 35 psi for 80 and 100 mil HDPE. The pressure shall be sustained for a minimum of 5 minutes. The loss of pressure shall not exceed a maximum of 3 psi in 5 minutes. If the pressure does not stabilize in the first two minutes or the pressure loss exceeds the loss specified, the seam test shall be considered a failure.

b4. The leak or suspected leak shall be located and repaired.

b5. The repaired seam shall be re-tested as required until all leaks are identified, and repaired, and the seam passes a subsequent air pressure test.

b6. When the geometry of a double wedge fusion weld makes air testing impossible or impractical, vacuum testing may be used to test the seam.

c. Extrusion Welded Seams:

c1. Extrusion welded seams shall be tested using vacuum chamber testing in accordance with ASTM D5641.

c2. The completed seam shall exhibit no leakage when tested between 4 and 8 psi minimum vacuum for approximately 10 seconds.

c3. If leaks are discovered during testing, they shall be located, marked, and repaired.

c4. The repaired area shall be re-tested and exhibit no leakage.

d. Inaccessible Seams:

d1. Where extrusion welded seam locations make use of vacuum box testing impractical, then the electric wire method of testing shall be used or the seam shall be cap stripped as approved by the Purchaser.

d2. If cap stripping is approved by the Purchaser, the seams shall be cap stripped as described in Paragraph 304.4, with strips of the same type and thickness of geomembrane being installed. The cap stripping shall be performed in the presence of the Purchaser.

d3. The electric wire test method shall consist of placing a 24 gauge copper wire 1/8 inch beneath the top sheet overlap of the two sheets prior to welding with the extruder. The wire shall be imbedded in the seam. After welding, a holiday spark detector, operating at 20,000 volts, shall be connected to one end of the wire and slowly moved over the length of the seam. A seam defect between the probe and the embedded wire shall result in an audible alarm indicating where the defect is located.

e. Test Reports:

e1. Test reports for all air pressure tests shall contain all data specified in ASTM D5820 and GRI GM 6.

e2. Test reports for vacuum box testing shall contain all the data specified in ASTM D5641.

e3. Test reports for other types of non-destructive tests shall contain as a minimum for each test:

e3.1 Location.

e3.2 Type of test.

e3.3 Test parameters.

e3.4 Test data.

e3.5 Test number.

e3.6 Name of tester.

e3.7 Outcome of the test.

303.4 Destructive Testing – Geomembrane:

a. Testing:

a1. Destructive testing shall be performed by an independent third party laboratory employed by the Geomembrane Contractor on samples cut from production welds in the field by the Geomembrane Contractor.

a2. Samples shall be taken by the Geomembrane Contractor to the third party laboratory and tested for shear strength and peel adhesion. For double wedge seam samples, both welds shall be tested for peel adhesion.

a3. The third party laboratory that will perform testing shall be identified by the Geomembrane Contractor with the bid proposal and agreed-to in writing by the Purchaser.

b. Location and Frequency:

b1. Test locations shall be determined after seaming. The location where the test samples shall be taken shall be marked by the CQA Geomembrane Inspector. Locations may be prompted by the appearance of excessive heating, contaminations, offset welds, or a suspected defect. Destructive test samples shall be taken at a minimum average frequency of one per every 500 linear feet of seam length.

b2. The Method of Attributes described in GRI GM 14 may be exercised to minimize the number of test samples taken if more than 100 destructive seam samples will be required based on the sampling strategy given in Paragraph 303.4.b1.

b3. Each sample location shall be numbered and marked with permanent identification and the location of the sample and the locations shall be indicated on a plan drawing prepared and maintained by the Geomembrane Contractor. The following shall be recorded for each sample:

b3.1 Date and Time.

b3.2 Ambient Temperature.

b3.3 Seam Number and Location.

b3.4 Welding Apparatus Used.

b3.5 Name of Master Seamer.

b3.6 Reason for Taking the Sample.

b3.7 Size of Sample.

b3.8 Test Results.

b3.9 Name of Tester.

b4. Samples shall be cut by the Geomembrane Contractor. The CQA Geomembrane Inspector shall witness test sample cutting.

b5. Test samples shall be cut every shift and taken by the Geomembrane Contractor to the third party laboratory the same day that the sample is prepared.

c. Sample Size:

c1. The minimum sample size shall be 12 inches wide with a seam 16 inches long centered length wise in the sample. As agreed to with Purchaser, a sample may be increased in size to accommodate the requirements of the testing laboratory.

d. Field Testing:

d1. A one-inch wide specimen shall be cut from each end of each sample for field testing.

d2. Each one-inch wide specimen shall be tested with a field tensiometer for peel adhesion.

d3. The CQA Geomembrane Inspector shall witness each field test.

d4. A test is considered acceptable if a specimen meets the criteria specified in Tables 1 and 2, respectively, for both peel and shear under Bonded Seam Strength or, exhibits Film Tear Bond (FTB). For double wedge fusion welds, both welds must pass the test. If either sample fails the field test, it shall be assumed that the seam will not pass the specified laboratory testing and the sample shall be given a fail designation.

e. Laboratory Testing:

e1. Full size (12 inch minimum length) samples shall be taken to an independent third-party laboratory for testing.

e2. Samples shall be tested for shear strength and peel adhesion in accordance with ASTM D6392. Five specimens shall be tested for each test method. All samples shall meet minimum requirements for shear strength and peel adhesion given in Tables 1 and 2, respectively, under Bonded Seam Strength.

f. Test Results:

f1. Verbal test results shall be given to the Geomembrane Contractor within 24 hours of receipt of the samples. Written results shall follow within one week.

f2. All test locations shall be marked with a pass/fail designation on the liner and on the drawings maintained by the Geomembrane Contractor for submittal to the Purchaser after construction is complete.

g. Re-Testing if Failure Occurs:

g1. If a seam fails testing, one additional sample shall be taken 10 feet on each side of the location of the failed test. Additional samples shall continue to be taken at 10 foot intervals until tests show that seam strength is adequate and the zone in which the seam requires reconstruction is identified.

g2. All passing seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

g3. The entire seam length failing strength tests shall be reconstructed at no additional cost to the Purchaser.

g4. If the length of reconstructed seam exceeds 150 feet, a sample shall be taken of the reconstructed seam every 150 feet and shall pass destructive testing.

303.5 Inspection – Geomembrane:

a. After seaming is complete, the Geomembrane Contractor and the CQA Geomembrane Inspector shall conduct a detailed walk-down to visually check all seams and non-seam areas of the geomembrane.

b. All defects, holes, blisters, tears, signs of damage during installation, areas of undispersed carbon and holes from destructive or non-destructive testing shall be marked and repaired.

304. <u>REPAIR OF DEFECTS AND SEAMS - GEOMEMBRANE</u>

304.1 Patching:

a. Patching shall be used to repair large holes, tears and destructive sample locations.

b. All patches shall be round, oval, or shall have rounded corners.

c. All patches shall be made of the base geomembrane material and shall extend a minimum of 3 inches beyond the edges of the defect.

d. Patches shall be extrusion welded to the base sheet.

304.2 Grinding and Welding:

a. Grinding and welding shall be used to repair sections of extruded fillet seams with small defects.

304.3 Spot Welding:

a. Spot welding shall be used to repair small tears, pinholes, or other minor localized flaws.

304.4 Capping:

a. Capping shall be used to repair lengths of extrusion welded seams with large defects and to repair double wedge fusion welded seams.

b. Cap strips shall be made with strips of the same type and thickness of geomembrane being installed. Strips shall extend a minimum of 6 inches beyond the weld, and shall have rounded corners.

c. Cap strips shall be extrusion welded to the base sheet.

304.5 Cut Out and Replacement:

a. When approved by the Purchaser, a length of defective seam may be cut out and replaced with a strip of new material seamed into place.

304.6 Verification of Repairs:

a. All repairs shall be non-destructive tested using one of the procedures described in Paragraph 303.3.

b. Repairs, which pass the non-destructive test, shall be deemed acceptable.

c. Repairs of a seam in excess of 150 feet in length shall have one destructive seam test per 150 feet in length.

305. <u>CREST ANCHOR TRENCH EXCAVATION AND BACKFILLING</u>

305.1 Excavation and Shaping:

a. Unless specified otherwise on the Design Drawings, the geomembrane liner shall be anchored in an anchor trench at the top of the slope. The anchor trench shall be excavated by the Earthwork Contractor to the lines and widths shown on the Design Drawings prior to placement of the liner.

b. A slightly rounded corner shall be provided in the trench where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench.

c. The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open.

305.2 Backfilling:

a. Anchor trench backfill shall be placed as shown on the Design Drawings by the Earthwork Contractor.

b. Backfilling of the anchor trench shall occur during the morning or during extended periods of overcast skies when the liners are at their most contracted state.

c. Backfill shall be placed in layers not exceeding 4 inches loose thickness and compacted using hand compaction equipment to a minimum of 95% of the maximum dry density as determined by ASTM D698 at optimum water content ± 2%.

306. ATTACHMENT TO CONCRETE

306.1 Geomembrane shall be attached to concrete using batten strips or to extruded HDPE mechanical anchorages set in cast-in-place concrete in accordance with details on the Design Drawings.

307. ATTACHMENT TO PIPE PENETRATIONS

307.1 Geomembrane shall be attached to pipe penetrations through the lining in accordance with details on the Design Drawings.

307.2 Prefabricated or field fabricated HDPE sleeves (pipe boots) used for attaching the geomembrane to the pipe shall be supplied by the Manufacturer.

END OF SECTION

GOLDER
MEMBER OF WSP

golder.com

APPENDIX B

Narrative Description

APPENDIX B

Narrative Description of the Bottom Ash Basin

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency

1021 North Grand Avenue East
P. O. Box 19276
Springfield, Illinois 62794-9276

Submitted by:

Illinois Power Resources Generating, LLC

1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by:

Golder Associates USA Inc.

701 Emerson Road, Suite 250
Creve Coeur, Missouri 63141

21454861-8-R-0

January 25, 2022

Table of Contents

1.0 FACILITY INFORMATION 1

1.1 Coal Combustion Residuals Material Received 1

1.1.1 Chemical Analysis 1

1.2 Facility Capacity 1

1.3 Facility Operation 1

1.4 Transportation Plan 1

ATTACHMENTS

Figure 1
Transportation Plan

Attachment 1
Chemical Analysis

1.0 FACILITY INFORMATION

1.1 Coal Combustion Residuals Material Received

The Bottom Ash Basin is subdivided into three basins: Primary Pond 1, Primary Pond 2, and the Secondary Pond. Primary Ponds 1 and 2 received and temporarily stored sluiced bottom ash from the Duck Creek Power Plant prior to its retirement. These ponds operated alternately so that while one pond was receiving sluiced bottom ash, bottom ash could be dewatered and removed from the other pond. The removed bottom ash was disposed in the permitted on-site landfill. The Secondary Pond operated as a polishing basin and received water decanted from Primary Ponds 1 and 2. Bottom ash particles that settled out of the decanted water was periodically removed from the Secondary Pond and disposed in the permitted on-site landfill.

1.1.1 Chemical Analysis

Available information regarding chemical analysis of the bottom ash that was managed in the Bottom Ash Basin during operation is provided in Attachment 1.

1.2 Facility Capacity

Facility capacity was estimated by a stage–storage analysis using Autodesk Civil 3D. The maximum combined capacity for all three basins is estimated as approximately 4.77 acre-feet or 1.55 million gallons. No appreciable coal combustion residuals (CCR) are currently contained in the Bottom Ash Basin.

1.3 Facility Operation

The Bottom Ash Basin is no longer receiving CCR or other waste streams. The Bottom Ash Basin operated from early 2008 until the Duck Creek Power Plant was retired in December 2019.

1.4 Transportation Plan

During operation, transport of CCR to the Bottom Ash Basin was by pipeline. Figure 1 shows the main route that is used for vehicle travel between the Duck Creek Power Plant and the Bottom Ash Basin and the route that was used by trucks transporting CCR from the Bottom Ash Basin to the permitted on-site landfill during operation. The same route between the Bottom Ash Basin and the permitted on-site landfill will be used to transport waste materials generated during facility closure for disposal. This route will also be used to transport fill materials from the borrow area to the Bottom Ash Basin during facility closure. These routes are all on site.

Signature Page

Golder Associates USA Inc.

https://golderassociates.sharepoint.com/sites/141778/project files/5 technical work/duck creek/bottom ash basin/permit application/final/app b narr descr/appb-bab_narrative_description.docx

FIGURE 1

Transportation Plan

LEGEND

- - - ROUTE BETWEEN BOTTOM ASH BASIN AND ON-SITE LANDFILL OR BORROW AREA

— ROUTE BETWEEN DUCK CREEK POWER PLANT AND BOTTOM ASH BASIN

REFERENCE(S)

AERIAL IMAGERY OBTAINED FROM ESRI-PROVIDED BASEMAP SURVEY. IMAGERY COLLECTED 5/14/2017, 10/21/2017, AND 4/1/2019.

CLIENT	ILLINOIS POWER RESOURCES GENERATING, LLC DUCK CREEK POWER PLANT
PROJECT	BOTTOM ASH BASIN PART 845 CONSTRUCTION PERMIT APPLICATION
CONSULTANT	GOLDER MEMBER OF WSP
YYYY-MM-DD	2022-01-13
DESIGNED	AGD
PREPARED	AGD
REVIEWED	JJS
APPROVED	JEO
TITLE	**TRANSPORTATION PLAN**
PROJECT NO.	21454861
REV.	A
FIGURE	1

ATTACHMENT 1

Chemical Analysis

DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	ASTM Bottom Ash
Synonyms:	Ash; Ashes; Ash residues; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Coal Fly Ash; Pozzolan; Waste solids.
Formula:	UVCB Substance

1.2 Relevant Identified Uses of the Substance or Mixture and Uses Advices Against

Relevant Identified Uses:	Component of wallboard, concrete, roofing material, bricks, cement kiln feed.
Uses Advised Against:	None known.

1.3 Details of the Supplier of the SDS

Manufacturer/Supplier:	Dynegy, Inc.
Street Address:	601 Travis Street, Suite 1400
City, State and Zip Code:	Houston, TX 77002
Customer Service Telephone:	800-633-4704

Section 2
Hazards Identification

2.1 Classification of the Substance

GHS Classification(s) according to OSHA Hazard Communication Standard (29 CFR 1910.1200):

- Eye Irritant, Category 2A
- STOT-SE, Category 3 (Respiratory Irritation)
- Carcinogen, Category 1A
- STOT-RE, Category 1 (Lungs)
- Toxic to Reproduction, Category 2

2.2 Label Elements

Labelling according to 29 CFR 1910.1200 Appendices A, B and C*	
Hazard Pictogram(s):	
Signal word:	**DANGER**
Hazard Statement(s):	*Causes serious eye irritation.* *May cause respiratory irritation.* *May cause damage to lungs after repeated/prolonged exposure via inhalation.* *May cause cancer of the lung.* *Suspected of damaging fertility or the unborn child.*
Precautionary Statement(s):	*Obtain special instructions before use.* *Do not handle until all safety precautions have been read and understood.* *Avoid breathing dust.* *Wash thoroughly after handling.* *Do not eat drink or smoke when using this product.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Use outdoors or in a well-ventilated area.* *If exposed or concerned: Get medical advice/attention.* *Store in a secure area.* *Dispose of product in accordance with local/national regulations.*

** Fly ash and other coal combustion products (CCPs) are UVCB substances (unknown or variable composition or biological). Various CCPs, noted as ashes/ash residuals; Ashes, residues, bottom; Bottom ash; Bottom ash residues; Waste solids, ashes under TSCA are defined as: "The residuum from the burning of a combination of carbonaceous materials. The following elements may be present as oxides: aluminum, calcium, iron, magnesium, nickel, phosphorus, potassium, silicon, sulfur, titanium, and vanadium." Ashes including fly ash and fluidized bed combustion ash are identified by CAS number 68131-74-8. The exact composition of the ash is dependent on the fuel source and flue additives composed of many constituents. The classification of the final substance is dependent on the presence of specific identified oxides as well as other trace elements.*

2.3 Other Hazards

Listed Carcinogens:

-Respirable Crystalline Silica

IARC: [Yes] **NTP:** [Yes] **OSHA:** [Yes] **Other:** **(ACGIH)** [Yes]

Section 3
Composition/Information on Ingredients

Substance	*CAS No.*	*Percentage (%)*	*GHS Classification*
Crystalline Silica	*14808-60-7*	*20 - 40%*	*Repeat Dose STOT, Category 1* *Carcinogen, Category 1A*
Silica, crystalline respirable (RCS)	*14808-60-7*	*See Footnote 1*	*Repeat Dose STOT, Category 1* *Carcinogen. Category 1A*
Aluminosilicates[2]	*Various, see Footnote 2*	*10 - 60%*	*Single Exposure STOT, Category 3*
Calcium oxide (CaO)	*1305-78-8*	*10 - 30%*	*Skin Irritant, Category 2* *Eye Irritant, Category 1* *Single Exposure STOT, Category 3*
Iron oxide	*1309-37-1*	*1 - 10%*	*Not Classified*
Manganese dioxide (MnO_2)	*1313-13-9*	*<2%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Magnesium oxide	*1309-48-4*	*2 - 10%*	*Not Classified*
Phosphorus pentoxide (P_2O_5)	*1314-56-3*	*≤2%*	*Skin Irritant, Category 2* *Eye Irritant, Category 2B*
Sodium oxide	*1313-59-3*	*1 - 10%*	*Not Classified*
Potassium oxide (K_2O)	*12136-45-7*	*≤1%*	*Skin Irritant Category 2* *Eye Irritant Category 2B*
Titanium dioxide (TiO_2)	*13463-67-7*	*<3%*	*Not Classified*

[1]The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen 1A has been assigned.

[2]Aluminosilicates (CAS# 1327-36-2) may be in the form of mullite (CAS# 1302-93-8); aluminosilicate glass; pozzolans (CAS# 71243-67-9); or calcium aluminosilicates such as tricalcium aluminate (C3A), or calcium sulfoaluminate (C4A3S). The form is dependent on the source of the coal and or the process used to create the CCP. Pulverized coal combustion would be more likely to create high levels of pozzolans. Aluminosilicates may have inclusions of calcium, titanium, iron, potassium, phosphorus, magnesium and other metal oxides.

Section 4
First Aid Measures

4.1 Description of First Aid Measures

Inhalation:	If product is inhaled and irritation of the nose or coughing occurs, remove person to fresh air. Get medical advice/attention if respiratory symptoms persist.
Skin Contact:	If skin exposure occurs, wash with soap and water.
Eye Contact:	If product gets into the eye, rinse copiously with water for several minutes. Remove contact lenses, if present and easy to do. Seek medical attention/advice if irritation occurs or persists.
Ingestion:	No specific first aid measures are required.

4.2 Most Important Health Effects, Both Acute and Delayed

Acute Effects: Direct exposure may cause respiratory irritation, eye irritation and skin irritation. The product dust can dry and irritate the skin and cause dermatitis and can irritate eyes and skin through mechanical abrasion.

Chronic Effects: Chronic exposure may cause lung damage from repeated exposure. Prolonged inhalation of respirable crystalline silica above certain concentrations may cause lung diseases, including silicosis and lung cancer.

4.3 Indication of Any Immediate Medical Attention and Special Treatment Needed

Seek first aid or call a doctor or Poison Control Center if contact with eyes occurs and irritation remains after rinsing. Get medical advice if inhalation occurs and respiratory symptoms persist.

Section 5
Firefighting Measures

5.1 Extinguishing Media

Suitable Extinguishing Media:	Product is not flammable. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Not applicable, the product is not flammable.

5.2 Special Hazards Arising from the Substance or Mixture

Hazardous Combustion Products:	None known.

5.3 Advice for Firefighters

Special Protective Equipment and Precautions for Firefighters:	As with any fire, wear self-contained breathing apparatus (NIOSH approved or equivalent) and full protective gear.

Section 6
Accidental Release Measures

6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Personal precautions/Protective Equipment:	See Section 8.2.2 Individual Protective Measures. For concentrations exceeding Occupational Exposure Levels (OELs), use a self-contained breathing apparatus (SCBA).
Emergency procedures:	Use scooping, water spraying/flushing/misting or ventilated vacuum cleaning systems to clean up spills. Do not use pressurized air.

6.2 Environmental Precautions

Environmental precautions:	Prevent contamination of drains or waterways and dispose according to local and national regulations.

6.3 Methods and Material for Containment and Cleaning Up

Methods and materials for containment and cleaning up:	Do not use brooms or compressed air to clean surfaces. Use dust collection vacuum and extraction systems. Large spills of dry product should be removed by a vacuum system. Dampened material should be removed by mechanical means and recycled or disposed of according to local and national regulations.

See Sections 8 and 13 for additional information on exposure controls and disposal.

Section 7
Handling and Storage

7.1 Precautions for Safe Handling

Practice good housekeeping. Use adequate exhaust ventilation, dust collection and/or water mist to maintain airborne dust concentrations below permissible exposure limits (note: respirable crystalline silica dust may be in the air without a visible dust cloud).

Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain and test ventilation and dust collection equipment. In cases of insufficient ventilation, wear a NIOSH approved respirator for silica dust when handling or disposing dust from this product. Avoid contact with skin and eyes. Wash or vacuum clothing that has become dusty. Avoid eating, smoking, or drinking while handling the material.

7.2 Conditions for Safe Storage, Including any Incompatibilities

Minimize dust produced during loading and unloading.

Section 8
Exposure Controls/Personal Protection

8.1 Control Parameters

OCCUPATIONAL EXPOSURE LIMITS					
SUBSTANCE		**OSHA PEL TWA (mg/m^3)**	**NIOSH REL TWA (mg/m^3)**	**ACGIH TLV TWA (mg/m^3)**	**CA - OSHA PEL (mg/m^3)**
Calcium oxide		5	2	2	2
Particulates Not Otherwise Regulated	Total	15	15	10	10
	Respirable	5	5	3	5
Respirable Crystalline Silica	Respirable	0.05	0.05	0.025	0.05
Manganese dioxide (as manganese compounds)	Total	5 (Ceiling)	1 3 (STEL)	0.1	0.2
	Respirable	-	-	0.02	-

8.2 Exposure Controls

8.2.1 Engineering Controls

Provide ventilation to maintain the ambient workplace atmosphere below the occupational exposure limit(s). Use general and local exhaust ventilation and dust collection systems as necessary to minimize exposure.

8.2.2 Personal Protective Equipment (PPE)

Respiratory protection:	Wear a NIOSH approved particulate respirator if exposure to airborne particulates is unavoidable and where occupational exposure limits may be exceeded. If airborne exposures are anticipated to exceed applicable PELs or TLVs, a self-contained breathing apparatus or airline respirator is recommended.
Eye and face protection:	If eye contact is possible, wear protective glasses with side shields. Avoid contact lenses.
Hand and skin protection:	Wear gloves and protective clothing. Wash hands with soap and water after contact with material.

Section 9
Physical and Chemical Properties

9.1 Information on Basic Physical and Chemical Properties

Property: Value	Property: Value
Appearance (physical state, color, etc.): Fine tan/ gray particulate	**Upper/lower flammability or explosive limits:** Not applicable
Odor: Odorless[1]	**Vapor Pressure (Pa):** Not applicable
Odor threshold: Not applicable	**Vapor Density:** Not applicable
pH (25 °C) (in water): 8 - 11	**Specific gravity or relative density:** 2.2 – 2.9
Melting point/freezing point (°C): Not applicable	**Water Solubility:** Slight
Initial boiling point and boiling range (°C): Not applicable	**Partition coefficient: n-octane/water:** Not determined
Flash point (°C): Not determined	**Auto ignition temperature (°C):** Not applicable
Evaporation rate: Not applicable	**Decomposition temperature (°C):** Not determined
Flammability (solid, gas): Not combustible	**Viscosity:** Not applicable

[1] The use of urea or aqueous ammonia injected into the flue gas to reduce nitrogen oxides (NOx) emissions may result in the presence of ammonium sulfate or ammonium bisulfate in the ash at less than 0.1%. When ash containing these substances becomes wet under high pH (>9), free ammonia gas may be released resulting in objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces.

Section 10
Stability and Reactivity

10.1 Reactivity:	The material is an inert, inorganic material primarily composed of elemental oxides.
10.2 Chemical stability:	The material is stable under normal use conditions.
10.3 Possibility of hazardous reactions:	The material is a relatively stable, inert material; however, when ash containing ammonia becomes wet under high pH (>9), free ammonia gas may be released resulting in an objectionable/nuisance ammonia odor and potential exposure to ammonia gas especially in confined spaces. Polymerization will not occur.
10.4 Conditions to avoid:	Product can become airborne in moderate winds. Dry material should be stored in silos. Materials stored out of doors should be covered or maintained in a damp condition.
10.5 Incompatible materials:	None known.
10. 6 Hazardous decomposition products:	None known.

Section 11
Toxicological Information

11.1 Information on Toxicological Effects

Endpoint	Data
Acute oral toxicity	LD50 > 2000 mg/kg
Acute dermal toxicity	LD50 > 2000 mg/kg
Acute inhalation toxicity	LD50 > 5.0 mg/L
Skin corrosion/irritation	Does not meet the classification criteria but may cause slight skin irritation. Product dust can dry the skin which can result in irritation.
Eye damage/irritation	Causes serious eye irritation. Positive scores for conjunctiva irritation and chemosis in 2/3 animals based on average of 24, 48 and 72-hour scores with irritation clearing within 21 days; no corneal or iritis effects observed.
Respiratory/skin sensitization	Not a respiratory or dermal sensitizer.
Germ cell mutagenicity	Not mutagenic in in-vitro and in-vivo assays with or without metabolic activation.
Carcinogenicity	Not available. Respirable crystalline silica has been identified as a carcinogen by OSHA, NTP, ACGIH and IARC.
Reproductive toxicity	No developmental toxicity was observed in available animal studies. Reproductive studies on CCPs showed either no reproductive effects, or some effects on male and female reproductive organs and parameters but without a clear dose response.
STOT-SE	CCPs when present as a nuisance dust may result in respiratory irritation.
STOT-RE	In a 180-day inhalation study with fly ash dust, no effects were observed at the highest dose tested. NOEC = 4.2 mg/m^3; it is not possible to assess the level at which toxicologically significant effects may occur. Repeated inhalation exposures to high levels of respirable crystalline silica may result in lung damage (i.e., silicosis).
Aspiration Hazard	Not applicable based product form.

Section 12
Ecological Information

12.1 Toxicity

Fly Ash (CAS# 68131-74-8)	
Toxicity to Fish	LC50 > 100 mg/L
Toxicity to Aquatic Invertebrates	Data indicates that the test substance is not toxic to *Daphnia magna* (EC50 undetermined)
Toxicity to Aquatic Algae and Plants	EC50 = 10 mg/L
Calcium oxide CAS# 1305-78-8	
Toxicity to Fish	LC50 = 50.6 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Invertebrates	EC50 = 49.1 mg/L The findings were closely related to the pH of the test solutions; therefore, pH is considered to be the main reason for the effects.
Toxicity to Aquatic Algae and Plants	NOEC =48 mg/L @ 72 hours based on $Ca(OH)_2$ The initial pH of the test medium was not directly related to the biologically relevant effects. The formation of precipitates is likely the result of the reaction between CO_2 dissolved in the medium.

12.2 Persistence and Degradability

Not relevant for inorganic materials.

12.3 Bioaccumulative Potential

This material does not contain any compounds that would bioaccumulate up the food chain.

12.4 Mobility in Soil

No data available.

12.5 Results of PBT and vPvB Assessment

This material does not contain any compounds classified as “persistent, bioaccumulative or toxic” nor as “very persistent/very bioaccumulative”.

12.6 Other Adverse Effects

None known.

Section 13
Disposal Considerations

See Sections 7 and 8 above for safe handling and use, including appropriate industrial hygiene practices.

Dispose of all waste product and containers in accordance with federal, state and local regulations.

Section 14
Transport Information

Regulatory entity: U.S. DOT	Shipping Name:	Not Regulated
	Hazard Class:	Not Regulated
	ID Number:	Not Regulated
	Packing Group:	Not Regulated

Section 15
Regulatory Information

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Mixture

- TSCA Inventory Status

  All components are listed on the TSCA Inventory.

- California Proposition 65

  The following substances are known to the State of California to be carcinogens and/or reproductive toxicants:

  - Respirable crystalline silica
  - Titanium dioxide

- State Right-to-Know (RTK)

Component	CAS	MA[1,2]	NJ[3,4]	PA[5]	RI[6]
Ammonium bisulfate	7803-63-6	No	Yes	No	No
Ammonium sulfate	7783-20-2	Yes	No	Yes	No
Calcium oxide	1305-78-8	Yes	Yes	Yes	No
Iron oxide	1309-37-1	Yes	Yes	Yes	No
Magnesium oxide	1309-48-4	No	Yes	No	No
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO_2), quartz	14808-60-7	Yes	Yes	Yes	No
Sodium oxide	1313-59-3	No	Yes	No	No
Titanium dioxide	13463-67-7	Yes	Yes	Yes	Yes

[1] Massachusetts Department of Public Health, no date
[2] 189th General Court of The Commonwealth of Massachusetts, no date
[3] New Jersey Department of Health and Senior Services, 2010a
[4] New Jersey Department of Health, 2010b
[5] Pennsylvania Code, 1986
[6] Rhode Island Department of Labor and Training, no date

Section 16
Other Information, Including Date of Preparation or Last Revision

16.1 Indication of Changes

Date of preparation or last revision: February 23, 2018

16.2 Abbreviations and Acronyms

- ACGIH: American Conference of Industrial Hygienists
- CA: California
- CAS: Chemical Abstract Services
- CCP: Coal Combustion Product
- CFR: Code of Federal Regulations
- EPA: Environmental Protection Agency
- GHS: Globally Harmonized System of Classification and Labelling
- IARC: International Agency for Research on Cancer
- LC50: Concentration resulting in the mortality of 50 % of an animal population
- LD50: Dose resulting in the mortality of 50 % of an animal population
- MA: Massachusetts
- NA: Not Applicable
- NJ: New Jersey
- NOEC: No observed effect concentration
- NIOSH: National Institute of Occupational Safety and Health
- NOx: Nitrogen oxides
- NTP: US National Toxicology Program
- OEL: Occupational Exposure Limit
- OSHA: Occupational Safety and Health Administration
- PA: Pennsylvania
- PBT: Persistent, Toxic and Bioaccumulative
- PEL: Permissible exposure limit
- PPE: Personal Protective Equipment
- REL: Recommended exposure limit
- RI: Rhode Island
- RCS: Respirable Crystalline Silica
- RTK: Right-to-Know
- SCBA: Self-contained breathing apparatus
- SDS: Safety Data Sheet
- STEL: Short-term exposure limit
- STOT-RE: Specific target organ toxicity-repeated exposure
- STOT-SE: Specific target organ toxicity-single exposure
- TLV: Threshold limit value
- TSCA: Toxic Substances Control Act
- TWA: Time-weighted average
- UEL: Upper explosive limit
- UVCB: Unknown or Variable Composition/Biological
- U.S.: United States
- U.S. DOT: United States of Department of Transportation

16.3 Other Hazards

Hazardous Materials Identification System (HMIS) Degree of hazard (0= low, 4 = extreme)							
Health:	2*	**Flammability:**	0	**Physical Hazards:**	0	**Personal protection:****	

** Chronic Health Effects*
****** *Appropriate personal protection is defined by the activity to be performed.*
See Section 8 for additional information.

DISCLAIMER:

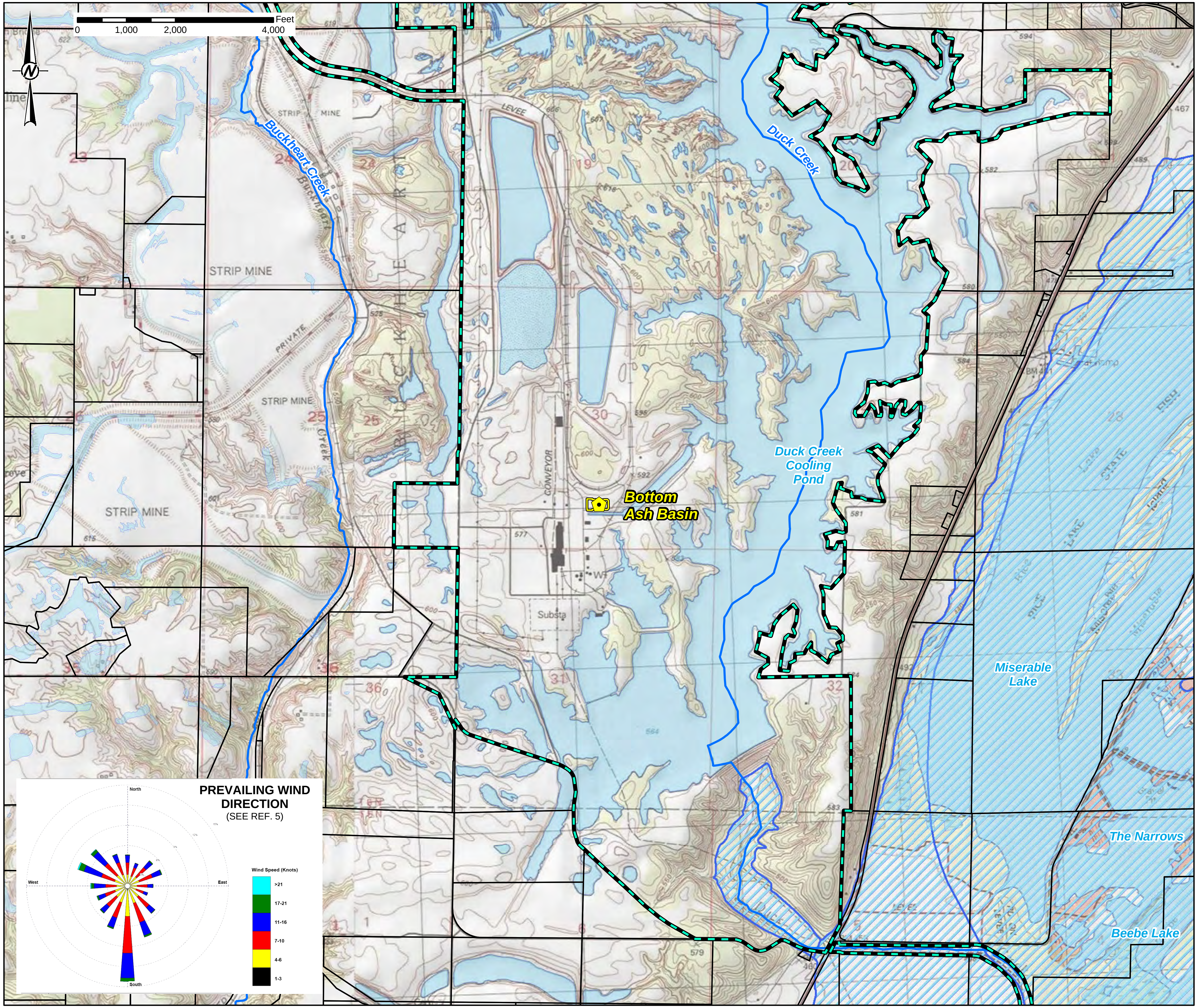
This SDS has been prepared in accordance with the Hazard Communication Rule 29 CFR 1910.1200. Information herein is based on data considered to be accurate as of date prepared. No warranty or representation, express or implied, is made as to the accuracy or completeness of this data and safety information. No responsibility can be assumed for any damage or injury resulting from abnormal use, failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

GOLDER
MEMBER OF WSP

golder.com

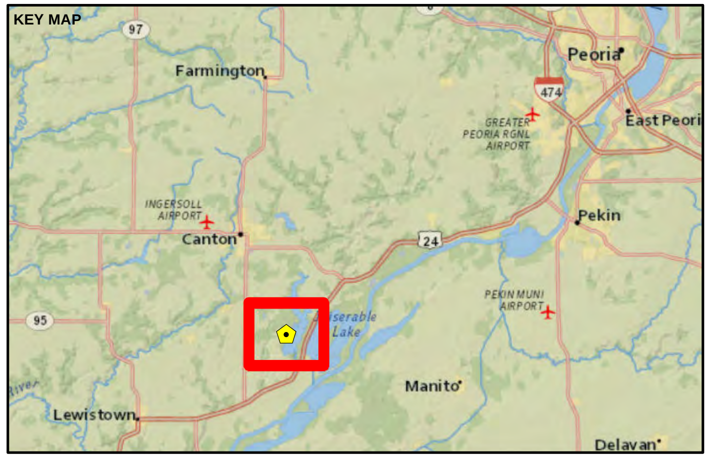
APPENDIX C

Map Package



LEGEND

- SITE LOCATION
- SURFACE WATER - LINEAR FEATURE
- SURFACE WATER BODY
- FEMA 100-YEAR FLOODPLAIN
- IPRG BOUNDARY
- NEIGHBORING PROPERTY BOUNDARIES
- LIMIT OF LINER



NOTES

1. A SEARCH OF THE ILLINOIS DEPARTMENT OF NATURAL RESOURCES (IDNR) NATURAL HERITAGE DATABASE FOR NATURAL AREAS AND PROTECTED AREAS WITHIN 1,000 METERS OF THE BAB WAS PERFORMED. ACCORDING TO THE IDNR NATURAL HERITAGE DATABASE, THERE ARE 15 NATURAL AREAS IN FULTON COUNTY, INCLUDING TWO CATEGORY III - NATURE PRESERVES (HARPER-RECTOR WOODS NATURE PRESERVE [34.67 ACRES] AND KEDZIOR WOODLANDS LAND AND WATER RESERVE [163.64 ACRES]). NO NATURAL AREAS WERE IDENTIFIED WITHIN 1,000 METERS OF THE BAB.
2. THE IDNR NATURAL HERITAGE DATABASE THREATENED AND ENDANGERED SPECIES BY COUNTY LISTS 11 STATE THREATENED AND 12 STATE ENDANGERED SPECIES IN FULTON COUNTY. THE USFWS ENVIRONMENTAL CONSERVATION ONLINE SYSTEM LISTS THREE FEDERALLY THREATENED AND ONE FEDERALLY ENDANGERED SPECIES IN FULTON COUNTY.

REFERENCES

1. TOPOGRAPHIC BASEMAP: UNITED STATES GEOLOGICAL SURVEY 7.5-MINUTE TOPOGRAPHIC QUADRANGLES SHOWN: SAINT DAVID AND DUCK ISLAND.
2. PROPERTY BOUNDARIES: FULTON COUNTY ASSESSOR'S OFFICE, APRIL 2021.
3. FLOODPLAIN DATA: FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA). PANEL 17057C0250E, EFFECTIVE ON FEBRUARY 4, 2011.
4. SURFACE WATER FEATURES: NATIONAL HYDROGRAPHY DATASET (NHD), USGS.
5. PREVAILING WIND DIRECTION GRAPHIC: ILLINOIS STATE CLIMATOLOGIST OFFICE. 1961-1990 ANNUAL AVERAGE WIND SPEEDS AND DIRECTIONS, AS MEASURED AT STATION #14842 -PEORIA/GREATER PEORIA ARPT, IL.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC

PROJECT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN

TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	JS
PREPARED	KJC/RHG
REVIEWED	-
APPROVED	-

PROJECT NO.
21454861

FIGURE
1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
0
1 in

PATH: M:\VistraLuminant845\DuckCreek\11x17_21454861_SiteLocationMaps_DDP.mxd PRINTED ON: 2021-10-19 AT: 9:41:14 AM

LEGEND

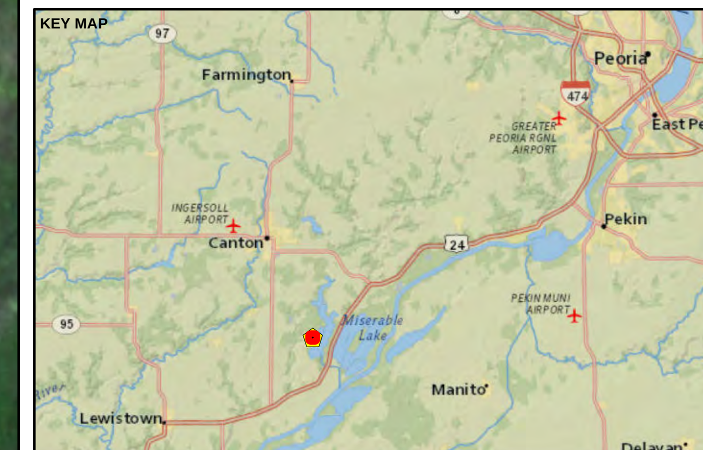
IPRG BOUNDARY

LIMIT OF LINER

ROUTE FROM BAB TO SOIL BORROW AREA AND EXISTING SITE LANDFILL

BACKGROUND WELL

MONITORING WELL



REFERENCES

1. AERIAL BASEMAP: ESRI PROVIDED BASEMAP SERVICE. VIVID. MAXAR. IMAGERY COLLECTED 10/21/2017.
2. PROPERTY BOUNDARIES: FULTON COUNTY ASSESSOR'S OFFICE, APRIL 2021.

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC

PROJECT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN

TITLE
SITE PLAN MAP

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-10-19
DESIGNED	JS
PREPARED	KJC/RHG
REVIEWED	-
APPROVED	-

PROJECT NO.
21454861

FIGURE
1

PATH: M:\VistraLuminant845\DuckCreek\11x17_21454861_SitePlanMaps_DDP.mxd PRINTED ON: 2021-10-19 AT: 10:59:01 AM

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

1 in

APPENDIX D

Hydrogeologic Site Characterization

Intended for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT BOTTOM ASH BASIN

Project Name	**Duck Creek Power Plant Bottom Ash Basin**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Hydrogeologic Site Characterization Report**
Revision	**FINAL**
Date	**October 25, 2021**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Nicole M. Pagano
Senior Managing Engineer

Brian G. Hennings, PG
Senior Managing Hydrogeologist

Terra A. Dalton
Senior Scientist

Nathaniel R. Keller
Senior Hydrogeologist

CONTENTS

EXECUTIVE SUMMARY		**6**
1.	**Introduction**	**12**
1.1	Overview	12
1.2	Part 845 Description	12
1.3	Previous Investigations and Reports	12
1.4	Site Location and Background	13
1.5	Site History and CCR Units	13
2.	**Regional and Local Geology**	**15**
2.1	Topography	15
2.2	Regional Geomorphology	15
2.3	Soils	15
2.4	Regional Geology	16
2.4.1	Regional Unlithified Geology	16
2.4.2	Regional Bedrock Geology	16
2.4.3	Structure	16
2.4.4	Seismic Setting	17
2.4.5	Mining Activities	17
2.5	Site Geology	17
2.5.1	Site-Specific Unlithified Geology	17
2.5.1.1	Fill and CCR	17
2.5.1.2	Peoria/Roxanna Loess	18
2.5.1.3	Radnor Till	18
2.5.2	Site Specific Bedrock Geology	20
3.	**Regional and Local Hydrogeology**	**21**
3.1	Regional Hydrogeology	21
3.2	Site Hydrogeology	21
3.2.1	Hydrostratigraphic Units	21
3.2.2	Uppermost Aquifer	22
3.2.3	Potential Migration Pathway	22
3.2.4	Water Table Elevation and Groundwater Flow Direction	22
3.2.4.1	Vertical Hydraulic Gradients	22
3.2.4.2	Impact of Existing Ponds and Ash Saturation	22
3.2.4.3	Impact of Surface Water Bodies	23
3.2.5	Hydraulic Conductivities	23
3.2.5.1	Field Hydraulic Conductivities	23
3.2.5.2	Laboratory Hydraulic Conductivities	23
3.2.6	Horizontal Groundwater Gradients and Flow Velocity	24
3.2.7	Groundwater Classification	24
3.3	Surface Water Hydrology	24
3.3.1	Climate	24
3.3.2	Surface Waters	25
4.	**Groundwater Quality**	**26**
4.1	Summary of Groundwater Monitoring Activities	26
4.1.1	40 C.F.R. § 257 Program Monitoring and Well Network	26
4.1.2	Part 845 Well Installation and Groundwater Monitoring	26

4.2	Groundwater Monitoring Results and Analysis	27
4.2.1	Total Arsenic	27
4.2.2	Total Beryllium	27
4.2.3	Total Boron	28
4.2.4	Total Chloride	28
4.2.5	Total Cobalt	28
4.2.6	Total Lead	28
4.2.7	Total Lithium	28
4.2.8	pH	28
4.2.9	Radium 226 and 228 Combined	28
4.2.10	Total Sulfate	28
4.2.11	Total Dissolved Solids	28
5.	**Evaluation of Potential Receptors**	**29**
5.1	Water Well Survey	29
5.2	Surface Water	29
5.3	Nature Preserves, Historic Sites, Endangered/Threatened Species	30
6.	**Conclusions**	**31**
References		**33**

TABLES (IN TEXT)

Table A	Average Monthly Temperature Extremes and Precipitation for Peoria, Illinois
Table B	40 C.F.R. § 257 Groundwater Monitoring Program Parameters
Table C	Part 845 Groundwater Monitoring Program Parameters

TABLES (ATTACHED)

Table ES-1	Part 845 Requirements Checklist
Table 2-1	Geotechnical Results
Table 2-2	Soil Analytical Results
Table 3-1	Monitoring Well Locations and Construction Details
Table 3-2	Vertical Hydraulic Gradients
Table 3-3	Field Hydraulic Conductivities
Table 3-4	Horizontal Hydraulic Gradients and Groundwater Flow Velocities
Table 4-1	Groundwater Analytical Results
Table 4-2	Groundwater Field Parameters

FIGURES

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 2-1	Site Topographic Map
Figure 2-2	Soil Survey Map
Figure 2-3	Major Structural Features of Illinois
Figure 2-4	Field Investigation Location Map
Figure 2-5	Geologic Cross Section A-A’
Figure 2-6	Geologic Cross Sections B-B’
Figure 3-1	Monitoring Well Location Map
Figure 3-2	Top of Uppermost Aquifer
Figure 3-3	Uppermost Aquifer Groundwater Elevation Contours, April 28, 2021

APPENDICES

Appendix A	Information Pertinent to 35 I.A.C. §845.220(a)(3)
Appendix B	Boring and Well Construction Logs
Appendix C	Geotechnical Laboratory Reports
Appendix D	Groundwater Contour Maps and Elevations
Appendix E	Hydraulic Conductivity Test Data
Appendix F	FEMA Flood Hazard Map

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
BAB	Bottom Ash Basin
bgs	below ground surface
CCR	coal combustion residuals
CCR Rule	40 C.F.R. § 257 Subpart D
cm/s	centimeters per second
CSM	conceptual site model
DCPP	Duck Creek Power Plant
DWW	Illinois Drinking Water Watch
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
ft/day	feet per day
ft/ft	feet per feet
GMF	Gypsum Management Facility
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standard
Hanson	Hanson Professional Services, Inc.
HCR	Hydrogeologic Site Characterization Report
HDPE	high density polyethylene
HMP	Hydrogeologic Monitoring Plan
HUC	Hydrologic Unit Code
ID	identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ILWATER	Illinois Water and Related Wells
IPRG	Illinois Power Resources Generating, LLC
ISAS	Illinois State Archaeological Survey
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NGWMN	National Groundwater Monitoring Network
NID	National Inventory of Dams
No.	Number
NRCS	Natural Resources Conservation Service
NRT/OBG	Natural Resource Technology, Inc., an OBG Company
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
pCi/L	picocuries per liter

pcf	Pound per cubic foot
PMP	potential migration pathway
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SDWIS	Safe Drinking Water Information System
SI	Surface Impoundment
SSURGO	Soil Survey Geographic
SU	standard unit
TDS	total dissolved solids
USCS	Unified Soil Classification System
USFWS	United States Fish and Wildfire Service
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

This Hydrogeologic Site Characterization Report (HCR) for the Bottom Ash Basin (BAB) at Duck Creek Power Plant (DCPP) expands upon the hydrogeology, groundwater quality data, and conceptual site model (CSM) presented in previous hydrogeologic investigation reports prepared for the BAB. This report has been assembled to satisfy the information and analysis requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845.620 as summarized in **Table ES-1**. The CSM includes hydrogeologic and groundwater quality data specific to the BAB, which has been collected from 2015 to 2021. The BAB (Vistra identification [ID] number [No.] 205, Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-03, and National Inventory of Dams [NID] No. IL50716) is located at the DCPP southwest of Canton, Illinois (**Figure 1-1**).

The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP. Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

The BAB is an inactive 2.2-acre lined coal combustion residuals (CCR) surface impoundment (SI) formerly used to manage CCR and non-CCR waste streams at DCPP. The BAB consists of three cells. The bottom and side slopes of all three cells are concrete lined. Gravel surfaced roads surround the basin cells. A sluice pipe delivered CCR material to the pond. An outlet structure for water is located in the southeast corner of the south cell. The western two cells are designed with a gently sloping ramp so that front-end loaders can remove bottom ash. The east cell flows toward a discharge structure that drains accumulated water. All bottom ash (*i.e.,* CCR) was removed from the BAB when the plant was retired in November 2019; the basin currently contains no impounded water or CCR materials.

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the DCPP property. Previous investigations completed outside of the BAB indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts, and silty clays of the unconsolidated glacial and aeolian deposits. The BAB was constructed in close proximity to mined areas and mine spoils were observed in some boring logs (*e.g.,* BA01, BA05 and BA06).

Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics:

- **Fill Unit:** Shallow groundwater present in fill material and coal mine spoils.
- **Uppermost Aquifer**: The uppermost aquifer in the area of the BAB includes the Peoria/Roxanna Loess and the sand and silt zones within the Radnor Till. Within the till sequences at the BAB, a continuous intercalated sand exists below the basin from approximately 18 to 40 feet below ground surface (bgs). The sand zone is typically very dense, very fine- to coarse-grained, with few silt and trace small gravel. This sand unit is the

primary horizontal migration pathway and generally ranges in thickness from about 2 to 7 feet.

- **Bedrock Confining Unit**: This unit includes the Pennsylvanian shaley siltstone and silty shale bedrock. The shale bedrock unit underlying the Springfield Coal Member has been demonstrated by packer testing to be an aquitard.

The Peoria/Roxanna Loess within the uppermost aquifer and above the sand unit has also been identified as a potential migration pathway (PMP). While the primary horizontal migration pathway consists of the sand zones of the uppermost aquifer, impacts have the potential to migrate within groundwater in the overlying Peoria/Roxanna Loess.

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow across the BAB within the uppermost aquifer is consistently southward toward a channel located approximately 50 feet to the south that leads to the Duck Creek Cooling Pond. Groundwater elevations of the uppermost aquifer across the BAB typically range from approximately 570 to 580 feet North American Vertical Datum of 1988 (NAVD88). Groundwater elevations may fluctuate seasonally, but the groundwater flow direction remains consistent in a south-southeast direction toward the Duck Creek Cooling Pond.

The BAB Pond is lined, has been drained, and bottom ash is no longer present in the settling basins. There is a minimal amount of water in the BAB, predominately due to precipitation. Groundwater elevation contours of surrounding monitoring wells indicate groundwater generally flows to the south, with no indication of radial flow. The minimal amount of water present in the BAB, in addition to no observations of radial flow, provide evidence that the BAB does not impact groundwater flow directions.

Part 845 parameters were monitored in uppermost aquifer and PMP monitoring wells as part of groundwater quality evaluations performed from 2015 to 2021. These data were supplemented with installation and sampling of additional locations in 2021. The results indicate that the following parameters were detected at concentrations greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow across the BAB within the uppermost aquifer is consistently southward toward a channel located approximately 50 feet to the south that leads to the Duck Creek Cooling Pond. Groundwater elevations of the uppermost aquifer across the BAB typically range from approximately 570 to 580 feet NAVD88. Groundwater elevations may fluctuate seasonally, but the groundwater flow direction remains consistent in a south-southeast direction toward the Duck Creek Cooling Pond.

- Total arsenic, beryllium, boron, cobalt, lead, and pH were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). All of these parameters, with the exception of pH, were also detected in one or both background wells at least once at concentrations greater than the GWPS. Total chloride, lithium, radium 226 and 228 combined, sulfate, and total dissolved solids (TDS) were also detected at least once at concentrations greater than the GWPS in one or both background wells.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS to determine potential exceedances. Potential exceedances include results reported during the background groundwater monitoring or prior period that are greater than the GWPS. The results are considered potential exceedances because the results were compared directly to the standard and did not include an evaluation of background groundwater quality or the statistical methodologies proposed in the groundwater monitoring plan (GMP) provided in the Operating Permit application. Exceedances will be determined following IEPA approval of the GMP.

TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)	**The hydrogeologic site characterization shall include but not be limited to the following:**	--
845.620(b)(1)	Geologic well logs/boring logs;	Table 3-1 Figure 3-1 Appendix B
845.620(b)(2)	Climatic aspects of the site, including seasonal and temporal fluctuations in groundwater flow;	Sections 3.2.2 & 3.3.1 Figure 3.3
845.620(b)(3)	Identification of nearby surface water bodies and drinking water intakes;	Sections 3.3.2 & 5.2 Appendix A
845.620(b)(4)	Identification of nearby pumping wells and associated uses of the groundwater;	Section 5.1 Appendix A
845.620(b)(5)	Identification of nearby dedicated nature preserves;	Section 5.3 Appendix A
845.620(b)(6)	Geologic setting;	Section 2 Figures 2-1 to 2-5
845.620(b)(7)	Structural characteristics;	Section 2.4.3 Figure 2-3
845.620(b)(8)	Geologic cross-sections;	Figures 2-5 & 2-6
845.620(b)(9)	Soil characteristics;	Section 2.3 Figure 2-2
845.620(b)(10)	Identification of confining layers;	Section 3.2.1

TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(11)	Identification of potential migration pathways;	Section 3.2.3
845.620(b)(12)	Groundwater quality data;	Section 4.2 Table 4-1
845.620(b)(13)	Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy;	Section 2.5 Figures 2-5 & 2-6
845.620(b)(14)	A map displaying any known underground mines beneath a CCR surface impoundment;	Section 2.4.5 Appendix A
845.620(b)(15)	Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface;	Section 2.5 Tables 2-1, 2-2, & 2-4 Appendix C
845.620(b)(16)	Hydraulic characteristics of the geologic layers identified as migration pathways and geologic layers that limit migration, including:	Sections 3.2.1, 3.2.1.1 & 3.2.1.2 Tables 3-2 to 3-4 Appendices C & E
845.620(b)(16)(A)	water table depth;	Section 3.2.4 Figure 3-3 Appendix D
845.620(b)(16)(B)	hydraulic conductivities;	Section 3.2.5 Table 3-3 Appendix E
845.620(b)(16)(C)	effective and total porosities;	Sections 2.5 & 3.2 Table 2-1
845.620(b)(16)(D)	direction and velocity of groundwater flow; and	Sections 3.2.4, 3.2.5 & 3.2.6 Tables 3-2 & 3-4 Figures 3-3

TABLE ES-1. PART 845 REQUIREMENTS CHECKLIST

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in HCR
845.620(b)(16)(E)	map of the potentiometric surface;	Figures 3-3 Appendix D
845.620(b)(17)	Groundwater classification pursuant to 35 I.A.C. § 620	Section 3.2.7

[O: EDP 08/06/21, U: SSW 09/17/21, C: SSW 09/22/21]

Notes:

35 I.A.C. § 620 = Title 35 of the Illinois Administrative Code, Part 620

HCR = Hydrogeologic Characterization Report

-- = reference to main regulation

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: 35 I.A.C. § 845 (Part 845) (IEPA, April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this HCR on behalf of DCPP (**Figure 1-1**), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the BAB. However, information gathered to evaluate other CCR units in the vicinity regarding geology, hydrogeology, and groundwater quality is included, where appropriate. The Duck Creek BAB is an inactive 2.2-acre lined CCR SI formerly used to manage CCR and non-CCR waste streams at the DCPP. The BAB consists of three cells. The bottom and side slopes of all three cells are concrete lined. Gravel surfaced roads surround the basin cells. A sluice pipe delivered CCR material to the pond. An outlet structure for water is located in the southeast corner of the south cell. The western two cells are designed with a gently sloping ramp so that front-end loaders can remove bottom ash. The east cell flows toward a discharge structure that drains accumulated water. All bottom ash (*i.e.,* CCR) was removed from the BAB when the plant was retired in November 2019, the basin currently contains no impounded water or CCR materials. This HCR includes Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the BAB at the DCPP.

1.2 Part 845 Description

CCR is commonly referred to as coal ash, and CCR SIs are commonly referred to as coal ash ponds. Part 845 contains comprehensive rules for the design, construction, operation, corrective action, closure, and post closure care of these SIs. This rule includes GWPSs applicable at the waste boundary at each CCR SI and requires each owner or operator to monitor groundwater. The rule includes a permitting program as well as all federal standards for CCR SIs promulgated by the United States Environmental Protection Agency (USEPA). In addition, the rules include procedures for public participation, closure alternatives analyses, and closure prioritization, and provides access to records via public website. The rules also include financial assurance requirements for CCR SIs.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.620 is included in **Table ES-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.620.

1.3 Previous Investigations and Reports

Numerous hydrogeologic investigations have been performed concerning the CCR Units located at the DCPP. The information presented in this HCR includes data collected in support of the monitoring well network established for development of the GMP and supplements comprehensive data collection and evaluations presented in prior hydrogeologic investigation reports (recent to oldest), including, but not limited to, the following:

- **Natural Resource Technology, an OBG Company (NRT/OBG), October 17, 2017. *Hydrogeologic Monitoring Plan, Bottom Ash Basin – CCR Unit ID 205, Duck Creek Power Station, Canton, Illinois*.**
  Hydrogeologic Monitoring Plan (HMP) prepared to provide background information necessary to support the groundwater monitoring system established to comply with Title 40 of the Code

of Federal Regulations (40 C.F.R.) § 257 Subpart D (CCR Rule; published in 80 FR 21302-21501, April 17, 2015) for the DCPP.

- **Hanson Professional Services, Inc. (Hanson), September 2015. *Initial Assessment and Rationale for Proposed Well Locations, Duck Creek Power Station, Bottom Ash Basins, Fulton County, Illinois*.**
  Results of initial assessment and proposed monitoring well locations and installation schedule.
- **Hanson, March 2010. *Hydrogeologic Report Ameren Duck Creek Power Generating Station Solid Waste Disposal System (Ash Pond 1, Ash Pond 2, and Recycle Pond).***
  Report summarizes data from previous groundwater investigations in support of closure activities at the DCPP related to Ash Pond 1, Ash Pond 2, and the Recycle Pond; identifies groundwater impacts related to those ponds; and provides preliminary recommendations related to future monitoring.
- **Hanson, 2009. *Section 3 – Hydrogeologic Report, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Springfield, Fulton County, Illinois.***
  An overview prepared to illustrate regional climate, geology, and hydrogeology and site-specific information related to geotechnical, hydrogeological, and geochemical characteristics found at the site.

A GMP is being prepared for the BAB in conjunction with this report and is included in the Operating Permit to which this HCR is attached.

1.4 Site Location and Background

The DCPP is located in Fulton County, Illinois and approximately 6 miles southeast of the town of Canton. The BAB is located north of the power plant in Section 30 of Township 6 North, Range 5 East (**Figure 1-1**). The DCPP is located near the Duck Creek Cooling Pond, which was used as a source of cooling water for the power plant when it was active, and several small ponds which are remnants of the area's surface mining history. The BAB is located just north of the Duck Creek Cooling Pond and just south of nearby surface mining (**Figure 1-2**). Prior to construction of the power plant and associated facilities, strip mining of coal took place within the property boundary of the DCPP (**Figures 1-1 and 1-2**). Currently, land use adjacent to the DCPP is agriculture, pasture, and forest with minimal development.

1.5 Site History and CCR Units

Construction of the BAB took place sometime in late 2007 or early 2008. In 2016, a History of Construction was provided by AECOM for the DCPP, but the BAB was small enough in volume (less than 20-acre feet) to be exempt from this history by 40 C.F.R. § 257.73(b).

A liner design criteria evaluation was performed by AECOM in 2016 and states that the BAB was constructed with a lower and upper liner; the lower consists of a 1 foot thick layer of compacted clay overlain by a 60-millimeter high density polyethylene (HDPE) membrane, and the upper consists of 8 inches of reinforced concrete. Permeability and hydraulic conductivity could not be determined from the records available; therefore, the BAB does not meet the §257.71(a)(1) criteria for a lined impoundment. The BAB is estimated to enable storage of approximately 25,000 cubic yards of CCR material (IPRG, 2016). During operation, CCR (bottom ash) was sluiced to the western cells of the pond. Particles settled within the cell and decant water was piped to the eastern cell. The western cells required frequent clean out events using heavy equipment to remove bottom ash from the cell for permanent disposal at the on-site landfill.

Several other CCR units are located on the DCPP property, including: the closed units, Ash Pond No. 1 and Ash Pond No 2 located north of the BAB; the Gypsum Management Facility (GMF) Pond and GMF Recycle Pond located north of the closed ponds; and the permitted Landfill located north of the GMF Pond.

2. REGIONAL AND LOCAL GEOLOGY

2.1 Topography

Topography within the DCPP property (**Figure 1-1**) is significantly influenced by the history of mining in the area. Strip mining has occurred in this area since the 1930s, prior to mine reclamation laws and, where present, has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit. The strip mining activity has produced rough topography from soil piles and depressions, often ponded with water (Hanson, 2009). Topography adjacent to the BAB is provided in **Figure 2-1**.

2.2 Regional Geomorphology

The DCPP lies near the east edge of Fulton County in north central Illinois. The BAB lies along the southeast edge of the Galesburg Plain Division of the Central Lowland Physiographic Province. The area consists of flat to gently rolling uplands that are dissected by many, deeply incised streams that are tributaries to major river systems. The erosional landforms have developed primarily within deposits of glacial drift that blanket Pennsylvanian-aged bedrock. The Pennsylvanian bedrock generally controls the landforms, particularly drainage ways and rivers in the area (Hanson, 2009).

The Illinois River delineates the southeast border of the Galesburg Plain and is the main drainage for the region. The physiography of many areas in the Galesburg Plain has been affected by strip mining of coal. Strip mines have altered the natural landforms and drainage systems. Unreclaimed strip mine areas are usually very hummocky with mine spoils and are pocked with ponds and depressions (Hanson, 2009).

2.3 Soils

Surficial soils at the Site and vicinity are shown on **Figure 2-2**, based on the soil survey performed in Fulton County in 1994 available in the Soil Survey Geographic database (SSURGO) by the United States Department of Agriculture Natural Resources Conservation Service (NRCS) provided by the Environmental Systems Research Institute (ESRI) web-hosted layer (NRCS, 1997).

Former soils underlying the Site are identified as Orthents (#801B). Orthents consists of somewhat poorly-drained to well-drained loess in uplands. This soil is unsuitable for cultivated crops due to low fertility, low pH, and water erosion, and moderately suitable for dwellings due to shrink-well and wetness.

Areas surrounding the BAB are classified as Dumps, mine (#536), Lenzburg silt loam (#871C, #871D, #871G, and #876B), Lenzwheel silt loam (#876B), Rozetta silt loam (#279B and #279C2), Fayette silt loam (#280gD2 and #280E2), Seaton silt loam (#274E2), Hickory silt loam (#8cF and #8E2), and Keomah silt loam (#17A). The Dumps, mine zone represents the former surface mined materials. The Lenzburg silt loam consists of a well-drained loam situated in graded spoil banks in the uplands. These soils formed from cast overburden from surface mining. Most areas of this association are moderately suitable for cultivated crops due to water erosion. The Lenzwheel silt loam consists of well-drained loam situated in graded spoil banks in the uplands. These soils formed from cast overburden from surface mining. Most areas of this association are moderately suitable for cultivated crops due to crusting and water erosion. The

Rozetta series consists of well drained loess in interfluvial areas, head slopes, and sideslopes along upland drainageways. These soils are moderately suitable for cultivated crops due to crusting and water erosion. The Fayette series consists of well drained loess on sideslopes along upland drainageways. These soils are moderately suitable for cultivated crops due to crusting and water erosion. The Seaton silt loam consists of well-drained loam on side slopes along upland drainageways. These soils formed from loess. Most areas of this association are unsuitable for cultivated crops due to equipment limitations, low pH, and water erosion. The Hickory series consists of well-drained till. These soils formed on sideslopes along upland drainageways. Most areas of this association are moderately unsuitable for cultivated crops due to frost heave, low pH, and water erosion. The Keomah series consists of somewhat poorly drained loess in interfluvial areas. These soils are moderately suitable for cultivated crops due to crusting and flooding.

2.4 Regional Geology

Regionally, the DCPP is positioned on the glacial uplands above the Illinois River in the Ancient Illinois Floodplain of the Till Plains Section of the Central Lowland Province.

2.4.1 Regional Unlithified Geology

Upper unlithified materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems. The erosional landforms have developed primarily within deposits of glacial drift that blanket Pennsylvanian-aged bedrock (NRT/OBG, 2017).

Areas near the BAB are part of several large surface coal mines where unlithified materials are present in the excavated strip mine spoils, but have been mixed due to the surface mining activities. Mining operations in the area have ceased (NRT/OBG, 2017).

2.4.2 Regional Bedrock Geology

The uppermost bedrock stratum in the area is the Carbondale Formation of the Kewanee Group of the Pennsylvanian System. The Carbondale Formation consists of interbedded sequences of shale, sandstone, limestone, and coal with associated underclay. These sediments were deposited in shallow marine, deltaic, and swamp environments. Some of the shales are fossiliferous (containing either plant or marine fossils), and some contain sideritic nodules and bands. The sandstones are mostly subgraywackes and occur in elongated channel facies. The limestones are generally gray to dark gray, argillaceous, and normally fossiliferous. Thin black fissile shales are commonly associated with the limestones. The Carbondale Formation includes the principle Illinois economic coals: the Herrin (No. 6) Coal, the Springfield (No. 5) Coal, the Colchester (No. 2) Coal, and the Danville (No. 7) Coal. Underclays occur at the base of the coal seams. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam (Hanson, 2009).

2.4.3 Structure

The bedrock surface in the site area has been mapped at an elevation of 560 feet NAVD88. The bedrock mapping indicates the beds dip to the east-southeast at approximately 60 feet per mile. The St. Davis anticline occurs within the Pennsylvanian sequence and passes through the landfill area, which explains the lack of strip mining activity in this portion of the DCPP (Hanson, 2005).

2.4.4 Seismic Setting

The major geologic structural features within Illinois are depicted on **Figure 2-3**. Fulton County is not located in a seismic impact zone. The nearest areas of present day fault-related, seismic activity are the Northern Illinois Seismic Source Zone and the Wabash Valley Fault Zone near southwestern Indiana and the New Madrid Fault Zone along the Ohio and Mississippi River Valleys in southeastern Illinois. Records dating from 1811 indicate that earthquakes greater than a Richter Scale Magnitude 6.0 occurred in or near the New Madrid Fault line. Away from the fault, all earthquakes have been a 5.9 magnitude or less. The earthquake epicenters appear to be the result of modern regional stress fields and are not related to the nearby inactive faults (Hanson, 2009).

2.4.5 Mining Activities

Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam (**Appendix A**). Mining operations in the area have ceased. As indicated in **Section 2.4.2**, strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the Site. Previous investigations completed at the Site also indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet (as observed at monitoring wells OM24D and OM15 near the ash ponds). The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts, and silty clays of the unconsolidated glacial and aeolian deposits. The BAB was constructed in close proximity to mined areas and mine spoils were observed in some boring logs (*e.g.,* BA01, BA05, and BA06).

2.5 Site Geology

A field investigation was performed in 2021 to collect additional data for the discussion of vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b). The 2021 field investigation locations are shown on **Figure 2-4**. The major geomorphic features occurring within and nearby the BAB include Peoria/Roxanna Loess overlying Glasford Formation clayey diamictons (Radnor Till).

2.5.1 Site-Specific Unlithified Geology

The unlithified stratigraphy within and immediately surrounding the BAB consists of the following in descending order: fill material and CCR; silt and clayey silt loess (Peoria/Roxanna Loess); weathered till; shallow, medium-grained sand to silt; and till. The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). Boring logs and monitoring well and piezometer construction forms obtained from investigations at the BAB are provided in **Appendix B**.

2.5.1.1 Fill and CCR

Areas immediately north of the BAB are part of several large surface coal mines where unlithified materials are present within the excavated strip mine spoils, but have been mixed due to the surface mining activities. Strip mine spoils are present in borings BA01, BA05, and BA06, north of the BAB. The Fill ranges in thickness from 8 to 28 feet bgs and is deepest adjacent to the railroad tracks north of the BAB. The Fill generally consists of silts and clays with fine- to coarse-grained sand and trace small gravel. Trace coal fragments are also observed at depth. Mining operations in the area have ceased.

All bottom ash (*i.e.,* CCR) was removed from the BAB when the plant was retired in 2019; the basin currently contains no impounded water or CCR materials. The BAB overlies the Loess Unit (**Section 2.5.1.2**). Because the BAB is empty, no bottom ash or leachate samples were collected for characterization.

2.5.1.2 Peoria/Roxanna Loess

The Wisconsinan Stage Peoria/Roxanna Loess extends from beneath the topsoil developed in the loess to depths ranging from 14 to 34 feet. The loess consists of medium to very stiff silt with little clay and trace very fine- to fine-grained sand. The loess is saturated below depths varying from approximately 4 to 12 feet in wells adjacent to the BAB. Trace wood fragments were observed at the loess contact with the underlying till in BA02 (NRT/OBG, 2017).

Geotechnical analysis results from samples collected from Peoria/Roxanna Loess yielded Unified Soil Classification System (USCS) soil classifications of silt and lean clay. Sample locations are shown on **Figure 2-4**, the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**. Geotechnical results indicated the following:

- Average moisture content of 27.1 percent, with a range of 24.1 to 29.0 percent.
- Average total porosity (calculated) of 41.6 percent, with a range of 39.2 to 44.2 percent.
- Average dry density of 96.3 pounds per cubic foot (pcf), with a range of 94.4 to 100.1 pcf.
- Average specific gravity of 2.69, with a range of 2.60 to 2.71.
- Average grain size composition of 0 percent gravel, 6.3 percent sand, and 93.7 percent fines (silt and clay). The fines content ranged from 91 to 99 percent, with a median value of 91 percent.
- Geometric mean vertical hydraulic conductivity of 2.1×10^{-5} centimeters per second (cm/s) and ranged from 4.5×10^{-6} to 2.4×10^{-4} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the Peoria/Roxanna Loess are summarized in **Table 2-2**.

2.5.1.3 Radnor Till

The Radnor Till underlies the Peoria/Roxanna Loess and ranges in thickness from 10 to 17 feet, extending to the termination depth of each boring. The till consists of silty clay with trace very fine- to coarse-grained sand and trace small gravel to hard clay with little silt, few very fine- to coarse-grained sand, and trace small gravel. The shallow till is generally weathered and exhibits signs of oxidation. The till sequences typically extend from the base of the loess unit to the bedrock surface (NRT/OBG, 2017). Based on geotechnical results and field observations, there are three distinct layers identified within the Radnor Till: upper Radnor Till, shallow sand zone, and lower Radnor till. Each of these layers of the Radnor Till is discussed below. Sample locations are shown on **Figure 2-4**, the geotechnical results from the most recent investigation are summarized in **Table 2-1**, and geotechnical laboratory reports are included in **Appendix C**.

Solid samples were also collected from the Radnor Till in 2021 for chemical analysis. The results of solid samples collected from the Radnor Till are summarized in **Table 2-2**.

Upper Radnor Till

Geotechnical analysis results from samples collected from the upper Radnor Till yielded USCS soil classifications of lean to fat clay, silt and clayey sand. Geotechnical results (**Table 2-1**) of the upper Radnor Till indicated the following:

- Average moisture content of 19.7 percent, with a range of 11.2 to 24.8 percent.
- Average total porosity (calculated) of 33.6 percent, with a range of 24.6 to 40.7 percent.
- Average dry density of 109.5 pcf, with a range of 100.2 to 128.0 pcf.
- Average specific gravity of 2.69, with a range of 2.63 to 2.73.
- Average grain size composition of 0 percent gravel, 42 percent sand, and 58 percent fines (silt and clay).
- Geometric mean vertical hydraulic conductivity of 7.6×10^{-7} cm/s and ranged from 5.5×10^{-8} to 7.5×10^{-5} cm/s.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the upper Radnor Till are summarized in **Table 2-2**.

Shallow Sand Zone

There are sand and silt zones within the till sequences; a continuous intercalated sand exists within the till below the BAB from approximately 18 to 40 feet bgs. The shallow sand zone is typically very dense, very fine- to coarse-grained, with few silt and trace small gravel. This unit generally ranges in thickness from approximately 2 to 7 feet. This sand unit also exhibits some lateral facies changes to include silty materials. These silty materials are generally described as hard silt with little clay, few very fine- to coarse-grained sand, and trace small gravel (NRT/OBG 2017). Similar sand and silt zones were observed underlying the Landfill and GMF Pond further north of the DCPP (Hanson 2005; Hanson, 2009). Geotechnical analysis results (**Table 2-1**) from one sample collected from the shallow sand zone in 2021 indicated the following:

- Moisture content of 9.9 percent.
- Specific gravity of 2.73.
- Grain size composition of 11 percent gravel, 78 percent sand, and 11 percent fines (silt and clay).

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the shallow sand zone are summarized in **Table 2-2**.

Lower Radnor Till

Geotechnical analysis results from samples collected from the lower Radnor Till yielded USCS soil classifications of silt and clay. Geotechnical results (**Table 2-1**) of the lower Radnor Till indicated the following:

- Average moisture content of 13.0 percent, with a range of 11.6 to 14.6 percent.
- Average total porosity (calculated) of 26.0 percent, with a range of 23.7 to 28.1 percent.

- Average dry density of 122.3 pcf, with a range of 117.6 to 127.6 pcf.
- Average specific gravity of 2.65, with a range of 2.60 to 2.68.
- Average grain size composition of 0 percent gravel, 32 percent sand, and 69 percent fines (silt and clay). The sand content ranged from 19 to 41 percent and fines content ranged from 59 to 81 percent.

Solid samples were also collected in 2021 for chemical analysis. The results of solid samples collected from the lower Radnor till are summarized in **Table 2-2**.

2.5.2 Site Specific Bedrock Geology

The bedrock below the Radnor Till is Pennsylvanian-aged bedrock encountered at greatly varying depths across the DCPP. Bedrock depths ranged from a minimum of 52 feet to a maximum of 108 feet. Although bedrock was encountered at the BAB at 26 feet bgs at well BA03, this is not typical. Top of bedrock was observed at soil boring SB01 (located at well nest BA01) at 46 feet bgs and other locations were drilled between 30 to 40 feet bgs without encountering bedrock. Where the Springfield (No. 5) Coal Member was mined, bedrock consists of a Carbondale Formation shale unit. The bedrock shows little compositional variation across the site and consists primarily of shaley siltstone and silty shale. These units often contained thin dolomite ledges and nodules and some fractures.

Boring locations for the BAB are provided in **Appendix B** and geologic cross-sections are provided in **Figures 2-5** and **2-6**.

3. REGIONAL AND LOCAL HYDROGEOLOGY

3.1 Regional Hydrogeology

As discussed in **Section 2**, unlithified materials consist of Wisconsinan Stage materials overlying Illinoian Stage deposits. The undisturbed unlithified materials consist of loess, diamictons, and lacustrine/alluvial deposits overlying Pennsylvanian-aged bedrock. The area is flat to gently rolling uplands that are dissected by deeply incised streams that are tributaries to major river systems in areas that have not been disturbed by strip mining activity.

Available records of wells within one mile of the site indicate potable water may be obtained from unconsolidated materials or from deep bedrock. Estimated specific capacity (used to approximate the transmissivity of a formation) indicated shallow sands near the site provide a very modest specific capacity and groundwater yield (Hanson, 2009).

3.2 Site Hydrogeology

Wells used for groundwater monitoring at the BAB have been constructed in phases since 2015. Four monitoring wells were installed in 2015, and two were installed in 2016. In 2021, four additional wells were installed to provide information to meet the requirements of Part 845. A summary of the current monitoring well network and construction details are included in **Table 3-1** and depicted in **Figure 3-1**. Boring logs, monitoring well, and piezometer construction forms are provided in **Appendix B**. This section discusses the recently collected information, focusing on the existing well network and monitoring wells installed after 2015 around the BAB, as well as appropriate historical data from wells outside the focus of the current investigation.

Surface water drainage over much of the Site flows into the Duck Creek Cooling Pond. The Duck Creek Cooling Pond was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River, and is used for thermal treatment of cooling water discharging from the DCPP. Groundwater generally mimics the surface topography and flows southward toward a channel leading to the Duck Creek Cooling Pond.

3.2.1 Hydrostratigraphic Units

Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics.

- **Fill Unit**: As observed in previous investigations at the DCPP (Hanson, 2010), shallow groundwater at the Site also occurs within coal mine spoils, which have been observed north of the BAB in borings BA01, BA05, and BA06.
- **Uppermost Aquifer**: At the BAB, the uppermost aquifer includes the Peoria/Roxanna Loess and the Radnor Till. The Peoria/Roxanna Loess present at the BAB is 14 to34 feet thick, medium to very stiff silt and trace fine- to very fine-grained sand, and is saturated below depths ranging from 4 to 12 feet. The Radnor Till consists of clay, silts, and sands, ranging in thickness from 10 to 25 feet. The till sequence typically extends from the base of the loess to the bedrock surface.
- **Bedrock Confining Unit**: The lower limit of the aquifer is the top of the underlying Pennsylvanian shaley siltstone and silty shale bedrock; top of bedrock occurs from 26 to 46 feet bgs at the BAB. The shale bedrock unit underlying the Springfield Coal Member has been demonstrated by packer testing to be an aquitard (Hanson, 2016).

3.2.2 Uppermost Aquifer

The uppermost aquifer in the area of the BAB includes the Peoria/Roxanna Loess and the sand and silt zones within the Radnor Till, similar to the GMF Pond located approximately 2.5 miles north of the BAB. Within the till sequences at the BAB, a continuous intercalated sand exists below the basin from approximately 18 to 40 feet bgs described as the shallow sand zone in Section 2.5.1.3 and illustrated on **Figures 2-5 and 2-6**. This sand unit is the primary horizontal migration pathway within the till and generally ranges in thickness from about 2 to 7 feet. The top of the uppermost aquifer (top of sand) is presented in **Figure 3-2**. The lower limit of the uppermost aquifer is the top of bedrock.

3.2.3 Potential Migration Pathway

The Peoria/Roxanna Loess within the uppermost aquifer and above the sand unit has also been identified as a PMP. While the primary horizontal migration pathway is the sand zones of the uppermost aquifer, impacts have the potential to migrate within groundwater in the overlying Peoria/Roxanna Loess. The PMP intersects the well screens of all "L" wells and is saturated at depths of 4 to 12 feet bgs. While the PMP and uppermost aquifer are hydraulically connected, groundwater flow in the PMP is expected to be primarily vertical, with the majority of the horizontal migration expected to occur within the uppermost aquifer. Monitoring wells with the suffix "L" are screened within the loess and provide representative data on the hydraulic properties and groundwater quality of the PMP.

3.2.4 Water Table Elevation and Groundwater Flow Direction

Groundwater flow across the BAB within the uppermost aquifer is consistently southward toward a channel located approximately 50 feet to the south that leads to the Duck Creek Cooling Pond (**Figure 3-3**). Groundwater elevations of the uppermost aquifer across the BAB typically range from approximately 570 to 580 feet NAVD88 (additional groundwater contour maps and groundwater elevations are provided in **Appendix D**). Groundwater elevations may fluctuate seasonally, but the groundwater flow direction remains consistent in a south-southeast direction.

3.2.4.1 Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated using available groundwater elevation data from April to August 2021 at well locations within the PMP and sands of the uppermost aquifer. Vertical hydraulic gradients for the BAB are presented in **Table 3-2**. The results of the vertical hydraulic gradient calculations for the uppermost aquifer to PMP are summarized below:

- Vertical hydraulic gradients between wells BA01L (PMP) and BA01 (uppermost aquifer) ranged from 0.095 feet per feet (ft/ft) to 0.245 ft/ft downward, averaging 0.14 ft/ft downward;
- Vertical hydraulic gradients between wells BA02L (PMP) and BA02 (uppermost aquifer) ranged from 0.0154 ft/ft to 0.04 ft/ft downward, averaging 0.02 ft/ft downward; and
- Vertical hydraulic gradients between wells BA03L (PMP) and BA03 (uppermost aquifer) ranged from 0.0055 ft/ft downward to 0.0113 ft/ft upward, averaging 0.004 ft/ft upward.

3.2.4.2 Impact of Existing Ponds and Ash Saturation

The BAB Pond is lined, as described in **Section 1.5**. The basin has been drained and bottom ash is no longer present in the settling basins. There is a minimal amount of water (from precipitation) in the BAB, predominately due to precipitation. Groundwater elevation contours of surrounding monitoring wells indicate groundwater generally flows to the south, with no indication of radial flow. The minimal amount of water present in the BAB, in addition to no observations of radial flow, provide evidence that the BAB does not impact groundwater flow directions.

The flat horizontal groundwater gradient beneath this area (**Table 3-3**) and the small downward vertical gradients at well pairs BA01L and BA01, and BA02L and BA02 (**Table 3-2**), suggests the BAB is not an area of increased recharge or infiltration.

3.2.4.3 Impact of Surface Water Bodies

The nearest surface water body to the BAB is the Duck Creek Cooling Pond, which is located approximately 500 feet to the east of the BAB. Groundwater flow across the BAB within the uppermost aquifer is consistently southward toward a channel located approximately 50 feet to the south that leads to the Duck Creek Cooling Pond. The surface water elevation of the Duck Creek Cooling Pond is estimated from 562.5 to 565 feet NAVD88, which is approximately 12 feet lower than downgradient groundwater at the BAB.

3.2.5 Hydraulic Conductivities

3.2.5.1 Field Hydraulic Conductivities

Field hydraulic conductivity tests were performed in the uppermost aquifer by Hanson in 2021 Hydraulic conductivity test analyses and results are summarized in **Table 3-3** and provided in **Appendix E**. Field hydraulic conductivity tests from monitoring wells BA01L, BA02L, BA03L, BA01, BA03, and BA01C indicated hydraulic conductivity measuring from 1.5×10^{-4} to 3.9×10^{-3} cm/s and a geometric mean of 6.3×10^{-4} cm/s.

As discussed in the hydrogeologic monitoring plan (NRT/OBG 2017), the 6 to 7 feet thick continuous intercalated sand within the till (uppermost aquifer) intersected by the well screens at BA01 and BA04 indicate the sand zone, when present, is highly permeable with a geometric mean hydraulic conductivity of 3.4×10^{-2} cm/sec. Hydraulic conductivity of the less permeable downgradient materials, intersected by wells BA02 and BA03, had a geometric mean hydraulic conductivity of 9.1×10^{-5} cm/sec, or 374 times lower permeability than the wells screened across the sand zone (*i.e.*, BA01 and BA04) (NRT/OBG 2017).

3.2.5.2 Laboratory Hydraulic Conductivities

Falling head permeability tests (ASTM D5084 Method F) were performed in the laboratory on samples collected during the 2021 investigations. Sample locations are shown on **Figure 2-4**. The geotechnical laboratory report is provided in **Appendix C**. The results are summarized in **Table 2-1** and discussed below.

- Three samples were collected from the Peoria/Roxanna Loess from soil borings SB01, SB02, and SB03. Laboratory falling head permeability test results in the uppermost aquifer indicated vertical hydraulic conductivities ranging from 4.5×10^{-6} to 2.4×10^{-4} cm/s, and a geometric mean vertical hydraulic conductivity of 2.1×10^{-5} cm/s.
- Four samples were collected from the upper Radnor Till from soil borings SB01, SB02, and SB03. Laboratory falling head permeability test results in the upper Radnor Till indicated a vertical hydraulic conductivity ranging from 5.5×10^{-8} to 7.5×10^{-5} cm/s, and a geometric mean vertical hydraulic conductivity of 7.6×10^{-7} cm/s.

3.2.6 Horizontal Groundwater Gradients and Flow Velocity

Groundwater flow below the BAB is consistently in a south-southeastern direction (**Figure 3-3**). Seasonal variation of groundwater levels at the BAB are indicated in the additional groundwater elevation contour maps and elevations shown in **Appendix D**. Observed groundwater elevations may fluctuate seasonally by approximately 1 to 2 feet. There is no observable seasonal variation of groundwater flow direction at the BAB.

Horizontal hydraulic gradients and groundwater velocities for the uppermost aquifer were calculated based upon groundwater elevation measurements from April through August 2021 between BA05 and BA04 (west side of basin), BA01 and BA03 (center of basin), and BA06 and BA02 (east side of basin) (**Table 3-4**). Horizontal hydraulic gradients are slight across the BAB and ranged from 0.0006 ft/ft between BA06 and BA02 in August 2021 to 0.0342 between BA06 and BA02 in July 2021.

Horizontal hydraulic gradients calculated to the west of the BAB, between BA05 and BA04, were on average 0.0132 ft/ft with an average groundwater velocity of 0.032 feet per day (ft/day). Horizontal hydraulic gradients calculated through the center of the BAB, between BA01 and BA03, were on average 0.0062 ft/ft with an average groundwater velocity of 0.05 ft/day. Horizontal hydraulic gradients calculated to the east of the BAB, between BA06 and BA02, were on average 0.0078 ft/ft, with an average groundwater velocity of 0.03 ft/day. In April through June 2021, average groundwater flow velocities at the BAB were 0.04 ft/day; from July to August 2021, groundwater flow velocities at the BAB were also on average 0.04 ft/day. Lower hydraulic gradients observed near the center of the BAB, between BA01 and BA03, are consistent with previous calculations of horizontal hydraulic conductivity at upgradient locations (NRT/OBG, 2017).

3.2.7 Groundwater Classification

Per 35 I.A.C. § 620.210, groundwater within the uppermost aquifer at the BAB meets the definition of a Class I - Potable Resource Groundwater based on the following criteria:

- Groundwater in the uppermost aquifer extends 10 feet or more below the land surface.
- Hydraulic conductivity exceeds the 1 x 10^{-4} cm/s criterion (**Table 3-3**).

Field hydraulic conductivity tests performed on the unlithified geologic materials that include loess, shallow sand, and intermediate sand at the BAB had geometric mean hydraulic conductivities exceeding 1 x 10^{-4} cm/s. Based on this information groundwater is classified as Class I – Potable Resource Groundwater.

However, background (upgradient) groundwater originates from areas north and west of the BAB that have been surface mined and present a significant alternative source for groundwater impacts.

3.3 Surface Water Hydrology

3.3.1 Climate

The climate in Canton is humid and annual precipitation generally exceeds evapotranspiration. Illinois State Water Survey (ISWS) records from 1989 through 2020 at Peoria, Illinois, which is located approximately 35 miles northeast of the DCPP, indicates precipitation averages 35.3 inches per year. Monthly precipitation averages higher than 3 inches from April through

August, and 1 to 3 inches in September through March. On average 16 inches of precipitation occur as snowfall.

As shown below in **Table A** below, ISWS temperature records show average maximum daily temperatures for 1989 to 2020 ranging from above 70 degrees Fahrenheit (°F) in May through September and minimum average daily temperatures that are below freezing December through March.

Table A. Average Monthly Temperature Extremes and Precipitation for Peoria, Illinois

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum Temperature (ºF)	33.3	37.6	49.9	62.5	72.6	81.3	84.4	82.5	76.9	64.5	50.1	37.2	61.2
Minimum Temperature (ºF)	18.3	21.5	31.6	41.8	52.2	61.7	65.4	63.2	55.4	44.1	33.3	22.7	42.7
Precipitation (inches)	1.71	1.60	2.08	3.42	3.93	3.18	3.02	3.10	2.97	2.64	2.35	1.84	35.3
https://www.isws.illinois.edu/warm/stationmeta.asp?site=ICC&from=wx													

3.3.2 Surface Waters

Duck Creek formerly bordered the east perimeter of the DCPP. In this area, Duck Creek has been dammed for use for thermal treatment of cooling water discharge from the DCPP and is now the predominant surface water body in the vicinity of the BAB. Surface water elevations of the Duck Creek Cooling Pond (**Figure 1-1**) are estimated from 562.5 to 565 feet NAVD88. Other surface waters in the vicinity include Buckheart Creek to the west, and Rice Lake, Miserable Lake, Big Lake, and Goose Lake to the east, all of which are backwater lakes located between Duck Creek and the Illinois River. The distance between the BAB and the Illinois River is sufficient to eliminate influence on local flow conditions at the site; therefore, site-specific flow conditions are not subject to surface water conditions of the Illinois River. Other surface waters in the vicinity of the BAB include freshwater emergent wetland to the east, and various freshwater ponds to the northeast, south, southeast, and southwest.

4. GROUNDWATER QUALITY

4.1 Summary of Groundwater Monitoring Activities

Groundwater monitoring is currently being conducted at the BAB as required by 40 C.F.R. § 257. Additional monitoring was completed in 2021 for development of the Part 845 monitoring program. These programs are summarized below.

4.1.1 40 C.F.R. § 257 Program Monitoring and Well Network

The 40 C.F.R. § 257 Well Network consists of six monitoring wells screened in the uppermost aquifer nearby and adjacent to the BAB including: two background monitoring wells (BA05 and BA06) and four compliance monitoring wells (BA01, BA02, BA03, and BA04). The boring logs, well construction forms, and other related monitoring well forms for the BAB 40 C.F.R. § 257 Well Network are included in **Appendix B** of this HCR. The well locations are shown on **Figure 3-1**.

Groundwater is being monitored at the BAB in accordance with the Detection Monitoring Program requirements specified in 40 C.F.R. § 257.94. Details of the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the BAB (NRT/OBG, 2017). Results are discussed in **Section 4.2**.

The 40 C.F.R. § 257 groundwater samples are collected semi-annually and analyzed for the field and laboratory parameters from Appendix III of 40 C.F.R. § 257, as summarized in **Table B** below.

Table B. 40 C.F.R. § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
pH	Groundwater Elevation	
Appendix III Parameters (Total, except TDS)		
Boron	Chloride	Sulfate
Calcium	Fluoride	TDS

[1] Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity are recorded during sample collection.

4.1.2 Part 845 Well Installation and Groundwater Monitoring

In 2021, four additional monitoring wells (BA01L, BA01C, BA02L, and BA03L) were installed at the BAB to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b).

Prospective Part 845 monitoring wells were sampled for eight rounds from April to August 2021 and the results were assessed for selection of the BAB Part 845 monitoring well network presented in the GMP. Samples were collected from the new monitoring points and analyzed for 35 I.A.C. § 845.600 parameters summarized in **Table C** below. Part 845 groundwater monitoring results are included below in **Section 4.2**.

Table C. Part 845 Groundwater Monitoring Program Parameters

Part 845 Groundwater Monitoring Parameters			
Field Parameters[1]			
pH	Turbidity	Groundwater Elevation	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

4.2 Groundwater Monitoring Results and Analysis

Groundwater data collected from the BAB 40 C.F.R. § 257 network monitoring wells from 2015 to 2021 were supplemented with sampling of additional locations in 2021 and evaluated with respect to the standards included in 35 I.A.C. § 845.600(a)(1). This data set was selected because it includes parameters (total metals) consistent with the parameter list in 35 I.A.C. § 845.600(a)(1). The groundwater analytical results are summarized in **Table 4-1** and discussed in the subsections below. Field parameters are included in **Table 4-2**. Results indicate that the parameters discussed in the following sections were detected at concentrations greater than the applicable 35 I.A.C. § 845.600(a)(1) standards and are considered potential exceedances[1].

4.2.1 Total Arsenic

Total arsenic was detected greater than the GWPS (0.01 milligrams per liter [mg/L]) in two downgradient wells (BA02 and BA02L), one upgradient well BA01, and one background well BA06. Total arsenic concentrations in downgradient and upgradient wells ranged from non-detect to 0.019 mg/L. Total arsenic in the background well ranged from non-detect to 0.024 mg/L.

4.2.2 Total Beryllium

Total beryllium was detected greater than the GWPS (0.004 mg/L) in one downgradient well BA02 and one background well BA06. Total beryllium concentrations in the downgradient well ranged from non-detect to 0.0068. Total beryllium concentrations in the background well ranged from non-detect to 0.02 mg/L.

[1] Potential exceedances include results reported during the eight rounds of baseline groundwater monitoring that are greater than the applicable 35 I.A.C. § 845.600(a)(1) standards. The results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the Groundwater Monitoring Plan (GMP). For simplicity, "GWPS" will be used hereafter in discussing potential exceedances. Exceedances will be determined following IEPA approval of the GMP.

4.2.3 Total Boron

Total boron was detected greater than the GWPS (2 mg/L) in downgradient well BA04, and background well BA06. Total boron concentrations in the downgradient well ranged from non-detect to 2.6 mg/L. Total boron concentrations in the background well ranged from non-detect to 4.75 mg/L.

4.2.4 Total Chloride

Total chloride was detected greater than the GWPS (200 mg/L) in background well BA06. Total chloride concentrations in the background well ranged from 470 to 598 mg/L.

4.2.5 Total Cobalt

Total cobalt was detected greater than the GWPS (0.006 mg/L) in two downgradient wells (BA02L and BA03L), one upgradient well BA01C, and two background wells (BA05 and BA06). Total cobalt concentrations in the downgradient wells ranged from non-detect to 0.017 mg/L. Total cobalt concentrations in the upgradient well ranged from 0.0024 to 0.01 mg/L. Total cobalt concentrations in the background wells ranged from non-detect to 0.037 mg/L.

4.2.6 Total Lead

Total lead was detected greater than the GWPS (0.0075 mg/L) in two downgradient wells (BA02L and BA03L), two upgradient wells (BA01 and BA01C), and background well BA06. Total lead concentrations in the downgradient wells ranged from non-detect to 0.023 mg/L. Total lead concentrations in the upgradient wells ranged from non-detect to 0.027 mg/L. Total lead concentrations in the background well ranged from non-detect to 0.042 mg/L.

4.2.7 Total Lithium

Total lithium was detected greater than the GWPS (0.04 mg/L) in background well BA06. Total lithium concentrations in the background well ranged from non-detect to 0.068 mg/L.

4.2.8 pH

The GWPS lower standard for pH (6.5 standard units [SU]) was exceeded once at one downgradient well BA02 and one upgradient well BA01. Measurements of pH ranged from 6.3 to 7.3 SU at BA02. Measurements of pH ranged from 6.2 to 7.1 SU at BA01.

4.2.9 Radium 226 and 228 Combined

Radium 226 and 228 combined was detected greater than the GWPS (5 picocuries per liter [pCi/L]) in one of 15 samples collected from background well BA06. Observations ranged from 0.06 to 9.64 pCi/L.

4.2.10 Total Sulfate

Total sulfate was detected greater than the GWPS (400 mg/L) in background wells BA05 and BA06. Total sulfate concentrations in the background wells ranged from 110 to 890 mg/L.

4.2.11 Total Dissolved Solids

TDS was detected greater than the GWPS (1,200 mg/L) in background wells BA05 and BA06. TDS concentrations in the background wells ranged from 380 to 2,300 mg/L.

5. EVALUATION OF POTENTIAL RECEPTORS

5.1 Water Well Survey

A water well survey was conducted for a 1,000 meter radius of the BAB (Hanson, 2021). Additionally, a potable water well inventory was completed in 2021 utilizing federal and state databases to assess nearby pumping wells, drinking water receptors, and other uses of water in the vicinity of the BAB. The following sources of information were queried to identify well locations, drinking water receptors, and other uses of water within 1,000 meters of the BAB boundary:

- United States Geological Survey (USGS) National Groundwater Monitoring Network (NGWMN)[1]
- Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map[2]
- USEPA Safe Drinking Water Information System (SDWIS)[3]
- IEPA Illinois Drinking Water Watch (DWW)[4]

According to the ISGS ILWATER Map, USEPA SDWIS, and IEPA DWW, there are no public or private water supply wells or intakes located within 1,000 meters of the BAB (**Appendix A**). There is no data for Fulton County available from USGS NGWMN.

5.2 Surface Water

A comprehensive search was performed utilizing the United States Fish and Wildlife Service (USFWS) Wetlands Mapper[5] and the USGS National Map[6] for surface water bodies within 1,000 meters of the BAB.

As indicated on the USFWS Wetlands Mapper and USGS National Map, various surface water features were identified within a 1,000-meter radius of the BAB. Surface waters in the vicinity of the BAB include various freshwater ponds to the east, south, and west (**Appendix A**).

The predominant surface water body in the vicinity of both the BAB and DCPP is the Duck Creek Cooling Pond (**Figure 1-1**), which was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River. The Illinois River and associated lowland backwater lakes, including Duck Lake, are located further east. According to the topographic map, the surface water elevation of Duck Creek (*i.e.*, Duck Creek Cooling Pond) is estimated from 562.5 to 565 feet NAVD88. The USGS National Map places the DCPP within the Lower Illinois-Lake Chautauqua watershed subbasin (Hydrologic Unit Code [HUC] 07130003) (**Appendix A**).

A Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map for Fulton County Unincorporated Areas, Illinois (Map No. 17057C0375E, effective on 02/04/2011) is attached in **Appendix F**. The flood hazard areas to the east of the DCPP are defined as those areas subject

[1] USGS NGWMN: https://cida.usgs.gov/ngwmn/index.jsp
[2] ISGS ILWATER Map: https://prairieresearch.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87
[3] USEPA SDWIS: https://www.epa.gov/enviro/sdwis-search
[4] IEPA Illinois DWW: http://water.epa.state.il.us/dww/index.jsp
[5] USFWS Wetlands Mapper: https://www.fws.gov/wetlands/data/mapper.html
[6] USGS National Map: https://apps.nationalmap.gov/viewer/

to inundation by the 1 percent annual chance flood (*i.e.,* 100-year flood), also known as the base flood, that has a 1 percent chance of being equaled or exceeded in any given year.

5.3 Nature Preserves, Historic Sites, Endangered/Threatened Species

A search of the Illinois Department of Natural Resources (IDNR) Natural Heritage Database[7] for natural areas and protected areas within 1,000 meters of the BAB was performed. According to the IDNR Natural Heritage Database, there are 15 Natural Areas in Fulton County, including two Category III - Nature Preserves (Harper-Rector Woods Nature Preserve [34.67 acres] and Kedzior Woodlands Land and Water Reserve [163.64 acres]). No natural areas were identified within 1,000 meters of the BAB.

The IDNR Natural Heritage Database Threatened and Endangered Species by County[8] lists 11 state threatened and 12 state endangered species in Fulton County. The USFWS Environmental Conservation Online System[9] lists three federally threatened and one federally endangered species in Fulton County (**Appendix A**).

Additionally, a search of the IDNR Historic Preservation Division[10] database for historic sites in the vicinity of the Site yielded no results within 1,000 meters of the BAB. The Illinois State Archaeological Survey (ISAS)[11] databases that do not require credentials to access were also searched and yielded no results within 1,000 meters of the BAB.

[7] IDNR Natural Heritage Database: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Pages/NaturalHeritageDatabase.aspx
[8] Illinois Threatened and Endangered Species by County: https://www2.illinois.gov/dnr/ESPB/Documents/ET_by_County.pdf
[9] Illinois Threatened and Endangered Species by County: https://www2.illinois.gov/dnr/ESPB/Documents/ET_by_County.pdf
[10] IDNR Historic Preservation Division: https://www2.illinois.gov/dnrhistoric/Pages/default.aspx
[11] ISAS: https://www.isas.illinois.edu/

6. CONCLUSIONS

Numerous hydrogeologic investigations have been performed concerning the CCR Units located at the DCPP and have been most recently updated for this HCR. Results of previous hydrogeologic studies were reintroduced in this HCR and updated to include geologic, hydrogeologic, and groundwater quality data collected with a focus on the BAB (Part 845 regulated) CCR Unit.

The data were summarized and evaluated for changes in groundwater conditions since the previous investigations; available groundwater quality data for the BAB was compared to the Part 845 Standards.

The results of the hydrogeologic and groundwater quality evaluation are:

- The unlithified stratigraphy within and immediately surrounding the BAB GMF Pond consists of the following in descending order: fill material; silt and clayey silt loess (Peoria/Roxanna Loess); weathered till (upper Radnor Till); shallow, medium-grained sand to silt (shallow sand zone); and till (lower Radnor Till).
- The unlithified units overlay Pennsylvanian-age shaley siltstone and silty shale bedrock (Carbondale Formation). Bedrock was encountered at 26 and 46 feet bgs at the BAB.
- Strip mining has occurred in this area since the 1930s. Strip mining in the site vicinity extracted coal from the Springfield (No. 5) Coal seam. Mining operations in the area have ceased. Strip mining has completely disrupted the natural stratigraphy down to the Springfield (No. 5) Coal unit at some portions of the DCPP property. Previous investigations indicated that bedrock in the area is overlain by mine spoil ranging in thickness from approximately 10 to 75 feet. The mine spoil consists of excavated bedrock (weathered shale, shale fragments, and some coal fines) mixed with the sand, silts and silty clays of the unconsolidated glacial and aeolian deposits. The BAB was constructed in close proximity to mined areas and mine spoils were observed in some boring logs (*e.g.,* BA01, BA05 and BA06).
- Three distinct water-bearing layers have been identified at the Site based on stratigraphic relationships and common hydrogeologic characteristics:
  - **Fill Unit:** shallow groundwater present in fill material and coal mine spoils.
  - **Uppermost Aquifer**: The uppermost aquifer in the area of the BAB includes the Peoria/Roxanna Loess and the sand and silt zones within the Radnor Till. Within the till sequences at the BAB, a continuous intercalated sand exists below the basin from approximately 18 to 40 feet bgs. The sand zone is typically very dense, very fine- to coarse-grained, with few silt and trace small gravel. This sand unit is the primary horizontal migration pathway and generally ranges in thickness from about 2 to 7 feet.
  - **Bedrock Confining Unit**: This unit includes the Pennsylvanian shaley siltstone and silty shale bedrock. The shale bedrock unit underlying the Springfield Coal Member has been demonstrated by packer testing to be an aquitard.
- The Peoria/Roxanna Loess within the uppermost aquifer and above the sand unit has also been identified as a PMP.
- Groundwater flow across the BAB within the uppermost aquifer is consistently southward toward a channel located approximately 50 feet to the south that leads to the Duck Creek

Cooling Pond. Groundwater elevations of the uppermost aquifer across the BAB typically range from approximately 570 to 580 feet NAVD88. Groundwater elevations may fluctuate seasonally, but the groundwater flow direction remains consistent in a south-southeast direction toward the Duck Creek Cooling Pond.

- Surface water drainage over much of the site flows east or southeast into the Duck Creek Cooling Pond. The Duck Creek Cooling Pond was formed by damming a portion of Duck Creek, a minor tributary of the Illinois River.
- Groundwater flow velocities in the uppermost aquifer are estimated from 2.0×10^{-3} to 1.3×10^{-1} ft/day.
- The BAB is lined, has been drained, and bottom ash is no longer present in the settling basins. There is a minimal amount of water in the BAB, predominately due to precipitation. Groundwater elevation contours of surrounding monitoring wells indicate groundwater generally flows to the south, with no indication of radial flow. The minimal amount of water (from precipitation) present in the BAB, in addition to no observations of radial flow, provide evidence that the BAB does not impact groundwater flow directions.
- Based on the detailed geologic information provided, and the hydrogeologic and groundwater quality data, groundwater within the uppermost aquifer at the BAB is classified as Class I – Potable Resource Groundwater. However, background (upgradient) groundwater originates from areas north and west of the BAB that have been extensively surface mined and present a significant alternative source for groundwater impacts.
- Total arsenic, beryllium, boron, cobalt, lead, and pH were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). All of these parameters, with the exception of pH were also detected in one or both background wells at least once at concentrations greater than the GWPS. Total chloride, lithium, radium 226 and 228 combined, sulfate, and TDS were also detected at least once at concentrations greater than the GWPS in one or both background wells.

Groundwater results are considered potential exceedances because they were compared directly to the standard and did not include an evaluation of background groundwater quality or apply the statistical methodologies proposed in the GMP.

This HCR satisfies Part 845 content requirements specific to 35 I.A.C. § 845.620(b) (Hydrogeologic Site Characterization) for the BAB at the DCPP.

REFERENCES

AECOM, 2016. *CCR Certification Report: Liner Design Criteria Evaluation for Bottom Ash Basin at Duck Creek Power Station.* October 2016.

Federal Emergency Management Agency (FEMA), 2021. Flood Insurance Rate Map for Fulton County Unincorporated Areas, Illinois (Map No. 17057C0375E, effective on 02/04/2011). Accessed on August 27, 2021 from https://msc.fema.gov/portal/search?AddressQuery=17751%20North%20Cilco%20Rd%2C%20Canton%2C%20IL#searchresultsanchor

Hanson Professional Services, Inc. (Hanson), 2005. Geology and Hydrogeology Report in Illinois EPA Bureau of Land Permit Application – Log No. 2005-121-LF. Hanson Professional Services Inc., Springfield, IL, 115 pp + App.

Hanson Professional Services, Inc. (Hanson), 2009. Section 3 – *Hydrogeologic Report*, in Support Document for Permit Application, Duck Creek Power Generating Station, Gypsum Management Facility, Springfield, Fulton County, Illinois.

Hanson Professional Services, Inc. (Hanson), 2010. Hydrogeologic Report Ameren Duck Creek Power Generating Station Solid Waste Disposal System (Ash Pond 1, Ash Pond 2, and Recycle Pond). March.

Hanson Professional Services, Inc. (Hanson), 2016. Ash Pond 1 and Ash Pond 2, Aquifer Evaluation in the Surface (Strip) Mining Area, Duck Creek Power Station, Illinois Power Resources Generating, LLC, Fulton County, IL. February 29, 2016.

Illinois Department of Natural Resources (IDNR), 2021. Historic Preservation Division. Central Region Historic Sites. Accessed from URL: https://www2.illinois.gov/dnrhistoric/Experience/Sites/Central/Pages/Default.aspx#region

Illinois Department of Natural Resources (IDNR), 2021. Natural Heritage Database. Accessed from URL: https://www2.illinois.gov/dnr/conservation/NaturalHeritage/Pages/NaturalHeritageDatabase.aspx

Illinois Environmental Protection Agency (IEPA), 2021. Illinois Drinking Water Watch (DWW). Accessed from URL: http://water.epa.state.il.us/dww/index.jsp

Illinois Power Resources Generating, LLC (IPRG), 2016. *Closure Plan for Existing CCR Surface Impoundment*. October 2016.

Illinois State Geological Survey (ISGS), 2021. Fulton County Coal Data, including Mine Map and Mine Directory. Accessed on August 27, 2021 from URL: https://isgs.illinois.edu/research/coal/maps/county/fulton

Illinois State Geological Survey (ISGS), 2021. *Illinois Water & Related Wells Map (ILWATER) for 17751 North Cilco Rd Canton, IL 61520*. Accessed from URL: https://prairie-research.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87

Illinois State Geological Survey (ISGS), 2021. ILMINES Interactive Map. Accessed from https://isgs.illinois.edu/illinois-coal-mines-ilmines

Illinois State Water Survey (ISWS), 2021. *Official Climate Network: Station Data: Peoria. 1989-2020.* Accessed from https://www.isws.illinois.edu/warm/stationmeta.asp?site=ICC&from=wx

Natural Resource Technology, an OBG Company (NRT/OBG), 2017. Hydrogeologic Monitoring Plan, Duck Creek Bottom Ash Pond – CCR Unit ID 205. October 17, 2017.

NRCS, 1997. Soil Survey of Fulton County, Illinois, Part 1. Natural Resources Conversation Service. 1997.

United States Environmental Protection Agency (USEPA), 2021. Safe Drinking Water Information System (SDWIS). Accessed from: https://www.epa.gov/enviro/sdwis-search

United States Fish and Wildlife Service (USFWS), 2021. Environmental Conservation Online System. Listed species believed to or known to occur in Fulton County, Illinois. Accessed from: https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=17057

United States Fish and Wildlife Service (USFWS), 2021. Wetlands Mapper, National Wetlands Inventory, surface waters and wetlands. Accessed from URL: https://www.fws.gov/wetlands/data/mapper.html

United States Geological Survey (USGS), 2021. Daily Gauge Height January 1, 2018 to May 31, 2021 for USGS Gaging Station 05568615 at the Illinois River at Copperas Creek, Illinois. Accessed from URL: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=05568615

United States Geological Survey (USGS), 2021. National Groundwater Monitoring Network (NGWMN). Accessed from URL: https://cida.usgs.gov/ngwmn/index.jsp

United States Geological Survey (USGS), 2021. National Map Viewer. Accessed from URL: https://apps.nationalmap.gov/viewer/

TABLES

TABLE 2-1. GEOTECHNICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample ID	Field Location ID	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Moisture Content (%)	Dry Density (pcf)	Specific Gravity	Total Porosity[1] (%)	Vertical Hydraulic Conductivity (cm/s)	LL	PL	PI	Laboratory USCS	Gravel (%)	Sand (%)	Fines (%)
Peoria/Roxana Loess															
SB01/Comp 1	BA01L	10	24	24.1	100.1	2.640	39.2	--	31	19	12	CL	0	9.0	91
SB-01/ST-9	BA01L	16	18	27.2	95.8	--	--	4.50E-06	--	--	--	CL	--	--	--
SB02/Comp 1	BA02L	4	6	27.2	95.0	2.600	41.4	--	28	24	4	ML	0.0	1	99
SB-02/ST-5	BA02L	8	10	27.7	96.8	--	--	8.00E-06	--	--	--	CL	--	--	--
SB03/Comp 1	BA03L	6	16	29.0	94.4	2.710	44.2	--	35	22	13	CL	0.0	9	91
SB-03/ST-5	BA03L	8	10	27.4	95.5	--	--	2.40E-04	--	--	--	CL	--	--	--
Upper Radnor Till															
SB01/Comp 2	BA01L	26	30	11.4	127.9	2.720	24.6	--	23	14	9	CL	0.0	41	59
SB-01/ST-15	BA01L	28	30	24.6	100.7	--	--	5.90E-08	--	--	--	CL/CH	--	--	--
SB02/Comp 2	BA02L	16	22	24.8	101.0	2.730	40.7	--	33	17	16	ML	0.0	30	70
SB02/Comp 3	BA02L	22	26	19.3	106.0	2.630	35.4	--	31	16	15	SC	0.0	54	46
SB-02/ST-10	BA02L	18	20	22.8	102.7	--	--	7.50E-05	--	--	--	CL	--	--	--
SB-02/ST-13	BA02L	24	26	24.1	100.2	--	--	5.50E-08	--	--	--	CL/CH	--	--	--
SB-03/ST-10	BA03L	18	20	11.2	128.0	--	--	1.40E-06	--	--	--	CL	--	--	--
Shallow Sand Zone															
SB01/Comp 3	BA01L	32	38	9.9	--	2.730	--	--	NP	NP	NP	SP	11.0	78	11
Lower Radnor Till															
SB01/Comp 4	BA01L	38	46	14.6	119.3	2.660	28.1	--	18	15	3	ML	0.0	25	75
SB02/Comp 4	BA02L	28	40	14.3	117.6	2.600	27.5	--	30	17	13	CL	0.0	19	81
SB03/Comp 3	BA03L	20	26	11.6	127.6	2.680	23.7	--	23	14	9	CL	0.0	41	59

[O:FPO 7/13/21, U: EDP 8/25/21, C:LDC 09/07/21; C:SSW 09/24/21]

Notes:
[1] Porosity calculated as relationship of bulk density (p_b) to particle density (p_d) ($n = 100[1- (p_b/p_d)]$)
-- = Not Analyzed
% = Percent
bgs = below ground surface
cm/s = centimeters per second
ft = foot/feet
LL = Liquid limit
NP = Non Plastic
pcf = pounds per cubic foot
PI = Plasticity Index
PL = Plastic Limit

USCS = Unified Soil Classification System
CL = Lean Clay
CL/CH = Lean to Fat Clay
ML = Silt
SC = Clayey Sand
SP = Poorly Graded Sand

HSU = Hydrostratigraphic Unit
UA = uppermost aquifer

TABLE 2-2. SOIL ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Geologic Unit	Sample Depth (ft BGS)	Sample Date	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Boron (mg/kg)	Cadmium (mg/kg)	Chloride (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Fluoride (mg/kg)	Lead (mg/kg)	Lithium (mg/kg)	Mercury (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Sulfate (mg/kg)	Thallium (mg/kg)
SB-01C	Peoria/Roxana Loess	10-24	02/05/2021	<2.8	<0.93	62	<0.93	<9.3	<0.93	<10	13	2.3	3.8	7.1	5.8	<0.19	<0.93	<0.93	48	<0.93
SB-01C	Upper Radnor Till	26-30	02/05/2021	<2.3	2.6	9	<0.76	<7.6	<0.76	38	4.7	2.7	<2.5	3.7	<3.8	<0.15	<0.76	<0.76	12	<0.76
SB-01C	Shallow Sand Zone	32-38	02/05/2021	<3	6.2	21	<1	<10	<1	<10	5.6	5.1	<2.5	5.9	<5	<0.2	2.8	<1	10	<1
SB-01C	Lower Radnor Till	38-46	02/05/2021	<3.3	4.8	27	<1.1	<11	1.6	<11	11	8	<2.7	10	11	<0.22	4.6	<1.1	3900	<1.1
SB-02	Peoria/Roxana Loess	4-6	02/03/2021	<2.8	1.1	38	<0.92	<9.2	<0.92	<10	11	2.2	<2.5	4	6	<0.18	<0.92	<0.92	320	<0.92
SB-02	Upper Radnor Till	16-22	02/03/2021	<3	1.1	78	<1	<10	<1	<10	11	5.2	<2.5	13	5.3	<0.2	<1	<1	<10	<1
SB-02	Upper Radnor Till	22-26	02/03/2021	<3	3	51	<1	<10	1.8	<10	36	7.4	<2.5	10	12	<0.2	1.4	<2	18	<1
SB-02	Lower Radnor Till	28-40	02/04/2021	<3.4	4.4	170	1.6	29	6.2	<11	26	11	7	8.1	7.9	<0.22	4.8	4.9	5600	<1.1
SB-03	Peoria/Roxana Loess	6-16	02/02/2021	<2.8	1.2	49	<0.92	<9.2	<0.92	<10	16	4.6	<2.5	5.4	6.9	<0.18	<0.92	<0.92	150	<0.92
SB-03	Shallow Sand Zone	18-20	02/02/2021	<3	5.4	56	<1	<10	<1	<10	11	5.4	<2.5	6.7	6.2	<0.2	<1	<1	15	<1
SB-03	Lower Radnor Till	20-26	02/02/2021	<3	4.4	54	<1	<10	<1	<10	11	5.7	<2.5	8	9	<0.2	1.2	<1	<10	<1

Notes:
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method.
BGS = below ground surface
ft = foot or feet
mg/kg = milligrams per kilogram

generated 10/05/2021, 2:45:41 PM CDT

RAMBOLL

TABLE 3-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Well Number	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
BA01	UA	12/16/2015	--	587.09	Top of Disk	584.44	33.06	37.73	551.49	546.82	38.20	544.10	4.7	2	40.468895	-89.982141
BA01C	BR	02/08/2021	586.64	586.64	Top of PVC	584.35	35.81	45.26	548.54	539.09	45.90	538.45	9.45	2	40.468897	-89.982103
BA01L	PMP	02/05/2021	586.80	586.80	Top of PVC	584.24	11.90	21.37	572.34	562.87	22.15	562.09	9.47	2	40.468897	-89.982116
BA02	UA	12/30/2015	--	579.92	Top of Disk	577.18	23.63	28.43	553.65	548.85	28.80	547.90	4.8	2	40.468427	-89.981325
BA02L	PMP	02/04/2021	579.91	579.91	Top of PVC	577.17	6.98	11.66	570.19	565.51	12.09	565.08	9.52	2	40.468439	-89.981326
BA03	UA	12/29/2015	--	578.34	Top of Disk	575.73	16.11	25.57	559.75	550.29	26.20	548.40	9.5	2	40.468091	-89.982136
BA03L	PMP	02/02/2021	577.75	577.75	Top of PVC	575.13	5.25	9.94	569.88	565.19	10.29	564.84	4.69	2	40.468077	-89.982135
BA04	UA	12/29/2015	--	578.19	Top of Disk	575.55	24.58	29.38	551.07	546.27	29.80	545.70	4.8	2	40.468382	-89.982991
BA05	UA	07/28/2016	--	595.72	Top of Disk	593.23	36.48	46.08	556.39	546.79	46.60	546.30	9.6	2	40.469355	-89.983075
BA06	UA	08/03/2016	--	595.63	Top of Disk	593.12	32.32	41.93	560.58	550.97	42.40	548.90	9.6	2	40.469324	-89.980961

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
-- = data not available
BGS = below ground surface
BR = bedrock
ft = foot or feet
HSU = Hydrostratigraphic Unit
PMP = potential migration pathway
PVC = polyvinyl chloride
UA = uppermost aquifer
generated 10/05/2021, 2:45:59 PM CDT

TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Date	BA01L Groundwater Elevation (ft NAVD88)	BA01 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	PMP	UA				
4/14/2021	579.44	574.89	4.55	18.58	0.245	down
4/28/2021	577.00	574.31	2.69	18.58	0.145	down
5/10/2021	577.47	575.26	2.21	18.58	0.119	down
6/1/2021	577.92	575.03	2.89	18.58	0.156	down
6/10/2021	576.38	573.97	2.41	18.58	0.130	down
6/21/2021	574.68	572.91	1.77	18.58	0.095	down
7/12/2021	577.60	574.85	2.75	18.58	0.148	down
7/26/2021	576.65	574.02	2.63	18.58	0.142	down
8/5/2021	574.73	572.68	2.05	18.58	0.110	down
			Middle of screen elevation BA01L			567.6
			Middle of screen elevation BA01			549.0

Date	BA02L Groundwater Elevation (ft NAVD88)	BA02 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	PMP	UA				
4/14/2021	574.63	574.38	0.25	14.27	0.0175	down
4/28/2021	573.24	572.97	0.27	14.27	0.0189	down
5/10/2021	574.75	574.46	0.29	14.27	0.0203	down
6/1/2021	573.94	573.72	0.22	14.27	0.0154	down
6/10/2021	572.77	572.51	0.26	14.27	0.0182	down
6/21/2021	571.54	571.28	0.26	14.27	0.0182	down
7/12/2021	574.21	573.64	0.57	14.27	0.0399	down
7/26/2021	572.81	572.55	0.26	14.27	0.0182	down
8/5/2021	571.42	571.20	0.22	14.27	0.0154	down
			Middle of screen elevation BA02L			565.4
			Middle of screen elevation BA02			551.2

TABLE 3-2. VERTICAL HYDRAULIC GRADIENTS

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Date	BA03L Groundwater Elevation (ft NAVD88)	BA03 Groundwater Elevation (ft NAVD88)	Head Change (ft)	Distance Change [1] (ft)	Vertical Hydraulic Gradient [2] (dh/dl)	
	PMP	UA				
4/14/2021	574.20	574.29	-0.09	12.83	-0.0070	up
4/28/2021	571.92	572.05	-0.13	12.83	-0.0101	up
5/10/2021	574.42	574.38	0.04	12.83	0.0031	down
6/1/2021	572.87	572.94	-0.07	12.83	-0.0055	up
6/10/2021	570.79	570.90	-0.11	12.83	-0.0086	up
6/21/2021	570.52	570.54	-0.02	12.83	-0.0016	up
7/12/2021	574.31	574.24	0.07	12.83	0.0055	down
7/26/2021	571.92	571.93	-0.01	12.83	-0.0008	flat
8/5/2021	569.95	570.12	-0.17	15.08	-0.0113	up
			Middle of screen elevation BA03L			567.7
			Middle of screen elevation BA03			554.9

[O:EDP 8/26/21 U: LDC 09/09/21, C: SSW 09/17/21]

Notes:

1. Distance change was calculated using the midpoint of the piezometer screen and water table surface. If the water table surface was above the top of the monitoring well screen, then distance change was calculated using the midpoint of both screens.
2. Vertical gradients between ±0.0015 are considered flat, and typically have less than 0.02 foot difference in groundwater elevation between wells.

-- = Not calculated
BCU = bedrock confining unit
dh = head change
dl = distance change
ft = feet
NAVD88 = North American Vertical Datum of 1988
PMP = potential migration pathway
UA = uppermost aquifer

TABLE 3-3. FIELD HYDRAULIC CONDUCTIVITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Well ID	Gradient Position	Bottom of Screen Elevation (ft NAVD88)	Screen Length [1] (ft)	Field Identified Screened Material	Slug Type	Analysis Method	Falling Head (Slug In) K (cm/s)	Rising Head (Slug Out) K (cm/s)	Minimum Hydraulic Conductivity (cm/s)	Maximum Hydraulic Conductivity (cm/s)	Hydraulic Conductivity Geometric Mean (cm/s)
Uppermost Aquifer											
BA01L	U	562.87	9.47	ML, CL	Solid	KGS Model	3.00E-04	3.40E-04	1.50E-04	3.90E-03	6.3E-04
BA02L	D	565.51	9.52	ML	Solid	KGS Model	1.70E-04	2.30E-04			
BA03L	D	565.19	4.69	ML	Solid	KGS Model	1.10E-03	1.50E-03			
BA01	U	546.71	4.70	SP, CL	Solid	Hvorslev	1.50E-04	---			
BA03	D	550.16	9.50	ML, SP	Solid	KGS Model	6.90E-04	---			
BA01C	U	539.09	9.45	SP, ML	Solid	KGS Model	3.90E-03	3.90E-03			

[O:EDP 8/25/21 U: LDC 09/09/21, U: SSW 09/17/21]

Notes:
1. All wells are constructed from 2 inch PVC with 0.01 inch slotted screens.
- - - = no data collected on date / no vertical gradient calculated
cm/s = centimeters per second
D = downgradient
ft = foot/feet
K = hydraulic conductivity
KGS = Kansas Geological Survey
NAVD88 = North American Vertical Datum of 1988
U = upgradient

USCS = Unified Soil Classification System
CL = Lean clay
ML = Silt
SP= Poorly graded sand

RAMBOLL

TABLE 3-4. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

$V = K\,i\ /\ n_e$

V = Groundwater Velocity
K = Hydraulic Conductivity [1]
i = hydraulic gradient
n_e = Effective Porosity [2]

Western Bottom Ash Basin Uppermost Aquifer (BA05 to BA04)

Distance between Wells (ft): 354
Hydraulic Conductivity (ft/day): 0.67
Effective Porosity (%): 28 Assumes: sand

Date	BA05 Groundwater Elevation (ft NAVD88)	BA04 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	580.32	573.94	6.38	0.0180	0.043
4/28/2021	579.05	573.52	5.53	0.0156	0.038
5/10/2021	580.53	574.42	6.11	0.0173	0.042
6/1/2021	579.53	574.28	5.25	0.0148	0.036
6/10/2021	576.85	573.30	3.55	0.0100	0.024
6/21/2021	576.22	572.39	3.83	0.0108	0.026
7/12/2021	578.96	574.38	4.58	0.0129	0.031
7/26/2021	577.38	573.63	3.75	0.0106	0.025
8/5/2021	575.53	572.38	3.15	0.0089	0.021
			Average	0.0132	0.032

Central Bottom Ash Basin Uppermost Aquifer (BA01 to BA03)

Distance between Wells (ft): 294
Hydraulic Conductivity (ft/day): 1.21
Effective Porosity (%): 15 Assumes: sand/silt

Date	BA01 Groundwater Elevation (ft NAVD88)	BA03 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	574.89	574.29	0.60	0.0020	0.016
4/28/2021	574.31	572.05	2.26	0.0077	0.062
5/10/2021	575.26	574.38	0.88	0.0030	0.024
6/1/2021	575.03	572.94	2.09	0.0071	0.057
6/10/2021	573.97	570.90	3.07	0.0104	0.084
6/21/2021	572.91	570.54	2.37	0.0081	0.065
7/12/2021	574.85	574.24	0.61	0.0021	0.017
7/26/2021	574.02	571.93	2.09	0.0071	0.057
8/5/2021	572.68	570.12	2.56	0.0087	0.070
			Average	0.0062	0.050

RAMBOLL

TABLE 3-4. HORIZONTAL HYDRAULIC GRADIENTS AND GROUNDWATER FLOW VELOCITIES
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Eastern Bottom Ash Basin Uppermost Aquifer (BA06 to BA02)

Distance between Wells (ft): 341
Hydraulic Conductivity (ft/day): 0.67
Effective Porosity (%): 17.5 Assumes: clay/sand

Date	BA06 Groundwater Elevation (ft NAVD88)	BA02 Groundwater Elevation (ft NAVD88)	Change in Elevation (ft)	Horizontal Gradient (ft/ft)	Velocity (ft/day)
	UA	UA			
4/14/2021	575.98	574.38	1.60	0.0047	0.02
4/28/2021	575.54	572.97	2.57	0.0075	0.03
5/10/2021	576.13	574.46	1.67	0.0049	0.02
6/1/2021	575.88	573.72	2.16	0.0063	0.02
6/10/2021	574.58	572.51	2.07	0.0061	0.02
6/21/2021	572.53	571.28	1.25	0.0037	0.01
7/12/2021	585.29	573.64	11.65	0.0342	0.13
7/26/2021	573.29	572.55	0.74	0.0022	0.01
8/5/2021	571.40	571.20	0.20	0.0006	0.002
			Average	0.0078	0.03

[O: EDP 8/28/21, C: SSW 09/17/21]

Notes:

[1] Hydraulic conductivity values used above are the geometric mean of hydrostratigraphic unit hydraulic conductivity values calculated from slug tests completed in April 2021 by Ramboll.

[2] Effective porosity used in these calculations was derived from an average between estimated values of 0.20 for silt material, 0.267 for gravel, 0.07 for clay, and 0.28 for sand from *Morris, D.A and A.I. Johnson, 1967. Summary of hydrologic and physical properties of rock and soil materials as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey. U.S. Geological Survey Water-Supply Paper 1839-D, 42p. and Heath, R.C., 1983. Basic ground-water hydrology, U.S. Geological Survey Water-Supply Paper 2220, 86p*. Effective porosity may be as high as maximum total porosity (44%) calculated in Table 2-1.

% = percent
ft/day = feet per day
ft/ft = feet per feet
ft= feet
NAVD88 = North American Vertical Datum of 1988
UA = uppermost aquifer

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA01	02/05/2016	<0.003	0.0028	0.18	<0.001	0.017	<0.001	120	11	<0.004	<0.002	<0.25	0.0057	<0.01	0.0002	0.0022	6.2	0.758	<0.001	120	<0.001	560
BA01	04/22/2016	<0.003	0.001	0.17	<0.001	0.019	<0.001	120	9.6	<0.004	<0.002	0.272	0.0032	<0.01	<0.0002	0.0019	6.8	0.852	<0.001	120	<0.001	360
BA01	06/28/2016	<0.003	<0.001	0.18	<0.001	0.017	<0.001	140	11	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.002	6.9	0.62	<0.001	120	<0.001	600
BA01	08/11/2016	<0.003	0.0055	0.17	<0.001	0.03	<0.001	130	11	<0.004	<0.002	0.29	0.0083	<0.01	<0.0002	0.0019	7.0	1.08	<0.001	130	<0.001	540
BA01	10/29/2016	<0.003	0.0055	0.14	<0.001	0.033	<0.001	98	11	<0.004	<0.002	0.287	0.0077	<0.01	<0.0002	0.0022	6.9	0.983	<0.001	130	<0.001	590
BA01	01/25/2017	<0.003	0.006	0.14	<0.001	0.019	<0.001	100	9.6	<0.004	<0.002	<0.25	0.0051	<0.01	<0.0002	0.002	6.9	0.403	<0.001	120	<0.001	600
BA01	05/03/2017	<0.003	0.013	0.23	<0.001	0.13	<0.001	140	13	0.0084	0.0047	0.266	0.027	<0.01	<0.0002	0.009	6.8	0.422	0.002	130	<0.001	560
BA01	06/26/2017	<0.003	0.0079	0.17	<0.001	0.023	<0.001	110	12	<0.004	0.0022	<0.25	0.0089	<0.01	<0.0002	0.0028	7.0	1.84	<0.001	140	<0.001	500
BA01	11/07/2017	--	--	--	--	0.044	--	120	11	--	--	0.317	--	--	--	--	6.9	--	--	150	--	580
BA01	06/05/2018	--	--	--	--	0.019	--	120	11	--	--	0.254	--	--	--	--	7.1	--	--	140	--	520
BA01	10/13/2018	--	--	--	--	0.024	--	130	9.9	--	--	<0.25	--	--	--	--	7.1	--	--	150	--	640
BA01	02/07/2019	--	--	--	--	0.036	--	120	9.9	--	--	<0.25	--	--	--	--	7.0	--	--	140	--	640
BA01	07/10/2019	--	--	--	--	0.032	--	130	8.4	--	--	0.278	--	--	--	--	7.0	--	--	140	--	610
BA01	01/13/2020	--	--	--	--	0.033	--	130	11	--	--	0.251	--	--	--	--	6.7	--	--	140	--	570
BA01	06/09/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
BA01	08/13/2020	--	--	--	--	0.021	--	120	13	--	--	<0.25	--	--	--	--	6.5	--	--	150	--	540
BA01	11/19/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
BA01	02/19/2021	--	--	--	--	0.026	--	120	13	--	--	<0.25	--	--	--	--	6.9	--	--	140	--	520
BA01C	04/14/2021	<0.003	0.0064	0.31	<0.001	0.12	<0.001	140	16	0.045	0.01	0.297	0.011	0.028	<0.0002	0.0094	7.2	4.76	0.0018	140	<0.001	610
BA01C	04/29/2021	<0.003	0.005	0.24	<0.001	0.094	<0.001	150	14	0.034	0.006	0.257	0.0069	<0.02	<0.0002	0.0072	7.2	--	0.0015	140	<0.001	610
BA01C	05/12/2021	<0.003	0.0026	0.21	<0.001	0.073	<0.001	140	14	0.014	0.0027	<0.25	0.0021	<0.02	<0.0002	0.0058	7.3	0.437	<0.001	140	<0.001	570
BA01C	06/01/2021	<0.003	0.0017	0.2	<0.001	0.086	<0.001	120	14	0.012	0.0024	0.35	0.0018	<0.02	<0.0002	0.0054	7.3	1.93	<0.001	150	<0.001	630

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA01C	06/14/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.658	--	--	--	--
BA01L	04/14/2021	<0.003	0.0082	0.13	<0.001	0.23	<0.001	130	<50	0.013	0.0031	<0.25	0.004	<0.02	<0.0002	0.0015	6.7	0.388	<0.001	110	<0.001	660
BA01L	04/29/2021	<0.003	0.0019	0.085	<0.001	0.18	<0.001	150	8.4	<0.004	<0.002	0.29	<0.001	<0.02	<0.0002	0.0013	6.9	--	<0.001	120	<0.001	720
BA01L	05/13/2021	<0.003	0.0016	0.075	<0.001	0.18	<0.001	140	7.8	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0013	6.9	0.213	<0.001	130	<0.001	710
BA01L	06/01/2021	<0.003	0.0014	0.074	<0.001	0.2	<0.001	140	7.8	<0.004	<0.002	0.278	<0.001	<0.02	<0.0002	0.0013	7.0	0.171	<0.001	110	<0.001	720
BA01L	06/14/2021	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.33	--	--	--	--
BA02	02/05/2016	<0.003	0.019	0.25	<0.001	0.045	<0.001	100	6.8	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0056	6.3	0.897	0.015	3.9	<0.001	440
BA02	04/22/2016	<0.003	0.0021	0.22	<0.001	0.04	<0.001	100	6.2	<0.004	<0.002	0.261	<0.001	<0.01	<0.0002	0.005	6.5	0.927	<0.001	3.4	<0.001	320
BA02	06/28/2016	<0.003	0.0052	0.25	0.0068	0.033	<0.001	130	7.4	<0.004	<0.002	<0.25	0.0071	<0.01	<0.0002	0.0046	6.6	0.753	<0.001	4.2	<0.001	500
BA02	08/11/2016	<0.003	<0.001	0.16	<0.001	0.036	<0.001	83	7.3	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0036	7.1	0.93	<0.001	6.6	<0.001	460
BA02	10/29/2016	<0.003	0.0043	0.19	<0.001	0.045	<0.001	100	8	<0.004	<0.002	0.25	<0.001	<0.01	<0.0002	0.0037	7.2	1.52	<0.001	5.5	<0.001	420
BA02	01/25/2017	<0.003	0.0056	0.18	<0.001	0.027	<0.001	80	8.5	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0033	7.1	0.346	<0.001	6.9	<0.001	440
BA02	05/03/2017	<0.003	0.01	0.24	<0.001	0.046	<0.001	110	10	<0.004	<0.002	<0.25	0.0013	<0.01	<0.0002	0.0066	7.2	0.443	0.0062	15	<0.001	430
BA02	06/26/2017	<0.003	0.012	0.26	<0.001	0.037	<0.001	91	9.6	<0.004	<0.002	<0.25	0.0013	<0.01	<0.0002	0.0068	7.3	0.983	<0.001	10	0.001	380
BA02	11/07/2017	--	--	--	--	0.046	--	82	9.7	--	--	0.308	--	--	--	--	7.1	--	--	10	--	480
BA02	06/05/2018	--	--	--	--	0.041	--	100	9.3	--	--	<0.25	--	--	--	--	7.3	--	--	13	--	420
BA02	10/13/2018	--	--	--	--	0.057	--	110	9.9	--	--	<0.25	--	--	--	--	7.2	--	--	11	--	500
BA02	02/07/2019	--	--	--	--	0.071	--	110	10	--	--	<0.25	--	--	--	--	7.3	--	--	21	--	540
BA02	07/10/2019	--	--	--	--	0.061	--	110	10	--	--	0.282	--	--	--	--	7.3	--	--	16	--	520
BA02	01/13/2020	--	--	--	--	0.058	--	92	9.6	--	--	<0.25	--	--	--	--	7.3	--	--	19	--	450
BA02	08/13/2020	--	--	--	--	0.065	--	100	10	--	--	<0.25	--	--	--	--	6.6	--	--	15	--	490
BA02	11/19/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.1	--	--	--	--	--

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA02	02/19/2021	--	--	--	--	0.059	--	94	12	--	--	<0.25	--	--	--	--	7.0	--	--	15	--	410
BA02L	04/14/2021	<0.003	0.014	0.12	<0.001	0.085	<0.001	65	7.1	0.018	0.0066	0.672	0.0087	<0.02	<0.0002	0.013	7.5	1.52	<0.001	4.3	<0.001	240
BA02L	04/28/2021	<0.003	0.011	0.052	<0.001	0.086	<0.001	50	7.4	<0.004	<0.002	0.575	<0.001	<0.02	<0.0002	0.015	7.4	--	<0.001	1.3	<0.001	280
BA02L	05/12/2021	<0.003	0.01	0.049	<0.001	0.081	<0.001	45	6	<0.004	<0.002	0.692	<0.001	<0.02	<0.0002	0.013	7.6	0.117	<0.001	5.3	<0.001	200
BA02L	06/01/2021	<0.003	0.0099	0.046	<0.001	0.089	<0.001	45	5.4	<0.004	<0.002	0.627	<0.001	<0.02	<0.0002	0.013	7.6	1.82	<0.001	6.9	<0.001	200
BA02L	06/14/2021	<0.003	0.011	0.046	<0.001	0.088	<0.001	48	5.9	<0.004	<0.002	0.627	<0.001	<0.02	<0.0002	0.015	7.5	0.0508	<0.001	3.7	<0.001	240
BA02L	06/21/2021	<0.003	0.011	0.048	<0.001	0.096	<0.001	46	5.9	<0.004	<0.002	0.686	<0.001	<0.02	<0.0002	0.014	7.6	0.394	<0.001	3	<0.001	230
BA02L	07/12/2021	<0.003	0.012	0.057	<0.001	0.1	<0.001	47	3.5	<0.004	<0.002	0.564	0.0017	<0.02	<0.0002	0.0099	7.5	0.442	<0.001	13	<0.001	230
BA02L	07/27/2021	<0.003	0.012	0.052	<0.001	0.1	<0.001	42	3.9	<0.004	<0.002	0.702	<0.001	<0.02	<0.0002	0.011	7.4	0.267	<0.001	5.4	<0.001	190
BA03	02/05/2016	<0.003	<0.001	0.19	<0.001	0.03	<0.001	99	9.3	<0.004	<0.002	0.252	<0.001	<0.01	<0.0002	0.007	7.1	1.25	0.0038	26	<0.001	420
BA03	04/22/2016	<0.003	<0.001	0.21	<0.001	0.028	<0.001	100	6.8	<0.004	<0.002	0.291	0.0018	<0.01	<0.0002	0.0043	7.1	1.3	<0.001	22	<0.001	290
BA03	06/28/2016	<0.003	0.001	0.26	<0.001	0.031	<0.001	120	5.8	0.0046	<0.002	<0.25	0.0018	<0.01	<0.0002	0.005	7.2	0.264	<0.001	21	<0.001	460
BA03	08/11/2016	<0.003	<0.001	0.23	<0.001	0.038	<0.001	97	5.8	<0.004	<0.002	0.287	<0.001	<0.01	<0.0002	0.0025	7.3	0.857	<0.001	21	<0.001	400
BA03	10/29/2016	<0.003	<0.001	0.21	<0.001	0.05	<0.001	100	6.1	<0.004	<0.002	0.303	<0.001	<0.01	<0.0002	0.0025	7.3	0.264	<0.001	21	<0.001	430
BA03	01/25/2017	<0.003	<0.001	0.17	<0.001	0.026	<0.001	79	6.4	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0029	7.2	1.12	0.0011	18	<0.001	380
BA03	05/03/2017	<0.003	0.0022	0.2	<0.001	0.033	<0.001	110	7.3	0.0053	<0.002	0.264	0.0024	<0.01	0.0012	0.0033	7.1	0.489	0.0086	21	<0.001	440
BA03	06/26/2017	<0.003	<0.001	0.21	<0.001	0.027	<0.001	86	6.3	<0.004	<0.002	<0.25	<0.001	<0.01	<0.0002	0.0024	7.3	1.41	<0.001	19	<0.001	380
BA03	11/07/2017	--	--	--	--	0.037	--	92	5.7	--	--	0.335	--	--	--	--	7.3	--	--	16	--	440
BA03	06/05/2018	--	--	--	--	0.021	--	110	6.5	--	--	0.265	--	--	--	--	7.4	--	--	18	--	390
BA03	10/13/2018	--	--	--	--	0.046	--	150	6.4	--	--	<0.25	--	--	--	--	7.3	--	--	18	--	470
BA03	02/07/2019	--	--	--	--	0.026	--	110	6.1	--	--	<0.25	--	--	--	--	7.5	--	--	19	--	500
BA03	07/10/2019	--	--	--	--	0.032	--	110	6	--	--	0.314	--	--	--	--	7.3	--	--	18	--	480

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA03	01/13/2020	--	--	--	--	0.027	--	110	6.3	--	--	<0.25	--	--	--	--	7.1	--	--	20	--	490
BA03	08/13/2020	--	--	--	--	0.038	--	100	5.9	--	--	<0.25	--	--	--	--	6.9	--	--	17	--	410
BA03	11/19/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	--	--	--	--	--
BA03	02/19/2021	--	--	--	--	0.028	--	100	6.3	--	--	<0.25	--	--	--	--	7.2	--	--	19	--	390
BA03L	04/14/2021	<0.003	0.0013	0.15	<0.001	0.2	<0.001	180	24	0.0084	<0.002	<0.25	0.0016	<0.02	<0.0002	<0.001	6.8	0.313	<0.001	330	<0.001	920
BA03L	04/28/2021	<0.003	<0.001	0.13	<0.001	0.23	<0.001	180	24	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.001	6.8	--	<0.001	350	<0.001	1100
BA03L	05/12/2021	<0.003	<0.001	0.13	<0.001	0.19	<0.001	190	21	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	6.9	0.356	<0.001	350	<0.001	990
BA03L	06/01/2021	<0.003	<0.001	0.12	<0.001	0.21	<0.001	190	22	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	<0.001	7.0	0.614	<0.001	340	<0.001	1100
BA03L	06/14/2021	<0.003	0.0051	0.33	0.0015	0.29	<0.001	280	24	0.055	0.017	0.311	0.023	0.026	<0.0002	0.0016	6.9	4.29	0.0017	370	<0.001	1200
BA03L	06/21/2021	<0.003	0.0012	0.17	<0.001	0.26	<0.001	200	20	0.012	0.0025	<0.25	0.0035	<0.02	<0.0002	0.0011	6.9	0.238	<0.001	370	<0.001	1000
BA03L	07/12/2021	<0.003	<0.001	0.15	<0.001	0.24	<0.001	180	23	0.0075	<0.002	0.262	0.0023	<0.02	<0.0002	0.001	6.8	1.35	<0.001	350	<0.001	1000
BA03L	07/27/2021	<0.003	<0.001	0.15	<0.001	0.27	<0.001	170	24	0.0051	<0.002	0.265	0.0015	<0.02	<0.0002	<0.001	6.8	1.38	<0.001	350	<0.001	960
BA04	02/05/2016	<0.003	<0.001	0.19	<0.001	0.018	<0.001	100	23	<0.004	<0.002	0.282	<0.001	<0.01	<0.0002	0.0069	6.9	0.831	0.0031	100	<0.001	560
BA04	04/22/2016	<0.003	<0.001	0.14	<0.001	0.21	<0.001	120	27	<0.004	<0.002	0.336	<0.001	<0.01	<0.0002	0.0023	7.1	1.12	<0.001	110	<0.001	390
BA04	06/28/2016	<0.003	<0.001	0.13	<0.001	0.2	<0.001	140	26	<0.004	<0.002	0.283	0.0011	<0.01	<0.0002	0.0033	7.2	1.2	<0.001	120	<0.001	600
BA04	08/11/2016	<0.003	<0.001	0.17	<0.001	0.15	<0.001	130	22	<0.004	<0.002	0.362	<0.001	<0.01	<0.0002	0.0018	7.4	0.084	<0.001	99	<0.001	560
BA04	10/29/2016	<0.003	<0.001	0.1	<0.001	0.2	<0.001	100	22	<0.004	<0.002	0.38	<0.001	<0.01	<0.0002	0.002	7.4	0.915	<0.001	100	<0.001	550
BA04	01/25/2017	<0.003	<0.001	0.099	<0.001	0.16	<0.001	97	25	<0.004	<0.002	0.26	<0.001	<0.01	<0.0002	0.0023	7.3	0.42	<0.001	90	<0.001	590
BA04	05/03/2017	<0.003	0.0018	0.18	<0.001	0.18	<0.001	130	45	<0.004	<0.002	0.311	<0.001	<0.01	<0.0002	0.0027	7.2	0.744	<0.001	150	<0.001	640
BA04	06/26/2017	<0.003	<0.001	0.13	<0.001	0.1	<0.001	110	55	<0.004	<0.002	0.255	<0.001	<0.01	<0.0002	0.0016	7.1	1.42	<0.001	120	<0.001	510
BA04	11/07/2017	--	--	--	--	0.28	--	110	33	--	--	0.361	--	--	--	--	7.3	--	--	140	--	600
BA04	06/05/2018	--	--	--	--	0.1	--	120	25	--	--	0.327	--	--	--	--	6.9	--	--	120	--	520

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA04	10/13/2018	--	--	--	--	0.54	--	120	28	--	--	0.291	--	--	--	--	7.1	--	--	120	--	670
BA04	02/07/2019	--	--	--	--	1.8	--	120	36	--	--	<0.25	--	--	--	--	7.1	--	--	140	--	680
BA04	07/17/2019	--	--	--	--	0.09	--	120	36	--	--	0.326	--	--	--	--	7.1	--	--	120	--	700
BA04	01/13/2020	--	--	--	--	0.33	--	150	35	--	--	<0.25	--	--	--	--	7.0	--	--	150	--	710
BA04	08/13/2020	--	--	--	--	1.9	--	130	66	--	--	0.289	--	--	--	--	6.8	--	--	160	--	690
BA04	11/19/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
BA04	02/19/2021	--	--	--	--	2.6	--	130	57	--	--	0.388	--	--	--	--	7.0	--	--	140	--	580
BA05	09/12/2016	<0.003	0.0023	0.058	<0.001	0.28	<0.001	72	72	<0.004	0.002	0.611	<0.001	<0.01	0.00026	0.0058	7.6	1.93	<0.001	110	<0.001	380
BA05	11/01/2016	<0.003	0.0039	0.13	<0.001	0.38	<0.001	120	42	<0.004	0.0049	0.365	0.0022	0.011	<0.0002	0.0046	7.2	1.34	<0.001	320	<0.001	750
BA05	12/14/2016	<0.003	0.0023	0.18	<0.001	0.26	<0.001	110	28	<0.004	0.0037	0.426	<0.001	<0.01	<0.0002	0.0041	7.7	3.48	<0.001	310	<0.001	940
BA05	01/28/2017	<0.003	0.0012	0.13	<0.001	0.28	<0.001	110	30	<0.004	<0.002	0.314	<0.001	<0.01	<0.0002	0.0042	7.4	1.22	<0.001	390	<0.001	900
BA05	03/06/2017	<0.003	0.0019	0.083	<0.001	0.39	<0.001	110	81	<0.004	<0.002	0.4	0.0015	<0.01	<0.0002	0.0063	7.2	0.498	<0.001	230	<0.001	680
BA05	05/03/2017	<0.003	0.005	0.18	<0.001	0.26	<0.001	180	28	0.0058	0.0054	0.328	0.0038	<0.01	<0.0002	0.0042	7.4	1.27	<0.001	370	<0.001	890
BA05	06/09/2017	<0.003	0.0034	0.19	<0.001	0.2	<0.001	170	16	<0.004	0.003	<0.25	<0.001	<0.01	<0.0002	0.003	7.4	1.57	<0.001	420	<0.001	880
BA05	06/26/2017	<0.003	0.002	0.097	<0.001	0.36	<0.001	110	54	<0.004	<0.002	0.304	0.0014	<0.01	<0.0002	0.0049	7.3	0.475	<0.001	260	<0.001	610
BA05	11/09/2017	--	--	--	--	0.19	--	220	20	--	--	0.349	--	--	--	--	7.3	--	--	380	--	920
BA05	06/05/2018	--	--	--	--	0.16	--	190	13	--	--	0.305	--	--	--	--	7.1	--	--	440	--	960
BA05	10/13/2018	--	--	--	--	0.15	--	200	11	--	--	<0.25	--	--	--	--	7.2	--	--	450	--	1100
BA05	02/07/2019	--	--	--	--	0.33	--	160	41	--	--	0.254	--	--	--	--	7.3	--	--	350	--	970
BA05	07/17/2019	--	--	--	--	0.16	--	200	10	--	--	0.295	--	--	--	--	7.2	--	--	490	--	1200
BA05	01/13/2020	--	--	--	--	0.14	--	210	11	--	--	<0.25	--	--	--	--	7.0	--	--	470	--	1100
BA05	08/17/2020	--	--	--	--	0.13	--	190	8.9	--	--	<0.25	--	--	--	--	6.8	--	--	500	--	1200

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA05	11/19/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--
BA05	02/19/2021	--	--	--	--	0.12	--	200	8.2	--	--	<0.25	--	--	--	--	6.8	--	--	480	--	1100
BA05	04/14/2021	<0.003	0.0027	0.075	<0.001	0.12	<0.001	190	12	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0024	7.0	0.152	<0.001	490	<0.001	1000
BA05	04/28/2021	<0.003	0.0037	0.07	<0.001	0.1	<0.001	200	2	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0022	7.1	--	<0.001	490	<0.001	1300
BA05	05/12/2021	<0.003	0.0034	0.07	<0.001	0.1	<0.001	210	8.7	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0022	7.0	0.275	<0.001	550	<0.001	1100
BA05	06/01/2021	<0.003	0.0035	0.067	<0.001	0.11	<0.001	200	12	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0025	7.0	0.109	<0.001	490	<0.001	1200
BA05	06/14/2021	<0.003	0.0038	0.072	<0.001	0.11	<0.001	200	9	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0021	7.0	0.239	<0.001	480	<0.001	1200
BA05	06/21/2021	<0.003	0.0022	0.066	<0.001	0.11	<0.001	210	9.8	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0022	7.0	0.147	<0.001	500	<0.001	1200
BA05	07/12/2021	<0.003	0.0032	0.067	<0.001	0.11	<0.001	200	8.9	<0.004	<0.002	<0.25	<0.001	<0.02	<0.0002	0.0022	7.0	0.321	<0.001	480	<0.001	1200
BA05	07/26/2021	<0.003	0.0026	0.069	<0.004	0.19	<0.001	180	7.4	<0.004	<0.008	0.301	<0.004	<0.02	<0.0008	0.0019	7.1	0.359	0.0019	500	<0.001	1200
BA06	09/12/2016	<0.003	0.0024	0.22	<0.001	2.8	<0.001	250	470	0.0044	0.012	0.461	0.0023	0.013	<0.0002	0.0027	7.1	0.842	<0.001	370	<0.001	1600
BA06	11/01/2016	<0.003	0.0029	0.2	<0.001	3.4	<0.001	290	650	<0.004	0.011	0.258	0.0019	0.014	<0.0002	0.002	7.0	1.68	<0.001	570	<0.001	1800
BA06	12/14/2016	<0.003	0.024	0.45	0.0021	3.1	<0.001	270	580	0.073	0.037	0.322	0.037	0.068	<0.0002	0.0058	7.2	9.64	0.0023	430	<0.001	1900
BA06	01/28/2017	<0.003	0.023	0.48	0.0018	2.8	<0.001	360	610	0.073	0.037	0.294	0.042	0.063	<0.0002	0.0066	7.3	1.77	0.0018	540	<0.001	1700
BA06	03/06/2017	<0.003	0.0016	0.2	<0.001	2.4	<0.001	270	490	<0.004	0.0068	0.254	0.0012	0.018	<0.0002	0.0027	7.3	0.0607	<0.001	390	<0.001	1600
BA06	05/03/2017	<0.003	0.0042	0.21	<0.001	3.9	<0.001	370	620	0.0094	0.012	0.276	0.005	0.013	<0.0002	0.0027	7.1	0.838	<0.001	460	<0.001	1700
BA06	06/09/2017	<0.003	<0.001	0.19	<0.001	3.3	<0.001	350	640	<0.004	0.017	<0.25	<0.001	<0.01	<0.0002	0.0017	7.0	1.46	<0.001	440	<0.001	1500
BA06	06/26/2017	<0.003	0.0017	0.16	<0.001	2.2	<0.001	240	480	<0.004	0.0057	<0.25	0.0014	0.013	<0.0002	0.0016	7.2	0.135	<0.001	380	<0.001	1400
BA06	11/09/2017	--	--	--	--	3.5	--	340	530	--	--	<0.25	--	--	--	--	6.9	--	--	400	--	1500
BA06	06/05/2018	--	--	--	--	2.9	--	510	610	--	--	0.319	--	--	--	--	7.2	--	--	450	--	1900
BA06	10/13/2018	--	--	--	--	3.8	--	390	640	--	--	0.31	--	--	--	--	7.2	--	--	480	--	2000
BA06	02/07/2019	--	--	--	--	1.5	--	280	480	--	--	<0.25	--	--	--	--	7.3	--	--	300	--	1900

RAMBOLL

TABLE 4-1. GROUNDWATER ANALYTICAL RESULTS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Location	Sample Date	Antimony, total (mg/L)	Arsenic, total (mg/L)	Barium, total (mg/L)	Beryllium, total (mg/L)	Boron, total (mg/L)	Cadmium, total (mg/L)	Calcium, total (mg/L)	Chloride, total (mg/L)	Chromium, total (mg/L)	Cobalt, total (mg/L)	Fluoride, total (mg/L)	Lead, total (mg/L)	Lithium, total (mg/L)	Mercury, total (mg/L)	Molybdenum, total (mg/L)	pH (field) (SU)	Radium 226 and 228 combined (pCi/L)	Selenium, total (mg/L)	Sulfate, total (mg/L)	Thallium, total (mg/L)	Total Dissolved Solids (mg/L)
35 I.A.C. 845.600	Lower	0	0	0	0	0	0	--	0	0	0	0	0	0	0	0	6.5	0	0	0	0	0
	Upper	0.006	0.010	2.0	0.004	2	0.005	--	200	0.1	0.006	4.0	0.0075	0.04	0.002	0.1	9.0	5	0.05	400	0.002	1200
BA06	07/17/2019	--	--	--	--	5.2	--	380	700	--	--	0.314	--	--	--	--	7.2	--	--	500	--	2100
BA06	01/13/2020	--	--	--	--	4.9	--	390	690	--	--	<0.25	--	--	--	--	6.7	--	--	480	--	2000
BA06	06/09/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--
BA06	08/13/2020	--	--	--	--	6	--	360	680	--	--	0.269	--	--	--	--	6.7	--	--	480	--	2200
BA06	11/19/2020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--
BA06	02/19/2021	--	--	--	--	3.9	--	320	610	--	--	0.254	--	--	--	--	6.5	--	--	380	--	1900
BA06	04/14/2021	<0.003	0.0043	0.11	<0.001	6.9	<0.001	330	600	<0.004	0.0065	0.275	<0.001	<0.02	<0.0002	0.0015	6.7	0.478	<0.001	890	<0.001	2000
BA06	04/28/2021	<0.003	0.004	0.11	<0.001	7.1	<0.001	370	660	<0.004	0.0062	0.262	<0.001	<0.02	<0.0002	0.0018	6.6	--	<0.001	470	<0.001	2200
BA06	05/12/2021	<0.003	0.004	0.11	<0.001	6.2	<0.001	340	630	<0.004	0.0071	<0.25	<0.001	<0.02	<0.0002	0.0013	6.7	0.137	<0.001	450	<0.001	1700
BA06	06/01/2021	<0.003	0.0027	0.086	<0.001	7.8	<0.001	350	610	<0.004	0.0052	0.25	<0.001	<0.02	<0.0002	0.0017	6.7	0.806	<0.001	430	<0.001	2100
BA06	06/14/2021	<0.003	0.0023	0.093	<0.001	7.5	<0.001	340	610	<0.004	0.0046	<0.25	<0.001	<0.02	<0.0002	0.0014	6.7	0.248	<0.001	420	<0.001	2300
BA06	06/21/2021	<0.003	0.0023	0.097	<0.001	7.2	<0.001	350	580	<0.004	0.006	<0.25	<0.001	<0.02	<0.0002	0.0013	6.6	0.894	<0.001	390	<0.001	2300
BA06	07/12/2021	<0.003	0.0026	0.082	<0.001	7.9	<0.001	340	580	<0.004	0.0041	0.264	<0.001	<0.02	<0.0002	0.0015	6.7	1.18	<0.001	410	<0.001	2000
BA06	07/26/2021	<0.003	0.0017	0.088	<0.02	7.8	<0.001	310	600	<0.004	<0.04	0.457	<0.02	<0.02	<0.004	0.001	6.8	0.181	<0.001	430	<0.001	2300

Notes:
Detected at concentration greater than the GWPS
-- = data not available
GWPS = Groundwater Protection Standard
mg/L = milligrams per liter
pCi/L = picocuries per liter
SU = standard units
< = concentration is less than the concentration shown, which corresponds to the reporting limit for the method. Estimated concentrations below the reporting limit and associated qualifiers are not provided since they are not utilized in statistics to determine exceedances above Part 845 standards.
35 I.A.C. 845.600 = Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845

RAMBOLL

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
BA01	02/05/2016	0	5	6.2	1040	11.8	0
BA01	04/22/2016	0	-12	6.8	1070	13.2	0
BA01	06/28/2016	0	-15	6.9	1240	15.9	0
BA01	08/11/2016	0	-32	7.0	1030	18.5	18.3
BA01	10/29/2016	0	-30	6.9	1095	15.0	15.6
BA01	01/25/2017	0	-62	6.9	996	11.4	16.3
BA01	05/03/2017	0	-53	6.8	1020	14.0	20.4
BA01	06/26/2017	0	-63	7.0	975	18.6	20.2
BA01	11/07/2017	0	-78	6.9	968	13.9	19.7
BA01	06/05/2018	0	-74	7.1	1030	16.0	20.8
BA01	10/13/2018	0	-57	7.1	928	14.1	21.9
BA01	02/07/2019	0	-72	7.0	981	12.4	42.6
BA01	07/10/2019	0	-60	7.0	980	16.1	25.9
BA01	01/13/2020	0.10	50.8	6.7	974.9	10.3	88.9
BA01	06/09/2020	0.50	-7.5	6.9	980	14.4	0.83
BA01	08/13/2020	0.09	16.7	6.5	923	19.2	10
BA01	11/19/2020	--	--	6.9	--	--	--
BA01	02/19/2021	0.34	-16.1	6.9	968	7.6	4.33
BA01C	04/14/2021	2.30	46.5	7.2	1013	12.2	707
BA01C	04/29/2021	1.30	-42.1	7.2	959	13.0	389
BA01C	05/12/2021	1.60	43.7	7.3	1025	14.8	119
BA01C	06/01/2021	1.80	-1.3	7.3	1003	14.4	128
BA01L	04/14/2021	1.30	12.5	6.7	1128	11.3	290
BA01L	04/29/2021	1.30	-33.1	6.9	1213	12.3	57.6
BA01L	05/13/2021	1.80	-18.8	6.9	300.9	13.8	10.7
BA01L	06/01/2021	0.59	-36.3	7.0	1182	13.5	7.15
BA02	02/05/2016	0	44	6.3	851	10.0	7.6
BA02	04/22/2016	0	39	6.5	962	13.0	11.2
BA02	06/28/2016	0	61	6.6	990	16.1	18.5
BA02	08/11/2016	0	61	7.1	980	18.9	19.8
BA02	10/29/2016	0	73	7.2	1044	14.8	19.8
BA02	01/25/2017	0	65	7.1	997	12.5	10.1
BA02	05/03/2017	0	65	7.2	975	14.3	13.9
BA02	06/26/2017	0	69	7.3	1040	17.5	11.3
BA02	11/07/2017	0	78	7.1	979	13.2	13.7
BA02	06/05/2018	0	80	7.3	996	15.4	9.3
BA02	10/13/2018	0	70	7.2	1080	14.6	11.6
BA02	02/07/2019	0	59	7.3	1031	12.6	22.3
BA02	07/10/2019	0	65	7.3	1025	16.0	14.8
BA02	01/13/2020	8.10	141	7.3	644.1	8.7	32.3
BA02	08/13/2020	2.10	13	6.6	502	22.2	152
BA02	11/19/2020	--	--	7.1	--	--	--
BA02	02/19/2021	3.30	71.1	7.0	880	8.4	64.5
BA02L	04/14/2021	0.16	-99	7.5	334	10.1	811

RAMBOLL

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
BA02L	04/28/2021	0.77	-141	7.4	410.9	14.0	79.8
BA02L	05/12/2021	0.21	-162	7.6	366.1	13.0	61.1
BA02L	06/01/2021	0.74	-151	7.6	334	14.5	29.2
BA02L	06/14/2021	0.46	-163	7.5	320	15.4	99.9
BA02L	06/21/2021	0.97	-144	7.6	373.4	16.1	59.4
BA02L	07/12/2021	0.98	-146	7.5	289	18.4	54.3
BA02L	07/27/2021	1.20	-134	7.4	389	20.5	151
BA03	02/05/2016	0	115	7.1	824	12.5	21.1
BA03	04/22/2016	0	129	7.1	921	13.4	17.9
BA03	06/28/2016	0	134	7.2	1050	16.6	10.8
BA03	08/11/2016	0	123	7.3	1010	16.8	40.2
BA03	10/29/2016	0	99	7.3	887	15.8	44.9
BA03	01/25/2017	0	91	7.2	935	11.8	37.8
BA03	05/03/2017	0	85	7.1	924	14.1	29.9
BA03	06/26/2017	0	81	7.3	815	17.2	27.1
BA03	11/07/2017	0	101	7.3	926	13.7	36.5
BA03	06/05/2018	0	68	7.4	843	14.8	30.6
BA03	10/13/2018	0	77	7.3	765	15.1	23.6
BA03	02/07/2019	0	91	7.5	810	11.9	31
BA03	07/10/2019	0	79	7.3	826	16.5	28
BA03	01/13/2020	3.60	162	7.1	808.7	10.6	127
BA03	08/13/2020	0.31	174	6.9	843	17.9	1.61
BA03	11/19/2020	--	--	7.0	--	--	--
BA03	02/19/2021	6.60	45.9	7.2	797	10.6	90.8
BA03L	04/14/2021	1.40	10.4	6.8	1270	11.2	89.1
BA03L	04/28/2021	0.24	139	6.8	1504	12.3	20.9
BA03L	05/12/2021	0.27	91.8	6.9	1473	13.3	44.2
BA03L	06/01/2021	0.22	77.2	7.0	1472	15.1	16.7
BA03L	06/14/2021	0.45	62.4	6.9	1466	15.7	1490
BA03L	06/21/2021	1.50	68.5	6.9	1475	16.3	189
BA03L	07/12/2021	0.23	85.5	6.8	1478	19.0	134
BA03L	07/27/2021	0.97	104	6.8	1526	20.8	68.8
BA04	02/05/2016	0	-30	6.9	1000	13.4	12.1
BA04	04/22/2016	0	-55	7.1	974	13.9	17.4
BA04	06/28/2016	0	-39	7.2	1030	15.4	15.2
BA04	08/11/2016	0	-69	7.4	950	18.2	24.1
BA04	10/29/2016	0	-55	7.4	989	14.3	26.5
BA04	01/25/2017	0	-44	7.3	1030	12.6	26.9
BA04	05/03/2017	0	-48	7.2	1060	13.7	27.7
BA04	06/26/2017	0	-44	7.1	1110	18.5	36.2
BA04	11/07/2017	0	-41	7.3	1090	12.9	28.6
BA04	06/05/2018	0	-68	6.9	1170	16.3	39.9
BA04	10/13/2018	0	-61	7.1	1140	14.8	41.7
BA04	02/07/2019	0	-52	7.1	1090	12.1	32.9

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
BA04	07/17/2019	0	-52	7.1	1098	15.7	29.1
BA04	01/13/2020	0.84	147	7.0	999.6	12.7	23.2
BA04	08/13/2020	1.20	183	6.8	1177	17.6	4.89
BA04	11/19/2020	--	--	6.9	--	--	--
BA04	02/19/2021	5.00	103	7.0	1109	10.3	2.1
BA05	09/12/2016	0	75	7.6	664	16.1	16.2
BA05	11/01/2016	0.30	-80	7.2	979	14.8	109
BA05	12/14/2016	0.29	-84	7.7	1200	12.2	132
BA05	01/28/2017	0	-73	7.4	1350	12.3	77.8
BA05	03/06/2017	0	-91	7.2	1195	14.8	1000
BA05	05/03/2017	0	-57	7.4	1380	14.5	87.4
BA05	06/09/2017	0	<-500	7.4	1360	17.0	97.5
BA05	06/26/2017	0	-61	7.3	1250	19.4	114
BA05	11/09/2017	0	-36	7.3	1210	13.6	113
BA05	06/05/2018	0	-55	7.1	1320	14.8	95.6
BA05	10/13/2018	0	-74	7.2	1230	15.8	128
BA05	02/07/2019	0	-64	7.3	1207	12.2	106
BA05	07/17/2019	0	-60	7.2	1198	16.0	90.4
BA05	01/13/2020	1.30	-87.4	7.0	1546	10.7	148
BA05	08/17/2020	2.20	-53.1	6.8	1663	17.7	21.9
BA05	11/19/2020	--	--	6.9	--	--	--
BA05	02/19/2021	0.19	-43.2	6.8	1602	8.6	165
BA05	04/14/2021	0.54	-64.6	7.0	1645	13.6	36.6
BA05	04/28/2021	3.10	-70.7	7.1	1664	16.1	2.24
BA05	05/12/2021	0.60	-70.7	7.0	1660	13.6	1.11
BA05	06/01/2021	0.24	-79	7.0	1647	15.2	7.39
BA05	06/14/2021	1.40	-59.3	7.0	1598	16.8	49
BA05	06/21/2021	0.70	-43.2	7.0	1540	13.8	18.1
BA05	07/12/2021	1.80	-43.9	7.0	1321	14.9	7.19
BA05	07/26/2021	3.80	-74.5	7.1	310.5	20.7	6.01
BA06	09/12/2016	0	-93	7.1	2842	16.8	27.1
BA06	11/01/2016	0.38	-51	7.0	1629	14.8	86.2
BA06	12/14/2016	0.21	-40	7.2	1730	12.4	84.5
BA06	01/28/2017	0	-50	7.3	815	11.6	67.5
BA06	03/06/2017	0	-69	7.3	1532	15.1	99.3
BA06	05/03/2017	0	-60	7.1	845	14.7	73.5
BA06	06/09/2017	0	-65	7.0	883	17.1	68.1
BA06	06/26/2017	0	-46	7.2	1010	18.3	56.5
BA06	11/09/2017	0	74	6.9	1340	12.8	45.2
BA06	06/05/2018	0	-38	7.2	1050	16.1	58.7
BA06	10/13/2018	0	-42	7.2	969	13.9	40
BA06	02/07/2019	0	-57	7.3	970	12.1	64.1
BA06	07/17/2019	0	-48	7.2	1014	15.9	60.7
BA06	01/13/2020	0.49	8.3	6.7	3295	10.5	77.2

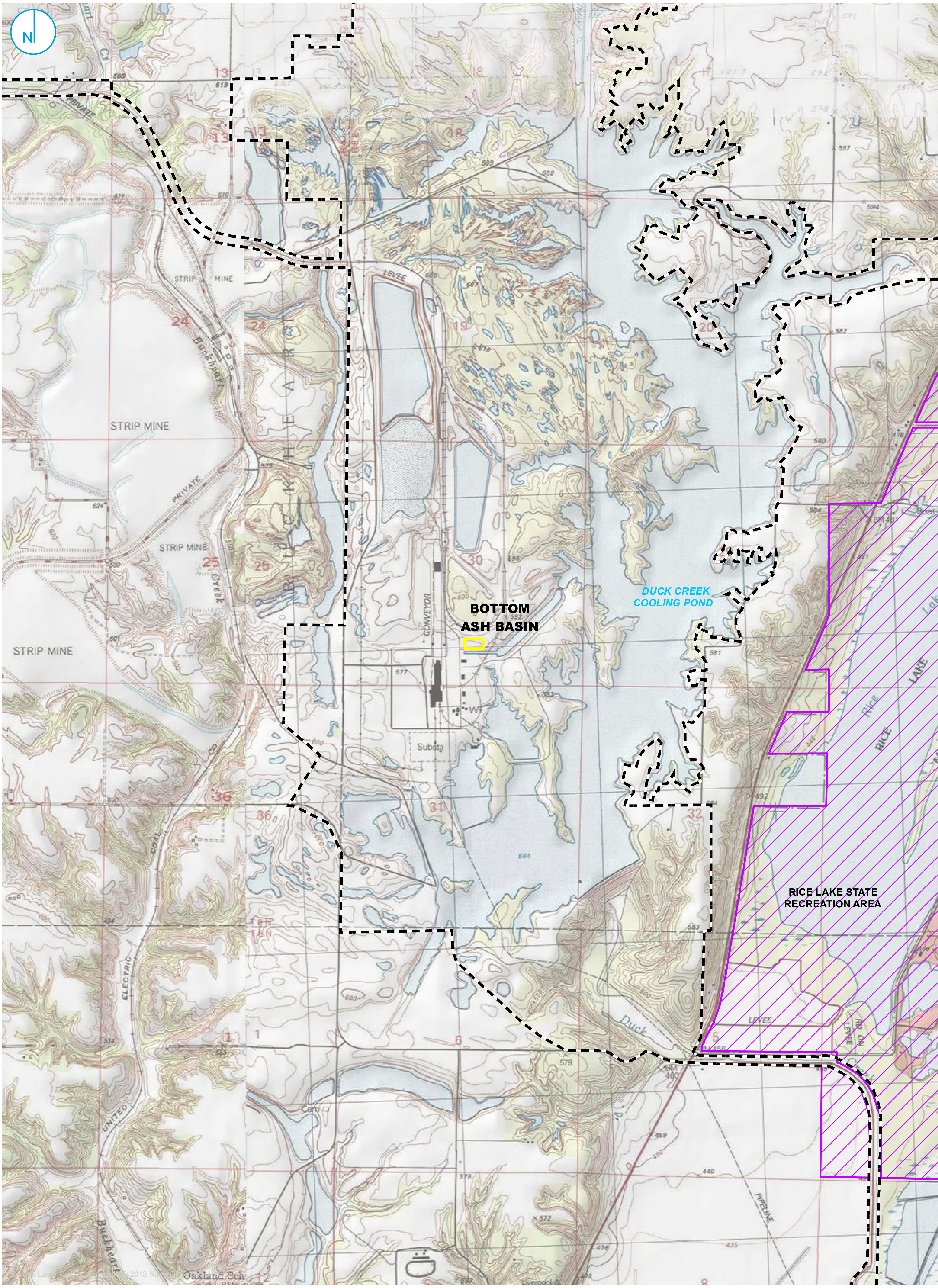
RAMBOLL

TABLE 4-2. GROUNDWATER FIELD PARAMETERS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (field) (SU)	Specific Conductance (micromhos/cm)	Temperature (deg. C)	Turbidity (NTU)
BA06	06/09/2020	1.80	-4	6.5	3095	16.2	97.8
BA06	08/13/2020	1.80	32.9	6.6	3326	17.1	66.9
BA06	11/19/2020	--	--	6.6	--	--	--
BA06	02/19/2021	0.18	-40.7	6.5	3083	8.3	1020
BA06	04/14/2021	0.52	5.4	6.7	2958	11.9	69.3
BA06	04/28/2021	0.30	-26.2	6.6	3257	16.0	15.9
BA06	05/12/2021	1.10	-17.6	6.7	3294	14.9	7.33
BA06	06/01/2021	0.30	-11.6	6.7	3270	15.0	6.71
BA06	06/14/2021	6.90	24	6.7	3144	18.0	93.9
BA06	06/21/2021	0.27	-5.2	6.6	3228	14.2	11.8
BA06	07/12/2021	0.29	-11.6	6.7	3262	15.6	3.56
BA06	07/26/2021	0.69	-28.6	6.8	3224	19.2	8.9

Notes:
Field readings are reported with as many significant figures as provided by analytical laboratory.
-- = data not available
cm = centimeter
deg. C = degrees Celsius
mg/L = milligrams per liter
mV = millivolts
NTU = nephelometric turbidity units
SU = standard units
generated 10/05/2021, 3:56:33 PM CDT

FIGURES



PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY
RICE LAKE STATE RECREATION AREA

0 1,000 2,000
Feet

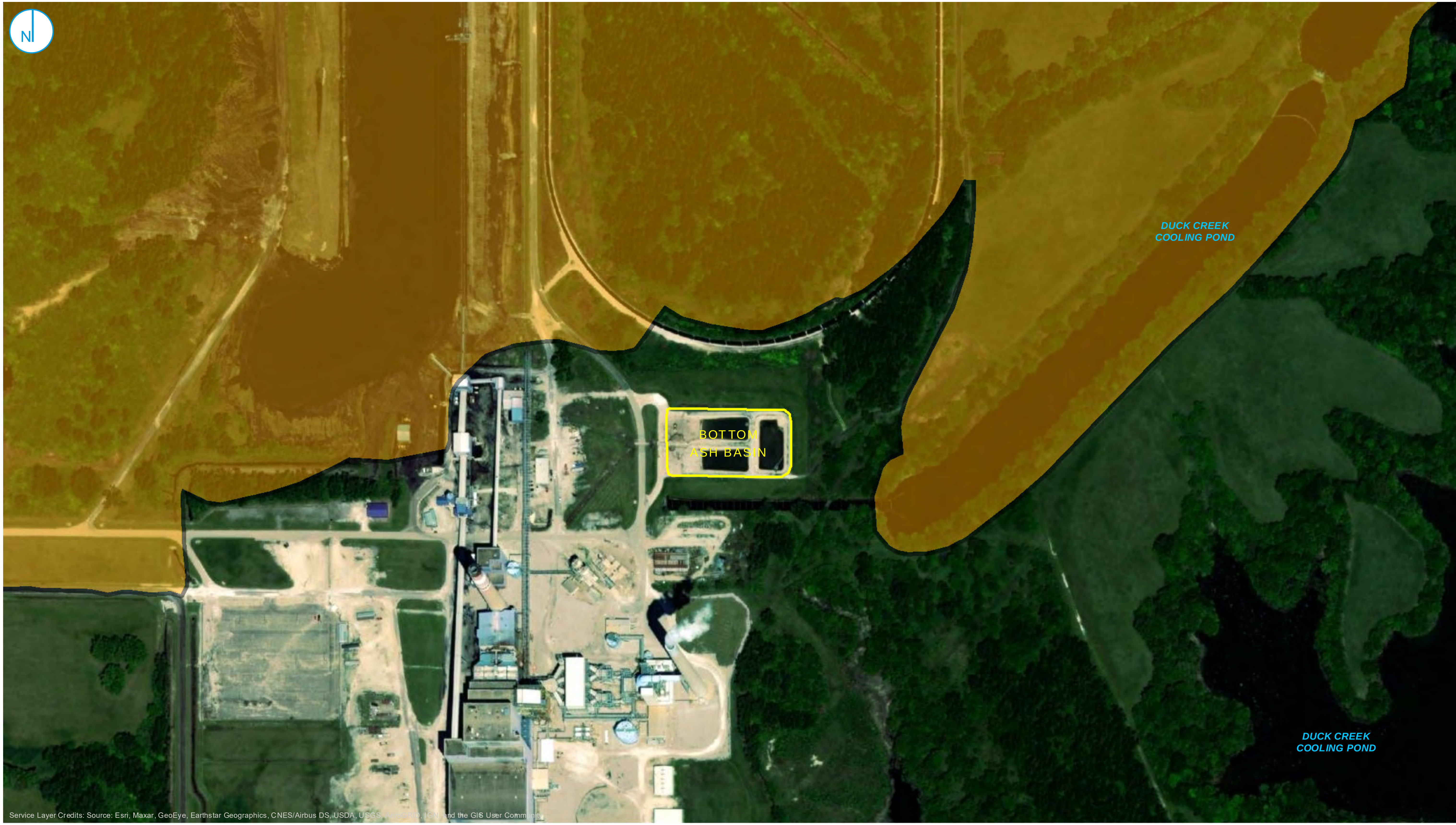
SITE LOCATION MAP

FIGURE 1-1

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



PROJECT: 169000XXXX | DATED: 10/11/2021 | DESIGNER: HOTCALD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure 1-2_Site Map.mxd

SURFACE COAL MINE
PART 845 REGULATED UNIT (SUBJECT UNIT)
PROPERTY BOUNDARY

0 150 300 Feet

SITE MAP

FIGURE 1-2

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

10 FOOT ELEVATION CONTOUR
2 FOOT ELEVATION CONTOUR
PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

SOURCE:
INGENAE SURVEY, 2021

SITE TOPOGRAPHIC MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

MAP UNIT SYMBOL	MAP UNIT NAME
17A	Keomah silt loam, 0 to 2 percent slopes
274E2	Seaton silt loam, 18 to 25 percent slopes, eroded
279B	Rozetta silt loam, 2 to 5 percent slopes
279C2	Rozetta silt loam, 5 to 10 percent slopes, eroded
280E2	Fayette silt loam, glaciated, 18 to 25 percent slopes, eroded
280gD2	Fayette silt loam, glaciated, 10 to 18 percent slopes, eroded
536	Dumps, mine
801B	Orthents, silty, undulating
871B	Lenzburg silt loam, 1 to 7 percent slopes
871D	Lenzburg silty clay loam, 7 to 20 percent slopes
871G	Lenzburg silty clay loam, 20 to 60 percent slopes
876B	Lenzwheel silt loam, 1 to 7 percent slopes
8cF	Hickory silt loam, cool mesic, 18 to 35 percent slopes
8E2	Hickory silt loam, 18 to 25 percent slopes, eroded
W	Water

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure 2-2_Soil Survey.mxd

PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGNER: STOLZSD

PART 845 REGULATED UNIT (SUBJECT UNIT)

NRCS SOIL SURVEY MAP UNIT BOUNDARY

0 150 300 Feet

SOURCE:
NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

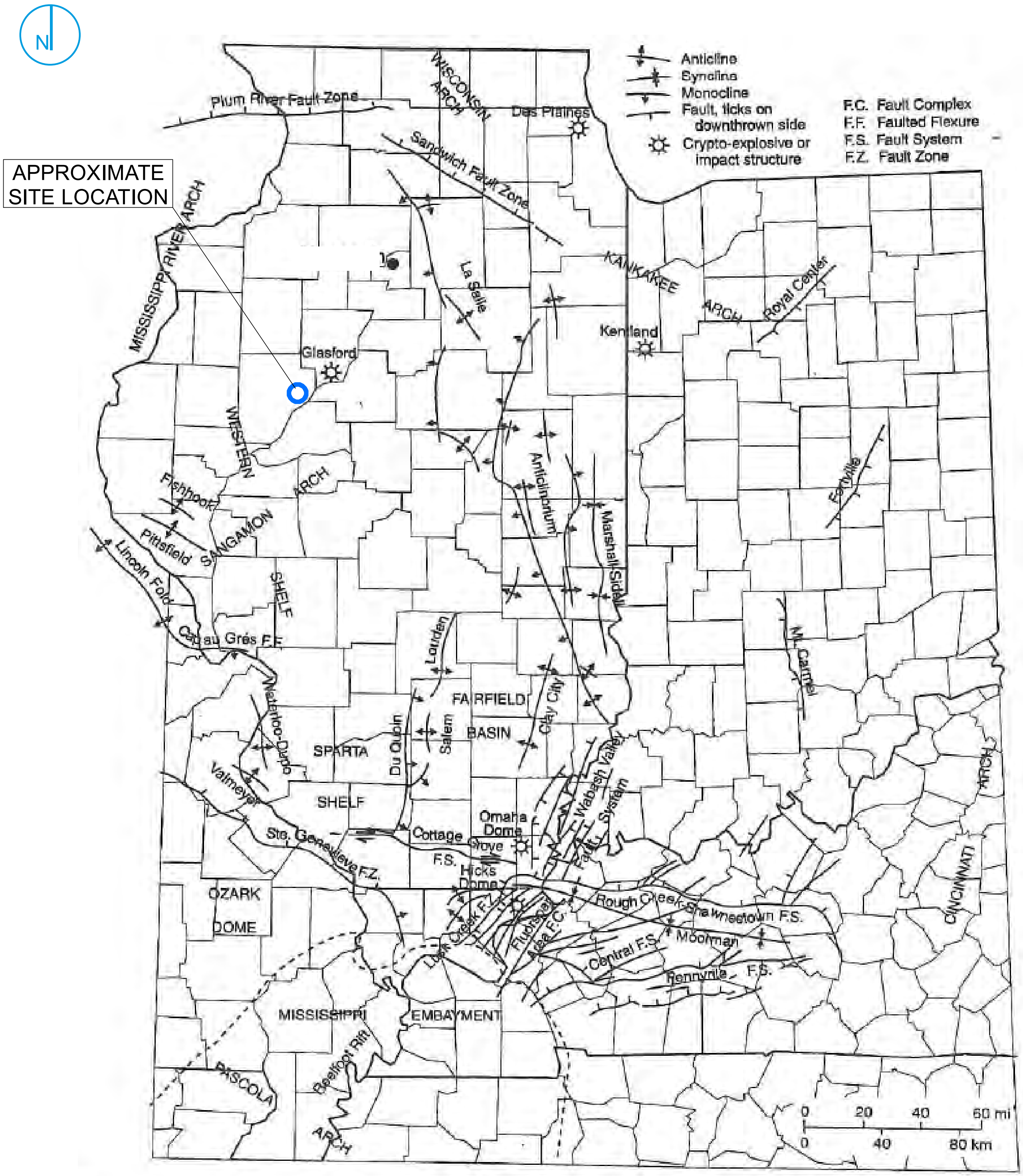
SOIL SURVEY MAP

FIGURE 2-2

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

RAMBOLL



SOURCE NOTE: MODIFIED FROM "NELSON, W.J. 1995, STRUCTURAL FEATURES IN ILLINOIS, ILLINOIS STATE GEOLOGICAL SURVEY, BULLETIN 100, CHAMPAIGN, ILLINOIS."

Service Layer Credits:

MAJOR STRUCTURAL FEATURES OF ILLINOIS

FIGURE 2-3

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

MONITORING WELL

PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100
Feet

FIELD INVESTIGATION LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

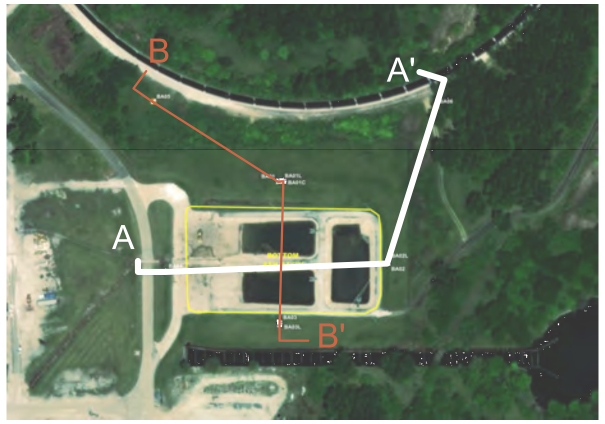
FIGURE 2-4

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

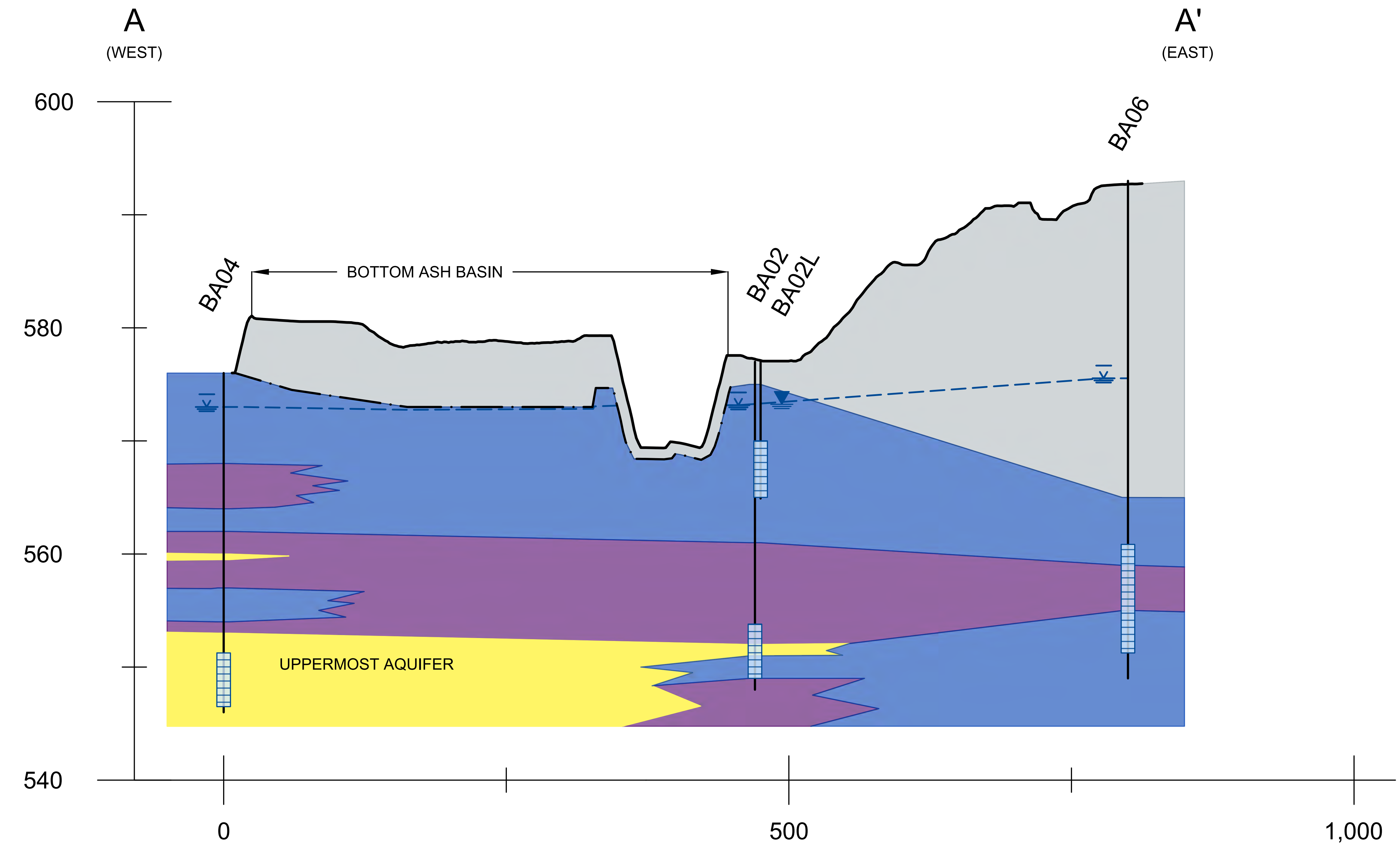
RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure 2-4_Field Investigation Location Map.mxd

PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGNER: STOLZSD



NOTES
1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on April 28, 2021.



LEGEND

FILL

CLAY (CL/CH)

SILT (ML)

SAND (SP/SM/SW)

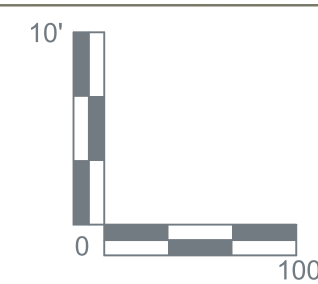
WELL SCREEN INTERVAL

UPPERMOST AQUIFER POTENTIOMETRIC SURFACE

UPPER AQUIFER GROUNDWATER ELEVATION

OTHER GROUNDWATER ELEVATIONS

ESTIMATED BASE OF BOTTOM ASH BASIN LINER



GEOLOGIC CROSS SECTION
A-A'

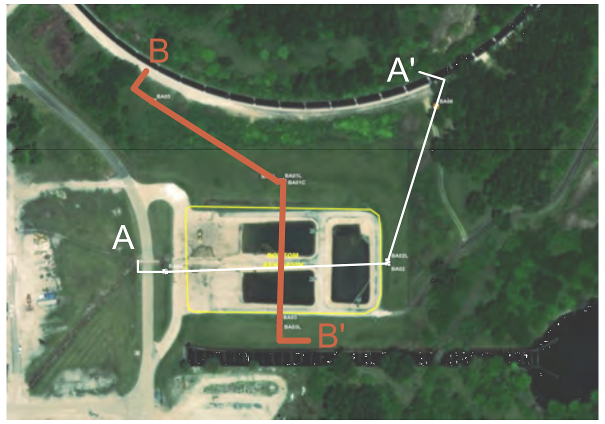
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-5

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

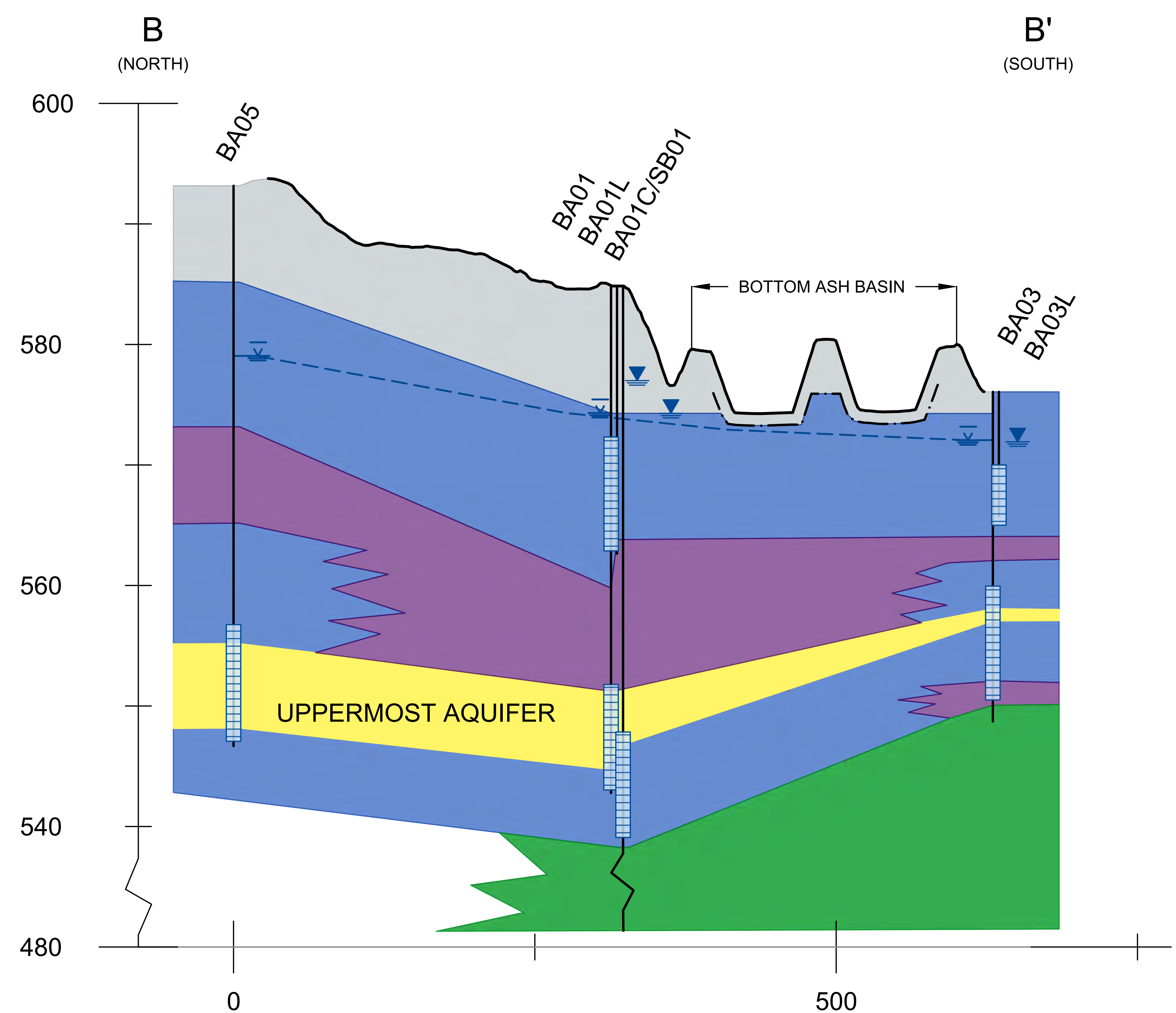
RAMBOLL

PROJECT: 1940100806



NOTES

1. This profile was developed by interpolation between widely spaced boreholes. Only at the borehole location should it be considered as an approximately accurate representation and then only to the degree implied by the notes on the borehole logs.
2. Scale is approximate.
3. Vertical scale is exaggerated 10X.
4. Groundwater elevations measured on April 28, 2021.



LEGEND

- FILL
- CLAY (CL/CH)
- SILT (ML)
- SAND (SP/SM/SW)
- BEDROCK / WEATHERED BEDROCK (INTERBEDDED SHALE, LIMESTONE, SANDSTONE, V. LITTLE SS)
- WELL SCREEN INTERVAL
- UPPERMOST AQUIFER POTENTIOMETRIC SURFACE
- UPPER AQUIFER GROUNDWATER ELEVATION
- OTHER GROUNDWATER WATER ELEVATIONS
- ESTIMATED BASE OF BOTTOM ASH BASIN LINER

10'
0
100'

GEOLOGIC CROSS SECTION
B-B'

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 2-6

RAMBOLL AMERICAS ENGINEERING SOLUTIONS, INC.

PROJECT: 1940100806

BACKGROUND WELL
MONITORING WELL
PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

MONITORING WELL LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 3-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

PROJECT: 169000XXXX | DATED: 9/24/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure 3-1_Monitoring Well Location Map.mxd

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure 3-2_Top of Uppermost Aquifer.mxd

PROJECT: 169000XXXX | DATED: 10/11/2021 | DESIGNER: HOTCALD

UPPERMOST AQUIFER ELEVATION, TOP OF SAND (1-FOOT INTERVAL)

PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

NOTE:
TOP OF AQUIFER CONTOURS GENERATED IN 2018 (HALEY & ALDRICH, INC., 2018) FOR 40 C.F.R. § 257; CONTOURS HAVE NOT BEEN MODIFIED USING BORING DATA COLLECTED IN 2021, ALTHOUGH THE SEPARATION DISTANCE BETWEEN TOP OF UPPERMOST AQUIFER AND BASE OF CCR IS CONSISTENT

TOP OF UPPERMOST AQUIFER

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 3-2

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure 3-3_GWE Contours 20210428.mxd

PROJECT: 169000XXXX | DATED: 9/23/2021 | DESIGNER: STOLZSD

BACKGROUND WELL

MONITORING WELL

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

NOTE
PARENTHESIS INDICATES WELL NOT USED FOR CONTOURING

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS
APRIL 28, 2021

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT

BOTTOM ASH BASIN

DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE 3-3

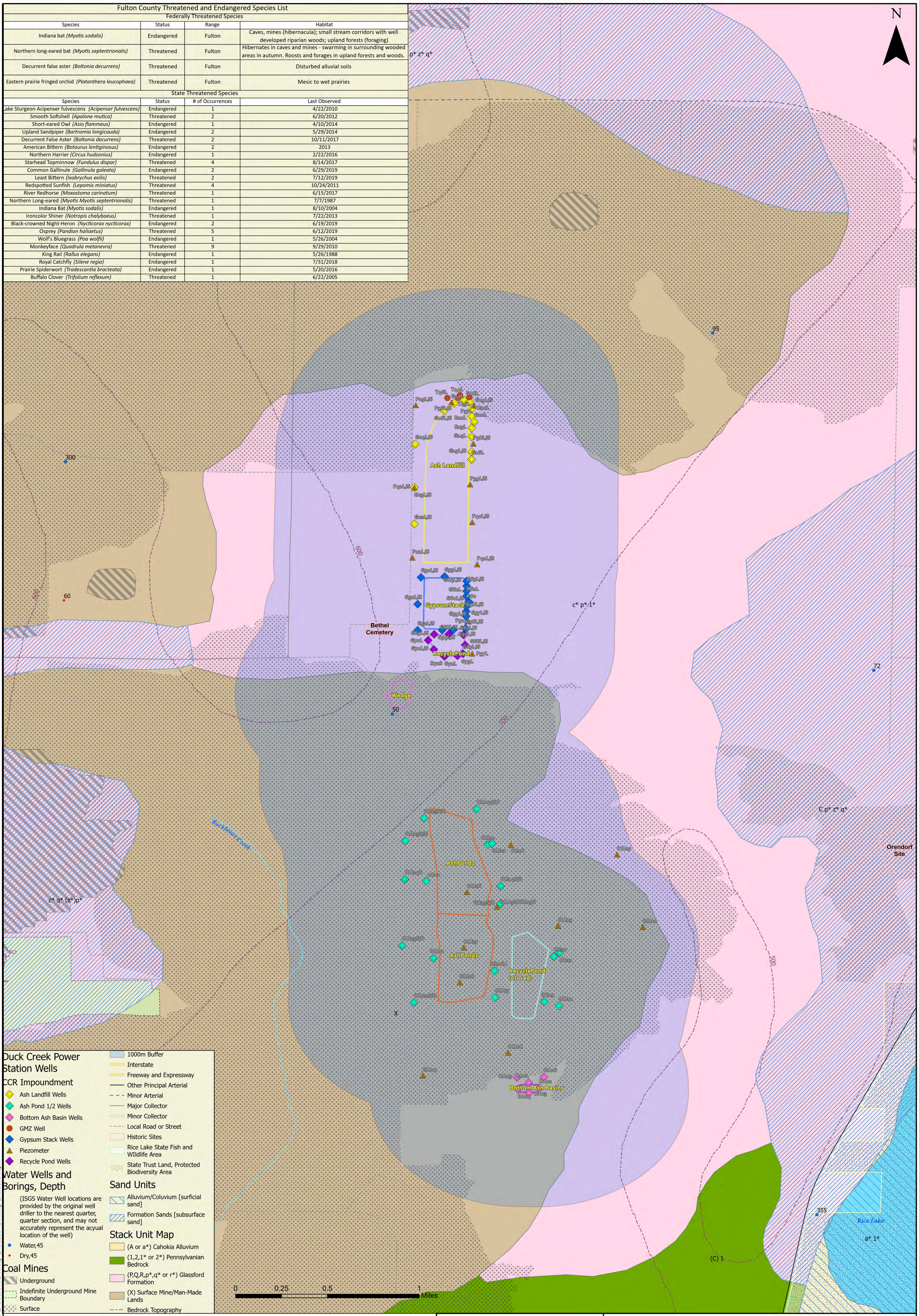
RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

APPENDICES

APPENDIX A
INFORMATION PERTINENT TO 35 I.A.C. § 845.220(a)(3)

Fulton County Threatened and Endangered Species List			
Federally Threatened Species			
Species	Status	Range	Habitat
Indiana bat *(Myotis sodalis)*	Endangered	Fulton	Caves, mines (hibernacula); small stream corridors with well developed riparian woods; upland forests (foraging)
Northern long-eared bat *(Myotis septentrionalis)*	Threatened	Fulton	Hibernates in caves and mines - swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods.
Decurrent false aster *(Boltonia decurrens)*	Threatened	Fulton	Disturbed alluvial soils
Eastern prairie fringed orchid *(Platanthera leucophaea)*	Threatened	Fulton	Mesic to wet prairies
State Threatened Species			
Species	Status	# of Occurrences	Last Observed
Lake Sturgeon Acipenser fulvescens *(Acipenser fulvescens)*	Endangered	1	4/22/2010
Smooth Softshell *(Apalone mutica)*	Threatened	2	6/20/2012
Short-eared Owl *(Asio flammeus)*	Endangered	1	4/10/2014
Upland Sandpiper *(Bartramia longicauda)*	Endangered	2	5/29/2014
Decurrent False Aster *(Boltonia decurrens)*	Threatened	2	10/11/2017
American Bittern *(Botaurus lentiginosus)*	Endangered	2	2013
Northern Harrier *(Circus hudsonius)*	Endangered	1	2/22/2016
Starhead Topminnow *(Fundulus dispar)*	Threatened	4	8/14/2017
Common Gallinule *(Gallinula galeata)*	Endangered	2	6/29/2019
Least Bittern *(Ixobrychus exilis)*	Threatened	2	7/12/2019
Redspotted Sunfish *(Lepomis miniatus)*	Threatened	4	10/24/2011
River Redhorse *(Moxostoma carinatum)*	Threatened	1	6/15/2017
Northern Long-eared *(Myotis Myotis septentrionalis)*	Threatened	1	7/7/1987
Indiana Bat *(Myotis sodalis)*	Endangered	1	8/10/2004
Ironcolor Shiner *(Notropis chalybaeus)*	Threatened	1	7/22/2013
Black-crowned Night-Heron *(Nycticorax nycticorax)*	Endangered	2	6/19/2019
Osprey *(Pandion haliaetus)*	Threatened	5	6/12/2019
Wolf's Bluegrass *(Poa wolfii)*	Endangered	1	5/26/2004
Monkeyface *(Quadrula metanevra)*	Threatened	9	9/29/2010
King Rail *(Rallus elegans)*	Endangered	1	5/26/1988
Royal Catchfly *(Silene regia)*	Endangered	1	7/31/2018
Prairie Spiderwort *(Tradescantia bracteata)*	Endangered	1	5/20/2016
Buffalo Clover *(Trifolium reflexum)*	Threatened	1	6/22/2005



I:\20jobs\20E0111A\CAD\GIS\Projects\Desktop Evaluations\Desktop Evaluation\Desktop Evaluation.aprx

Hanson Professional Services Inc.

Duck Creek Power Station

Work Plan Desktop Evaluation
Fulton County
Canton, Illinois

Job Number: 20E0111A

Sheet 1

APPENDIX B
BORING LOGS AND WELL CONSTRUCTION LOGS

BORING AND WELL LOCATIONS MAP

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\Figure B-1_SB and MW Location Map.mxd

PROJECT: 169000XXXX | DATED: 10/13/2021 | DESIGNER: STOLZSD

BACKGROUND WELL

MONITORING WELL

PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

SOIL BORING AND MONITORING WELL LOCATION MAP

HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

FIGURE B-1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

BORING LOGS

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/16/2015
Finish: 12/16/2015
WEATHER:

CONTRACTOR: Geotechnics
Rig mfg/model: CME-55 on Marooka Track Vehicle
Drilling Method: 4 ¼" HSA, split spoon sampler

FIELD STAFF: Driller: M. Sick
Helper: B. Janson
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA01
Well ID: BA01
Surface Elev: 584.75 ft. MSL
Completion: 40.42 ft. BGS
Station: 1,684.03N
2,374.44E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 24.50 - During Drilling
▼ =
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type
1A	17/24 *71%*	SS	*1-2 4-5* N=6	19		0.50 P
2A	6/24 *25%*	SS	*woh-1 3-3* N=4			1.00 P
3A	19/24 *79%*	SS	*3-8 10-7* N=18	20		1.00 P
4A	18/24 *75%*	SS	**-4 4-5* N=8	26		2.00 P
5A	19/24 *79%*	SS	*1-3 2-2* N=5	26		1.50 P
6A	21/24 *88%*	SS	**-* 1-9*	49		1.75 P
7A	21/24 *88%*	SS	*woh-1 3-3* N=4	26		
8A	22/24 *92%*	SS	*woh-1 3-3* N=4	28		0.50

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0 – 9.5	Dark yellowish brown (10YR4/6), moist, soft, SILT with few clay and trace very fine- to coarse-grained sand - FILL.	584 – 576
9.5 – 12	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, wet, stiff, SILT with few clay and trace very fine-grained sand.	574
12 – 15.8	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, set, stiff, SILT with few clay and trace very fine-grained sand.	572 – 570
15.8 – 18	Very dark gray (10YR3/1), moist, stiff, SILT with few clay and trace very fine-grained sand.	568
18 – 21	Gray (10YR5/1), moist, medium, SILT with few clay and trace very fine-grained sand.	566 – 564

Borehole Detail | Remarks

NOTE(S): BA01 installed in boring.
Station coordinates are on Plant (Local) grid.
*Rig geometry required pushing split spoon sampler for designated interval.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/16/2015
Finish: 12/16/2015
WEATHER:

CONTRACTOR: Geotechnics
Rig mfg/model: CME-55 on Marooka Track Vehicle
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: M. Sick
Helper: B. Janson
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA01
Well ID: BA01
Surface Elev: 584.75 ft. MSL
Completion: 40.42 ft. BGS
Station: 1,684.03N
2,374.44E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 24.50 - During Drilling
▼ =
▽ =

Number	Recov / Total (in) / % Recovery	Type	Blows / 6 in / N - Value / RQD	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) / Qp (tsf) / Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
						P				
9A	21/24 88%	SS	*-1 3-4 N=4	21		1.00 P	22	Gray (10YR5/1), moist, medium, SILT with few clay and little very fine- to coarse-grained sand.	562	
10A	24/24 100%	SS	woh-1 3-4 N=4	25		1.00 P	24		560	
								Gray (10YR5/1) with 30% dark yellowish brown (10YR3/6) mottles, moist, stiff, CLAY with little very fine- to very coarse-grained sand and trace small gravel.		
11A	24/24 100%	SS	*-* 2-3	17			26	Yellowish brown (10YR5/6), moist, soft, CLAY with some silt, trace very fine- to very coarse-grained sand, and trace small gravel.	558	
								Gray (10YR5/1), wet, soft, CLAY with some silt, trace very fine- to very coarse-grained sand, and trace small gravel.		
12A	24/24 100%	SS	woh-3 12-15 N=15	12			28	Yellowish brown (10YR5/6), moist, hard, CLAY some silt, trace very fine- to very coarse-grained sand, and trace small gravel.	556	
13A	24/24 100%	SS	2-12 27-43 N=39	11			30		554	
14A	4/6 67%	SS	36-50/2"	18			32	Gray (10YR5/1), moist, hard, CLAY some silt, little very fine- to very coarse-grained sand, and trace small gravel.	552	
15A	24/24 100%	SS	18-26 14-39 N=40	8			34	Yellowish brown (10YR5/6), wet, dense, very fine- to very coarse-grained SAND with trace small gravel.	550	
	0/24 0%	SS					36		548	
17A	12/22 55%	SS	3-26 43-50/4" N=69	8			38		546	
18A	9/11 82%	SS	15-50/5"				40	Gray (10YR5/1), moist, hard, SILT with few clay and trace very fine-grained sand.		

End of boring = 40.4 feet

NOTE(S): BA01 installed in boring.
Station coordinates are on Plant (Local) grid.
*Rig geometry required pushing split spoon sampler for designated interval.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/8/2021
Finish: 2/8/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA01C
Well ID: BA01C
Surface Elev: 584.24 ft. MSL
Completion: 45.90 ft. BGS
Station: 1,384,728.21N
2,347,929.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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 – 6.4	Brownish yellow (10YR5/6), moist, medium, SILT with little clay and trace sand.			
							6.4 – 10.5	Yellowish brown (10YR5/4), moist, soft, SILT with few clay, trace sand, and trace gravel.			
							10.5 – 14.7	Brownish yellow (10YR5/6), moist, soft, SILT with few clay and trace sand.			
							14.7 – 18.0	Gray (10YR5/1), moist, soft, SILT with few clay and trace sand.			
							18.0 – 19.5	Brown (10YR4/3) with 10% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.			
							19.5 – 20	Dark yellowish brown (10YR4/4), wet, soft, SILT with few clay and trace sand.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation scale: 584, 582, 580, 578, 576, 574, 572, 570, 568, 566

NOTE(S): BA01C blind drilled adjacent to SB01. Lithology copied from SB01.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/8/2021
Finish: 2/8/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA01C
Well ID: BA01C
Surface Elev: 584.24 ft. MSL
Completion: 45.90 ft. BGS
Station: 1,384,728.21N
2,347,929.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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
								Dark yellowish brown (10YR4/4), wet, soft, SILT with few clay and trace sand. *[Continued from previous page]*		564	
							22	Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand.		562	
							24			560	
							26	Gray (10YR5/1) with 30% yellowish brown (10YR5/8) mottles, moist, medium, CLAY with some silt and trace sand.		558	
							28	Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, CLAY with some silt, little sand, and trace gravel.		556	
							30			554	
							32	Dark gray (10YR4/1), moist, hard, CLAY with some silt, little sand, and trace gravel.		552	
							34	Yellowish brown (10YR5/6), wet, dense, very fine- to very coarse-grained SAND with few silt and little gravel.		550	
							36			548	
								Gray (10YR5/1), wet, dense, very fine- to very coarse-grained SAND with few silt and little gravel.			
							38	Dark gray (10YR4/1), moist, very hard, SILT with some clay, little sand, and trace gravel.		546	
							40				

NOTE(S): BA01C blind drilled adjacent to SB01. Lithology copied from SB01.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC	**CONTRACTOR:** Ramsey Geotechnical Engineering, LLC		
Site: Duck Creek Part 845 Groundwater	**Rig mfg/model:** CME-550 ATV Drill	**BOREHOLE ID:** BA01C	
Location: Canton, Illinois	**Drilling Method:** Hollow Stem Auger	**Well ID:** BA01C	
Project: 20E0111A		**Surface Elev:** 584.24 ft. MSL	
DATES: Start: 2/8/2021	**FIELD STAFF: Driller:** Dusty	**Completion:** 45.90 ft. BGS	
Finish: 2/8/2021	**Helper:** Mosley	**Station:** 1,384,728.21N	
WEATHER: Overcast, cold (hi-20's)	**Eng/Geo:** R. Hasenyager	2,347,929.30E	

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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
							42, 44	Gray (10YR5/1), moist, hard, SILT with few clay and trace sand.		544, 542, 540	

End of boring = 45.9 ft.

NOTE(S): BA01C blind drilled adjacent to SB01. Lithology copied from SB01.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA01L
Well ID: BA01L
Surface Elev: 577.19 ft. MSL
Completion: 22.15 ft. BGS
Station: 1,384,728.82N
2,347,929.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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
							0–6.4	Brownish yellow (10YR5/6), moist, medium, SILT with little clay and trace sand.			
							6.4–10.5	Yellowish brown (10YR5/4), moist, soft, SILT with few clay, trace sand, and trace gravel.			
							10.5–14.7	Brownish yellow (10YR5/6), moist, soft, SILT with few clay and trace sand.			
							14.7–18	Gray (10YR5/1), moist, soft, SILT with few clay and trace sand.			
							18–19.5	Brown (10YR4/3) with 10% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.			
							19.5–20	Dark yellowish brown (10YR4/4), wet, soft, SILT with few clay and trace sand.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation scale: 576, 574, 572, 570, 568, 566, 564, 562, 560, 558

NOTE(S): BA01L blind drilled adjacent to SB01. Lithology copied from SB01.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA01L
Well ID: BA01L
Surface Elev: 577.19 ft. MSL
Completion: 22.15 ft. BGS
Station: 1,384,728.82N
2,347,929.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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
								Dark yellowish brown (10YR4/4), wet, soft, SILT with few clay and trace sand. *[Continued from previous page]*			
								Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand.		556	
							22				

End of boring = 22.15 ft.

NOTE(S): BA01L blind drilled adjacent to SB01. Lithology copied from SB01.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/29/2015
Finish: 12/30/2015
WEATHER: Overcast, windy, cold, lo-30s.

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-550X ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler

FIELD STAFF: Driller: C. Dutton
Helper: C. Jones
Eng/Geo: S. Keim

BOREHOLE ID: BA02
Well ID: BA02
Surface Elev: 577.48 ft. MSL
Completion: 29.42 ft. BGS
Station: 1,513.78N
2,601.74E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 5.65 - 12/30/2015
▼ =
▽ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	16/24 *67%*	SS	*1-4 6-5* N=10	17		2.50 P	0–2	Brown (10YR5/3) with 10% dark yellowish brown (10YR4/6) mottles, moist, very stiff, SILT with few clay, trace very fine- to medium-grained sand, and trace roots - FILL.		576	
2A	14/24 *58%*	SS	*3-3 4-5* N=7	23		3.00 P	2–4	Dark yellowish brown (10YR4/6), moist, very stiff, SILT with little clay and trace very fine- to fine-grained sand.		574	
3A	20/24 *83%*	SS	*5-9 8-10* N=17	19		4.00 P	4–6	Light brownish gray (2.5Y6/2) with 15% yellowish brown (10YR5/6) mottles, dry, very stiff, SILT with few clay and trace very fine- to fine-grained sand.		572	
4A	16/24 *67%*	SS	*1-2 3-3* N=5	24		0.50 P	6–8.5	Greenish gray (5GY6/1), with 5% dark yellowish brown (10YR4/6) mottles, moist, soft, SILT with few clay and trace very fine- to fine-grained sand.		570	
5A	18/24 *75%*	SS	*1-1 3-6* N=4	25		1.00 P	8.5–10	Greenish gray (5GY6/1), with 35% olive (5Y4/3) mottles, wet, medium, SILT with few clay and trace very fine- to fine-grained sand.		568	
6A	16/24 *67%*	SS	*1-2 3-4* N=5	27		1.00 P	10–14	Greenish gray (5GY6/1), with 10% olive (5Y4/3) mottles, wet, medium, SILT with few clay and trace very fine- to fine-grained sand.		566	
7A	12/24 *50%*	SS	*1-1 1-1* N=2	26		0.75 P				564	
8A	20/24 *83%*	SS	*1-2 5-6* N=7	66		1.75 P	14–15.6	Very dark brown (10YR2/2), moist, very stiff, SILT with few clay, trace very fine- to fine-grained sand and trace wood fragments.		562	
9A	19/24 *79%*	SS	*1-2 2-2* N=4	25		0.75 P	15.6–20	Dark gray (10YR4/1), moist, medium, silty CLAY with trace very fine-to fine-grained sand.		560	
10A	20/24 *83%*	SS	*1-1 3-3* N=4	25		0.75 P	20			558	

NOTE(S): BA02 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/29/2015
Finish: 12/30/2015
WEATHER: Overcast, windy, cold, lo-30s.

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-550X ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: C. Dutton
Helper: C. Jones
Eng/Geo: S. Keim

BOREHOLE ID: BA02
Well ID: BA02
Surface Elev: 577.48 ft. MSL
Completion: 29.42 ft. BGS
Station: 1,513.78N
2,601.74E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 5.65 - 12/30/2015
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 *79%*	SS	*1-2 3-4* N=5	27		1.00 P		Greenish gray (10GY5/1), moist, medium, CLAY with little silt and few very fine- to medium-grained sand.		556	
12A	23/24 *96%*	SS	*1-3 3-3* N=6	24		1.75 P	22	Greenish gray (10GY5/1), moist, medium, CLAY with little silt, few very fine- to coarse-grained sand, and trace small gravel.		554	
13A	23/24 *96%*	SS	*wor-1 3-3* N=4	33		1.50 P	24	Dark gray (10YR4/1), wet, loose, very fine- to coarse-grained SAND with some clay, little silt, and trace small gravel.		552	
14A	15/24 *63%*	SS	*4-8 12-18* N=20	19		4.50 P	26	Gray (10YR5/1), moist, hard, SILT with little clay and trace very fine- to medium-grained sand.		550	
15A	9/17 *53%*	SS	*16-12 50/5"*	19		4.50 P	28	Dark gray (10YR4/1), moist, hard, CLAY with little silt.			

End of boring = 29.4 feet

NOTE(S): BA02 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

CLIENT: Illinois Power Resource Generating, LLC	**CONTRACTOR:** Ramsey Geotechnical Engineering, LLC		HANSON
Site: Duck Creek Part 845 Groundwater	**Rig mfg/model:** CME-550 ATV Drill		**BOREHOLE ID:** BA02L
Location: Canton, Illinois	**Drilling Method:** Hollow Stem Auger		**Well ID:** BA02L
Project: 20E0111A			**Surface Elev:** 577.17 ft. MSL
DATES: Start: 2/4/2021	**FIELD STAFF: Driller:** Dusty		**Completion:** 12.09 ft. BGS
Finish: 2/4/2021	**Helper:** Mosley		**Station:** 1,384,558.03N
WEATHER: Sunny, cold (lo-30's)	**Eng/Geo:** R. Hasenyager		2,348,149.66E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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
							0–3.7	Brownish yellow (10YR5/6), moist, medium, SILT with little clay and trace sand.			
							3.7–12.09	Gray (10YR5/1), moist, medium, SILT with little clay and trace sand.			

End of boring = 12.09 ft.

NOTE(S): BA02L blind drilled adjacent to SB02. Lithology copied from SB02.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/29/2015
Finish: 12/29/2015
WEATHER: Overcast, windy, cold, lo-30s.

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-550X ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler

FIELD STAFF: Driller: C. Dutton
Helper: C. Jones
Eng/Geo: S. Keim

BOREHOLE ID: BA03
Well ID: BA03
Surface Elev: 576.06 ft. MSL
Completion: 27.42 ft. BGS
Station: 1,390.83N
2,376.20E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - During Drilling
▼ =
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
							0	Grayish brown (10YR5/2), wet, soft, silty CLAY with trace very fine- to fine-grained sand, roots - TOPSOIL.		
1A	13/24 *54%*	ss	*1-4 7-9* N=11	19		2.50 P		Yellowish brown (10YR5/4) with 5% gray (10YR6/1) mottles, moist, very stiff, SILT with little clay, trace very fine- to fine-grained sand, and trace roots.		
								Gray (10YR6/1) with 3% dark yellowish brown (10YR4/6), dry, stiff, SILT with few clay and trace very fine- to fine-grained sand.		
							2		574	
2A	15/24 *63%*	ss	*2-3 4-3* N=7	26		1.00 P		Light brownish gray (10YR6/2) with 5% dark yellowish brown (10YR4/6) mottles, wet, medium, SILT with little clay and trace very fine- to fine-grained sand.		
							4		572	
3A	17/24 *71%*	ss	*1-2 3-4* N=5	29		0.25 P		Light brownish gray (10YR6/2) with 5% dark yellowish brown (10YR4/6) mottles, wet, soft, SILT with little clay and trace very fine- to fine-grained sand.		
							6		570	
4A	18/24 *75%*	ss	*2-2 3-3* N=5	26		0.75 P				
							8	Brown (7.5YR4/3) with 10% dark yellowish (10YR4/6) mottles, moist, medium, SILT with little clay and trace very fine- to fine-grained sand.	568	
5A	15/24 *63%*	ss	*1-2 2-3* N=4	27		0.50 P				
							▼ 10		566	
6A	16/24 *67%*	ss	*1-1 2-2* N=3	27		0.25 P		Brown (7.5YR5/3) with 10% dark yellowish (10YR4/6) mottles, moist, medium, SILT with little clay and trace very fine- to medium-grained sand.		
							12		564	
7A	17/24 *71%*	ss	*1-2 3-3* N=5	17		1.00 P		Brown (10YR5/3) with 20% dark yellowish brown (10YR4/6) mottles, moist, medium, silty CLAY with trace very fine- to coarse-grained sand.		
							14		562	
8A	19/24 *79%*	ss	*1-2 3-4* N=5	27		1.00 P		Dark yellowish brown (10YR4/6) with 15% gray (10YR6/1) mottles, moist, medium, SILT with some clay, trace very fine- to coarse-grained sand, and trace small gravel.		
							16		560	
9A	20/24 *83%*	ss	*1-2 6-11* N=8	23		0.75 P		Yellowish brown (10YR4/4), moist, medium, SILT with some clay and trace very fine- to coarse-grained sand.		
9B				12		4.50 P		Dark yellowish brown (10YR4/6), moist, hard, SILT with little clay, few very fine- to coarse-grained sand, and trace small gravel.		
							18		558	
10A	19/24 *79%*	ss	*wor-2 8-11* N=10	14				Yellowish brown (10YR5/6), wet, very loose, silty, very fine- to coarse-grained SAND with trace small gravel.		
10B				12		4.50 P		Brown (10YR5/3) with 10% dark yellowish brown (10YR4/6) mottles, moist, hard, SILT with little clay, few fine- to coarse-grained sand, and trace small gravel.		
							20			

NOTE(S): BA03 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/29/2015
Finish: 12/29/2015
WEATHER: Overcast, windy, cold, lo-30s.

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-550X ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: C. Dutton
Helper: C. Jones
Eng/Geo: S. Keim

HANSON

BOREHOLE ID: BA03
Well ID: BA03
Surface Elev: 576.06 ft. MSL
Completion: 27.42 ft. BGS
Station: 1,390.83N
2,376.20E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 10.00 - During Drilling
▼ =
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	19/24 *79%*	SS	*2-9* *11-12* N=20	12		4.50 P		Brown (10YR5/3) with 10% dark yellowish brown (10YR4/6) mottles, moist, hard, SILT with little clay, few fine- to coarse-grained sand, and trace small gravel. *[Continued from previous page]*			
							22			554	
12A	13/24 *54%*	SS	*7-10* *27-16* N=37	12		4.50 P					
							24			552	
13A	15/24 *63%*	SS	*6-12* *15-22* N=27	11		4.50 P		Dark gray (10YR4/1), moist, hard, CLAY with little silt.			
							26			550	
14A	3/17 *18%*	SS	*10-16* *50/5"*	14		4.50 P		Gray (10YR5/1), dry, weathered SHALE.			

End of boring = 27.4 feet

NOTE(S): BA03 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger

FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: BA03L
Well ID: BA03L
Surface Elev: 575.13 ft. MSL
Completion: 10.29 ft. BGS
Station: 1,384,429.96N
2,347,924.50E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

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
							0–5	Light yellowish brown (10YR6/4), moist, medium, SILT with little clay and trace sand.		574, 572, 570	
							5–6	Light yellowish brown (10YR6/4), wet, soft, SILT with little clay and trace sand.			
							6–10.3	Yellowish brown (10YR5/6), wet, soft, SILT with little clay and trace sand.		568, 566	

End of Boring = 10.3 feet

NOTE(S): BA03L blind drilled adjacent to SB03. Lithology copied from SB03.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/29/2015
Finish: 12/29/2015
WEATHER: Overcast, windy, cold, lo-30s.

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: .

BOREHOLE ID: BA04
Well ID: BA04
Surface Elev: 575.85 ft. MSL
Completion: 30.00 ft. BGS
Station: 1,496.62N
2,138.12E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - During Drilling
▼ =
▽ =

Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
1A	18/24 *75%*	ss	*1-1 4-12* N=5	17		2.50 P	0–0.3	Brown (10YR4/3), moist, medium, silty CLAY with trace very fine- to fine-grained sand, and trace roots - FILL.			
							0.3–2	Dark yellowish brown (10YR4/5), dry, stiff, SILT with little clay and trace very fine- to fine-grained sand.		574	
2A	22/24 *92%*	ss	*9-9 4-3* N=13	27		0.75 P	2–4	Dark yellowish brown (10YR4/5), moist, soft, SILT with little clay and trace very fine- to fine-grained sand.		572	
3A	24/24 *100%*	ss	*1-2 3-2* N=5	24		0.50 P	4–6	Strong brown (7.5YR4/6), moist, soft, SILT with some clay and trace very fine- to fine-grained sand.		570	
4A	19/24 *79%*	ss	*1-2 2-3* N=4	22		0.50 P	6–8	Strong brown (7.5YR4/6), moist, soft, SILT with some clay, few very fine- to coarse-grained sand, and trace small gravel.		568	
5A	18/24 *75%*	ss	*2-2 3-4* N=5	23		2.00 P	8–10	Yellowish red (5YR4/6), moist, stiff, silty CLAY with trace very fine- to fine-grained sand and trace small gravel.		566	
6A	22/24 *92%*	ss	*1-2 3-3* N=5	19		1.00 P	10–12	Yellowish brown (10YR5/4) with 20% light brownish gray (10YR6/2) mottles, moist, stiff, silty CLAY with trace very fine- to fine-grained sand.		564	
7A	18/24 *75%*	ss	*1-1 1-2* N=2	30		0.75 P	12–14	Grayish brown (10YR5/4) with 40% dark yellowish brown (10YR4/6) mottles, moist, medium, SILT with little clay and trace very fine- to medium-grained sand.		562	
8A	22/24 *92%*	ss	*4-9 14-20* N=23	11		4.50 P	14–16	Strong brown (7.5YR4/6) with 10% brown (7.5YR5/2) mottles, dry, hard, CLAY with little silt and little very fine- to medium-grained sand.		560	
9A	24/24 *100%*	ss	*1-6 8-13* N=14	14			16–16.6	Yellowish brown (10YR5/6), wet, loose, very fine- to medium-grained SAND with some clay.			
9B				12		4.50 P	16.6–19	Yellowish brown (10YR5/6), moist, hard, silty CLAY with few very fine- to coarse-grained sand and trace small gravel.		558	
10A	22/24 *92%*	ss	*2-11 12-13* N=23	11		4.50 P					
10B				11			19–20	Gray (10YR5/1), hard, SILT with some clay, little very fine- to coarse-grained sand, and trace small gravel.		556	

NOTE(S): BA04 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Natural Resource Technology, Inc.
Site: Duck Creek Power Station
Location: Canton, Illinois
Project: 15E0030
DATES: Start: 12/29/2015
Finish: 12/29/2015
WEATHER: Overcast, windy, cold, lo-30s.

CONTRACTOR: Bulldog Drilling, Inc.
Rig mfg/model: CME-750 ATV Drill
Drilling Method: 4 ¼" HSA, split spoon sampler

FIELD STAFF: Driller: J. Dittmaier
Helper: M. Hill
Eng/Geo: .

BOREHOLE ID: BA04
Well ID: BA04
Surface Elev: 575.85 ft. MSL
Completion: 30.00 ft. BGS
Station: 1,496.62N
2,138.12E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - During Drilling
▼ =
▽ =

SAMPLE: Number	SAMPLE: Recov / Total (in) *% Recovery*	SAMPLE: Type	TESTING: *Blows / 6 in* N - Value **RQD**	TESTING: Moisture (%)	TESTING: Dry Den. (lb/ft^3)	TESTING: Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
11A	23/24 *96%*	ss	*1-5* *9-13* N=14	10		4.50 P	20–22	Gray (10YR5/1), hard, SILT with some clay, little very fine- to coarse-grained sand, and trace small gravel. *[Continued from previous page]*		554	
12A	22/24 *92%*	ss	*12-10* *16-22* N=26	11		4.50 P	22–24	Dark grayish brown (10YR4/2), dry, hard, silty CLAY with trace very fine- to fine-grained sand and trace small gravel.		552	
13A	18/24 *75%*	ss	*5-6* *20-29* N=26	9			24–26	Dark grayish brown (10YR4/2), wet, medium dense, very fine- to very coarse-grained SAND.		550	
14A	19/24 *79%*	ss	*5-6* *12-27* N=18	9			26–30	Gray (10YR5/1), wet, dense, very fine- to very coarse-grained SAND with few small to large gravel.		548	
15A	21/24 *88%*	ss	*4-17* *22-40* N=39	6			30			546	

End of boring = 30.0 feet

NOTE(S): BA04 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

BA05 (BA05b)

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Bottom Ash Basin
Location: Canton, Illinois
Project: 16E0106
DATES: Start: 7/27/2016
Finish: 7/28/2016
WEATHER: Sunny, humid, hot (hi-80s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4 ¼" HSA, split spoon sampler

FIELD STAFF: Driller: B. Williamson
Helper: M. Bly
Eng/Geo: S. Keim

BOREHOLE ID: ~~BA-05b~~
Well ID: ~~BA-05~~
Surface Elev: 593.17 ft. MSL
Completion: 46.57 ft. BGS
Station: 1,850.48N
2,114.51E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - During Drilling
▼ = 13.44 - 8/8/16 @ 09:12
∇ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	TESTING: *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp* (tsf) Failure Type
1A	16/24 *67%*	SS	*1-1 3-4* N=4	28		*2.00*
2A	19/24 *79%*	SS	*3-3 4-4* N=7	22		*2.25*
3A	24/24 *100%*	SS	*1-3 2-3* N=5	27		*0.50*
4A	18/24 *75%*	SS	*1-2 2-5* N=4	24		*1.00*
5A	17/24 *71%*	SS	*2-3 4-2* N=7	24		*0.75*
6A	17/24 *71%*	SS	*3-3 3-3* N=6	24		*1.00*
7A	18/24 *75%*	SS	*2-2 3-4* N=5	26		*0.75*
8A	18/24 *75%*	SS	*2-3 2-4* N=5	28		*0.50*
9A	20/24 *83%*	SS	*2-2 3-3* N=5	28		*1.00*
10A	17/24 *71%*	SS	*1-2 2-2* N=4	25		*1.00*

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
0–0.6	Dark brown (10YR3/3), moist, soft, SILT with little clay, few very fine- to coarse-grained sand, roots - TOPSOIL			
0.6–4	Yellowish brown (10YR5/6), moist, very stiff, SILT with some clay, few very fine- to coarse-grained sand and trace roots. [Fill]		592, 590	
4–8	Brown (10YR5/3) with 30% dark yellowish brown (10YR4/6) mottles, moist, medium, CLAY with some silt. [Fill]		588, 586	
8–16	Grayish brown (10YR5/2) with 30% dark yellowish brown (10YR4/6) mottles, moist, medium, SILT with some clay.		584, 582, 580, 578	
16–17	Grayish brown (10YR5/2) with 30% dark yellowish brown (10YR4/6) mottles, wet, medium, SILT with some clay.			
17–20	Brown (10YR4/3) with 10% dark yellowish brown (10YR4/6) mottles, wet, medium, SILT with some clay.		576, 574	

NOTE(S): BA-05 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Bottom Ash Basin
Location: Canton, Illinois
Project: 16E0106
DATES: Start: 7/27/2016
Finish: 7/28/2016
WEATHER: Sunny, humid, hot (hi-80s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: M. Bly
Eng/Geo: S. Keim

BOREHOLE ID: BA-05b
Well ID: BA-05
Surface Elev: 593.17 ft. MSL
Completion: 46.57 ft. BGS
Station: 1,850.48N
2,114.51E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - During Drilling
▼ = 13.44 - 8/8/16 @ 09:12
▽ =

Number	Recov / Total (in) / % Recovery	Type	Blows / 6 in / N - Value / **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) / Qp (tsf) / Failure Type
11A	17/24 *71%*	ss	*3-2 4-4* N=6	23		*1.00*
12A	16/24 *67%*	ss	*1-2 1-3* N=3	24		*1.00*
13A	20/24 *83%*	ss	*2-2 2-3* N=4	25		*1.30*
14A	21/24 *88%*	ss	*3-4 4-4* N=8	22		*1.50*
15A	22/24 *92%*	ss	*2-2 4-5* N=6	24		*0.50*
16A	20/24 *83%*	ss	*3-7 7-9* N=14	23		*1.50*
17A	20/24 *83%*	ss	*6-11 13-23* N=24	16		*3.50*
18A	16/24 *67%*	ss	*5-11 15-22* N=26	21		*4.50*
19A	14/24 *58%*	ss	*13-17 22-30* N=39	11		*4.50*
20A	20/24 *83%*	ss	*22-41 50-39* N=91	16		

Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
20–24	Yellowish brown (10YR5/6) with 10% dark yellowish brown (10YR4/6) mottles, moist, stiff, CLAY with some silt and few very fine- to fine-grained sand.	572, 570	
24–28	Brown (10YR5/3) with 30% dark yellowish brown (10YR4/6) mottles, moist, stiff, CLAY with some silt, few very fine- to coarse-grained sand, and trace small gravel.	568, 566	
28–30.6	Gray (10YR6/1) with 30% yellowish brown (10YR5/6) mottles, wet, medium, SILT with some clay and trace very fine- to fine-grained sand.	564	
30.6–32	Gray (10YR5/1), very moist, stiff, SILT with little clay and trace very fine- to coarse-grained sand.	562	
32–34.3	Gray (10YR5/1) with 40% yellowish brown (10YR5/4) mottles, very moist, very stiff, SILT with little clay, few very fine- to coarse-grained sand and trace small gravel.	560	
34.3–38	Gray (10YR5/1), moist, hard, SILT with little clay, little very fine- to coarse-grained sand and trace small to large gravel.	558, 556	
38–40	Dark gray (10YR4/1) with 10% black (2.5/N) mottles, wet, very dense, very fine- to coarse-grained SAND with few silt and trace small gravel.	554	

NOTE(S): BA-05 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Bottom Ash Basin
Location: Canton, Illinois
Project: 16E0106
DATES: Start: 7/27/2016
Finish: 7/28/2016
WEATHER: Sunny, humid, hot (hi-80s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: M. Bly
Eng/Geo: S. Keim

BOREHOLE ID: BA-05b
Well ID: BA-05
Surface Elev: 593.17 ft. MSL
Completion: 46.57 ft. BGS
Station: 1,850.48N
2,114.51E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 16.00 - During Drilling
▼ = 13.44 - 8/8/16 @ 09:12
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	TESTING *Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft³)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	20/24 *83%*	SS	*16-23 19-32* N=42	13				Dark gray (10YR4/1) with 10% black (2.5/N) mottles, wet, very dense, very fine- to coarse-grained SAND with few silt and trace small gravel. *[Continued from previous page]*		552	
22A	20/24 *83%*	SS	*15-24 40-96* N=64	14			42			550	
23A	16/24 *67%*	SS	*8-7 12-18* N=19	19		*4.50*	44			548	
	0/7 *0%*	BD					46	Dark gray (10YR4/1), moist, hard, SILT with some clay.			

End of boring = 46.57 feet

NOTE(S): BA-05 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

BA06 (BA05c)

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Bottom Ash Basin
Location: Canton, Illinois
Project: 16E0106
DATES: Start: 8/3/2016
Finish: 8/3/2016
WEATHER: Partly cloudy, humid, warm (mid-80s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: M. Bly
Eng/Geo: S. Keim

BOREHOLE ID: ~~BA-05c~~
Well ID: ~~BA-06~~
Surface Elev: 593.20 ft. MSL
Completion: 44.00 ft. BGS
Station: 1,840.64N
2,702.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.00 - During Drilling
▼ = 14.36 - 8/8/16 @ 09:07
∇ =

SAMPLE: Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Elevation ft. MSL	Remarks
1A	15/24 *63%*	SS	*7-6 4-8* N=10	19		*3.00*	0–2	Brown (10YR4/3), dry, very stiff, SILT with little clay, few very fine- to medium-grained sand, roots. [Fill]	592	
2A	14/24 *58%*	SS	*6-7 8-6* N=15	12		*2.00*	2–4	Yellowish brown (10YR5/6), dry, very stiff, SILT with some clay and few very fine- to medium-grained sand. [Fill]	590	
3A	16/24 *67%*	SS	*5-5 4-5* N=9	16		*2.50*	4–10	Brown (10YR4/3), moist, very stiff, SILT with little clay and trace very fine- to fine-grained sand. [Fill]	588	
4A	18/24 *75%*	SS	*6-5 5-6* N=10	14		*2.30*			586	
5A	19/24 *79%*	SS	*6-7 8-9* N=15	18		*2.80*			584	
6A	12/24 *50%*	SS	*3-3 7-7* N=10	15			10–12	Brown (10YR4/3) with 40% light gray (10YR7/1) mottles, moist, stiff, SILT with some clay and trace very fine- to fine-grained sand. [Fill]	582	
7A	15/24 *63%*	SS	*5-6 7-7* N=13	18		*2.50*	12–14	Brown (10YR4/3) with 10% dark yellowish brown (10YR4/6) and 10% light gray (10YR7/1) mottles, moist, stiff, SILT with some clay and trace very fine- to fine-grained sand. [Fill]	580	
8A	11/24 *46%*	SS	*3-1 2-2* N=3	27		*1.00*	14–16 ▼	Yellowish brown (10YR5/6) with 35% gray (10YR5/1) mottles, moist, medium, CLAY with some silt and trace very fine- to fine-grained sand. [Fill]	578	
9A	11/24 *46%*	SS	*1-5 8-8* N=13	19		*1.80*	16–18	Yellowish brown (10YR5/6), moist, stiff, SILT with little clay, trace very fine- to coarse-grained sand, and trace small gravel. [Fill]	576	
10A	14/24 *58%*	SS	*1-3 4-4* N=7	20		*2.00*	18–20	Gray (10YR5/1) with 40% olive gray (5Y5/2) mottles, moist, stiff, SILT with some clay and trace coal fragments. [Fill]	574	

NOTE(S): BA-06 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Bottom Ash Basin
Location: Canton, Illinois
Project: 16E0106
DATES: Start: 8/3/2016
Finish: 8/3/2016
WEATHER: Partly cloudy, humid, warm (mid-80s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: M. Bly
Eng/Geo: S. Keim

BOREHOLE ID: BA-05c
Well ID: BA-06
Surface Elev: 593.20 ft. MSL
Completion: 44.00 ft. BGS
Station: 1,840.64N
2,702.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.00 - During Drilling
▼ = 14.36 - 8/8/16 @ 09:07
▽ =

SAMPLE Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type
11A	20/24 *83%*	SS	*4-5 6-8* N=11	25		*2.00*
12A	16/24 *67%*	SS	*6-5 7-9* N=12	24		*2.80*
13A	19/24 *79%*	SS	*3-4 5-7* N=9	25		*2.00*
14A	19/24 *79%*	SS	*6-7 10-10* N=17	23		*2.30*
15A	20/24 *83%*	SS	*3-5 7-7* N=12	29		*2.50*
16A	17/24 *71%*	SS	*3-3 7-8* N=10	21		*2.00*
17A	13/24 *54%*	SS	*3-4 5-8* N=9	23		*1.50*
18A	24/24 *100%*	SS	*4-6 7-5* N=13	19		*3.00*
19A	20/24 *83%*	SS	*4-7 10-11* N=17	19		*2.50*
20A	22/24 *92%*	SS	*8-9 14-22* N=23	14		*4.50*

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
22, 24	Yellowish brown (10YR5/6) with 30% gray (10YR5/1) mottles. moist, very stiff, CLAY with little silt and trace very fine- to coarse-grained sand. [Fill]		572, 570	
26	Yellowish brown (10YR5/6) with 25% gray (10YR5/1) mottles, moist, stiff, CLAY with little silt, and trace very fine- to fine-grained sand. [Fill]		568	
28	Dark gray (10YR4/1), moist, very stiff, CLAY with some silt and trace very fine- to fine-grained sand. [Fill]		566	
30, 32, 34	Very dark gray (10YR3/1) moist, very stiff, SILT with some clay, trace very fine- to fine-grained sand, and roots.		564, 562, 560	
▼ 36	Yellowish brown (10YR5/6) with 10% gray (10YR5/1) mottles, moist, very stiff, CLAY with some silt, few very fine- to coarse-grained sand, and trace small gravel.		558	
38	Yellowish brown (10YR5/6) with 20% gray (10YR5/1) and 10% very dark gray (10YR3/1) mottles, moist, very stiff, CLAY with some silt, little very fine- to coarse-grained sand, and trace small to large gravel.		556	
40	Dark gray (10YR4/1), moist, hard, SILT with little clay, few very fine- to coarse-grained sand, and trace small to large gravel.		554	

NOTE(S): BA-06 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Generating Company, LLC
Site: Duck Creek Power Station - Bottom Ash Basin
Location: Canton, Illinois
Project: 16E0106
DATES: Start: 8/3/2016
Finish: 8/3/2016
WEATHER: Partly cloudy, humid, warm (mid-80s)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: Diedrich D-50
Drilling Method: 4 ¼" HSA, split spoon sampler
FIELD STAFF: Driller: B. Williamson
Helper: M. Bly
Eng/Geo: S. Keim

BOREHOLE ID: BA-05c
Well ID: BA-06
Surface Elev: 593.20 ft. MSL
Completion: 44.00 ft. BGS
Station: 1,840.64N
2,702.30E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▼ = 35.00 - During Drilling
▼ = 14.36 - 8/8/16 @ 09:07
▽ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Moisture (%)	Dry Den. (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	19/24 *79%*	SS	*4-7* *6-6* N=13	14		*4.50*		Dark gray (10YR4/1), moist, hard, SILT with little clay, few very fine- to coarse-grained sand, and trace small to large gravel. *[Continued from previous page]*		552	
							42				
22A	0/24 *0%*	SS	*8-18* *25-28* N=43							550	
							44				

End of boring = 44.0 feet

NOTE(S): BA-06 installed in boring.
Station coordinates are on Plant (Local) grid.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger & Conventional Rock Core
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB01
Well ID: n/a
Surface Elev: 584.2 ft. MSL
Completion: 100.0 ft. BGS
Station: 1,384,727.73N
2,347,911.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 20.00 - durring drilling
▽ =
▼ =

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
1A	14/24 *58%*	SS	*2-2 5-4* N=7			*1.5*	0–6.4	Brownish yellow (10YR5/6), moist, medium, SILT with little clay and trace sand.	584	
2A	6/24 *25%*	SS	*1-2 1-2* N=3			*2.0*			582	
3A	11/24 *46%*	SS	*1-3 3-4* N=6			*2.5*			580	
4A	13/24 *54%*	SS	*1-1 3-4* N=4			*1.5*	6.4–10.5	Yellowish brown (10YR5/4), moist, soft, SILT with few clay, trace sand, and trace gravel.	578	
5A	6/24 *25%*	SS	*2-2 2-2* N=4			*1.5*			576	
6A	15/24 *63%*	SS	*2-1 2-4* N=3			*3.5*	10.5–14.7	Brownish yellow (10YR5/6), moist, soft, SILT with few clay and trace sand.	574	
7A	12/24 *50%*	SS	*woh-1 3-4* N=4			*3.0*			572	
8A	12/24 *50%*	SS	*2-3 3-3* N=6				14.7–18	Gray (10YR5/1), moist, soft, SILT with few clay and trace sand.	570	
ST9	24/24 *100%*	SH				*2.5*			568	
10A	20/24 *83%*	SS	*3-1 3-3* N=4			*0.5*	18–19.5	Brown (10YR4/3) with 10% yellowish brown (10YR5/6) mottles, moist, soft, SILT with few clay and trace sand.	566	
							19.5–20	Dark yellowish brown (10YR4/4), wet, soft, SILT with few clay and trace sand.		

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger & Conventional Rock Core
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB01
Well ID: n/a
Surface Elev: 584.2 ft. MSL
Completion: 100.0 ft. BGS
Station: 1,384,727.73N
2,347,911.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 20.00 - durring drilling
▼ =
▼ =

Number	Recov / Total (in) / *% Recovery*	Type	*Blows / 6 in* / N - Value / **RQD**	Water Content (%)	Dry Density (lb/ft³)	Qu (tsf) *Qp (tsf)* / Failure Type
11A	19/24 *79%*	SS	*2-2 3-3* N=5			
12A	18/24 *75%*	SS	*2-2 2-4* N=4			*1.5*
13A	24/24 *100%*	SS	*2-3 4-3* N=7			*2.0*
14A	24/24 *100%*	SS	*3-4 9-16* N=13			
	24/24 *100%*	SH				*4.5*
16A	24/24 *100%*	SS	*9-13 14-29* N=27			*3.5*
17A	17/17 *100%*	SS	*24-45 50/5"*			
18A	22/24 *92%*	SS	*25-26 28-41* N=54			
19A	23/24 *96%*	SS	*21-25 33-50* N=58			
20A	17/17 *100%*	SS	*27-41 50/5"*			*4.5*

Lithologic Description (Depth ft. BGS 20–40; Elevation ft. MSL 564–546)

Dark yellowish brown (10YR4/4), wet, soft, SILT with few clay and trace sand.
[Continued from previous page]

Gray (10YR5/1), moist, soft, CLAY with some silt and trace sand.

Gray (10YR5/1) with 30% yellowish brown (10YR5/8) mottles, moist, medium, CLAY with some silt and trace sand.

Gray (10YR5/1) with 20% yellowish brown (10YR5/8) mottles, moist, medium, CLAY with some silt, little sand, and trace gravel.

Dark gray (10YR4/1), moist, hard, CLAY with some silt, little sand, and trace gravel.

Yellowish brown (10YR5/6), wet, dense, very fine- to very coarse-grained SAND with few silt and little gravel.

Gray (10YR5/1), wet, dense, very fine- to very coarse-grained SAND with few silt and little gravel.

Dark gray (10YR4/1), moist, very hard, SILT with some clay, little sand, and trace gravel.

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger & Conventional Rock Core
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB01
Well ID: n/a
Surface Elev: 584.2 ft. MSL
Completion: 100.0 ft. BGS
Station: 1,384,727.73N
2,347,911.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 20.00 - durring drilling
▼ =
▼ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
21A	23/24 *96%*	SS	*13-33 34-36* N=67			*3.0*		Gray (10YR5/1), moist, hard, SILT with few clay and trace sand. (to 46.3)		544	
22A	21/23 *91%*	SS	*14-35 42-50/5"* N=77			*4.0*	42			542	
23A	16/17 *94%*	SS	*7-34 50/5"*				44			540	
24A	17/24 *71%*	SS	*4-9 20-42* N=29			*4.5*	46	Black (10YR2/1), moist, very hard, weathered SHALE. (46.3 to 50.2)		538	
25A	16/16 *100%*	SS	*16-38 50/4"*			*4.5*	48			536	
	24/24 *100%*	SS	*18-29 38-48* N=67				50	Dark gray (10YR4/1), moist, very hard, LIMESTONE. (50.2 to 55.6)		534	
	36/36 *100%*	RC					52, 54			532, 530	
	55/60 *92%*	RC	**RQD = 91.7%**				56, 58, 60	Gray (10YR5/1), moist, very hard, SHALE.		528, 526	

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger & Conventional Rock Core
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB01
Well ID: n/a
Surface Elev: 584.2 ft. MSL
Completion: 100.0 ft. BGS
Station: 1,384,727.73N
2,347,911.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 20.00 - durring drilling
▼ =
▼ =

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
										524	
							62			522	
							64			520	
	117/120 *98%*	RC	**RQD = 95.8%**								
							66			518	
							68			516	
							70	Gray (10YR5/1), moist, very hard, SHALE. *[Continued from previous page]*		514	
							72			512	
							74			510	
	119/120 *99%*	RC	**RQD = 93.3%**								
							76			508	
							78			506	
							80				

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/5/2021
Finish: 2/23/2021
WEATHER: Overcast, cold (hi-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger & Conventional Rock Core
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB01
Well ID: n/a
Surface Elev: 584.2 ft. MSL
Completion: 100.0 ft. BGS
Station: 1,384,727.73N
2,347,911.27E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 20.00 - durring drilling
▽ =
▼ =

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	**RQD = 85.0%**				80–94.6	Gray (10YR5/1), moist, very hard, SHALE. *[Continued from previous page]*		504–489.6	
	120/120 100%	RC	**RQD = 36.7%**				94.6–98.2	Very dark grayish brown (10YR3/1), moist, very hard, SHALE.		489.6–486	
							98.2–100	Dary gray (10YR4/1), moist, very hard, LIMESTONE. **End of boring = 100 ft.**		486–484.2	

Depth scale: 82, 84, 86, 88, 90, 92, 94, 96, 98, 100
Elevation scale: 504, 502, 500, 498, 496, 494, 492, 490, 488, 486

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/3/2021
Finish: 2/4/2021
WEATHER: Sunny, cold (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Chris
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB02
Well ID: n/a
Surface Elev: 577.2 ft. MSL
Completion: 43.5 ft. BGS
Station: 1,384,558.21N
2,348,157.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 6.00 - durring drilling
▼ =
▼ =

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	18/24 75%	SS	WOH-3 5-6 N=8			4.0
2A	21/24 88%	SS	3-4 4-8 N=8			2.5
3A	20/24 83%	SS	4-8 7-8 N=15			2.5
4A	18/24 75%	SS	1-3 2-4 N=5			1.5
ST5	24/24 100%	SH				2.5
6A	18/24 75%	SS	1-2 3-3 N=5			2.0
7A	15/24 63%	SS	1-2 3-3 N=5			1.5
8A	14/24 58%	SS	woh-2 3-4 N=5			1.5
9A	17/24 71%	SS	1-2 2-3 N=4			2.0
ST10	24/24 100%	SH				2.0

Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
0 – ~3.7	Brownish yellow (10YR5/6), moist, medium, SILT with little clay and trace sand.			
~3.7 – ~12.3	Gray (10YR5/1), moist, medium, SILT with little clay and trace sand.			
~12.3 – ~14.8	Gray (7.5YR5/1) with 20% strong brown (7.5YR5/6) mottles, wet, soft SILT with little clay and trace sand.			
~14.8 – 16	Brown (10YR4/3), wet, soft, PEAT.			
16 – 20	Gray (10YR5/1), wet, soft, CLAY with some silt and trace sand.			

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Elevation scale: 576, 574, 572, 570, 568, 566, 564, 562, 560, 558

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/3/2021
Finish: 2/4/2021
WEATHER: Sunny, cold (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Chris
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB02
Well ID: n/a
Surface Elev: 577.2 ft. MSL
Completion: 43.5 ft. BGS
Station: 1,384,558.21N
2,348,157.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 6.00 - durring drilling
▽ =
▼ =

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
11A	24/24 100%	SS	1-3 3-3 N=6			15.0	20.3–21.7	Gray (10YR5/1), wet, soft, CLAY with some silt and trace sand. [Continued from previous page]
12A	24/24 100%	SS	2-2 4-4 N=6				21.7–26	Yellowish brown (10YR5/6), wet, dense, very fine to medium grained SAND with few silt.
ST13	24/24 100%	SH						
14A	20/24 83%	SS	1-8 12-16 N=20				26–28.7	Gray (10YR5/1), wet, very dense, SILT and very fine to fine grained SAND.
15A	24/24 100%	SS	8-12 11-20 N=23			4.5	28.7–	Gray (10YR5/1), moist, hard, SILT with some clay, few sand, and trace gravel.
16A	20/24 83%	SS	8-20 46-50/5 N=66			4.5		
17A	9/9 100%	SS	24-50/3 ---			4.5		
18A	14/24 58%	SS	18-15 9-10 N=24			4.5		
19A	17/24 71%	SS	6-10 14-32 N=24			4.5		
20A	15/15 100%	SS	41-26 50/3--			4.5		

Depth scale (ft. BGS): 22, 24, 26, 28, 30, 32, 34, 36, 38, 40

Elevation (ft. MSL): 556, 554, 552, 550, 548, 546, 544, 542, 540, 538

Borehole Detail | Remarks

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/3/2021
Finish: 2/4/2021
WEATHER: Sunny, cold (lo-30's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Chris
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB02
Well ID: n/a
Surface Elev: 577.2 ft. MSL
Completion: 43.5 ft. BGS
Station: 1,384,558.21N
2,348,157.14E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 6.00 - durring drilling
▼ =
▼ =

SAMPLE			TESTING								
Number	Recov / Total (in) *% Recovery*	Type	*Blows / 6 in* N - Value **RQD**	Water Content (%)	Dry Density (lb/ft^3)	Qu (tsf) *Qp (tsf)* Failure Type	Depth ft. BGS	Lithologic Description	Borehole Detail	Elevation ft. MSL	Remarks
								Gray (10YR5/1), moist, hard, SILT with some clay, few sand, and trace gravel. *[Continued from previous page]*			
21A	17/17 *100%*	SS	*20-45 50/5--*							536	
							42	Black (10YR2/1), weathered SHALE.			
22A	16/16 *100%*	SS	*17-32 50/4--*							534	

End of boring = 43.5 ft.

NOTE(S): Borehole sealed with high solids bentonite grout

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB03
Well ID: n/a
Surface Elev: 575.1 ft. MSL
Completion: 25.3 ft. BGS
Station: 1,384,427.60N
2,347,928.05E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 5.00 - durring drilling
▼ =
▼ =

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
1A	12/24 50%	SS	2-3 8-7 N=11			
2A	13/24 54%	SS	5-4 4-4 N=8			1.5
3A	12/24 50%	SS	woh-3 3-4 N=6			1.5
4A	20/24 83%	SS	1-3 3-3 N=6			1.5
ST5	23/24 96%	SH				
6A	20/24 83%	SS	1-3 3-4 N=6			1.0
7A	20/24 83%	SS	1-2 3-3 N=5			2.0
8A	20/24 83%	SS	2-3 3-3 N=6			3.5
9A	24/24 100%	SS	woh-3 3-5 N=6			3.0
ST10	24/24 100%	SH				

Depth ft. BGS	Lithologic Description	Elevation ft. MSL
0–5	Light yellowish brown (10YR6/4), moist, medium, SILT with little clay and trace sand. (FILL)	575.1–570.1
5–6	Light yellowish brown (10YR6/4), wet, soft, SILT with little clay and trace sand.	570.1–569.1
6–13.2	Yellowish brown (10YR5/6), wet, soft, SILT with little clay and trace sand.	
13.2–20	Yellowish brown (10YR5/8), moist, soft, SILT with few clay and trace sand.	

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20. Elevation scale: 574, 572, 570, 568, 566, 564, 562, 560, 558, 556.

Borehole Detail | Remarks

NOTE(S): Borehole sealed with high solids bentonite grout.

FIELD BORING LOG

HANSON

CLIENT: Illinois Power Resource Generating, LLC
Site: Duck Creek Part 845 Groundwater
Location: Canton, Illinois
Project: 20E0111A
DATES: Start: 2/2/2021
Finish: 2/2/2021
WEATHER: Overcast, cold (lo-20's)

CONTRACTOR: Ramsey Geotechnical Engineering, LLC
Rig mfg/model: CME-550 ATV Drill
Drilling Method: Hollow Stem Auger
FIELD STAFF: Driller: Dusty
Helper: Mosley
Eng/Geo: R. Hasenyager

BOREHOLE ID: SB03
Well ID: n/a
Surface Elev: 575.1 ft. MSL
Completion: 25.3 ft. BGS
Station: 1,384,427.60N
2,347,928.05E

TOPOGRAPHIC MAP INFORMATION:
Quadrangle: Duck Island
Township: Banner
Section 30, **Tier** 6N; **Range** 5E

WATER LEVEL INFORMATION:
▽ = 5.00 - durring drilling
▼ =
▼ =

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
11 11A	20/24 *83%*	SS	*2-8* *11-14* N=19			*4.0*	22	Yellowish brown (10YR5/6), moist, medium, CLAY with some silt, trace sand, and trace gravel.		554	
12A	20/24 *83%*	SS	*7-11* *14-14* N=25			*4.5*	24			552	
13A 13	16/17 *94%*	SS	*1-6* *50/5"*					Gray (10YR5/1), moist, very hard, CLAY with some silt, little sand, and trace gravel.		550	

End of boring = 25.3 feet

NOTE(S): Borehole sealed with high solids bentonite grout.

WELL CONSTRUCTION LOGS

Illinois Environmental Protection Agency — Well Completion Report

Site #: 0570255197　County: Fulton County　Well #: BA01

Site Name: Duck Creek Power Station　Borehole #: BA01

~~State~~ Plant ~~Plane~~ Coordinate: X 2,374.4 Y 1,684.0 (or) Latitude: 40° 28' 7.995" Longitude: -89° 58' 55.707"

Surveyed By: Michael J. Graminski　IL Registration #: 035-002901

Drilling Contractor: Geotechnics　Driller: M. Sick

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

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

Logged By: Rhonald W. Hasenyager　Date Started: 12/16/2015　Date Finished: 12/16/2015

Report Form Completed By: Suzanna L. Keim　Date: 12/21/2015

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

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

Installation Method: Gravity

Setting Time: 55 minutes

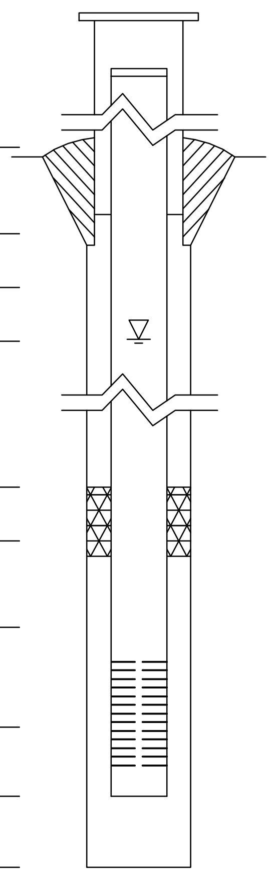
Type of Sand Pack: Quartz Sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Filter Sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
587.95	-3.20	Top of Protective Casing
587.29	-2.54	Top of Riser Pipe
584.75	0.00	Ground Surface
582.75	2.00	Top of Annular Sealant
572.75	12.00	Static Water Level (After Completion) 1/20/2016
556.00	28.75	Top of Seal
553.30	31.45	Top of Sand Pack
551.69	33.06	Top of Screen
547.02	37.73	Bottom of Screen
546.55	38.20	Bottom of Well
544.33	40.42	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)	35.60
Bottom of Screen to End Cap	(feet)	0.47
Screen Length (1st slot to last slot)	(feet)	4.67
Total Length of Casing	(feet)	40.74
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: Fulton Well #: BA01C

Site Name: Duck Creek Part 845 Groundwater Borehole #: BA01C

State Plane Coordinate: X 2,347,929.3 Y 1,384,728.2 (or) Latitude: ______ Longitude: ______

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: Dusty

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: 2/8/2021 Date Finished: 2/8/2021

Report Form Completed By: Tad A. Gass Date: 2/8/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

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

Installation Method: ______

Setting Time: ______

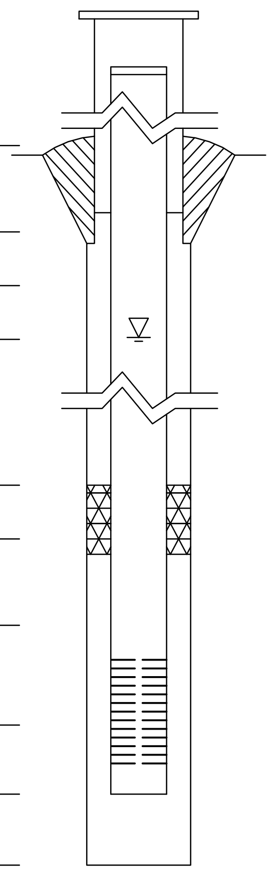
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
587.13	-2.78	Top of Protective Casing
586.64	-2.29	Top of Riser Pipe
584.35	0.00	Ground Surface
581.45	2.90	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
549.77	34.58	Top of Sand Pack
548.54	35.81	Top of Screen
539.09	45.26	Bottom of Screen
538.45	45.90	Bottom of Well
538.45	45.90	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)	10.0
Riser Pipe Length	(feet)	38.10
Bottom of Screen to End Cap	(feet)	0.64
Screen Length (1st slot to last slot)	(feet)	9.45
Total Length of Casing	(feet)	48.19
Screen Slot Size **	(inches)	0.010

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: BA01L

Site Name: Duck Creek Part 845 Groundwater Borehole #: BA01L

State Plane Coordinate: X 2,347,929.3 Y 1,384,728.8 (or) Latitude: ______ Longitude: ______

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: Dusty

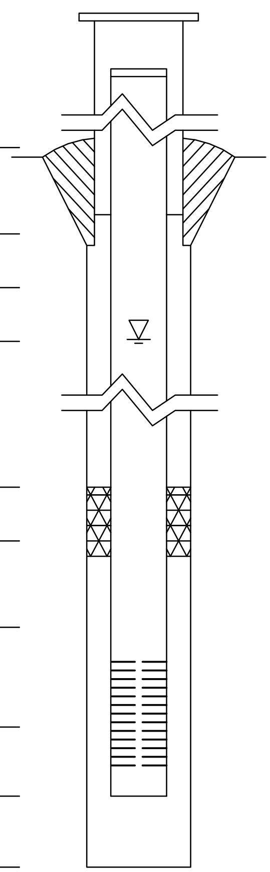
Consulting Firm: Hanson Professional Services Inc. Geologist: Rhonald W. Hasenyager, LPG #196-000246

Drilling Method: Hollow Stem Auger Drilling Fluid (Type): none

Logged By: Rhonald W. Hasenyager Date Started: 2/5/2021 Date Finished: 2/23/2021

Report Form Completed By: Tad A. Gass Date: 2/5/2021

ANNULAR SPACE DETAILS



Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

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

Installation Method: ______

Setting Time: ______

Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______

Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
587.19	-2.95	Top of Protective Casing
586.80	-2.57	Top of Riser Pipe
584.24	0.00	Ground Surface
581.94	2.30	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
573.29	10.95	Top of Sand Pack
572.34	11.90	Top of Screen
562.87	21.37	Bottom of Screen
562.09	22.15	Bottom of Well
562.09	22.15	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)	10.0
Riser Pipe Length	(feet)	14.61
Bottom of Screen to End Cap	(feet)	0.64
Screen Length (1st slot to last slot)	(feet)	9.47
Total Length of Casing	(feet)	24.72
Screen Slot Size **	(inches)	0.010

WELL CONSTRUCTION MATERIALS

(Choose one type of material for each area)

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

Well Completion Form (revised 02/06/02)

**Hand-Slotted Well Screens Are Unacceptable

Illinois Environmental Protection Agency — Well Completion Report

Site #: 0570255197 County: Fulton County Well #: BA02

Site Name: Duck Creek Power Station Borehole #: BA02

~~State~~ Plant ~~Plane~~ Coordinate: X 2,601.7 Y 1,513.8 (or) Latitude: 40° 28' 6.308" Longitude: -89° 58' 52.770"

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Bulldog Drilling, Inc. Driller: C. Dutton

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna L. Keim Date Started: 12/29/2015 Date Finished: 12/30/2015

Report Form Completed By: Suzanna L. Keim Date: 12/30/2015

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

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

Installation Method: Gravity

Setting Time: 45 minutes

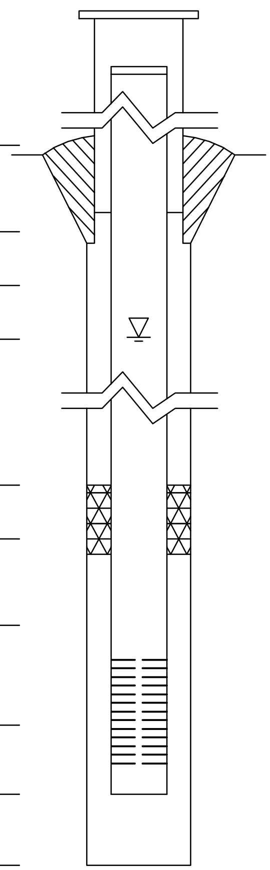
Type of Sand Pack: Quartz Sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Filter Sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
580.74	-3.26	Top of Protective Casing
580.13	-2.65	Top of Riser Pipe
577.48	0.00	Ground Surface
575.48	2.00	Top of Annular Sealant
571.98	5.50	Static Water Level (After Completion) 1/20/2016
557.58	19.90	Top of Seal
555.68	21.80	Top of Sand Pack
553.85	23.63	Top of Screen
549.05	28.43	Bottom of Screen
548.65	28.83	Bottom of Well
548.06	29.42	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)	26.28
Bottom of Screen to End Cap	(feet)	0.40
Screen Length (1st slot to last slot)	(feet)	4.80
Total Length of Casing	(feet)	31.48
Screen Slot Size **	(inches)	0.010

**Hand-Slotted Well Screens Are Unacceptable

WELL CONSTRUCTION MATERIALS
(Choose one type of material for each area)

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

Well Completion Form (revised 02/06/02)

Illinois Environmental Protection Agency — Well Completion Report

Site #: ______ County: Fulton Well #: BA02L

Site Name: Duck Creek Part 845 Groundwater Borehole #: BA02L

State Plane Coordinate: X 2,348,149.7 Y 1,384,558.0 (or) Latitude: ______ Longitude: ______

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: Dusty

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: 2/4/2021 Date Finished: 2/4/2021

Report Form Completed By: Tad A. Gass Date: 2/4/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

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

Installation Method: ______

Setting Time: ______

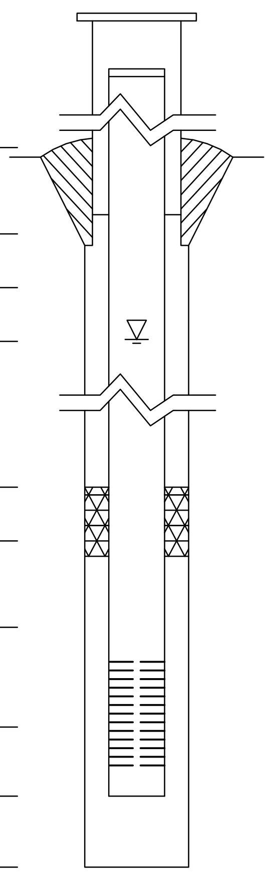
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
580.15	-2.98	Top of Protective Casing
579.71	-2.54	Top of Riser Pipe
577.17	0.00	Ground Surface
574.97	2.20	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
571.08	6.09	Top of Sand Pack
570.19	6.98	Top of Screen
565.51	11.66	Bottom of Screen
565.08	12.09	Bottom of Well
565.08	12.09	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)	9.52
Bottom of Screen to End Cap	(feet)	0.43
Screen Length (1st slot to last slot)	(feet)	4.68
Total Length of Casing	(feet)	14.63
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 #: 0570255197 County: Fulton County Well #: BA03

Site Name: Duck Creek Power Station Borehole #: BA03

~~State~~ Plant ~~Plane~~ Coordinate: X 2,376.2 Y 1,390.8 (or) Latitude: 40° 28' 5.097" Longitude: -89° 58' 55.691"

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Bulldog Drilling, Inc. Driller: C. Dutton

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna L. Keim Date Started: 12/29/2015 Date Finished: 12/29/2015

Report Form Completed By: Suzanna L. Keim Date: 12/30/2015

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular **Pellet** Slurry (choose one)

Installation Method: Gravity

Setting Time: 60 minutes

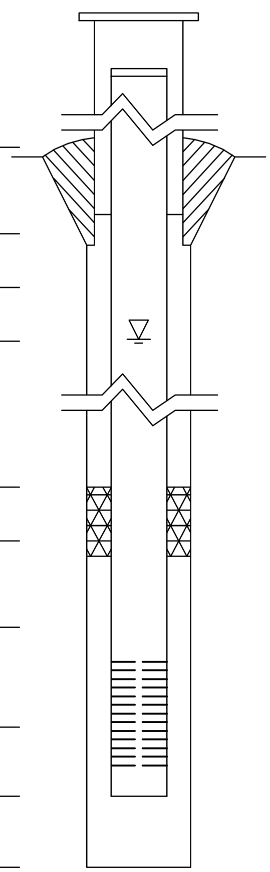
Type of Sand Pack: Quartz Sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Filter Sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
579.14	-3.08	Top of Protective Casing
578.54	-2.48	Top of Riser Pipe
576.06	0.00	Ground Surface
574.06	2.00	Top of Annular Sealant
570.32	5.74	Static Water Level (After Completion) 1/21/2016
562.73	13.33	Top of Seal
561.57	14.49	Top of Sand Pack
559.95	16.11	Top of Screen
550.49	25.57	Bottom of Screen
549.87	26.19	Bottom of Well
548.64	27.42	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)	18.59
Bottom of Screen to End Cap	(feet)	0.62
Screen Length (1st slot to last slot)	(feet)	9.46
Total Length of Casing	(feet)	28.67
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: Fulton Well #: BA03L

Site Name: Duck Creek Part 845 Groundwater Borehole #: BA03L

State Plane Coordinate: X 2,347,924.5 Y 1,384,430.0 (or) Latitude: ______ Longitude: ______

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: Dusty

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: 2/2/2021 Date Finished: 2/2/2021

Report Form Completed By: Rhonald W. Hasenyager Date: 2/8/2021

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: Granular bentonite

Installation Method: gravity

Setting Time: +24 hrs.

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

Installation Method: ______

Setting Time: ______

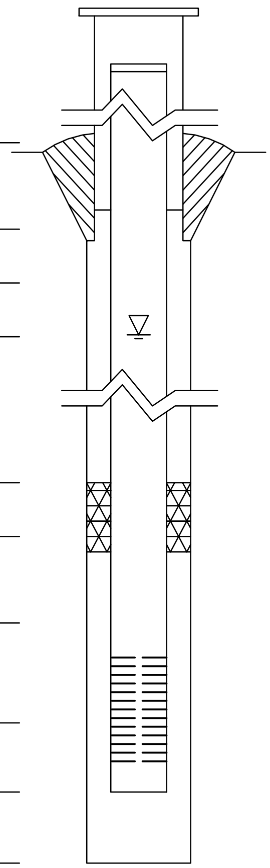
Type of Sand Pack: Quartz sand

Grain Size: 10/20 (sieve size)

Installation Method: gravity

Type of Backfill Material: ______ (if applicable)

Installation Method: ______



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
578.27	-3.14	Top of Protective Casing
577.75	-2.62	Top of Riser Pipe
575.13	0.00	Ground Surface
573.33	1.80	Top of Annular Sealant
		Static Water Level (After Completion)
n/a	n/a	Top of Seal
571.11	4.02	Top of Sand Pack
569.88	5.25	Top of Screen
565.19	9.94	Bottom of Screen
564.84	10.29	Bottom of Well
564.84	10.29	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)	7.87
Bottom of Screen to End Cap	(feet)	0.35
Screen Length (1st slot to last slot)	(feet)	4.69
Total Length of Casing	(feet)	12.91
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 #: 0570255197 County: Fulton County Well #: BA04

Site Name: Duck Creek Power Station Borehole #: BA04

~~State~~ Plant ~~Plane~~ Coordinate: X 2,138.1 Y 1,496.6 (or) Latitude: 40° 28' 6.147" Longitude: -89° 58' 58.769"

Surveyed By: Michael J. Graminski IL Registration #: 035-002901

Drilling Contractor: Bulldog Drilling, Inc. Driller: J. Dittmaier

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

Drilling Method: Hollow stem auger Drilling Fluid (Type): none

Logged By: Suzanna L. Keim Date Started: 12/29/2015 Date Finished: 12/29/2015

Report Form Completed By: Suzanna L. Keim Date: 12/30/2015

ANNULAR SPACE DETAILS

Type of Surface Seal: Concrete

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular **Pellet** Slurry (choose one)

Installation Method: Gravity

Setting Time: 30 minutes

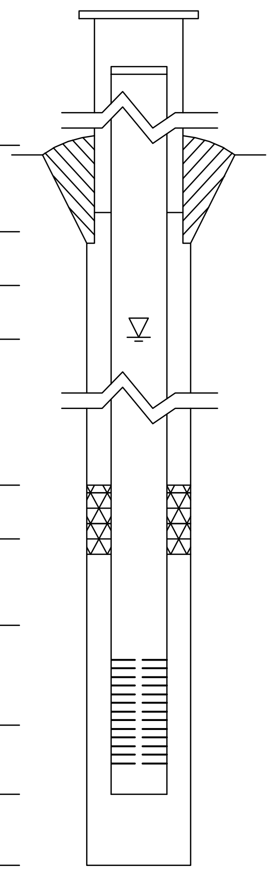
Type of Sand Pack: Quartz Sand

Grain Size: 10-20 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Filter Sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
578.96	-3.11	Top of Protective Casing
578.39	-2.54	Top of Riser Pipe
575.85	0.00	Ground Surface
573.85	2.00	Top of Annular Sealant
572.20	3.65	Static Water Level (After Completion) 1/20/2016
556.55	19.30	Top of Seal
553.55	22.30	Top of Sand Pack
551.27	24.58	Top of Screen
546.47	29.38	Bottom of Screen
546.08	29.77	Bottom of Well
545.85	30.00	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)	27.12
Bottom of Screen to End Cap	(feet)	0.39
Screen Length (1st slot to last slot)	(feet)	4.80
Total Length of Casing	(feet)	32.31
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: Fulton Well #: BA-05

Site Name: Duck Creek Power Station - Bottom Ash Basin Borehole #: BA-05b

~~State~~ Plant ~~Plane~~ Coordinate: X 2,114.5 Y 1,850.5 (or) Latitude: 40° 28' 9.650" Longitude: -89° 58' 59.070"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B. Williamson

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

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

Logged By: Suzanna L. Keim Date Started: 7/27/2016 Date Finished: 7/28/2016

Report Form Completed By: Suzanna L. Keim Date: 8/1/2016

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite Chips

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- **Granular** (circled) Pellet Slurry (choose one)

Installation Method: Gravity

Setting Time: 25 minutes

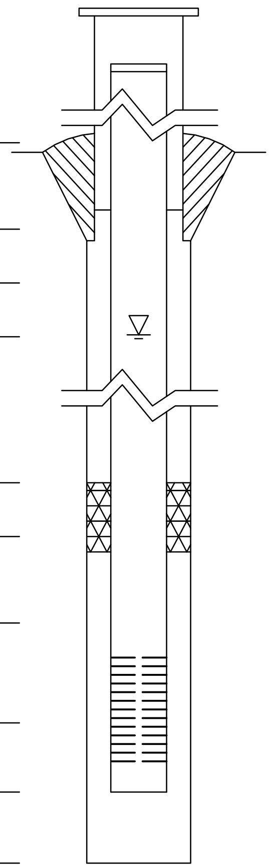
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Filter Sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
596.02	-2.85	Top of Riser Pipe
593.17	0.00	Ground Surface
591.17	2.00	Top of Annular Sealant
579.73	13.44	Static Water Level (After Completion) 8/8/2016
559.67	33.50	Top of Seal
558.57	34.60	Top of Sand Pack
556.69	36.48	Top of Screen
547.09	46.08	Bottom of Screen
546.60	46.57	Bottom of Well
546.60	46.57	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)	
Riser Pipe Length	(feet)	39.33
Bottom of Screen to End Cap	(feet)	0.49
Screen Length (1st slot to last slot)	(feet)	9.60
Total Length of Casing	(feet)	49.42
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: none
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: Fulton Well #: BA-06

Site Name: Duck Creek Power Station - Bottom Ash Basin Borehole #: BA-05c

~~State~~ Plant ~~Plane~~ Coordinate: X 2,702.3 Y 1,840.6 (or) Latitude: 40° 28' 9.539" Longitude: -89° 58' 51.461"

Surveyed By: Steven P. Ford IL Registration #: 035-003653

Drilling Contractor: Ramsey Geotechnical Engineering, LLC Driller: B. Williamson

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

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

Logged By: Suzanna L. Keim Date Started: 8/3/2016 Date Finished: 8/3/2016

Report Form Completed By: Suzanna L. Keim Date: 8/8/2016

ANNULAR SPACE DETAILS

Type of Surface Seal: Bentonite Chips

Type of Annular Sealant: High-solids bentonite

Installation Method: Tremie

Setting Time: >24 hours

Type of Bentonite Seal -- Granular Pellet Slurry (choose one) — Granular

Installation Method: Gravity

Setting Time: 50 minutes

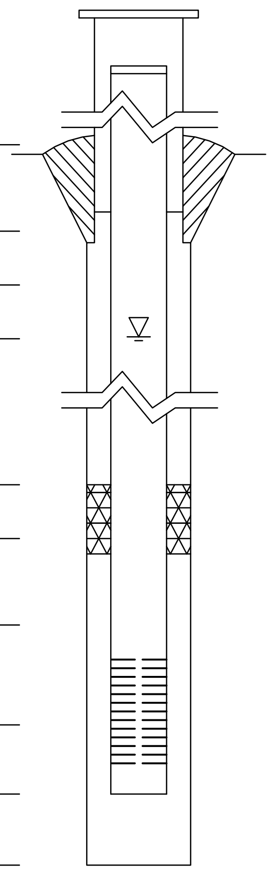
Type of Sand Pack: Quartz Sand

Grain Size: 10-40 (sieve size)

Installation Method: Gravity

Type of Backfill Material: Filter Sand (if applicable)

Installation Method: Gravity



Elevations (MSL)*	Depths (BGS)	(0.01 ft.)
		Top of Protective Casing
595.93	-2.73	Top of Riser Pipe
593.20	0.00	Ground Surface
587.20	6.00	Top of Annular Sealant
578.84	14.36	Static Water Level (After Completion) 8/8/2016
563.80	29.40	Top of Seal
562.48	30.72	Top of Sand Pack
560.88	32.32	Top of Screen
551.27	41.93	Bottom of Screen
550.77	42.43	Bottom of Well
549.20	44.00	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)	
Riser Pipe Length	(feet)	35.05
Bottom of Screen to End Cap	(feet)	0.50
Screen Length (1st slot to last slot)	(feet)	9.61
Total Length of Casing	(feet)	45.16
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: none
Riser Pipe Above W.T.	SS304	SS316	PTFE	PVC (selected)	OTHER:
Riser Pipe Below W.T.	SS304	SS316	PTFE	PVC (selected)	OTHER:
Screen	SS304	SS316	PTFE	PVC (selected)	OTHER:

APPENDIX C
GEOTECHNICAL LABORATORY REPORTS

GEOTECHNOLOGY INC
FROM THE GROUND UP

Via email: dramsey@ramgeoeng.com

February 19, 2021 J037264.01.6001

Mr. Douglas P. Ramsey, P.E.
Ramsey Geotechnical Engineering
1701 W. Market Street
Bloomington, Illinois 61701

Re: Duck Creek Power Station
Bottom Ash Basins
Fulton County, Illinois

Dear Mr. Ramsey:

Included in this report are the test results from seven Shelby tube samples received in our laboratory on February 12, 2021. The samples were tested in general accordance with the test method listed below.

Test to Determine	Method of Test
Water (Moisture) Content of Soils	ASTM D2216
Unconsolidated-Undrained Triaxial Compression Test	ASTM D2850
Hydraulic Conductivity of Soil Using Flexible Wall Permeameter	ASTM D5084
Density (Unit Weight) of Soil Specimens	ASTM D7263

We trust this is the information you require. Please contact the undersigned if you have any questions regarding this report.

Respectfully submitted,

GEOTECHNOLOGY, INC.

Janet M. May
Illinois Laboratory Manager

JMM/LPH:jmm

Attachment: Test Result Summary
Hydraulic Conductivity Test Data Sheets
Shelby Tube Logs
Testing Assignment Sheets

TEST RESULT SUMMARY

Duck Creek Power Station
Bottom Ash Basins
Fulton County, Illinois

			ASTM D2216	ASTM D7263	ASTM D5084	
Boring Number	Sample Number	Depth, feet	Moisture Content, %	Dry Unit Weight, pcf	Hydraulic Conductivity, cm/sec	Range of Hydraulic Gradient
SB-01	ST-9	16.0-18.0	27.2	95.8	4.5×10^{-6}	0.9 - 1.3
SB-01	ST-15	28.0-30.0	24.6	100.7	5.9×10^{-8}	6.9 - 17.9
SB-02	ST-5	8.0-10.0	27.7	96.8	8.0×10^{-6}	1.1 - 1.8
SB-02	ST-10	18.0-20.0	22.8	102.7	7.5×10^{-5}	0.2 - 1.5
SB-02	ST-13	24.0-26.0	24.1	100.2	5.5×10^{-8}	5.8 - 20.0
SB-03	ST-5	8.0-10.0	27.4	95.5	2.4×10^{-4}	0.1 - 1.5
SB-03	ST-10	18.0-20.0	11.2	128.0	1.4×10^{-6}	0.7 - 1.6

			ASTM D2488
Boring Number	Sample Number	Depth, feet	Material Description
SB-01	ST-9	16.0-18.0	Very dark gray-brown, LEAN CLAY – CL
SB-01	ST-15	28.0-30.0	Green-gray, LEAN to FAT CLAY – CL/CH
SB-02	ST-5	8.0-10.0	Olive-gray, LEAN CLAY – CL
SB-02	ST-10	18.0-20.0	Gray, LEAN CLAY, trace sand – CL
SB-02	ST-13	24.0-26.0	Green-gray, LEAN to FAT CLAY – CL/CH
SB-03	ST-5	8.0-10.0	Dark yellow-brown, LEAN CLAY – CL
SB-03	ST-10	18.0-20.0	Yellow-brown, LEAN CLAY with SAND, some gravel – CL

Notes and abbreviations:
% - Percent
cm/sec - Centimeters per second
pcf - Pounds per cubic foot

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

		Initial Unit Weight		Unit Weight as Tested	
JOB NO.:	J037264.01.6001	WET UNIT WEIGHT, pcf:	121.9	WET UNIT WEIGHT, pcf:	122.4
BORING NO.:	SB-01	DRY UNIT WEIGHT, pcf:	95.8	DRY UNIT WEIGHT, pcf:	96.5
SAMPLE NO.:	ST-9				
DEPTH (Feet):	16.0-18.0				

	Initial	As Tested**		Initial	As Tested	INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	4.021	4.014	LENGTH, cm:	10.213	10.196	WET WT SPLE+TARE	1113.89	WET WT SPLE+TARE	1111.96
DIAMETER, in.:	2.873	2.866	DIAMETER, cm	7.297	7.280	DRY WT SPLE+TARE	935.62	DRY WT SPLE+TARE	935.62
WET WT., gms.:	833.87	832.25				TARE WEIGHT	280.02	TARE WEIGHT	280.02
AREA, sq.in.:	6.483	6.451	AREA, sq cm:	41.824	41.621	**% MOISTURE**	27.2	% MOISTURE	26.9

B VALUE (before Permeation): 99% Cell / Back Pressure, psi: 44 / 40

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP °C		ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	13-Feb-21	12:28 PM	19.4	*	0	10.35	23.50				1.29	13.15		
0.0	13-Feb-21	01:24 PM	20.0	*	56	10.93	22.61	0.58	4.5E-06	*	1.14	11.68	11.18	1.8E-06
0.0	13-Feb-21	02:17 PM	20.2	*	53	11.50	21.97	0.57	4.4E-06	*	1.03	10.47	10.36	1.7E-06
0.0	13-Feb-21	02:59 PM	20.2	*	42	11.93	21.50	0.43	4.6E-06	*	0.94	9.57	8.60	1.8E-06
0.0	15-Feb-21	07:34 AM	15.2	*	0	11.70	23.40				1.15	11.70		
0.0	15-Feb-21	08:49 AM	17.8	*	75	12.40	22.62	0.70	3.9E-06	*	1.00	10.22	12.65	1.5E-06

Average Temp. = 18.8 *

AVERAGE K = 4.4E-06 * **AVERAGE K = 1.7E-06**

Corrected K for 20°C = 4.5E-06 **Corrected K for 20°C = 1.8E-06**

** Measurements at end of test

HYDRAULIC CONDUCTIVITY TEST DATA

(ASTM D 5084, Method F)

JOB NO.:	J037264.01.6001		
BORING NO.:	SB-01		
SAMPLE NO.:	ST-15		
DEPTH (Feet):	28.0-30.0		

Initial Unit Weight		**Unit Weight as Tested**	
WET UNIT WEIGHT, pcf:	125.5	WET UNIT WEIGHT, pcf:	126.0
DRY UNIT WEIGHT, pcf:	100.7	DRY UNIT WEIGHT, pcf:	102.1

	Initial	As Tested**		Initial	As Tested
LENGTH, in.:	4.021	4.004	LENGTH, cm:	10.213	10.170
DIAMETER, in.:	2.882	2.871	DIAMETER, cm:	7.320	7.292
WET WT., gms.:	864.14	857.27	AREA, sq cm:	42.087	41.766
AREA, sq.in.:	6.523	6.474			

INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
WET WT SPLE+TARE	1135.51	WET WT SPLE+TARE	1126.91
DRY WT SPLE+TARE	964.89	DRY WT SPLE+TARE	964.89
TARE WEIGHT	271.34	TARE WEIGHT	271.37
% MOISTURE	24.6	% MOISTURE	23.4

B VALUE (before Permeation): 99%   Cell / Back Pressure, psi: 34 / 30

	M_1	M_2		
Manometer Constants	0.0302	1.0410	Sample Constant (L/A)	0.2435

DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP °C		ELAPSED MINUTES	PIPET READING	ANNULUS READING	γ SPECIFIC GRAVITY	C TEST CONSTANT	T TRIAL CONSTANT	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	k (in/sec)
18-Feb-21	11:54 AM	19.9	*	0	15.65	1.17	12.570	0.000585	0.0719			17.90	182.01	
18-Feb-21	12:22 PM	19.8	*	28	13.40	1.22	12.570	0.000585	0.0855	7.4E-08	*	15.05	153.10	2.9E-08
18-Feb-21	01:03 PM	20.1	*	41	11.48	1.30	12.570	0.000585	0.1023	5.2E-08	*	12.58	127.96	2.0E-08
18-Feb-21	02:48 PM	20.2	*	105	8.18	1.42	12.570	0.000585	0.1540	6.6E-08	*	8.36	84.97	2.6E-08
18-Feb-21	03:39 PM	20.2	*	51	7.05	1.47	12.570	0.000585	0.1866	4.5E-08	*	6.90	70.14	1.8E-08

Average Temp. = 20.0 *

AVERAGE K = 5.9E-08 *   **AVERAGE K = 2.3E-08**

Corrected K for 20ºC = 5.9E-08   **Corrected K for 20ºC = 2.3E-08**

** Measurements at end of test

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

		Initial Unit Weight		Unit Weight as Tested	
JOB NO.:	J037264.01.6001	WET UNIT WEIGHT, pcf:	123.6	WET UNIT WEIGHT, pcf:	124.6
BORING NO.:	SB-02	DRY UNIT WEIGHT, pcf:	96.8	DRY UNIT WEIGHT, pcf:	98.8
SAMPLE NO.:	ST-5				
DEPTH (Feet):	8.0-10.0				

	Initial	As Tested**		Initial	As Tested	INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	3.969	3.888	LENGTH, cm:	10.081	9.876	WET WT SPLE+TARE	1097.43	WET WT SPLE+TARE	1086.88
DIAMETER, in.:	2.858	2.859	DIAMETER, cm	7.259	7.262	DRY WT SPLE+TARE	918.22	DRY WT SPLE+TARE	918.22
WET WT., gms.:	826.16	816.17				TARE WEIGHT	271.27	TARE WEIGHT	271.27
AREA, sq.in.:	6.415	6.420	AREA, sq cm:	41.389	41.418	**% MOISTURE**	27.7	% MOISTURE	26.1

B VALUE (before Permeation): 97% Cell / Back Pressure, psi: 24 / 20

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP °C		ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	13-Feb-21	01:14 PM	19.5		0	5.54	23.42				1.77	17.88		
0.0	13-Feb-21	01:31 PM	20.4	*	17	6.07	22.66	0.53	9.2E-06		1.65	16.59	7.21	3.6E-06
0.0	13-Feb-21	02:18 PM	20.3	*	47	7.47	21.27	1.40	8.2E-06	*	1.37	13.80	16.82	3.2E-06
0.0	13-Feb-21	03:04 PM	20.0	*	46	8.65	20.08	1.18	8.5E-06	*	1.13	11.43	17.17	3.4E-06
0.0	15-Feb-21	07:39 AM	15.4	*	0	7.20	23.45			*	1.61	16.25		
0.0	15-Feb-21	08:18 AM	18.4	*	39	8.20	22.46	1.00	7.0E-06	*	1.41	14.26	12.25	2.8E-06
0.0	15-Feb-21	08:54 AM	18.1	*	36	9.04	21.60	0.84	7.4E-06	*	1.25	12.56	11.92	2.9E-06

Average Temp. = 18.8 *

AVERAGE K = 7.8E-06 *
Corrected K for 20ºC = 8.0E-06

AVERAGE K = 3.1E-06
Corrected K for 20ºC = 3.2E-06

** Measurements at end of test

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

		Initial Unit Weight		Unit Weight as Tested	
JOB NO.:	J037264.01.6001	WET UNIT WEIGHT, pcf:	126.1	WET UNIT WEIGHT, pcf:	126.0
BORING NO.:	SB-02	DRY UNIT WEIGHT, pcf:	102.7	DRY UNIT WEIGHT, pcf:	102.2
SAMPLE NO.:	ST-10				
DEPTH (Feet):	18.0-20.0				

	Initial	As Tested**		Initial	As Tested	INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	4.373	4.385	LENGTH, cm:	11.107	11.138	WET WT SPLE+TARE	1239.10	WET WT SPLE+TARE	1242.77
DIAMETER, in.:	2.883	2.889	DIAMETER, cm	7.323	7.338	DRY WT SPLE+TARE	1063.71	DRY WT SPLE+TARE	1063.71
WET WT., gms.:	944.70	950.56				TARE WEIGHT	294.40	TARE WEIGHT	294.40
AREA, sq.in.:	6.528	6.555	AREA, sq cm:	42.116	42.291	**% MOISTURE**	22.8	% MOISTURE	23.3

B VALUE (before Permeation): 98%   Cell / Back Pressure, psi: 34 / 30

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC		ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	17-Feb-21	08:56 AM	20.0	*	0	5.87	22.68				1.51	16.81		
0.0	17-Feb-21	09:03 AM	20.1	*	7	7.63	20.81	1.76	8.0E-05	*	1.19	13.18	21.59	3.2E-05
0.0	17-Feb-21	09:32 AM	20.1	*	29	11.80	16.51	4.17	8.2E-05	*	0.42	4.71	64.26	3.2E-05
0.0	17-Feb-21	10:57 AM	20.9	*	85	13.90	14.35	2.10	6.4E-05	*	0.04	0.45	90.45	2.5E-05
0.0	17-Feb-21	10:58 AM	20.9	*	0	7.27	23.00				1.42	15.73		
0.0	17-Feb-21	11:09 AM	21.0	*	11	9.81	20.42	2.54	8.2E-05	*	0.96	10.61	32.55	3.2E-05
0.0	17-Feb-21	12:08 PM	20.7	*	59	14.27	15.90	4.46	7.3E-05	*	0.15	1.63	84.64	2.9E-05

Average Temp. = 20.5 *

AVERAGE K = 7.6E-05 *   **AVERAGE K = 3.0E-05**

Corrected K for 20ºC = 7.5E-05   **Corrected K for 20ºC = 3.0E-05**

** Measurements at end of test

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084, Method F)

JOB NO.:	J037264.01.6001		
BORING NO.:	SB-02		
SAMPLE NO.:	ST-13		
DEPTH (Feet):	24.0-26.0		

Initial Unit Weight		Unit Weight as Tested	
WET UNIT WEIGHT, pcf:	124.4	WET UNIT WEIGHT, pcf:	125.9
DRY UNIT WEIGHT, pcf:	100.2	DRY UNIT WEIGHT, pcf:	101.4

	Initial	As Tested**		Initial	As Tested
LENGTH, in.:	4.052	4.040	LENGTH, cm:	10.292	10.262
DIAMETER, in.:	2.878	2.867	DIAMETER, cm:	7.310	7.282
WET WT., gms.:	860.89	862.02	AREA, sq cm:	41.970	41.650
AREA, sq.in.:	6.505	6.456			

INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
WET WT SPLE+TARE	1148.97	WET WT SPLE+TARE	1149.19
DRY WT SPLE+TARE	981.69	DRY WT SPLE+TARE	981.69
TARE WEIGHT	288.08	TARE WEIGHT	288.08
% MOISTURE	24.1	% MOISTURE	24.1

B VALUE (before Permeation): 96% Cell / Back Pressure, psi: 64 / 60

	M_1	M_2		
Manometer Constants	0.0302	1.0410	Sample Constant (L/A)	0.2464

DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC		ELAPSED MINUTES	PIPET READING	ANNULUS READING	γ SPECIFIC GRAVITY	C TEST CONSTANT	T TRIAL CONSTANT	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	k (in/sec)
18-Feb-21	02:52 PM	20.8	*	0	8.45	1.18	12.570	0.000592	0.1432			8.91	91.38	
18-Feb-21	03:41 PM	20.6	*	49	7.17	1.23	12.570	0.000592	0.1752	5.1E-08	*	7.28	74.67	2.0E-08
18-Feb-21	04:40 PM	20.6	*	59	6.03	1.27	12.570	0.000592	0.2187	4.8E-08	*	5.83	59.83	1.9E-08
18-Feb-21	05:06 PM	20.5	*	0	17.13	0.81	12.570	0.000592	0.0638			19.99	205.14	
18-Feb-21	05:33 PM	20.6	*	27	14.90	0.90	12.570	0.000592	0.0744	6.6E-08	*	17.15	175.98	2.6E-08
18-Feb-21	05:51 PM	20.8	*	18	13.70	0.93	12.570	0.000592	0.0815	5.6E-08	*	15.64	160.52	

Average Temp. = 20.7 *

AVERAGE K = 5.5E-08 * **AVERAGE K = 2.2E-08**

Corrected K for 20ºC = 5.5E-08 **Corrected K for 20ºC = 2.1E-08**

** Measurements at end of test

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	J037264.01.6001		
BORING NO.:	SB-03		
SAMPLE NO.:	ST-5		
DEPTH (Feet):	8.0-10.0		

Initial Unit Weight		Unit Weight as Tested	
WET UNIT WEIGHT, pcf:	121.6	WET UNIT WEIGHT, pcf:	122.9
DRY UNIT WEIGHT, pcf:	95.5	DRY UNIT WEIGHT, pcf:	96.4

	Initial	As Tested**		Initial	As Tested
LENGTH, in.:	5.417	5.405	LENGTH, cm:	13.759	13.729
DIAMETER, in.:	2.874	2.864	DIAMETER, cm	7.300	7.275
WET WT., gms.:	1121.88	1123.10			
AREA, sq.in.:	6.487	6.442	AREA, sq cm:	41.853	41.563

INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
WET WT SPLE+TARE	1395.98	WET WT SPLE+TARE	1396.33
DRY WT SPLE+TARE	1154.76	DRY WT SPLE+TARE	1154.76
TARE WEIGHT	274.10	TARE WEIGHT	274.10
% MOISTURE	27.4	% MOISTURE	27.4

B VALUE (before Permeation): 97% Cell / Back Pressure, psi: 44 / 40

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP ºC		ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	15-Feb-21	07:50 AM	15.4	*	0	9.54	23.22				0.99	13.68		
0.0	15-Feb-21	07:57 AM	15.6	*	7	12.18	20.60	2.64	2.0E-04	*	0.61	8.42	38.45	7.9E-05
0.0	15-Feb-21	08:11 AM	15.9	*	14	14.71	17.96	2.53	2.0E-04	*	0.24	3.25	61.40	7.7E-05
0.0	15-Feb-21	08:19 AM	16.1	*	8	15.47	17.23	0.76	2.2E-04	*	0.13	1.76	45.85	8.7E-05
0.0	15-Feb-21	08:50 AM	18.4	*	0	3.60	23.83				1.47	20.23		
0.0	15-Feb-21	08:54 AM	18.3	*	4	6.78	21.12	3.18	2.5E-04	*	1.04	14.34	29.12	9.8E-05

Average Temp. = 16.6 *

AVERAGE K = 2.2E-04 *
Corrected K for 20ºC = 2.4E-04

AVERAGE K = 8.5E-05
Corrected K for 20ºC = 9.3E-05

** Measurements at end of test

HYDRAULIC CONDUCTIVITY TEST DATA
(ASTM D 5084)

JOB NO.:	J037264.01.6001	**Initial Unit Weight**		**Unit Weight as Tested**	
BORING NO.:	SB-03	WET UNIT WEIGHT, pcf:	142.3	WET UNIT WEIGHT, pcf:	142.7
SAMPLE NO.:	ST-10	DRY UNIT WEIGHT, pcf:	128.0	DRY UNIT WEIGHT, pcf:	128.2
DEPTH (Feet):	18.0-20.0				

	Initial	As Tested**		Initial	As Tested	INITIAL MOISTURE CONTENT		FINAL MOISTURE CONTENT	
LENGTH, in.:	4.490	4.484	LENGTH, cm:	11.405	11.389	WET WT SPLE+TARE	1377.35	WET WT SPLE+TARE	1378.61
DIAMETER, in.:	2.894	2.895	DIAMETER, cm	7.351	7.353	DRY WT SPLE+TARE	1266.66	DRY WT SPLE+TARE	1266.66
WET WT., gms.:	1103.21	1105.66				TARE WEIGHT	274.14	TARE WEIGHT	274.14
AREA, sq.in.:	6.578	6.582	AREA, sq cm:	42.438	42.467	**% MOISTURE**	11.2	% MOISTURE	11.3

B VALUE (before Permeation): 95% Cell / Back Pressure, psi: 54 / 50

HEAD (PSI)	DATE (YR,MO,DY)	TIME (HR,MN,SC)	TEMP °C		ELAPSED MINUTES	BOTTOM BURETTE	TOP BURETTE	Q (CC)	K CM/SEC		HYDRAULIC GRADIENT	HYDRAULIC HEAD	HEAD LOSS,%	k (in/sec)
0.0	17-Feb-21	11:14 AM	20.7	*	0	5.20	22.90				1.55	17.70		
0.0	17-Feb-21	02:25 PM	21.0	*	191	6.22	21.55	1.02	1.8E-06	*	1.34	15.33	13.39	7.0E-07
0.0	17-Feb-21	05:06 PM	21.6	*	161	6.96	20.76	0.74	1.5E-06	*	1.21	13.80	9.98	6.0E-07
0.0	18-Feb-21	08:37 AM	19.3	*	931	9.37	18.35	2.41	1.1E-06	*	0.79	8.98	34.93	4.3E-07
0.0	18-Feb-21	12:31 PM	20.7	*	234	9.90	17.87	0.53	1.2E-06	*	0.70	7.97	11.25	4.7E-07

Average Temp. = 20.7 *

AVERAGE K = 1.4E-06 * **AVERAGE K = 5.5E-07**

Corrected K for 20ºC = 1.4E-06 **Corrected K for 20ºC = 5.4E-07**

** Measurements at end of test

GEOTECHNOLOGY INC
FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: J037264.01.6001 Project Name.: Duck Creek Date Opened: 2/12/21 By: JMM

Boring No.: SB-01 Sample No.: ST-9 Depth (ft): 16.0 to 18.0

Type [X] Std. "Shelby" [ ] Other: ______

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 24

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed
	✓			

Remarks: ______

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Light Olive-brown LEAN CLAY-CL
2.0		
4.0		Qp = 0.75 tsf
6.0		
8.0		
10.0		
12.0		-very dark gray-brown
14.0	'K'	
16.0		
18.0		
20.0		Qp=1.75 tsf
22.0		
24.0		

Ave. Height (in.): ______ Ave. Diameter (in.): ______ Specimen Wt. (gms): ______

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See 'K' Data Sheet				

Wet Unit Weight: ______ pcf Dry Unit Weight ______ pcf

Tested By: JMM Calculated By: ______ Checked By: ______
Date: 2/12/21 Date: ______ Date: ______

GEOTECHNOLOGY INC. FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: 1037264.01.6001 Project Name.: Duck Creek Date Opened: 2/16/21 By: JMM

Boring No.: SB-01 Sample No.: ST-15 Depth (ft): 28.0 to 30.0

Type [X] Std. "Shelby" [ ] Other: ______

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 24

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed
		✓		

Remarks: Tube cut in order to extrude sample

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Greenish-gray, LEAN to Fat CLAY, CL/CH
2.0		
4.0		Qp= 0.25tsf
6.0		
8.0	'K'	
10.0		
12.0		with Sand some gravel - CL
14.0		Green-gray, Lean CLAY
16.0		- dark yellow-brown below 15"
18.0		Qp= 4.5+ tsf
20.0		
22.0		
24.0		

Ave. Height (in.): ______ Ave. Diameter (in.): ______ Specimen Wt. (gms): ______

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See 'K' Data Sheet				

Wet Unit Weight: ______ pcf Dry Unit Weight ______ pcf

Tested By: JMM Calculated By: ______ Checked By: ______

Date: 2/16/21 Date: ______ Date: ______

GEOTECHNOLOGY INC. FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: 1037264.01.6001 Project Name.: Duck Creek Date Opened: 2/13/21 By: JMM

Boring No.: SB-02 Sample No.: ST-5 Depth (ft): 8.0 to 10.0

Type [X] Std. "Shelby" [ ] Other: ____

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 21

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed
	✓			

Remarks: ____

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Olive-gray, LEAN CLAY - CL
2.0		
4.0		Qp = 0.75 tsf
6.0		
8.0		Sample saturated 8" from top
10.0		
12.0		
14.0	'K'	Qp = 1.25 tsf
16.0		
18.0		
20.0		
22.0		
24.0		

Ave. Height (in.): ____ Ave. Diameter (in.): ____ Specimen Wt. (gms): ____

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See	'K'	Data	Sheet	

Wet Unit Weight: ____ pcf Dry Unit Weight ____ pcf

Tested By: JMM Calculated By: ____ Checked By: ____

Date: 2/13/21 Date: ____ Date: ____

GEOTECHNOLOGY INC. FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: 1037264.01.6001 Project Name.: Duck Creek Date Opened: 2/16/21 By: JMM

Boring No.: SB-02 Sample No.: ST-10 Depth (ft): 18.0 to 20.0

Type [X] Std. "Shelby" [ ] Other: ____

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 20

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed
	✓			

Remarks: ____

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Gray, LEAN CLAY - CL
2.0		Qp = 2.5tsf
4.0		
6.0		- with sand
8.0		Clayey sand seam @ 10-12" from top
10.0		Gray, LEAN CLAY, trace Sand - CL
12.0		
14.0	'K'	
16.0		Qp = 1.5tsf
18.0		
20.0		
22.0		
24.0		

Ave. Height (in.): ____ Ave. Diameter (in.): ____ Specimen Wt. (gms): ____

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See 'K' Data Sheet				

Wet Unit Weight: ____ pcf Dry Unit Weight ____ pcf

Tested By: JMM Calculated By: ____ Checked By: ____

Date: 2/16/21 Date: ____ Date: ____

GEOTECHNOLOGY INC. FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: 1037264.01.6001 Project Name.: Duck Creek Date Opened: 2/16/21 By: JMM

Boring No.: SB-02 Sample No.: ST-13 Depth (ft): 24.0 to 26.0

Type [X] Std. "Shelby" [ ] Other: ____

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 18+2

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed
	✓			

Remarks: Bottom of tube bent. Bottom 2" dug out

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Green-gray, LEAN to Fat CLAY - CL/CH
2.0	'K'	
4.0		
6.0		Qp=1.0tsf
8.0		Clayey sand seam 8-10"
10.0		Green-gray, SANDY CLAY some gravel - CL
12.0		
14.0		sample came out pitted
16.0		
18.0		
20.0		
22.0		
24.0		

Ave. Height (in.): ____ Ave. Diameter (in.): ____ Specimen Wt. (gms): ____

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See	'K'	Data	Sheet	

Wet Unit Weight: ____ pcf Dry Unit Weight ____ pcf

Tested By: JMM Calculated By: ____ Checked By: ____

Date: 2/16/21 Date: ____ Date: ____

GEOTECHNOLOGY INC.
FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: 1037264.01.6001 Project Name.: Duck Creek Date Opened: 2/13/21 By: JMM

Boring No.: SB-03 Sample No.: ST-5 Depth (ft): 8.0 to 10.0

Type [X] Std. "Shelby" [ ] Other: ______

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 22

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed

Remarks: ______

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Dark yellow-brown, LEAN CLAY-CL
2.0		Blocky structure
4.0		Qp=1.75 tsf
6.0		
8.0	'K'	
10.0		
12.0		
14.0		
16.0		Qp=1.25 tsf
18.0		
20.0		
22.0		
24.0		

Ave. Height (in.): ______ Ave. Diameter (in.): ______ Specimen Wt. (gms): ______

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See 'K' Data Sheet				

Wet Unit Weight: ______ pcf Dry Unit Weight ______ pcf

Tested By: JMM Calculated By: ______ Checked By: ______
Date: 2/13/21 Date: ______ Date: ______

102 (12/08/09) TubeLog JMM Version.xls, 2.0-Scale 6/15/2017

GEOTECHNOLOGY INC
FROM THE GROUND UP

LABORATORY LOG OF TUBE SAMPLE

Project No.: 1037264.01.6001 Project Name.: Duck Creek Date Opened: 2/16/21 By: JMM

Boring No.: SB-03 Sample No.: ST-10 Depth (ft): 18.0 to 20.0

Type [X] Std. "Shelby" [ ] Other: ______

Tube Dimensions: Outside Diameter (in): 3 Recovery (in): 17

Tube Condition:	Dented	End(s) not sealed	Other:

Sample Condition	Good	Fair	Poor	Disturbed

Remarks: ______

Tube Scale (in)	Sample Use (Test Type)	Soil Identification and Processing Remarks (Draw lines to indicate top and botton of soil's surface and where sample was taken. Identify cut lines with: "Cut" "Date: m/d/y" "Your Initials")
0.0		Yellow-Brown, LEAN to FAT CLAY trace sand - CL
2.0		Qp = 0.75 tsf
		1" Clayey sand seam
4.0		Yellow-Br, LEAN CLAY with sand some gravel - CL
6.0		
8.0	'K'	
10.0		
12.0		
14.0		Qp = 4.5+ tsf
16.0		
18.0		
20.0		
22.0		
24.0		

Ave. Height (in.): ______ Ave. Diameter (in.): ______ Specimen Wt. (gms): ______

Natural Moisture Content				
Tare Number	Wet Mass + Tare (g)	Dry Mass+ Tare (g)	Tare Mass (g)	Water Content (%)
See 'K' Data Sheet				

Wet Unit Weight: ______ pcf Dry Unit Weight ______ pcf

Tested By: JMM Calculated By: ______ Checked By: ______
Date: 2/16/21 Date: ______ Date: ______

102 (12/08/09) TubeLog JMM Version.xls, 2.0-Scale 6/15/2017

Doug Ramsey

From:	Rhonald Hasenyager <RHasenyager@hanson-inc.com>
Sent:	Wednesday, February 10, 2021 1:36 PM
To:	Doug Ramsey
Subject:	RE: Duck Creek
Attachments:	SCH_LabTestingSchedule-RGE.pdf

Doug,

I have attached the testing schedule for the soil samples collected at Duck Creek. Each page is one boring. You will see a listing of jar sample number followed by Comp#. What I am looking for is a composite sample from the various jars that will be combined and then tested. I will also need to know what lithology is in the various Shelby tubes and if there are any lithology changes.

Feel free to give me a call if there are any questions.

Thanks, Rhon

From: Doug Ramsey <dramsey@ramgeoeng.com>
Sent: Wednesday, February 10, 2021 6:56 AM
To: Rhonald Hasenyager <RHasenyager@hanson-inc.com>
Subject: Duck Creek

EXTERNAL SENDER STOP.THINK.QUESTION If this is unexpected, verify before you click links or open attachments.

Hi Rhon,

Do you have lab testing assignments for the Duck Creek soil samples?

Douglas P. Ramsey, P.E.
President

RAMSEY GEOTECHNICAL ENGINEERING

1701 West Market Street
Bloomington, Illinois 61701
Office 309-821-0430
Cell 309-665-2965
Email: dramsey@ramgeoeng.com

Hanson Professional Services Inc.

Subcontract Agreement: RGE2014

Task Order No. 20E0111A/3000A

SCHEDULE OF LABORATORY TESTING

	Routine Testing [1]											Complex Testing [1]																Analytical Testing [1]						
Sample ID	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matte	
SB01																																		
6A																																		
7A																																		
8A																																		
10A																																		
11A																																		
12A																																		
Comp1				x	x			x			x			x																				
ST9																					x													
14A																																		
ST15																																		
Comp2				x	x			x			x			x																				
ST15																					x													
17A																																		
18A																																		
19A																																		
Comp3				x	x			x			x			x																				
20A																																		
21A																																		
22A																																		
23A																																		
Comp4				x	x			x			x			x																				

Note 1: All testing to be in accordance with *Laboratory Testing Specifications*.

See Task Order or Attachment for any special instructions regarding scheduled testing.

SCHEDULE OF LABORATORY TESTING

	Routine Testing											Complex Testing																Analytical Testing					
Sample ID	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB02																																	
3A																																	
4A																																	
6A																																	
7A																																	
8A																																	
Comp1				x	x			x			x			x																			
ST5																					x												
9A																																	
ST10																																	
11A																																	
Comp2				x	x			x			x			x																			
ST10																					x												
12A																																	
ST13																																	
Comp3				x	x			x			x			x																			
ST13																					x												
15A																																	
16A																																	
17A																																	
18A																																	
19A																																	
20A																																	
Comp4				x	x			x			x			x																			

SCHEDULE OF LABORATORY TESTING

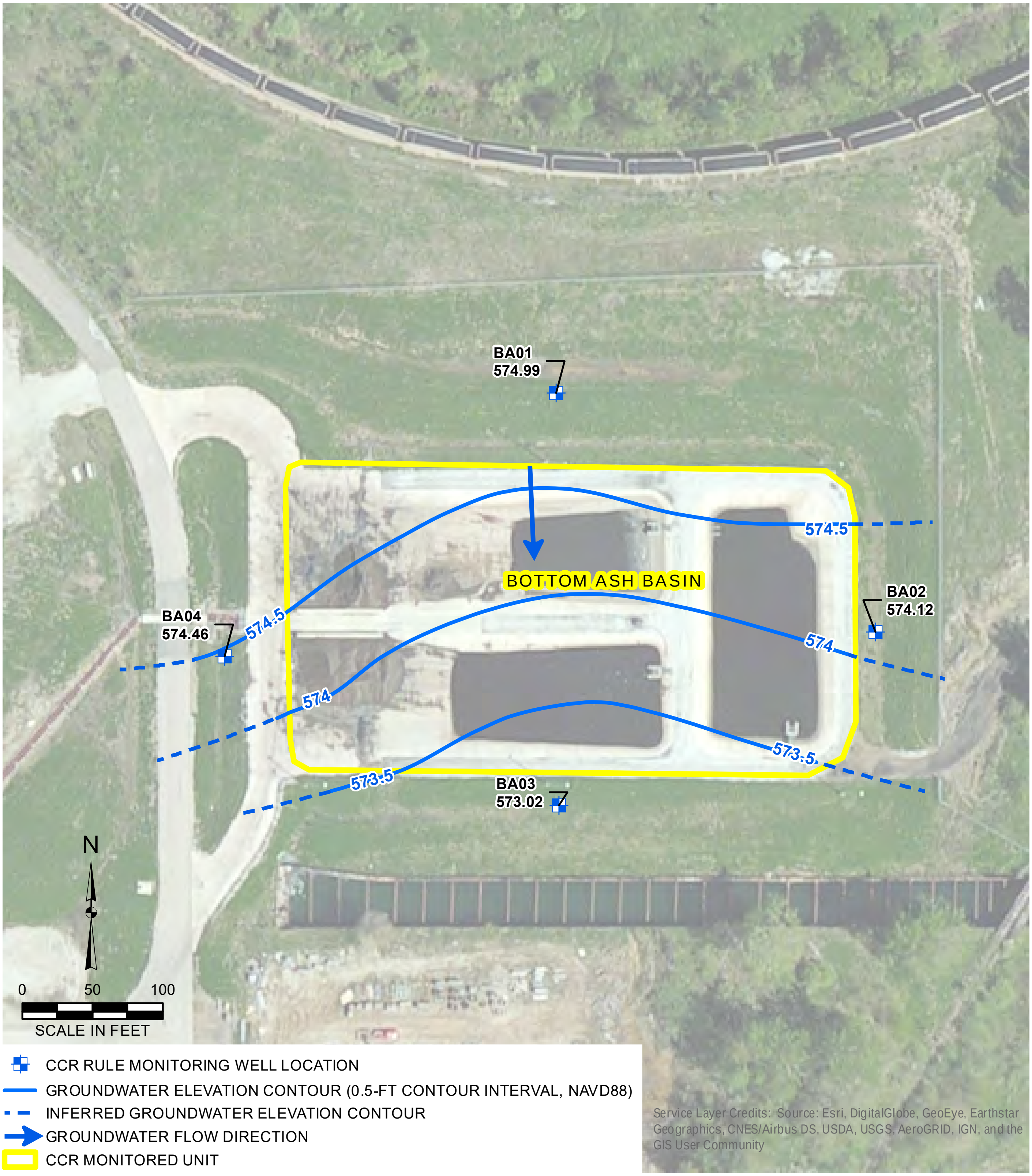
Sample ID	Routine Testing											Complex Testing																Analytical Testing					
	Rimac Comp Strength	Visual-Manual Classification	Unified Classification	Moisture Content	Liquid / Plastic Limits	Particle Size < #200	Particle Size - Sieves	Particle Size - Sieves + Hyd	Standard Compaction	Modified Compaction	Bulk Density	Unconfined Comp Strength	Consolidation Test	Specific Gravity	UU Triaxial Comp Strength	CU Traxail Comp Strength	CD Direct Shear Strength	Swell Test for Soil	Collapse Test for Soil	Permeability Granular Soil	Hyd Conduct Cohesive Soil	Shrinkafe Factor	Soil Resistivity	IBR and IBV of Soils	CBR Test	Elastic Moduli - Rock	Uniaxial Comp Str - Rock	Corrosivity	pH	Chloride	Sulfate	Total Organic Content	Moisture, Ash & Organ Matter
SB03																																	
4A																																	
6A																																	
7A																																	
8A																																	
Comp1				x	x			x			x			x																			
ST5																					x												
ST10*				x	x			x			x			x																			
ST10^																					x												
11A																																	
12A																																	
13A																																	
Comp3				x	x			x			x			x																			

* If sand is present in Shelby tube.

^ if sufficient sample, use lower portion of Shelby tube.

APPENDIX D
GROUNDWATER CONTOUR MAPS AND ELEVATIONS

GROUNDWATER CONTOUR MAPS



DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/7/17

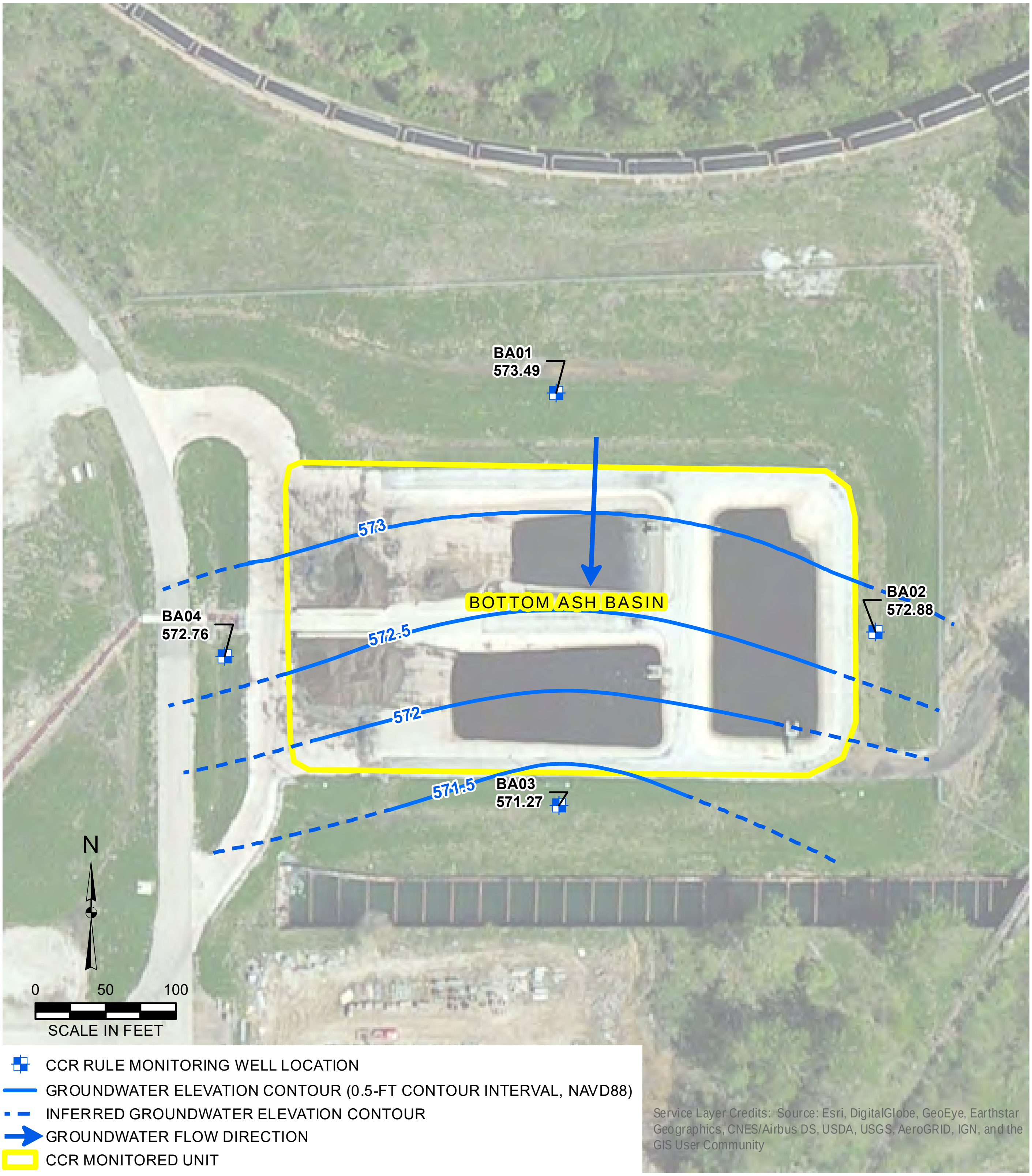
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 1: JANUARY 25, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

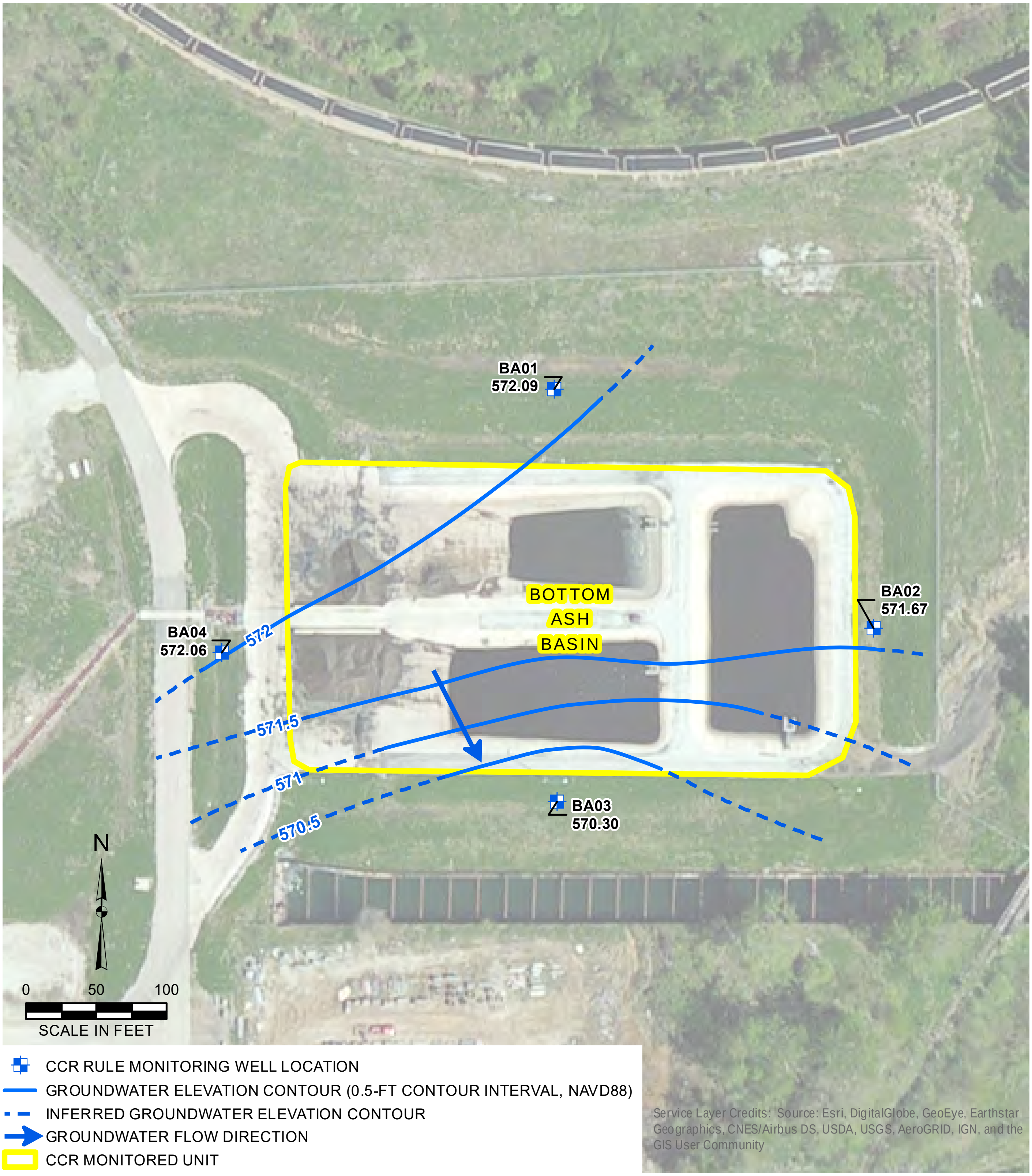
FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_02\R2_DuckCreekBAB_GW_Contours.mxd Author: sstolz; Date/Time: 3/2/2017, 3:39:20 PM

DRAWN BY/DATE: SDS 1/23/17 REVIEWED BY/DATE: ANS 1/25/17 APPROVED BY/DATE: JJW 2/8/17	**DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)** **UPPERMOST AQUIFER UNIT** **GROUNDWATER ELEVATION CONTOUR MAP** **ROUND 2: APRIL 18, 2016** DYNEGY CCR RULE GROUNDWATER MONITORING DUCK CREEK POWER STATION CANTON, ILLINOIS	PROJECT NO: 2285 FIGURE NO: 1 Natural Resource Technology AN OBG COMPANY



DRAWN BY/DATE:
SDS 1/23/17
REVIEWED BY/DATE:
ANS 1/25/17
APPROVED BY/DATE:
JJW 2/8/17

DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 3: JUNE 28, 2016

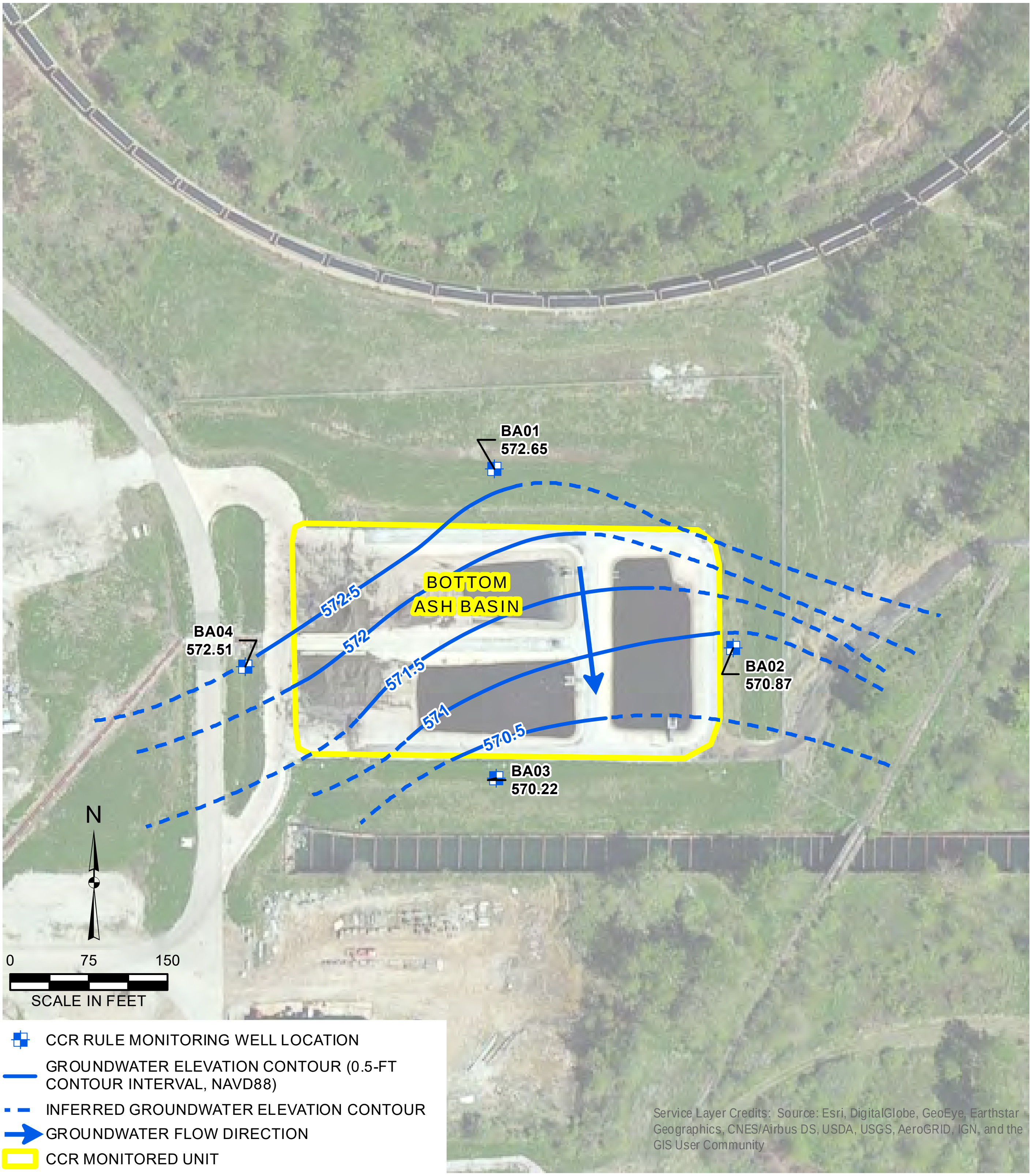
DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

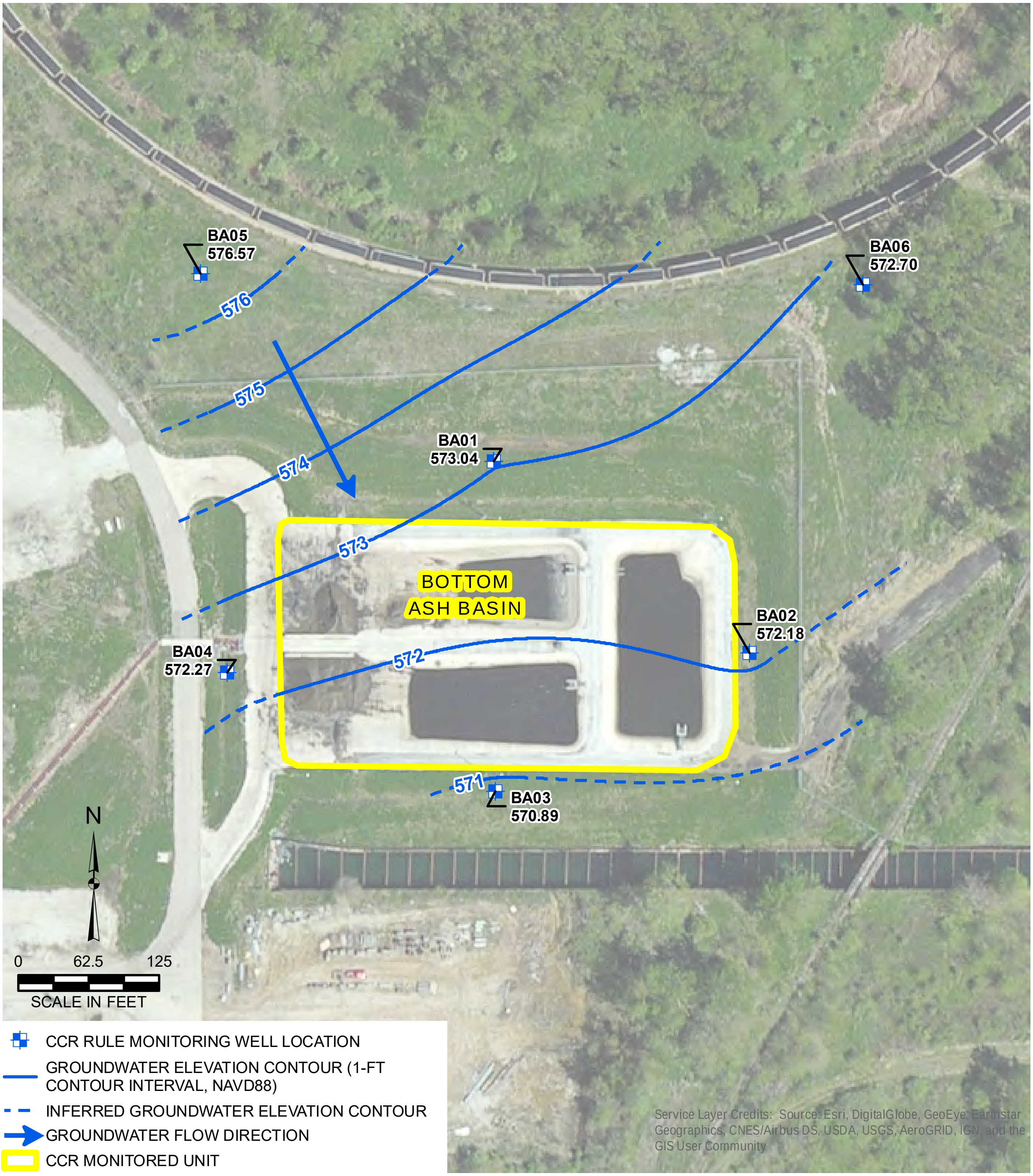
Natural Resource Technology
AN OBG COMPANY

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_03\R3_DuckCreekBAB_GW_Contours.mxd Author: sstolz; Date/Time: 3/3/2017, 10:45:44 AM



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_04\R4_DuckCreekBAB_GW_Contours.mxd Author: sstolz; Date/Time: 3/3/2017, 1:51:23 PM

DRAWN BY/DATE: SDS 1/23/17 REVIEWED BY/DATE: ANS 1/25/17 APPROVED BY/DATE: JJW 2/8/17	**DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP ROUND 4: AUGUST 9, 2016** DYNEGY CCR RULE GROUNDWATER MONITORING DUCK CREEK POWER STATION CANTON, ILLINOIS	PROJECT NO: 2285 FIGURE NO: 1 Natural Resource Technology AN OBG COMPANY



CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DRAWN BY/DATE:
SDS 3/21/17
REVIEWED BY/DATE:
ANS 3/21/17
APPROVED BY/DATE:
JJW 9/1/17

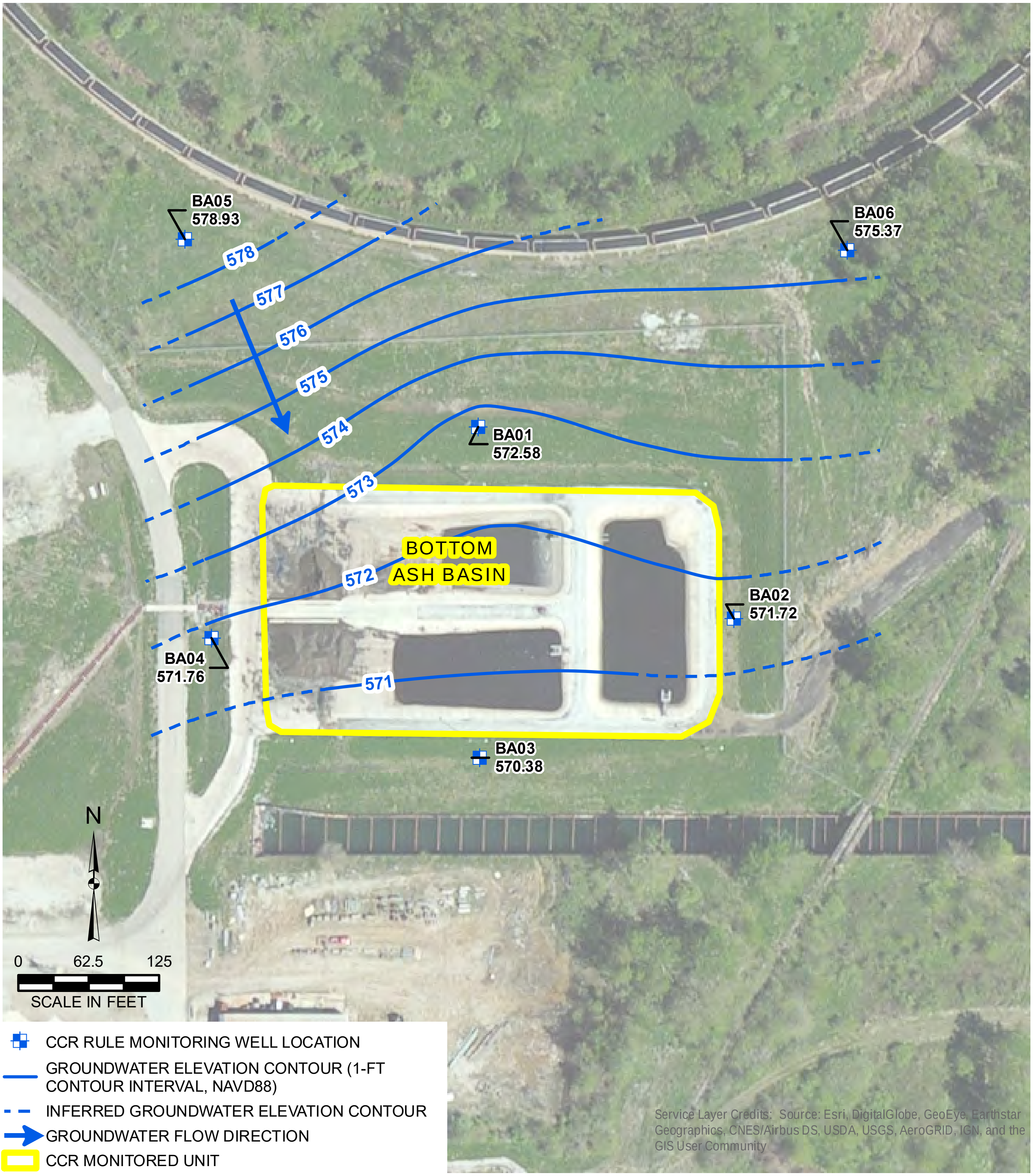
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 5: OCTOBER 17, 2016

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_06\R6_DuckCreekBAB_GW_Contours.mxd Author: stolzsd; Date/Time: 9/8/2017, 3:53:20 PM

DRAWN BY/DATE:
SDS 3/21/17
REVIEWED BY/DATE:
ANS 3/21/17
APPROVED BY/DATE:
JJW 9/1/17

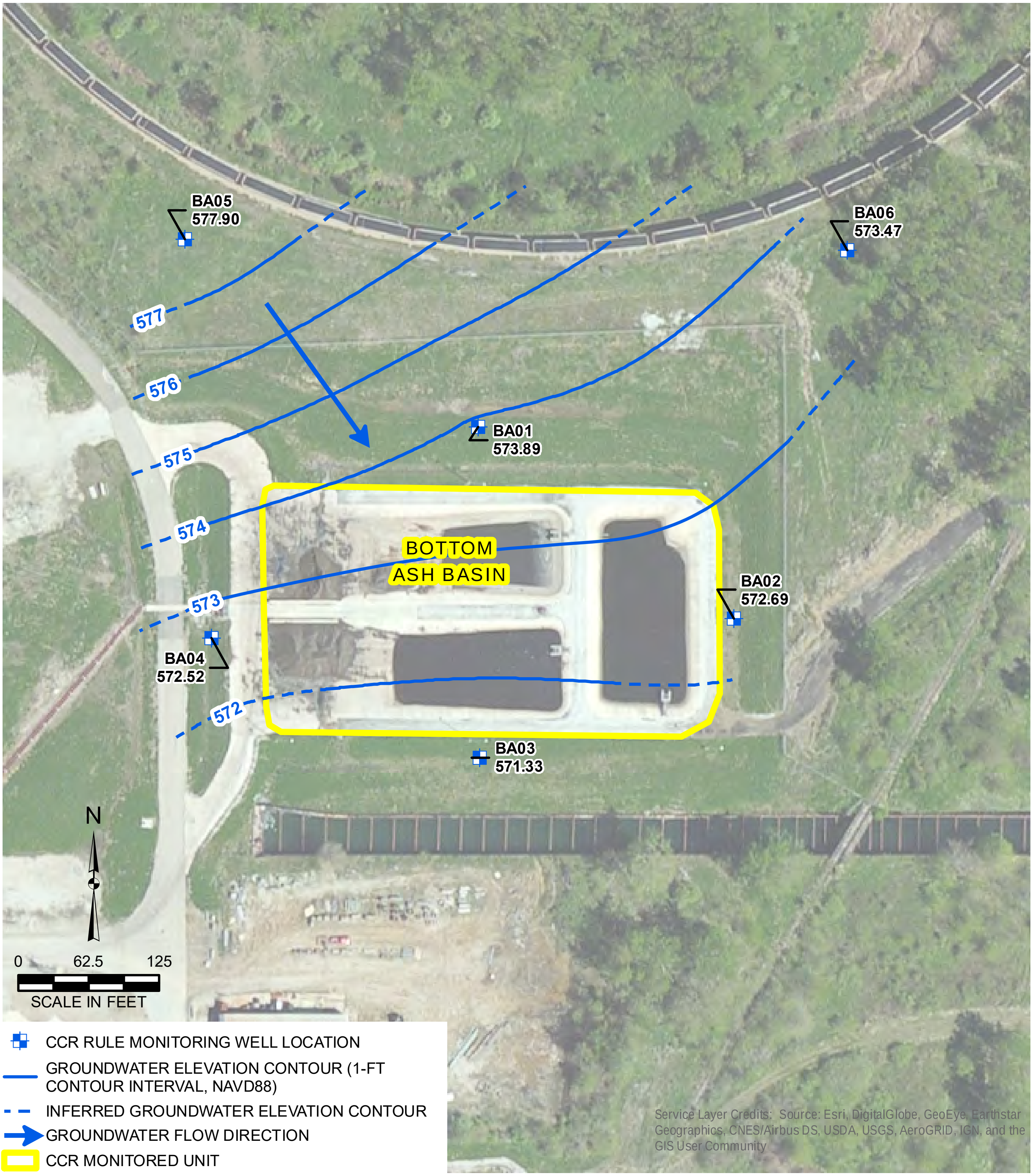
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 6: JANUARY 9, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

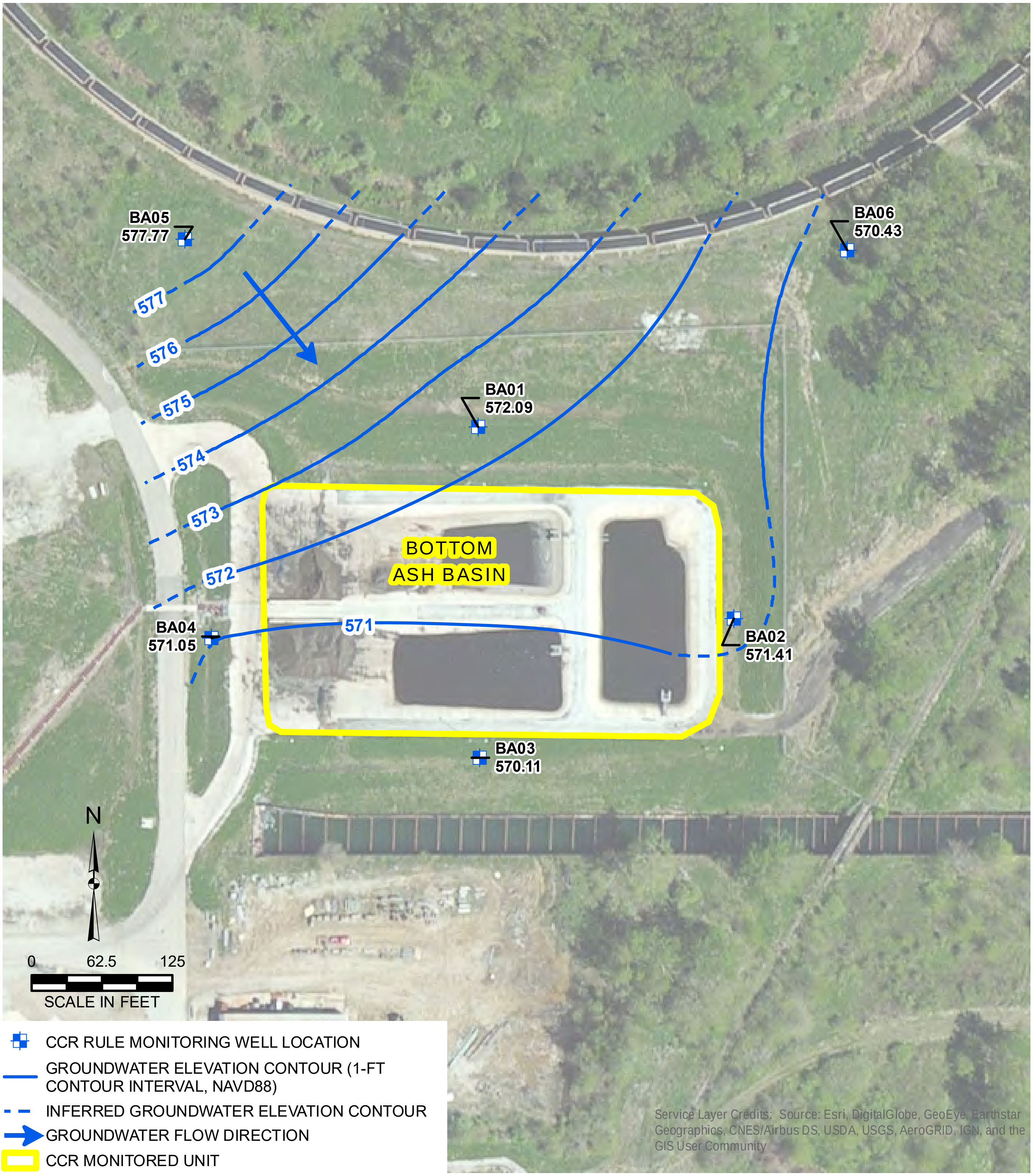
FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_07\R7_DuckCreekBAB_GW_Contours.mxd Author: stolzsd; Date/Time: 9/8/2017, 3:54:33 PM

DRAWN BY/DATE: SDS 5/22/17 REVIEWED BY/DATE: ANS 5/22/17 APPROVED BY/DATE: JJW 9/1/17	**DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205) UPPERMOST AQUIFER UNIT GROUNDWATER ELEVATION CONTOUR MAP ROUND 7: APRIL 2, 2017** DYNEGY CCR RULE GROUNDWATER MONITORING DUCK CREEK POWER STATION CANTON, ILLINOIS	PROJECT NO: 2285 FIGURE NO: 1 Natural Resource Technology AN OBG COMPANY



DRAWN BY/DATE:
SDS 7/27/17
REVIEWED BY/DATE:
ANS 7/28/17
APPROVED BY/DATE:
JJW 9/1/17

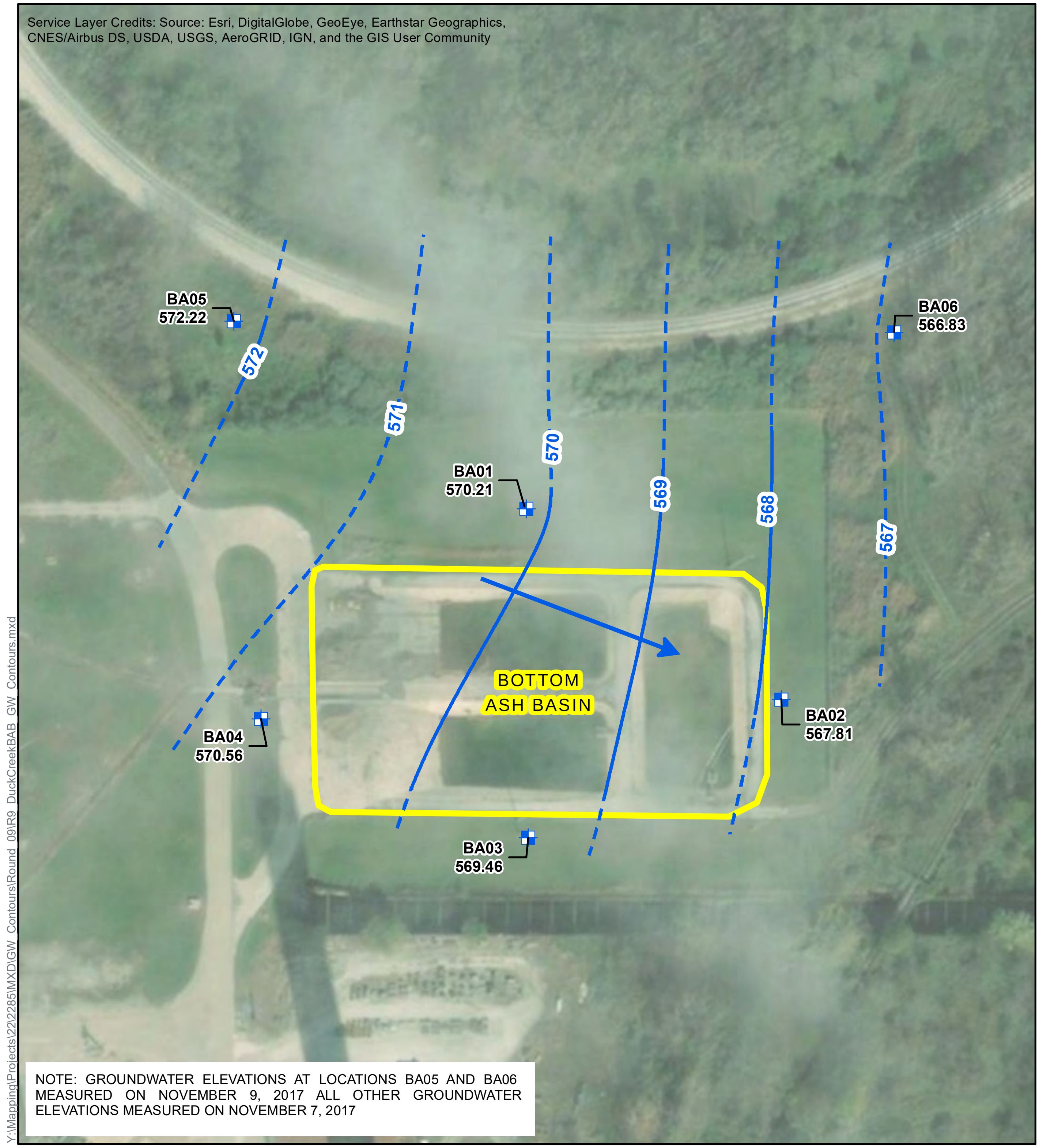
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 8: JUNE 26, 2017

DYNEGY CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

PROJECT NO: 2285

FIGURE NO: 1

Natural Resource Technology
AN OBG COMPANY



CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
GROUNDWATER ELEVATION CONTOUR MAP
NOVEMBER 7 AND 9, 2017

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 31.25 62.5 125
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2018_2Q\R2018_2Q_DC_BAB_GW_Contours.mxd

CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

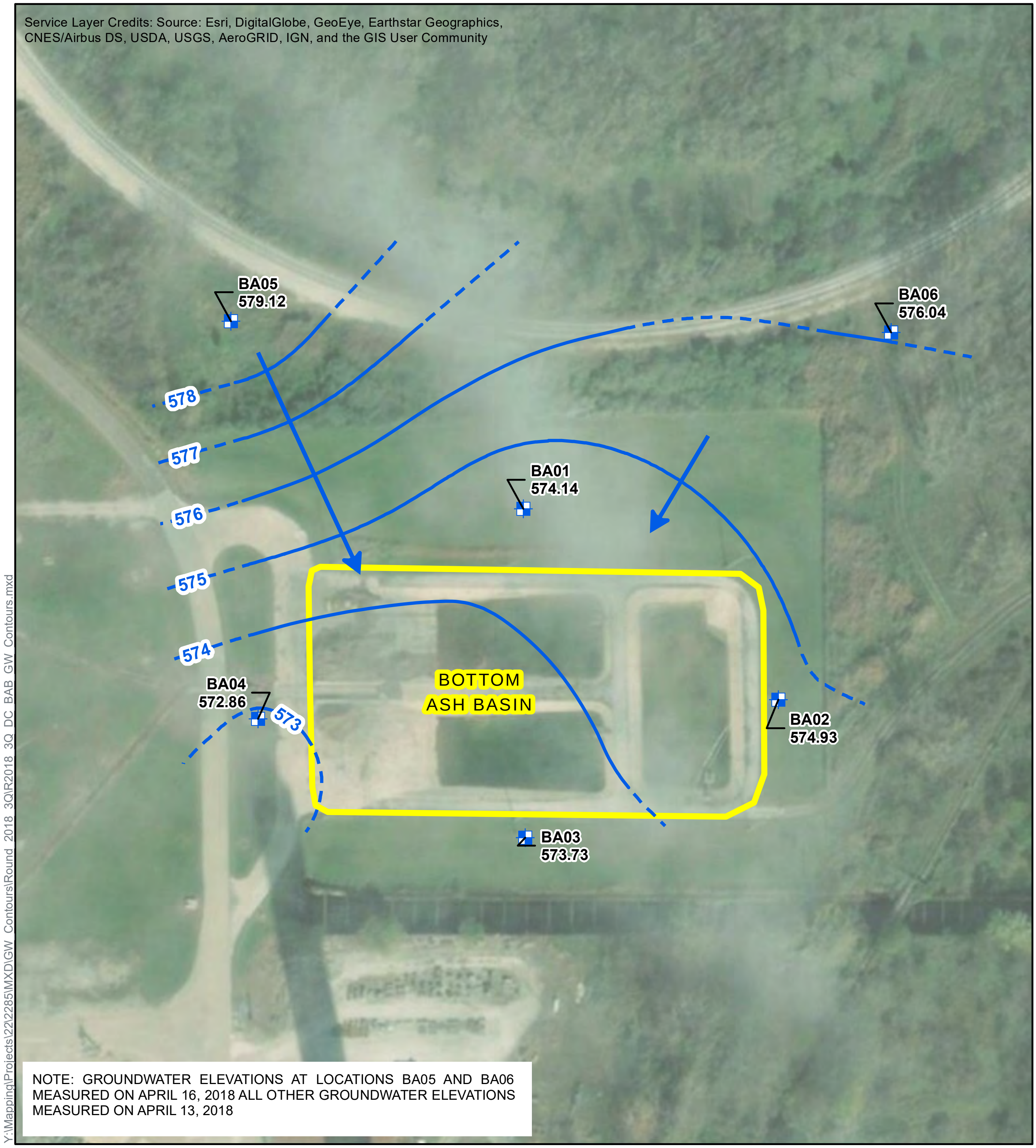
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
GROUNDWATER ELEVATION CONTOUR MAP
APRIL 13 AND 16, 2018

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 31.25 62.5 125
Feet

N

O'BRIEN & GERE ENGINEERS, INC.



CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

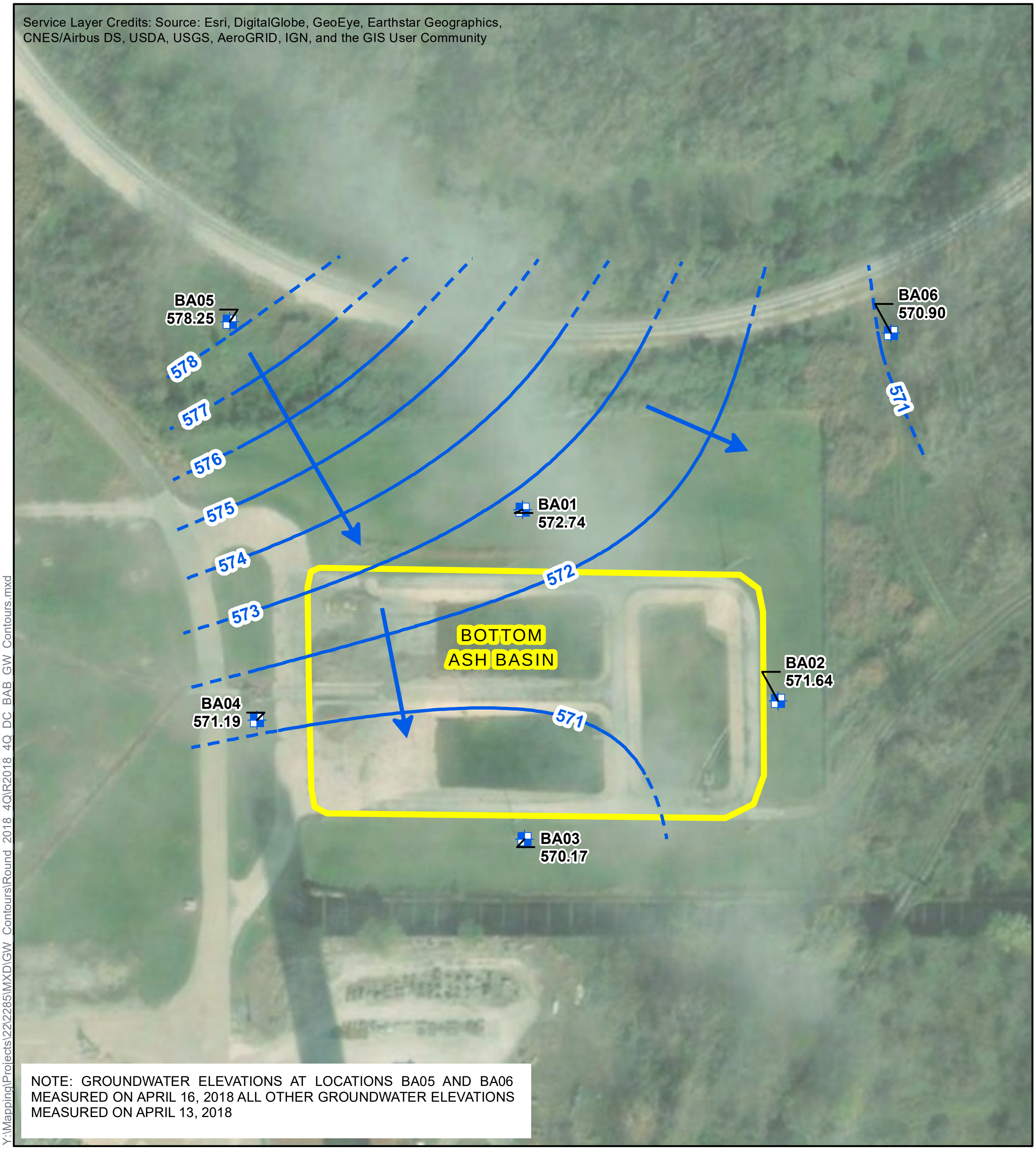
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
GROUNDWATER ELEVATION CONTOUR MAP
JULY 2, 2018

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 62.5 125 250
Feet

N

O'BRIEN & GERE ENGINEERS, INC.



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2018_4Q\R2018_4Q_DC_BAB_GW_Contours.mxd

CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

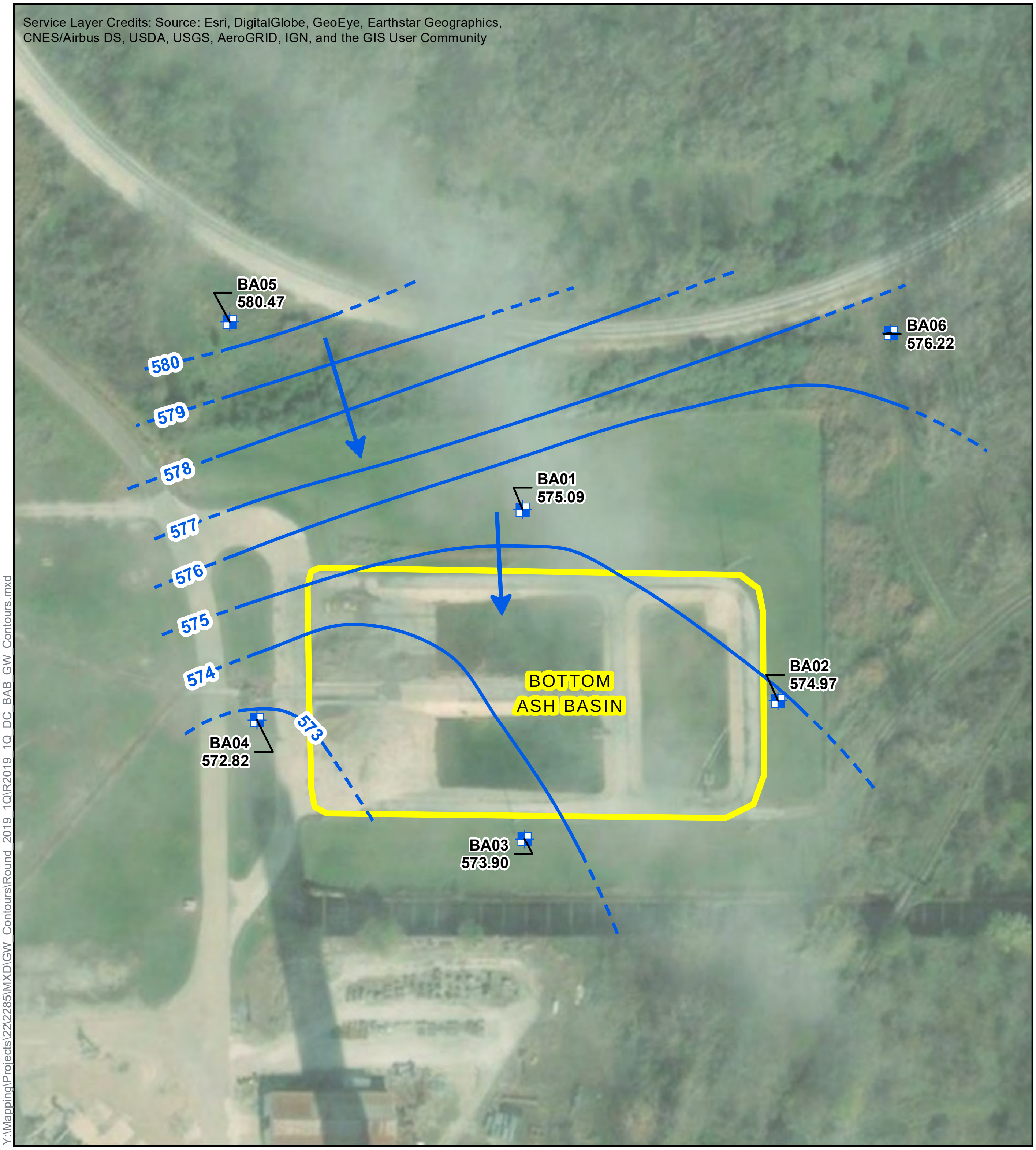
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
GROUNDWATER ELEVATION CONTOUR MAP
OCTOBER 2, 2018

N

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 31.25 62.5 125
Feet

O'BRIEN & GERE ENGINEERS, INC.



Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2019_1Q\R2019_1Q_DC_BAB_GW_Contours.mxd

CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
GROUNDWATER ELEVATION CONTOUR MAP
JANUARY 7, 2019

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 31.25 62.5 125
Feet

N

O'BRIEN & GERE ENGINEERS, INC.

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2019_3Q\R2019_3Q_DC_BAB_GW_Contours.mxd

CCR RULE MONITORING WELL LOCATION
GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
CCR MONITORED UNIT

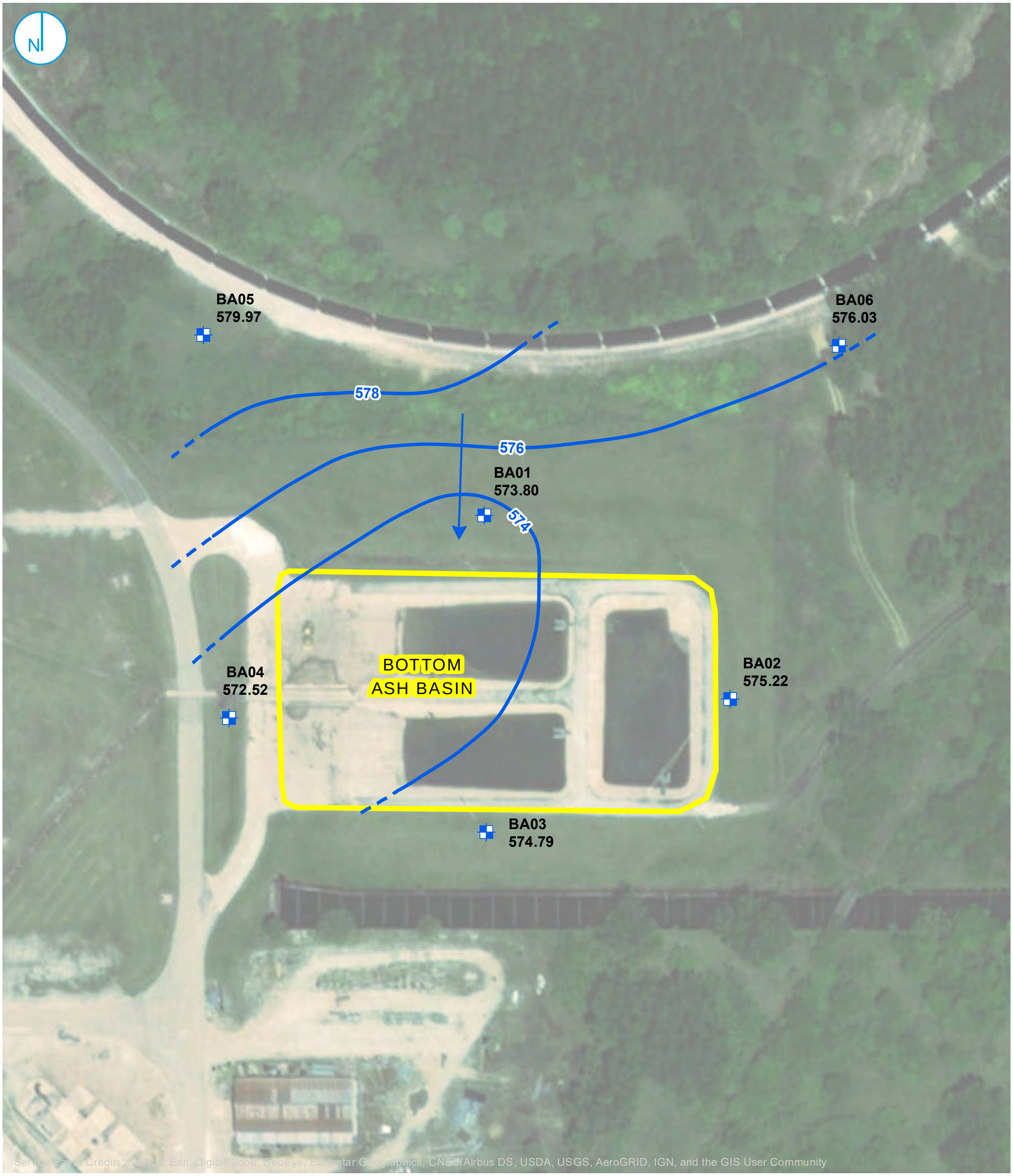
DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
GROUNDWATER ELEVATION CONTOUR MAP
JULY 1, 2019

CCR RULE GROUNDWATER MONITORING
DUCK CREEK POWER STATION
CANTON, ILLINOIS

0 31.25 62.5 125
Feet

N

O'BRIEN & GERE ENGINEERS, INC.



PROJECT: 169000XXXX | DATED: 8/25/2020 | DESIGNER: galarnmc

Y:\Mapping\Projects\22\2285\MXD\GW_Contours\Round_2020_1Q\R2020_1Q_DC_BAB_GW_Contours.mxd

CCR RULE MONITORING WELL

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR MONITORED UNIT

0 62.5 125 Feet

GROUNDWATER ELEVATION CONTOUR MAP

JANUARY 13, 2020

DUCK CREEK BOTTOM ASH BASIN (UNIT ID: 205)
VISTRA ENERGY
DUCK CREEK POWER STATION
CANTON, ILLINOIS

RAMBOLL US CORPORATION
A RAMBOLL COMPANY

TABLE D-1. GROUNDWATER ELEVATION RESULTS

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
BA01	01/25/2016	574.99
BA01	04/18/2016	573.49
BA01	06/28/2016	572.09
BA01	08/09/2016	572.65
BA01	10/17/2016	573.04
BA01	01/09/2017	572.58
BA01	04/02/2017	573.89
BA01	06/26/2017	572.09
BA01	11/07/2017	570.21
BA01	04/13/2018	573.99
BA01	07/02/2018	574.14
BA01	10/03/2018	572.74
BA01	01/07/2019	575.09
BA01	07/01/2019	575.09
BA01	01/13/2020	573.80
BA01	06/09/2020	574.61
BA01	08/06/2020	570.74
BA01	11/19/2020	570.38
BA01	02/19/2021	572.00
BA01	04/14/2021	574.89
BA01	04/28/2021	574.31
BA01	05/10/2021	575.26
BA01	06/01/2021	575.03
BA01	06/10/2021	573.97
BA01	06/21/2021	572.91
BA01	07/12/2021	574.85
BA01	07/26/2021	574.02
BA01	08/05/2021	572.68
BA01C	04/14/2021	574.82
BA01C	04/28/2021	574.26
BA01C	04/29/2021	574.51
BA01C	05/10/2021	575.24
BA01C	05/12/2021	575.09
BA01C	06/01/2021	574.96
BA01C	06/10/2021	573.94
BA01C	06/21/2021	572.89
BA01C	07/12/2021	574.79
BA01C	07/26/2021	574.01
BA01C	08/05/2021	572.62
BA01L	04/14/2021	579.44
BA01L	04/28/2021	577.00
BA01L	04/29/2021	577.21
BA01L	05/10/2021	577.47
BA01L	05/13/2021	578.12
BA01L	06/01/2021	577.92

RAMBOLL

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
BA01L	06/10/2021	576.38
BA01L	06/21/2021	574.68
BA01L	07/12/2021	577.60
BA01L	07/26/2021	576.65
BA01L	08/05/2021	574.73
BA02	01/25/2016	574.12
BA02	04/18/2016	572.88
BA02	06/28/2016	571.67
BA02	08/09/2016	570.87
BA02	10/17/2016	572.18
BA02	01/09/2017	571.72
BA02	04/02/2017	572.69
BA02	06/26/2017	571.41
BA02	11/07/2017	567.81
BA02	04/13/2018	575.15
BA02	07/02/2018	574.93
BA02	10/03/2018	571.64
BA02	01/07/2019	574.97
BA02	07/01/2019	574.87
BA02	01/13/2020	575.22
BA02	08/06/2020	568.92
BA02	11/19/2020	566.13
BA02	02/19/2021	570.53
BA02	04/14/2021	574.38
BA02	04/28/2021	572.97
BA02	05/10/2021	574.46
BA02	06/01/2021	573.72
BA02	06/10/2021	572.51
BA02	06/21/2021	571.28
BA02	07/12/2021	573.64
BA02	07/26/2021	572.55
BA02	08/05/2021	571.20
BA02L	04/14/2021	574.63
BA02L	04/28/2021	573.24
BA02L	05/10/2021	574.75
BA02L	05/12/2021	574.28
BA02L	06/01/2021	573.94
BA02L	06/10/2021	572.77
BA02L	06/14/2021	572.10
BA02L	06/21/2021	571.54
BA02L	07/12/2021	574.21
BA02L	07/26/2021	572.81
BA02L	07/27/2021	572.65
BA02L	08/05/2021	571.42
BA03	01/25/2016	573.02

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
BA03	04/18/2016	571.27
BA03	06/28/2016	570.30
BA03	08/09/2016	570.22
BA03	10/17/2016	570.89
BA03	01/09/2017	570.38
BA03	04/02/2017	571.33
BA03	06/26/2017	570.11
BA03	11/07/2017	569.46
BA03	04/13/2018	574.31
BA03	07/02/2018	573.73
BA03	10/03/2018	570.17
BA03	01/07/2019	573.90
BA03	07/01/2019	574.36
BA03	01/13/2020	574.79
BA03	08/06/2020	568.30
BA03	11/19/2020	570.04
BA03	02/19/2021	570.79
BA03	04/14/2021	574.29
BA03	04/28/2021	572.05
BA03	05/10/2021	574.38
BA03	06/01/2021	572.94
BA03	06/10/2021	570.90
BA03	06/21/2021	570.54
BA03	07/12/2021	574.24
BA03	07/26/2021	571.93
BA03	08/05/2021	570.12
BA03L	04/14/2021	574.20
BA03L	04/28/2021	571.92
BA03L	05/10/2021	574.42
BA03L	05/12/2021	573.89
BA03L	06/01/2021	572.87
BA03L	06/10/2021	570.79
BA03L	06/14/2021	569.81
BA03L	06/21/2021	570.52
BA03L	07/12/2021	574.31
BA03L	07/26/2021	571.92
BA03L	07/27/2021	571.62
BA03L	08/05/2021	569.95
BA04	01/25/2016	574.46
BA04	04/18/2016	572.76
BA04	06/28/2016	572.06
BA04	08/09/2016	572.51
BA04	10/17/2016	572.27
BA04	01/09/2017	571.76
BA04	04/02/2017	572.52

RAMBOLL

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
BA04	06/26/2017	571.05
BA04	11/07/2017	570.56
BA04	04/13/2018	573.02
BA04	07/02/2018	572.86
BA04	10/03/2018	571.19
BA04	01/07/2019	572.82
BA04	07/01/2019	573.19
BA04	01/13/2020	572.52
BA04	08/06/2020	570.70
BA04	11/19/2020	570.37
BA04	02/18/2021	574.46
BA04	02/19/2021	571.35
BA04	04/14/2021	573.94
BA04	04/28/2021	573.52
BA04	05/10/2021	574.42
BA04	06/01/2021	574.28
BA04	06/10/2021	573.30
BA04	06/21/2021	572.39
BA04	07/12/2021	574.38
BA04	07/26/2021	573.63
BA04	08/05/2021	572.38
BA05	10/17/2016	576.57
BA05	12/14/2016	577.06
BA05	01/09/2017	578.93
BA05	03/06/2017	577.26
BA05	04/02/2017	577.90
BA05	06/09/2017	578.91
BA05	06/26/2017	577.77
BA05	11/09/2017	572.22
BA05	04/13/2018	579.85
BA05	04/16/2018	579.85
BA05	07/02/2018	579.12
BA05	10/03/2018	578.25
BA05	01/07/2019	580.47
BA05	07/01/2019	581.26
BA05	01/13/2020	579.97
BA05	08/06/2020	573.78
BA05	11/19/2020	573.47
BA05	02/19/2021	576.56
BA05	04/14/2021	580.32
BA05	04/28/2021	579.05
BA05	05/10/2021	580.53
BA05	05/12/2021	580.50
BA05	06/01/2021	579.53
BA05	06/10/2021	576.85

TABLE D-1. GROUNDWATER ELEVATIONS
HYDROGEOLOGIC SITE CHARACTERIZATION REPORT
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Sample Location	Sample Date	Groundwater Elevation (ft NAVD88)
BA05	06/14/2021	576.76
BA05	06/21/2021	576.22
BA05	07/12/2021	578.96
BA05	07/26/2021	577.38
BA05	08/05/2021	575.53
BA06	10/17/2016	572.70
BA06	12/14/2016	573.53
BA06	01/09/2017	575.37
BA06	03/06/2017	574.97
BA06	04/02/2017	573.47
BA06	06/09/2017	574.33
BA06	06/26/2017	570.43
BA06	11/09/2017	566.83
BA06	04/13/2018	575.66
BA06	04/16/2018	575.66
BA06	07/02/2018	576.04
BA06	10/03/2018	570.90
BA06	01/07/2019	576.22
BA06	07/01/2019	576.33
BA06	01/13/2020	576.03
BA06	06/09/2020	576.29
BA06	08/06/2020	568.82
BA06	11/19/2020	567.78
BA06	02/19/2021	571.04
BA06	04/14/2021	575.98
BA06	04/28/2021	575.54
BA06	05/10/2021	576.13
BA06	05/12/2021	576.25
BA06	06/01/2021	575.88
BA06	06/10/2021	574.58
BA06	06/14/2021	573.26
BA06	06/21/2021	572.53
BA06	07/12/2021	585.29
BA06	07/26/2021	573.29
BA06	08/05/2021	571.40

Notes:
ft NAVD88 = feet relative to the North American Vertical Datum 1988, GEOID 12A

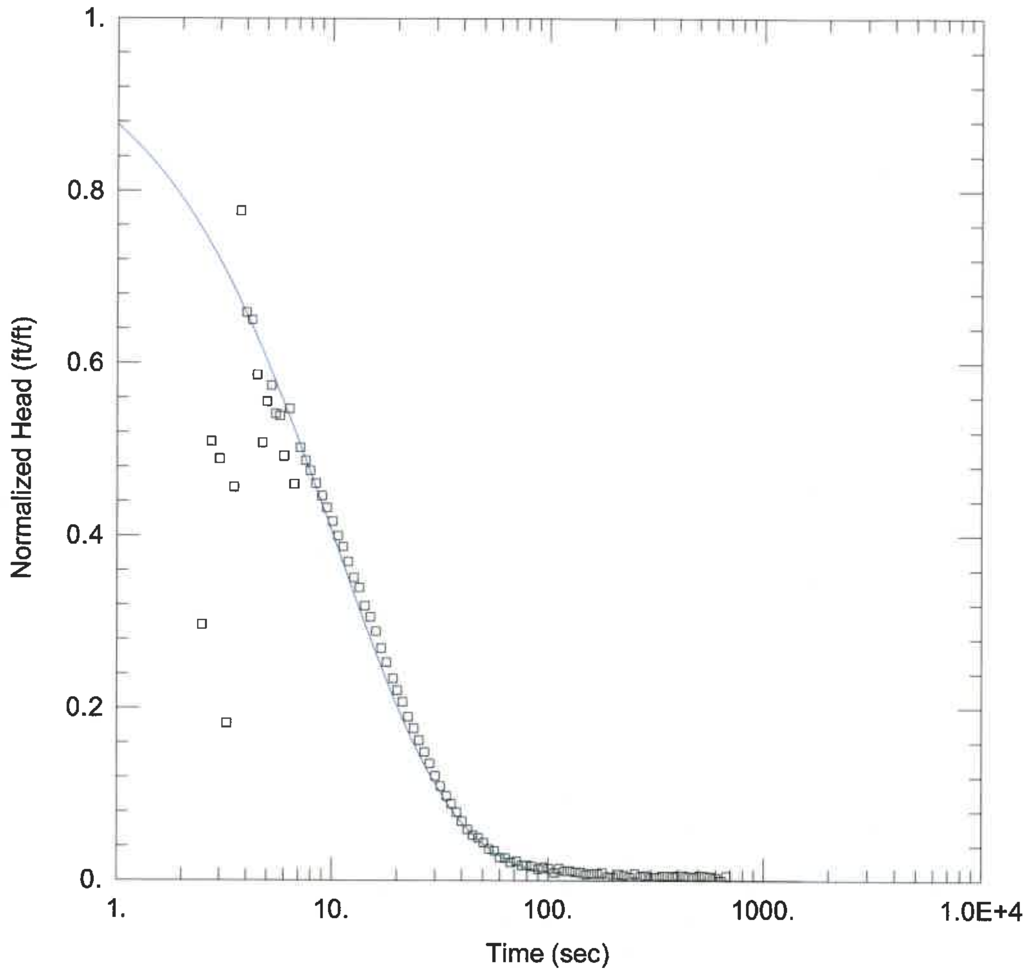
generated 10/05/2021, 4:06:53 PM CDT

RAMBOLL

APPENDIX E
HYDRAULIC CONDUCTIVITY TEST DATA

Slug Test data summary - Duck Creek Bottom Ash Basins

Well ID	Falling Head k (cm/sec)	Specific Storage (1/ft)	FH Solution	Rising Head k (cm/sec)	Specific Storage (1/ft)	RH Solution	Average	Geo. Mean
BA01	1.50E-04	n/a	Hvorslev	*No test results*			1.50E-04	1.50E-04
BA01C	3.90E-03	8.00E-05	KGS Model	3.90E-03	7.00E-05	KGS Model	3.90E-03	3.90E-03
BA01L	3.00E-04	5.00E-04	KGS Model	3.40E-04	1.50E-04	KGS Model	3.20E-04	3.19E-04
BA02L	1.70E-04	8.00E-04	KGS Model	2.30E-04	4.00E-04	KGS Model	2.00E-04	1.98E-04
BA03	6.90E-04	5.00E-06	KGS Model	*No test results*			6.90E-04	6.90E-04
BA03L	1.10E-03	1.10E-03	KGS Model	1.50E-03	5.00E-04	KGS Model	1.30E-03	1.28E-03



BA01C FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA01C-fh.aqt
Date: 06/02/21 Time: 15:58:47

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01C
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 24.08 ft

WELL DATA (BA01C)

Initial Displacement: 2.1 ft
Total Well Penetration Depth: 33.76 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 24.08 ft
Screen Length: 9.45 ft
Well Radius: 0.08333 ft

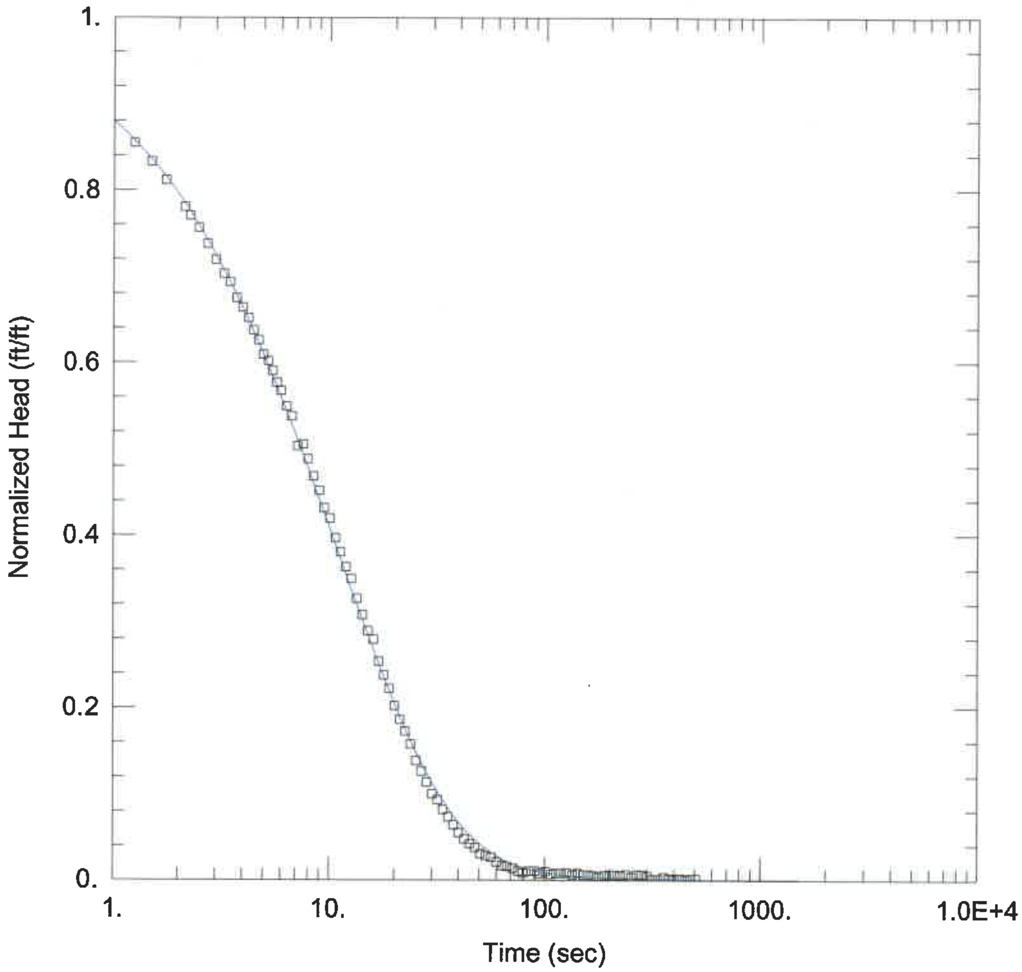
SOLUTION

Aquifer Model: Confined

Solution Method: KGS Model

Kr = 0.0039 cm/sec
Kz/Kr = 1.

Ss = 8.0E-5 ft^{-1}



BA01C RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA01C-rh.aqt
Date: 06/02/21 Time: 15:58:53

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01C
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 24.08 ft

WELL DATA (BA01C)

Initial Displacement: 2. ft
Total Well Penetration Depth: 33.76 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 24.08 ft
Screen Length: 9.45 ft
Well Radius: 0.08333 ft

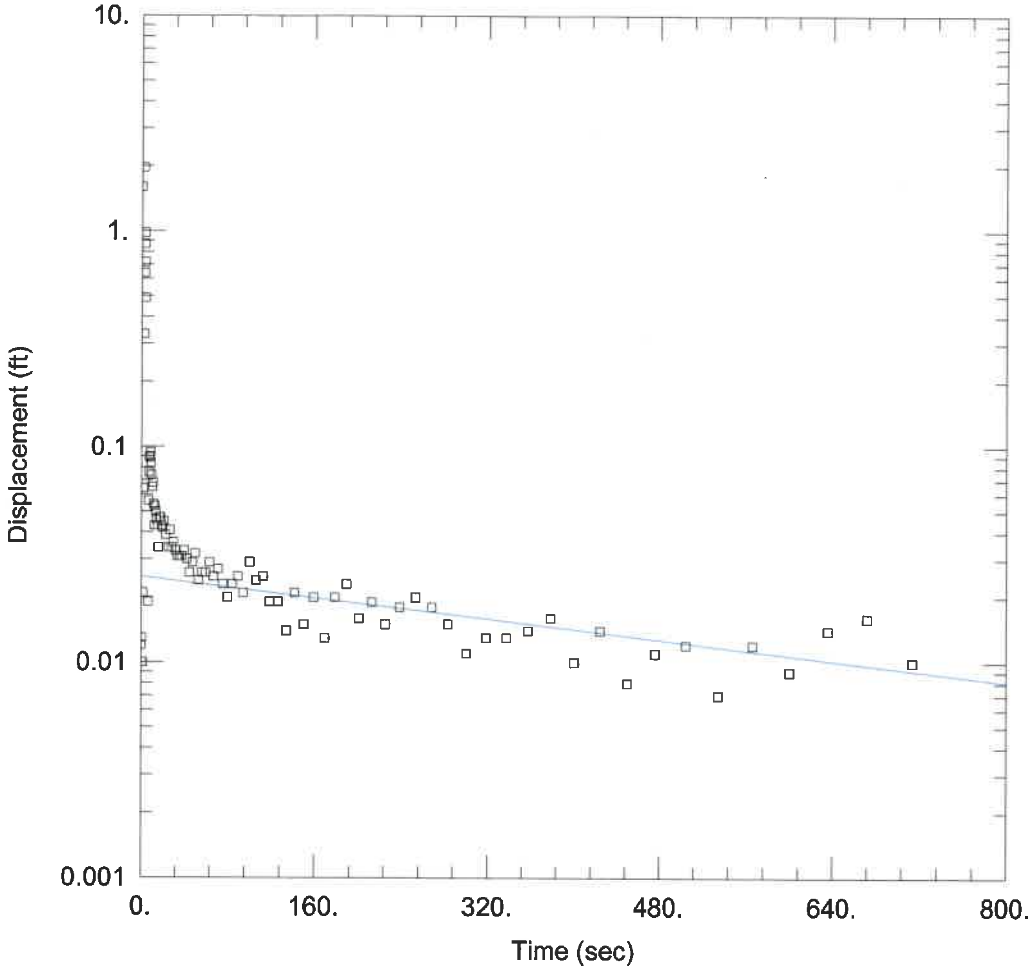
SOLUTION

Aquifer Model: Confined

Kr = 0.0039 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 7.0E-5 ft^{-1}



BA01 FALLING HEAD TEST	
Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA01-fh.aqt	
Date: 06/02/21	Time: 15:58:55

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01
Test Date: 3 March 2021

AQUIFER DATA

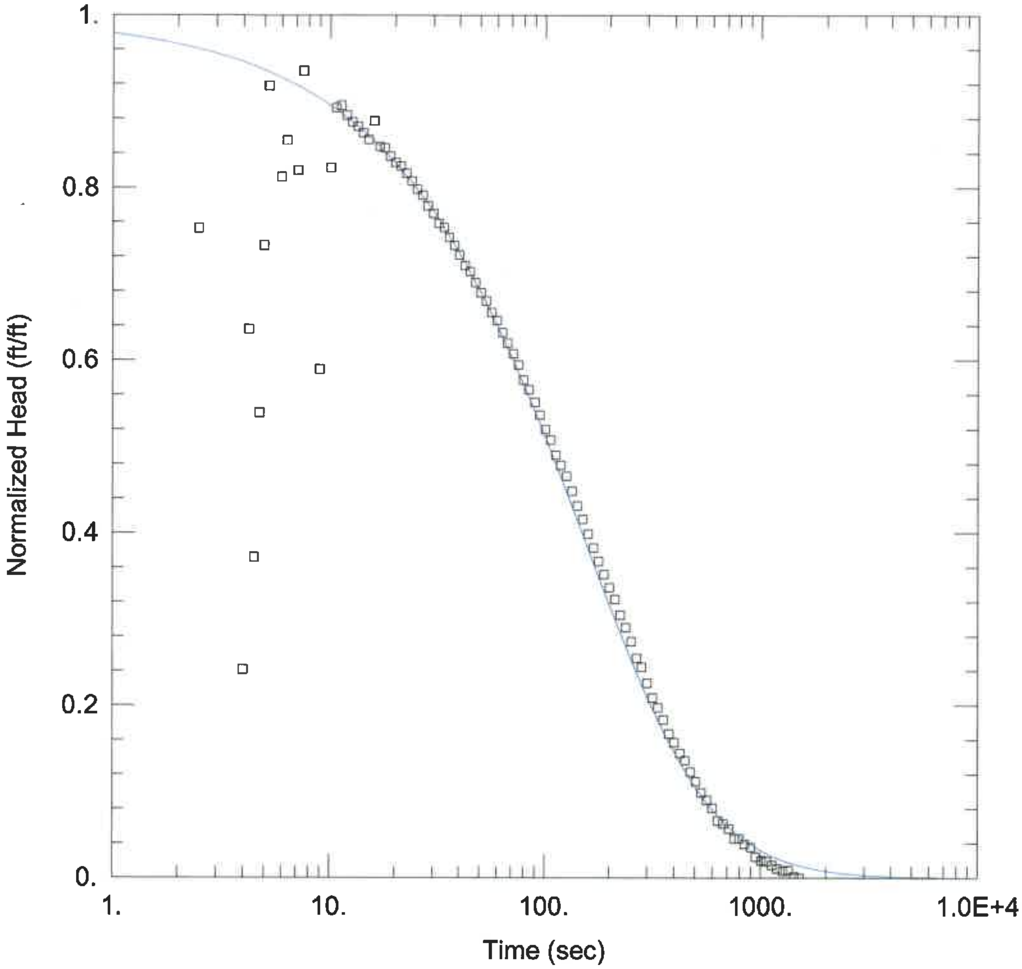
Saturated Thickness: 21.54 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BA01)

Initial Displacement: 1.6 ft
Total Well Penetration Depth: 37.73 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 24.14 ft
Screen Length: 4.67 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 0.00015 cm/sec
y0 = 0.025 ft



BA01L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA01L-fh.aqt
Date: 06/03/21 Time: 11:19:33

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01L
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 11.56 ft

WELL DATA (BA01L)

Initial Displacement: 1.72 ft
Total Well Penetration Depth: 13.35 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 11.56 ft
Screen Length: 9.47 ft
Well Radius: 0.08333 ft

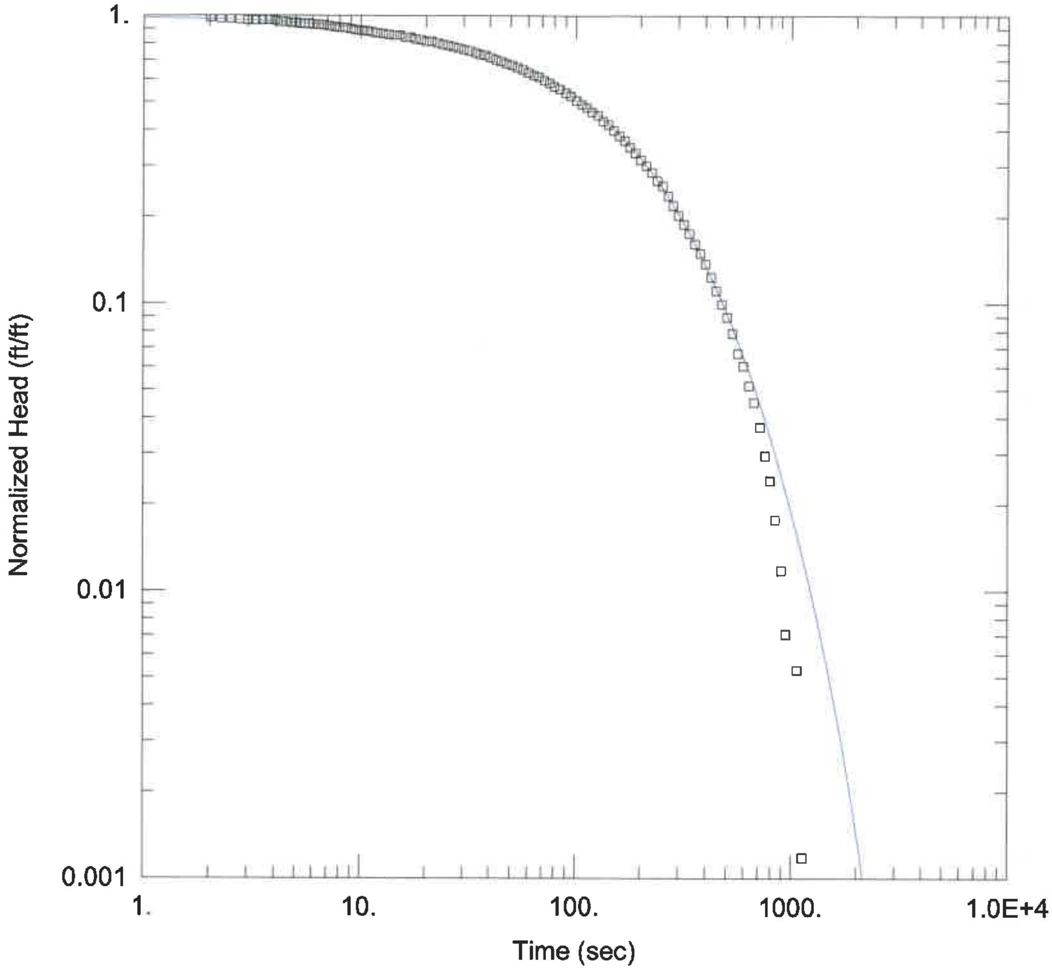
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.0003 cm/sec
Kz/Kr = 1.

Ss = 0.0005 ft^{-1}



BA01L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA01L-rh.aqt
Date: 06/02/21 Time: 15:59:14

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01L
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 11.56 ft

WELL DATA (BA01L)

Initial Displacement: 1.7 ft
Total Well Penetration Depth: 13.35 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 11.56 ft
Screen Length: 9.47 ft
Well Radius: 0.08333 ft

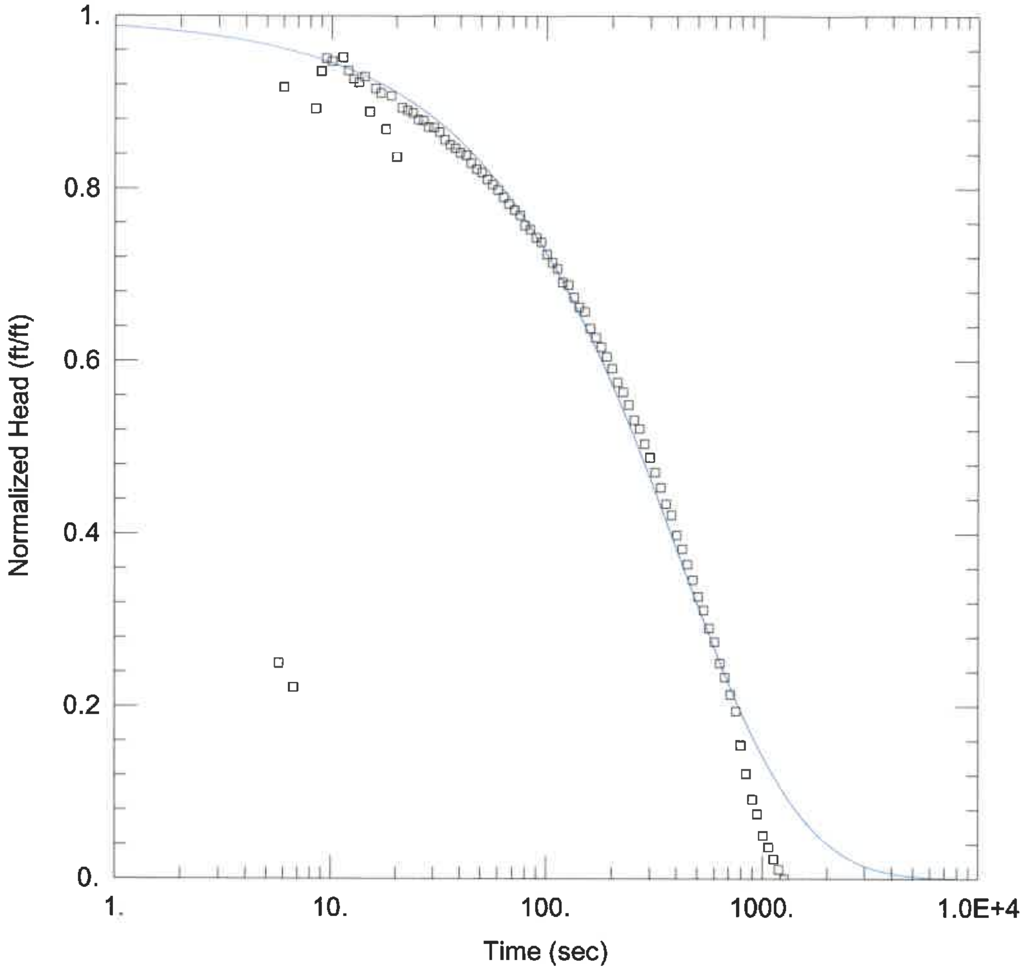
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.00034 cm/sec
Kz/Kr = 1.

Ss = 0.00015 ft^{-1}



BA02L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA02L-fh.aqt
Date: 06/02/21 Time: 15:59:17

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA02L
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 6.16 ft

WELL DATA (BA02L)

Initial Displacement: 1.7 ft
Total Well Penetration Depth: 10.84 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 6.16 ft
Screen Length: 4.68 ft
Well Radius: 0.08333 ft

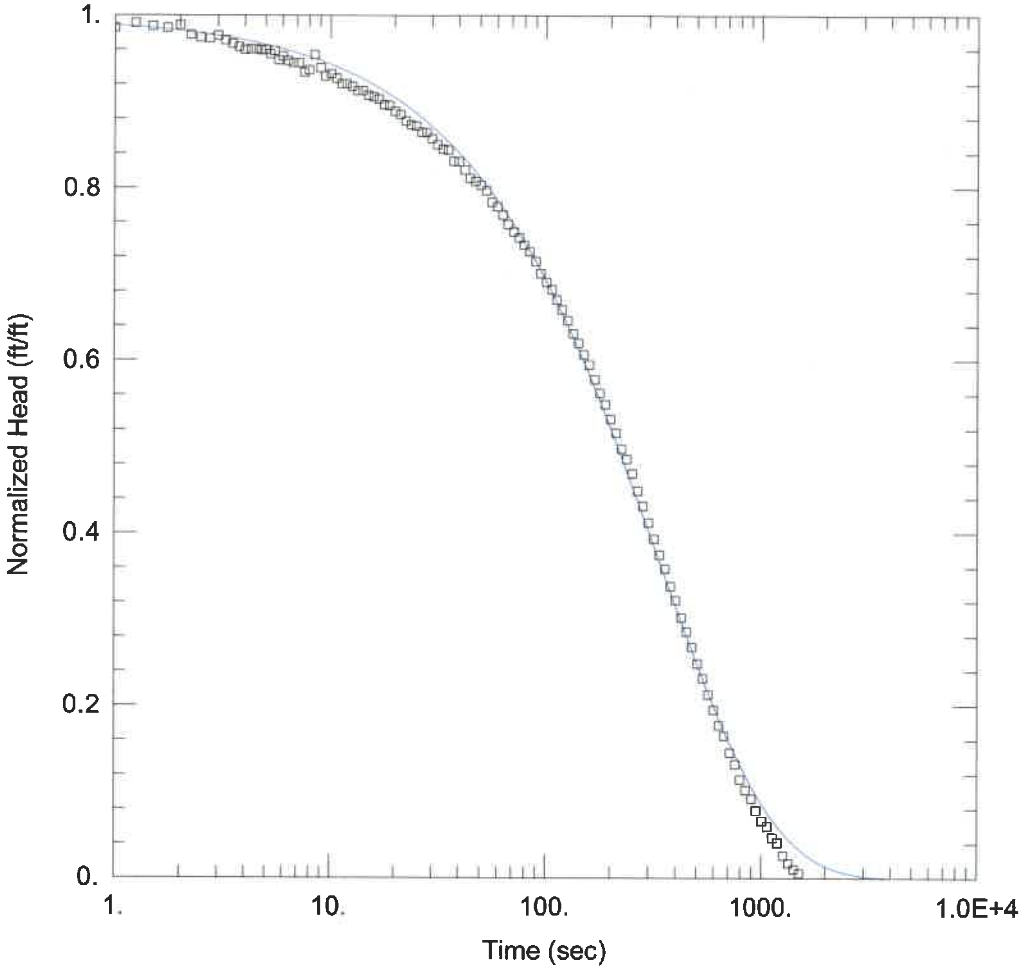
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.00017 cm/sec
Kz/Kr = 1.

Ss = 0.0008 ft^{-1}



BA02L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA02L-rh.aqt
Date: 06/02/21 Time: 15:59:21

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01
Test Date: 1 March 2021

AQUIFER DATA

Saturated Thickness: 6.16 ft

WELL DATA (BA02L)

Initial Displacement: 1.575 ft
Total Well Penetration Depth: 10.84 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 6.16 ft
Screen Length: 4.68 ft
Well Radius: 0.08333 ft

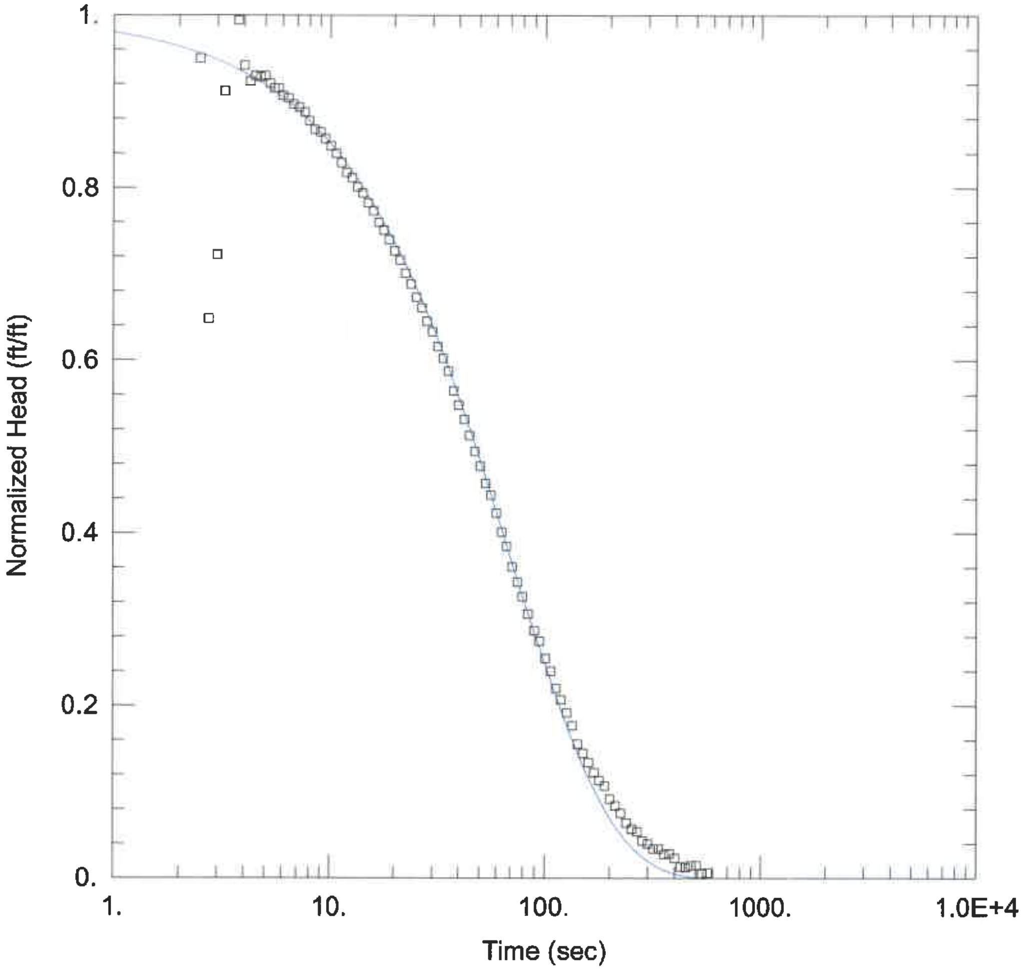
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.00023 cm/sec
Kz/Kr = 1.

Ss = 0.0004 ft^{-1}



BA03 FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA03-fh.aqt
Date: 06/02/21 Time: 15:59:23

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA01
Test Date: 1 March 2021

AQUIFER DATA

Saturated Thickness: 23.25 ft

WELL DATA (BA03)

Initial Displacement: 1.3 ft
Total Well Penetration Depth: 20.15 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 23.25 ft
Screen Length: 9.46 ft
Well Radius: 0.08333 ft

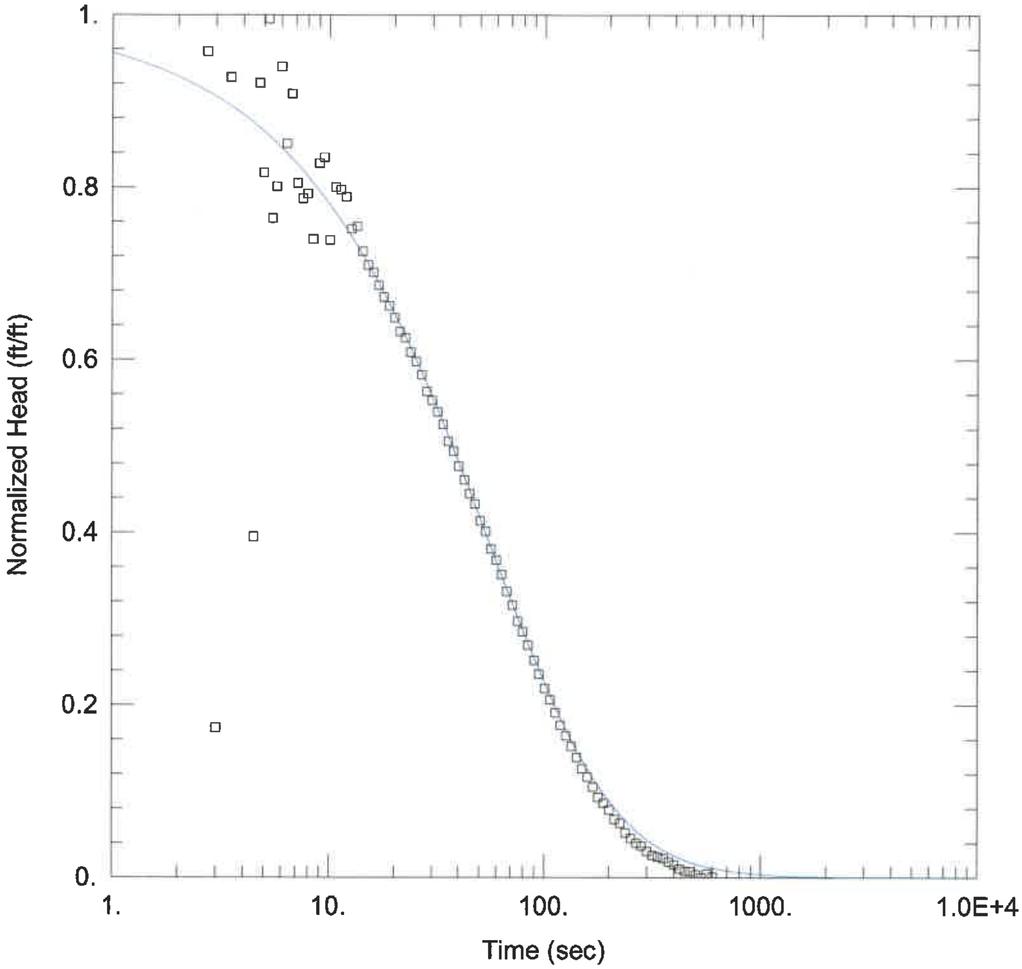
SOLUTION

Aquifer Model: Unconfined

Kr = 0.00069 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 5.0E-6 ft^{-1}



BA03L FALLING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA03L-fh.aqt
Date: 06/02/21 Time: 15:59:24

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA03L
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 7.99 ft

WELL DATA (BA03L)

Initial Displacement: 1.625 ft
Total Well Penetration Depth: 7.64 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 7.99 ft
Screen Length: 4.69 ft
Well Radius: 0.08333 ft

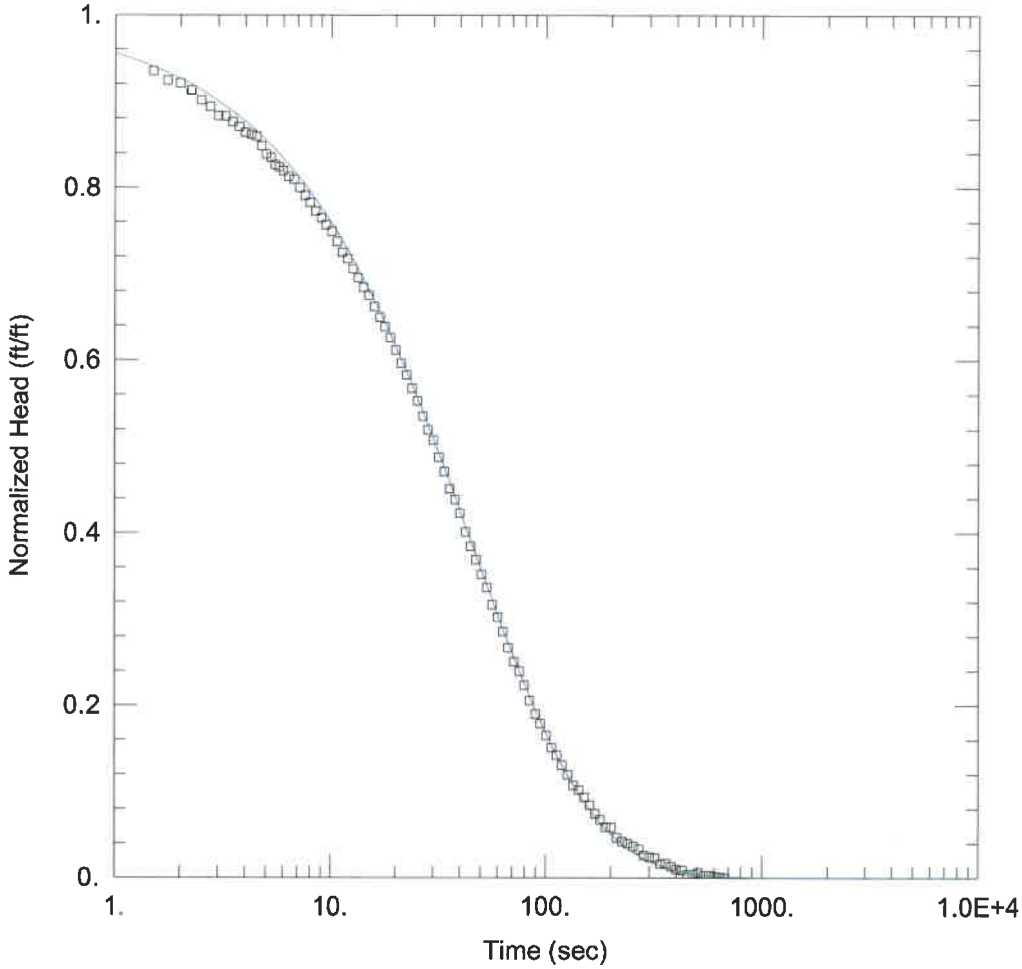
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 0.0011 cm/sec
Kz/Kr = 1.

Ss = 0.0011 ft^{-1}



BA03L RISING HEAD TEST

Data Set: I:\20jobs\20E0111A\Admin\13-Calculations\Slug Tests\Duck Creek\BA03L-rh.aqt
Date: 06/02/21 Time: 15:59:27

PROJECT INFORMATION

Client: Duck Creek Power Station
Project: 20E0111A
Location: Canton, IL
Test Well: BA03L
Test Date: 3 March 2021

AQUIFER DATA

Saturated Thickness: 7.99 ft

WELL DATA (BA03L)

Initial Displacement: 1.8 ft
Total Well Penetration Depth: 7.64 ft
Casing Radius: 0.08333 ft

Static Water Column Height: 7.99 ft
Screen Length: 4.69 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined

Kr = 0.0015 cm/sec
Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.0005 ft^{-1}

APPENDIX F
FEMA FLOOD HAZARD MAP

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or flood plain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or flood plain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

In the State of Illinois, any portion of a stream or watercourse that lies within the **floodway fringe** of a studied (AE) stream may have a state regulated floodway. The FIRM may not depict these state regulated floodways.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the model computed widths listed in the Floodway Data table in the Flood Insurance Study report.

Multiple **topographic sources** may have been used in the delineation of Special Flood Hazard Areas. See Flood Insurance Study report for details on source resolution and geographic extent.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, N/NGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey. Digital orthoimagery with a spatial resolution of 0.5 meter ground sample distance were photogrammetrically compiled from aerial photography acquired during the leaf-off period of spring 2005.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The Special Flood Hazard Areas and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

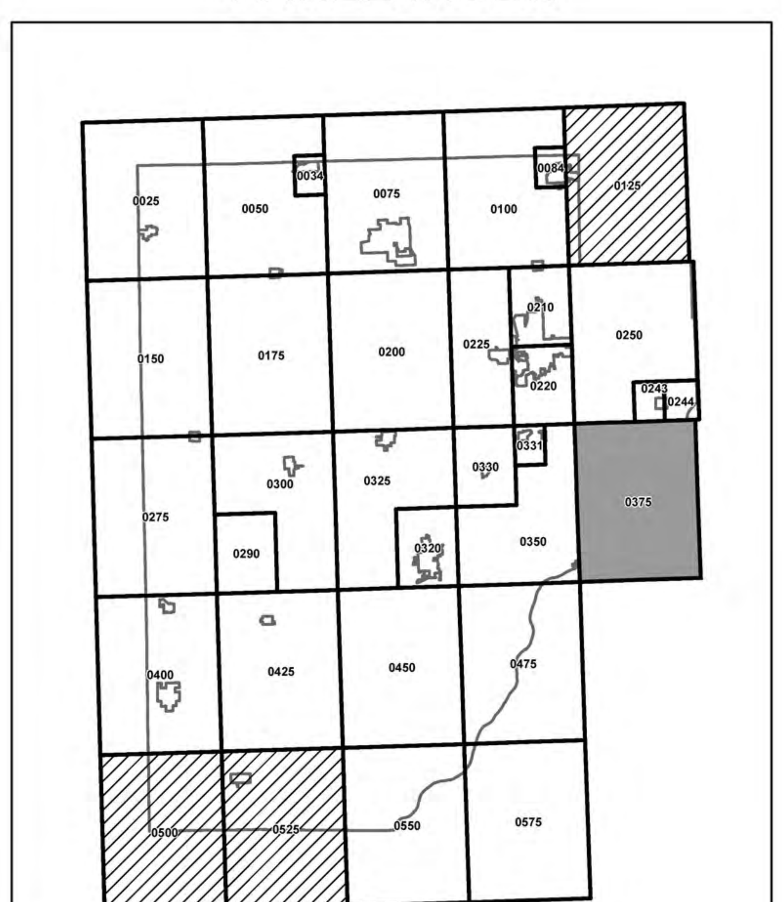
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the Map Service Center (MSC) website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

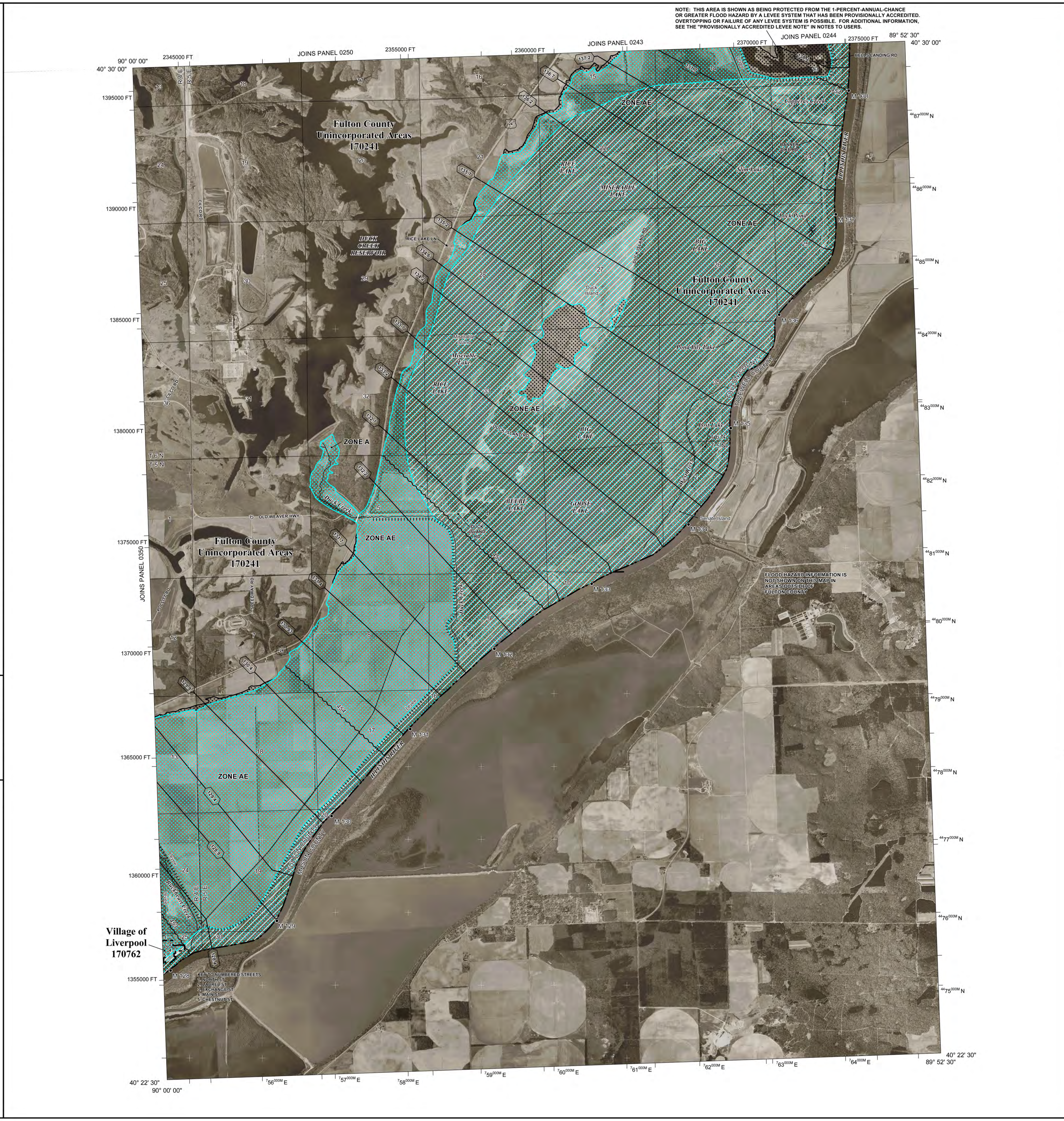
If you have **questions about this map**, how to order products or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

Provisionally Accredited Levee Notes to Users: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations by December 31, 2010. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicate the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA website at http://www.fema.gov/business/nfip/index.shtm.

PANEL INDEX



Panel Not Printed



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A Cross section line
23 - - - 23 Transect line
45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{45}89^{000m}$N 1000-meter Universal Transverse Mercator grid values, zone 15
1565000 FT 5000-foot grid ticks: Illinois State Plane West Coordinate System, 3801 zone (FIPSZONE 1202) Transverse Mercator
DX5510× Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
FEBRUARY 4, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0375E

FIRM
FLOOD INSURANCE RATE MAP
FULTON COUNTY, ILLINOIS
AND INCORPORATED AREAS

PANEL 375 OF 575

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FULTON COUNTY	170241	0375	E
LIVERPOOL, VILLAGE OF	170762	0375	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
17057C0375E

EFFECTIVE DATE
FEBRUARY 4, 2011

Federal Emergency Management Agency

APPENDIX E

Closure Priority Categorization

Phil Morris
Illinois Power Resources Generating
Luminant
1500 Eastport Plaza Drive
Collinsville, IL 62234

May 19, 2021

Mr. Darin LeCrone, P.E.
Manager, Industrial Unit
Bureau of Water, Division of Water Pollution Control, Permits Section
Illinois Environmental Protection Agency
1021 North Grand Avenue, East
Springfield, IL 62794-9276

Re: CCR Surface Impoundment Category Designation and Justification for Illinois Power Resources Generating, LLC

Dear Mr. LeCrone:

Pursuant to 35 I.A.C. 845.700(c), Illinois Power Resources Generating, LLC submits the information necessary to categorize the CCR surface impoundments located at the Edwards Power Plant and the now retired Duck Creek Power Plant. The following parameters were used in assessing and justifying each assigned category.

- Category 1 – *Impacts to existing potable water supply well or impacts to groundwater quality within the setback of an existing potable water supply well.*
    - This review includes an assessment of potable water wells within 2,500 feet of CCR surface impoundments to determine whether any potential impacts are occurring within the setback zone of any community water supply well established under the Illinois Groundwater Protection Act.
    - This information was developed during the Part 845 rulemaking and is summarized in Attachment 1, Table 2: Impacts to Potable Water Supply.
- Category 2 – *Imminent threat to human health or the environment or have been designated by IEPA under (g)(5)*
    - The surface impoundments at Edwards and Duck Creek Power Plants do not pose an imminent threat to human health or the environment. There are no known conditions at or around the facility where someone or something may be exposed to contaminant concentrations reasonably expected to cause harm
- Category 3 – *Located in areas of environmental justice ("EJ") concern*
    - EJ areas were evaluated using the EJ mapping link from IEPA's webpage located at https://www2.illinois.gov/epa/topics/environmental-justice. Per the IEPA mapping tool, the EJ Status thresholds were determined as twice the state averages for Minority and Low Income consistent with 35 IAC 845.700(g)(6).
    - An EJ map denoting the facilities with impoundments is located in Attachment 2.

- Category 4-7
  - Category 4 - Inactive CCR surface impoundments that have an exceedance of the groundwater protection standards in Section 845.600
  - Category 5 - Existing CCR surface impoundments that have exceedances of the groundwater protection standards in Section 845.600
  - Category 6 - Inactive CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600.
  - Category 7 – Existing CCR surface impoundments that are in compliance with the groundwater protection standards in Section 845.600

Based on the information above, category designations have been assigned. The category designations for each CCR impoundment are shown in Attachment 1, Table 1: Category Designations.

If you have any questions regarding this submittal, please contact Phil Morris at 618-343-7794 or phil.morris@vistracorp.com.

Sincerely,

Phil Morris
Senior Environmental Director

Attachments

Attachment 1

Table 1: Category Designation

Facility	Pond Description	Classifications	Potable Water Supply Impacts (Category 1)	Human Health or Environment Threat (Category 2)	Located within Environmental Justice Areas[1] (Category 3)	Standards Exceedances[2] (Categories 4,5,6,7)	Impoundment Category 845.700(g)
Edwards	Ash Pond 1	Existing	No	No	No	Yes	5
Duck Creek	Bottom Ash Basin	Inactive	No	No	Yes	NA[3]	3
	GMF Pond	Inactive	No	No	Yes	NA[3]	3
	GMF Recycle Pond	Inactive	No	No	Yes	NA[3]	3

[1] See Attachment 2 Environmental Justice Area Map

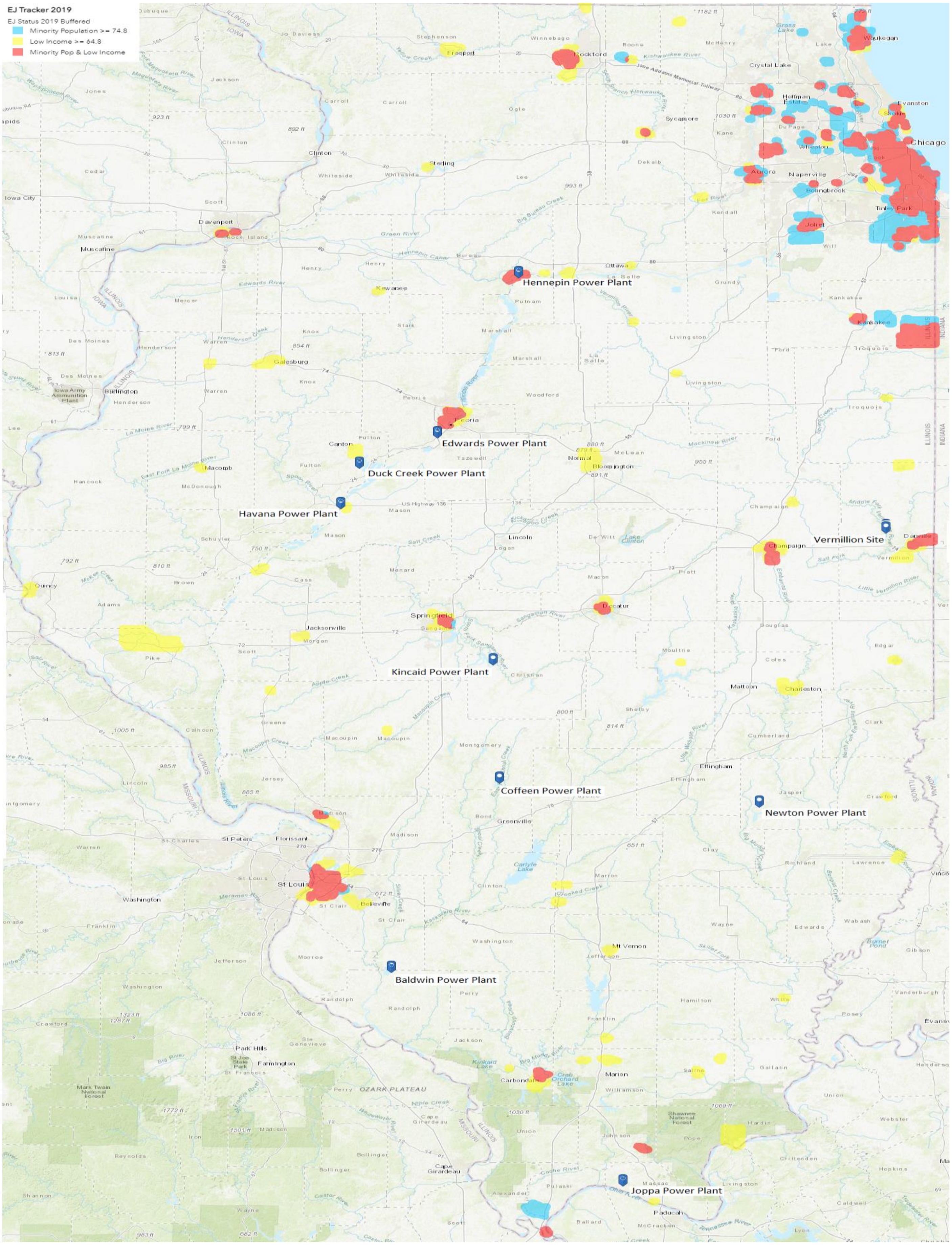
[2] Ground water analyses for purposes of categories 4-7, assumptions have been made based on current groundwater data. However, since sampling and analysis is ongoing and subject to IEPA review and approval, IPGC reserves the right to update its category designations for Categories 4-7.

[3] NA for this determination since the CCR surface impoundment was assign a highest priority category

Table 2: Impacts to Potable Water Supply

Site Name	Private and Semi-Private Wells	Non-Community Water Supply (CWS) Wells	Non-CWS Surface Water Intakes	Community Water Supply Wells	CWS Surface Water Intakes
Edwards	**Present, but not at risk** Seven (7) water wells were identified and one (or possibly two) are located potentially downgradient of the site. Based on Ramboll's review of groundwater data, these wells are unlikely to be impacted by coal ash constituents.	**Present, but not at risk** One non-CWS well was identified; however, it is unlikely to be at risk because of its hydrogeologic location relative to the power plant.	Absent	Absent	Absent
Duck Creek	**Present, but not at risk** Three (3) water wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant and/or they are abandoned. None of the off-site wells are located in a downgradient direction.	Absent	Absent	Absent	Absent

Attachment 2: EJ Mapping Denoting Facilities with Impoundments



APPENDIX F

Final Closure Plan

GOLDER
MEMBER OF WSP

APPENDIX F

Final Closure Plan for the Bottom Ash Basin

Duck Creek Power Plant

Submitted to:

Illinois Environmental Protection Agency

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Submitted by:

Illinois Power Resources Generating, LLC

1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Prepared by:

Golder Associates USA Inc.
701 Emerson Road, Suite 250
Creve Coeur, Missouri 63141

21454861-12-R-1

January 25, 2022

Table of Contents

1.0 INTRODUCTION 1

1.1 Selected Closure Method 1

2.0 FINAL CLOSURE PLAN 1

2.1 Narrative Closure Description 1

2.2 Decontamination of CCR Surface Impoundment 1

2.3 Final Cover System Performance Standards 2

2.4 Maximum CCR Inventory Estimate 2

2.5 Largest Surface Area Estimate 2

2.6 Closure Completion Schedule 2

3.0 AMENDMENT OF THE FINAL CLOSURE PLAN 3

4.0 CLOSURE BY REMOVAL 3

4.1 Groundwater Monitoring and Corrective Action 3

4.2 CCR Handling and Transport 4

4.3 Dust Controls 4

4.4 Public Notices 5

4.5 Contamination Preventions 5

4.6 Reporting 6

4.6.1 Monthly Construction Reports 6

4.6.2 Completion of CCR Removal and Decontamination Report 6

4.6.3 Groundwater Monitoring Report 6

TABLES

Table 1: Closure Completion Milestone Schedule 3

ATTACHMENTS

Attachment 1
Closure Alternatives Analysis

Attachment 2
Drawings

Attachment 3
Hydrologic Calculations

1.0 INTRODUCTION

This Final Closure Plan has been prepared to address certain requirements of Illinois Administrative Code Title 35, Part 845, Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (Part 845) for Illinois Power Resources Generating, LLC's (IPRG's) Bottom Ash Basin (BAB) at the Duck Creek Power Plant near Canton, Illinois. Specifically, this document addresses requirements pertaining to the development of a Final Closure Plan for the BAB. The BAB has an IEPA ID Number of W0578010001-03.

1.1 Selected Closure Method

Part 845.720 (b)(3): The final closure plan must identify the proposed selected closure method, and must include the information required in subsection (a)(1) and the closure alternatives analysis specified in Section 845.710.

IPRG evaluated closure with a final cover system (Part 845.750) and closure by removal of CCR (Part 845.740). An analysis of these closure alternatives is summarized in Attachment 1. Based on the Closure Alternatives Analysis, closure by removal of CCR has been identified as the most appropriate closure method.

2.0 FINAL CLOSURE PLAN

2.1 Narrative Closure Description

Part 845.720(a)(1)(A): A narrative description of how the CCR surface impoundment will be closed in accordance with this Part.

The closure approach and details are shown in the Drawings included as Attachment 2. The facility will be closed as described below:

- Any nominal amount of CCR that remains in the BAB will be hauled to the existing permitted on-site landfill and disposed.
- The concrete, compacted clay, and geomembrane components of the existing liner system will be removed as required under 845.740(a). These materials, along with any subsoils excavated, will be disposed in the existing permitted on-site landfill, which has adequate capacity to accept these materials.
- Fill will be placed and compacted to reach final elevations designed with minimum 2% slopes to promote positive site drainage. Hydrologic calculations for the closure condition are provided in Attachment 3. Based on a review of the materials available on site, the fill needed to reach final closure grades is anticipated to consist of low-plasticity silts. To limit the potential for settlement, the fill will be compacted to a minimum of 95% of the standard Proctor maximum dry density, except that the uppermost six inches will be tracked in place to achieve a density suitable for establishment of vegetation.
- The closed facility will be seeded to promote long-term vegetation.

2.2 Decontamination of CCR Surface Impoundment

Part 845.720(a)(1)(B): If closure of the CCR surface impoundment will be accomplished through removal of CCR from the CCR surface impoundment, a description of the procedures to remove the CCR and decontaminate the CCR surface impoundment in accordance with Section 845.740.

The existing liner system will be removed and disposed in the existing permitted on-site landfill. Up to 1 foot of subsoil will be removed beneath the existing liner system, and removal of CCR will be visually confirmed. If subsoils containing CCR are observed, they will be removed and disposed.

2.3 Final Cover System Performance Standards

Part 845.720(a)(1)(C): If closure of the CCR surface impoundment will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with Section 845.750, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in Section 845.750.

Because the BAB will be closed by removal of CCR, Section 845.720(a)(1)(C) is not applicable.

2.4 Maximum CCR Inventory Estimate

Part 845.720(a)(1)(D): An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR surface impoundment.

In the Final Closure Plan developed for compliance with the United States Environmental Protection Agency's (USEPA's) CCR Rule (40 CFR 257, Subpart D), the maximum inventory of CCR at the BAB over the facility's active life was approximately 25,000 cubic yards (cy). No appreciable CCR is present in the BAB, and no additional CCR will be placed in the BAB before it is closed.

2.5 Largest Surface Area Estimate

Part 845.720(a)(1)(E): An estimate of the largest area of the CCR surface impoundment ever requiring a final cover (see Section 845.750), at any time during the CCR surface impoundment's active life.

Based on the current lined footprint of the BAB, the maximum area that could have required a final cover system is approximately 2 acres. However, no CCR is present in the BAB and the facility will be closed by removal of CCR and will not require a final cover system.

2.6 Closure Completion Schedule

Part 845.720(a)(1)(E): A schedule for completing all activities necessary to satisfy the closure criteria in this Section, including an estimate of the year in which all closure activities for the CCR surface impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR surface impoundment, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR surface impoundment closure. When preparing the preliminary written closure plan, if the owner or operator of a CCR surface impoundment estimates that the time required to complete closure will exceed the timeframes specified in Section 845.760(a), the preliminary written closure plan must include the site-specific information, factors and considerations that would support any time extension sought under Section 845.760(b).

Table 1: Closure Completion Milestone Schedule

Milestone	Timeframe (All Preliminary Estimates)
Final Closure Plan Submittal	February 2022
Final Design and Bid Process	6 to 12 months after Final Closure Plan approval
Agency Coordination and Permit Acquisition ▪ State permits for dewatering/water treatment (NPDES), land disturbance, and dam modification	
Remove Liner System ▪ No appreciable amount of CCR is currently present in the BAB ▪ Remove concrete, compacted clay, and geomembrane and dispose of materials in the existing permitted on-site landfill	3 to 6 months after issuance of necessary permits, design completion, and bid award
Site Restoration ▪ Place fill to promote site drainage ▪ Seed and mulch	3 to 6 months after liner system removal
Timeframe to Complete Closure	Prior to April 2026

3.0 AMENDMENT OF THE FINAL CLOSURE PLAN

Part 845.720(b)(4): If a final written closure plan revision is necessary after closure activities have started for a CCR surface impoundment, the owner or operator must submit a request to modify the construction permit within 60 days following the triggering event.

IPRG will submit a written request to modify the construction permit within 60 days of a triggering event.

4.0 CLOSURE BY REMOVAL

4.1 Groundwater Monitoring and Corrective Action

Part 845.740(a): An owner or operator may elect to close a CCR surface impoundment by removing all CCR and decontaminating all areas affected by releases of CCR from the CCR surface impoundment. CCR removal and decontamination of the CCR surface impoundment are complete when all CCR and CCR residues, containment system components such as the impoundment liner and contaminated subsoils, and CCR impoundment structures and ancillary equipment have been removed. Closure by removal must be completed before the completion of a groundwater corrective action under Subpart F.

Part 845.740(b): After closure by removal has been completed, the owner or operator must continue groundwater monitoring under Subpart F for three years after the completion of closure or for three years after groundwater monitoring does not show an exceedance of the groundwater protection standard established under Section 845.600, whichever is longer.

Groundwater quality monitoring to date has not identified impacts from the BAB. Plans for post-closure groundwater monitoring are provided in Appendix H to the Part 845 Construction Permit Application for the BAB.

4.2 CCR Handling and Transport

Part 845.740(c)(1)(A): Manifests

- *i) When transporting CCR off-site by motor vehicle, manifests must be carried as specified in 35 Ill. Adm. Code 809. For purposes of this Part, coal combustion fly ash that is removed from a CCR surface impoundment is not exempt from the manifest requirement.*
- *ii) When transporting CCR off-site by any other mode or method, including trains or barges, manifests must be carried specifying, at a minimum, the following information: the volume of the CCR; the location from which the CCR was loaded onto the mode of transportation and the date the loading took place; and the location where the CCR is being taken and the date it will be delivered.*

Part 845.740(c)(1)(B): The owner or operator of a CCR surface impoundment from which CCR is removed and transported off-site must develop a CCR transportation plan, which must include:

- *i) Identification of the transportation method selected, including whether a combination of transportation methods will be used;*
- *ii) The frequency, time of day, and routes of CCR transportation;*
- *iii) Any measures to minimize noise, traffic, and safety concerns caused by the transportation of the CCR;*
- *iv) Measures to limit fugitive dust from any transportation of CCR;*
- *iv) Installation and use of a vehicle washing station;*
- *v) A means of covering the CCR for any mode of CCR transportation, including conveyor belts; and*
- *vi) A requirement that, for transport by motor vehicle, the CCR is transported by a permitted special waste hauler under 35 Ill. Adm. Code 809.201.*

No appreciable amount of CCR is currently present in the BAB. Liner system components will be disposed in the existing permitted on-site landfill. Because no CCR will be disposed off site, the requirements of Section 845.740(c)(1)(A) and Section 845.740(c)(1)(B) are not applicable.

4.3 Dust Controls

Part 845.740(c)(2): The owner or operator of a CCR surface impoundment must develop and implement onsite 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) Handling of CCR to minimize airborne particulates and offsite particulate movement during any weather event or condition.*

While no appreciable amount of CCR remains in the BAB, dust controls (water spray) will be in place for the removal of the existing liner system and placement of fill to reach final closure grades, including transport on access roads, in accordance with the site's fugitive dust control plan.

4.4 Public Notices

Part 845.740(c)(3): The owner or operator of a CCR surface impoundment 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.*

Although no appreciable amount of CCR remains in the BAB and the BAB is more than ½ mile from the security gate, signage will be posted at the property entrance to warn of the hazards of CCR dust inhalation. No CCR will be transported off site, so the requirements of Section 845.740(c)(3)(B) are not applicable.

4.5 Contamination Preventions

Part 845.740(c)(4): The owner or operator of the surface impoundment must take measures to prevent contamination of surface water, groundwater, soil and sediments from the removal of CCR, including the following:

- *A) CCR removed from the surface impoundment may only be temporarily stored, and must be stored in a lined landfill, CCR surface impoundment, enclosed structure, or CCR storage pile.*
- *B) CCR storage piles must:*
  - *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 a storage pad, or a geomembrane liner, with a hydraulic conductivity no greater than 1 x 10^{-7} cm/sec, 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; and*
  - *vi) Have a groundwater monitoring system that is consistent with the requirements of Section 845.630 and approved by the Agency.*
- *C) The owner or operator of the CCR surface impoundment must 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 owner or operator of the CCR must minimize the amount of time the CCR is exposed to precipitation and wind.*
- *E) The discharge of stormwater runoff that has contact with CCR must be covered by an individual National Pollutant Discharge Elimination System (NPDES) permit. The owner or operator must develop and implement a Stormwater Pollution Prevention Plan (SWPPP) in addition to any other requirements of the facility's NPDES permit. Any construction permit application for closure must include a copy of the SWPPP.*

Because no appreciable amount of CCR remains in the BAB, the requirements of Section 845.740(c)(4)(A) through Section 845.740(c)(4)(D) are generally not applicable. A SWPPP will be developed and best management practices (BMPs) will be implemented as part of the closure construction. General housekeeping procedures will be followed during removal of liner system components and fill placement.

4.6 Reporting

4.6.1 Monthly Construction Reports

Part 845.740(d): At the end of each month during which CCR is being removed from a CCR surface impoundment, the owner or operator must prepare a report that:

1) *Describes the weather, precipitation amounts, the amount of CCR removed from the CCR surface impoundment, the amount and location of CCR being stored on-site, the amount of CCR transported offsite, the implementation of good housekeeping procedures required by subsection (c)(4)(C), and the implementation of dust control measures; and*

2) *Documents worker safety measures implemented. The owner or operator of the CCR surface impoundment must place the monthly report in the facility's operating record as required by Section 845.800(d)(23).*

Because no appreciable amount of CCR remains in the BAB, the requirements of Section 845.740(d) are not applicable. Nevertheless, the housekeeping procedures, dust control measures, and worker safety measures will be documented in the facility’s operating record.

4.6.2 Completion of CCR Removal and Decontamination Report

Part 845.740(e): Upon completion of CCR removal and decontamination of the CCR surface impoundment under subsection (a), the owner or operator of the CCR surface impoundment must submit to the Agency a completion of CCR removal and decontamination report and a certification from a qualified professional engineer that CCR removal and decontamination of the CCR surface impoundment has been completed in accordance with this Section. The owner or operator must place the CCR removal and decontamination report and certification in the facility's operating record as required by Section 845.800(d)(32).

IPRG will submit a completion of CCR removal and decontamination report in accordance with Section 845.800(d)(32) after completion of the liner system removal and closure grading. The report will be certified by a qualified professional engineer.

4.6.3 Groundwater Monitoring Report

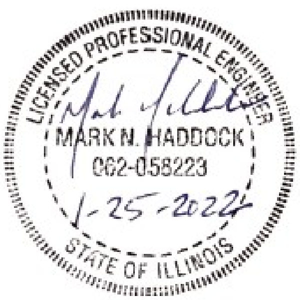
Part 845.740(e): Upon completion of groundwater monitoring required under subsection (b), the owner or operator of the CCR surface impoundment must submit to the Agency a completion of groundwater monitoring report and a certification from a qualified professional engineer that groundwater monitoring has been completed in accordance with this Section. The owner or operator must place the groundwater monitoring report and certification in the facility's operating record as required by Section 845.800(d)(24).

IPRG will submit a groundwater monitoring report in accordance with Part 845.800(d)(24) after completion of the groundwater monitoring required under Section 845.740(b). The report will be certified by a qualified professional engineer.

Signature Page

Golder Associates USA Inc.

I, Mark Haddock, being a registered professional engineer in good standing in the State of Illinois, certify to the best of my knowledge that this Final Closure Plan meets the requirements of Illinois Administrative Code Title 35, Part 845.



Mark Haddock, PE
Principal

MH/JO/af

Golder and the G logo are trademarks of Golder Associates Corporation

https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/12-r-closure_plan_bottom_ash_basin/12-r-1/21454861-12-r-1-closure_plan_bottom_ash_basin_25jan22.docx

ATTACHMENT 1

Closure Alternatives Analysis

Closure Alternatives Analysis
Duck Creek Power Plant
Gypsum Management Facility (GMF) and Bottom Ash Basin (BAB)
Canton, Illinois

January 28, 2022

GRADIENT

www.gradientcorp.com
One Beacon Street, 17th Floor
Boston, MA 02108
617-395-5000

Table of Contents <u>*Page*</u>

Summary of Findings S-1

1 Introduction 1
1.1 Site Description and History 1
1.1.1 Site Location and History 1
1.1.2 CCR Impoundments 1
1.1.3 Surface Water Hydrology 2
1.1.4 Hydrogeology 2
1.1.4.1 GMF 2
1.1.4.2 BAB 3
1.1.5 Site Vicinity 4
1.2 Part 845 Regulatory Review and Requirements 4

2 Closure Alternatives Analysis – GMF 5
2.1 Closure Alternative Descriptions (IAC Section 845.710(c)) 5
2.1.1 Closure-in-Place 5
2.1.2 Closure-by-Removal with On-Site Disposal 7
2.1.3 Closure-by-Removal with Off-Site Disposal 9
2.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1)) 11
2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A)) 11
2.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B)) 11
2.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C)) 12
2.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D)) 13
2.2.4.1 Worker Risks 13
2.2.4.2 Community Risks 15
2.2.4.3 Environmental Risks 19
2.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3)) 20
2.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F)) 21
2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G)) 21

2.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H)) 21
2.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))....................22
2.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))....................22
2.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))....................22
2.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))....................22
2.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative....................22
2.4.2 Expected Operational Reliability of the Closure Alternative....................23
2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies....................23
2.4.4 Availability of Necessary Equipment and Specialists 24
2.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services 24
2.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))....................25
2.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))....................25
2.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1)) 26
2.8 Summary....................26

3 Closure Alternatives Analysis – BAB 27
3.1 Closure Alternative Descriptions (IAC Section 845.710(c))....................27
3.1.1 Closure-by-Removal with On-Site Disposal 27
3.1.2 Closure-by-Removal with Off-Site Disposal....................28
3.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1))....................30
3.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))....................30
3.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))....................30
3.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C)) 30
3.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D)) 31
3.2.4.1 Worker Risks....................31
3.2.4.2 Community Risks 32
3.2.4.3 Environmental Risks 36
3.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))....................37

3.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F)) 37
3.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G)) 37
3.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H)) 38
3.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2)) 38
3.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A)) 38
3.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B)) 38
3.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3)) 38
3.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative 38
3.4.2 Expected Operational Reliability of the Closure Alternative 39
3.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies 39
3.4.4 Availability of Necessary Equipment and Specialists 39
3.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services 39
3.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4)) 39
3.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4)) 40
3.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1)) 40
3.8 Summary 41

References 42

Appendix A Human Health and Ecological Risk Assessment
Appendix B Supporting Information

List of Tables

Table S.1	Comparison of Proposed Closure Scenarios for the GMF
Table S.2	Comparison of Proposed Closure Scenarios for the BAB
Table 2.1	Key Parameters for the Closure-in-Place Scenario – GMF
Table 2.2	Key Parameters for the Closure-by-Removal with On-Site Disposal Scenario – GMF
Table 2.3	Key Parameters for the Closure-by-Removal with Off-Site Disposal Scenario – GMF
Table 2.4	Expected Number of On-Site Worker Accidents Under Each Closure Scenario – GMF
Table 2.5	Expected Number of Off-Site Worker Accidents Due to Hauling Under Each Closure Scenario – GMF
Table 2.6	Expected Number of Community Accidents Due to Hauling Under Each Closure Scenario – GMF
Table 2.7	Expected Costs of Closure – GMF
Table 3.1	Key Parameters for the Closure-by-Removal with On-Site Disposal Scenario – BAB
Table 3.2	Key Parameters for the Closure-by-Removal with Off-Site Disposal Scenario – BAB
Table 3.3	Expected Number of On-Site Worker Accidents Under Each Closure Scenario – BAB
Table 3.4	Expected Number of Off-Site Worker Accidents Due to Hauling Under Each Closure Scenario – BAB
Table 3.5	Expected Number of Community Accidents Due to Hauling Under Each Closure Scenario – BAB
Table 3.6	Expected Costs of Closure – BAB

List of Figures

Figure 1.1	Site Location Map
Figure 2.1	Environmental Justice Communities in the Vicinity of Site Features and the Off-Site Landfill – GMF
Figure 3.1	Environmental Justice Communities in the Vicinity of Site Features and the Off-Site Landfill – BAB

Abbreviations

AACE	Association for the Advancement of Cost Engineering
BAB	Bottom Ash Basin
bgs	Below Ground Surface
BMP	Best Management Practice
CAA	Closure Alternatives Analysis
CBR	Closure-by-Removal
CBR-Offsite	Closure-by-Removal with Off-Site CCR Disposal
CBR-Onsite	Closure-by-Removal with On-Site CCR Disposal
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EJ	Environmental Justice
GHG	Greenhouse Gas
GMF	Gypsum Management Facility
GWPS	Groundwater Protection Standard
HDPE	High-Density Polyethylene
IAC	Illinois Administrative Code
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
LLDPE	Linear Low-Density Polyethylene
N_2O	Nitrous Oxide
NID	National Inventory of Dams
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
PM	Particulate Matter
SFWA	State Fish and Wildlife Area
TVA	Tennessee Valley Authority
US BLS	United States Bureau of Labor Statistics
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
US FWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WPC Permit	Water Pollution Control Construction and Operating Permit

Summary of Findings

Title 35, Part 845, of the Illinois Administrative Code (IAC; IEPA, 2021a) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain surface impoundments containing coal combustion residuals (CCRs) in the State of Illinois. Pursuant to requirements under IAC Section 845.710, this report presents a CAA for the Gypsum Management Facility (GMF) and the Bottom Ash Basin (BAB) located on the Illinois Power Resources Generating, LLC (IPRG) Duck Creek Power Plant property near Canton, Illinois. The GMF contains synthetic gypsum generated historically by the plant's flue gas desulfurization system. No significant volume of CCR remains in the BAB. CCR that was historically contained within the BAB has already been excavated from the impoundment.

The goal of a CAA is to holistically evaluate potential closure scenarios with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IAC Part 845; IEPA, 2021a). For the GMF, Gradient evaluated three closure scenarios: Closure-in-Place (CIP), Closure-by-Removal with On-Site CCR Disposal (CBR-Onsite), and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). For the BAB, Gradient evaluated two closure scenarios: CBR-Onsite and CBR-Offsite. CIP was not evaluated for the BAB because there is no significant CCR remaining in the unit. The CIP scenario for the GMF entails consolidating all of the gypsum in the northern portion of the impoundment, then capping the impoundment with a new cover system. The CBR-Onsite scenario entails excavating the CCR and liner system materials from the GMF and/or the BAB and transporting these materials to an on-Site landfill for disposal. The CBR-Offsite scenario entails excavating the CCR and liner system materials from the GMF and/or the BAB and transporting these materials to an off-Site landfill. IPRG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the GMF as an alternative to disposal.

Table S.1 summarizes the expected impacts of the CIP, CBR-Onsite, and CBR-Offsite closure scenarios at the GMF with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Table S.2 summarizes the expected impacts of the CBR-Onsite and CBR-Offsite closure scenarios at the BAB with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on Table S.1 and the additional details provided in Section 2 of this report, CIP has been identified as the most appropriate closure scenario for the GMF. Key benefits of CIP at the GMF include the more rapid re-development of the Site for use in utility-scale solar generation and reduced impacts on workers, community members, and the environment during construction (*e.g.*, fewer construction-related accidents, lower energy demands, less air pollution and greenhouse gas [GHG] emissions, and less traffic). Based on Table S.2 and the additional details provided in Section 3 of this report, CBR-Onsite has been identified as the most appropriate closure scenario for the BAB. Key benefits of CBR-Onsite at the BAB are that no off-Site hauling is required and, consequently, that this scenario will result in reduced impacts to the community (due to, *e.g.*, accidents, traffic, noise, and air pollution) compared to CBR-Offsite.

Table S.1 Comparison of Proposed Closure Scenarios for the GMF

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Closure Alternative Descriptions (Section 2.1; IAC Section 845.710(c))	The CIP scenario would entail consolidating all of the gypsum in the GMF in the northern portion of the impoundment, then capping the impoundment with a new cover system consisting of, from bottom to top, a geomembrane layer, a geocomposite layer, and 24 inches of protective cover soil capable of supporting vegetative growth.	For CBR-Onsite, CCR and existing liner system materials would be excavated from the GMF and sent *via* truck to the on-Site landfill for disposal. The gypsum, the primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the underlying 3-foot compacted clay liner would be hauled to the on-Site landfill for disposal. The on-Site landfill does not have sufficient capacity for these materials and would require expansion. This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a), which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.	For CBR-Offsite, CCR and existing liner system materials would be excavated from the GMF and sent *via* truck to an off-Site landfill for disposal. The gypsum, the primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the underlying 3-foot compacted clay liner would be hauled to the off-Site landfill for disposal. Expansion of the off-Site landfill may be necessary in order to accept all of the CCR and liner materials from the GMF.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.3; IAC Section 845.710(b)(1)(C))	Monitoring would be performed at the GMF for at least 30 years post-closure, or until GWPSs have been achieved, whichever is longer. The post-closure care plan under the CIP scenario additionally includes periodic inspections and mowing and maintenance of the final cover system for the GMF.	Monitoring would be performed at the GMF for at least 3 years post-closure, or until GWPSs have been achieved, whichever is longer.	Monitoring would be performed at the GMF for at least 3 years post-closure, or until GWPSs have been achieved, whichever is longer.
Magnitude of Reduction of Existing Risks (Section 2.2.1; IAC Sections 845.710(b)(1)(A) and 845.710(b)(1)(F))	There are no current risks to any human or ecological receptors associated with the GMF. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors associated with the GMF. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors associated with the GMF. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Likelihood of Future Releases of CCR (Section 2.2.2; IAC Sections 845.710(b)(1)(B) and 845.710(b)(1)(F))	During closure, there would be minimal risk of dike failure occurring (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure would be even smaller than they are currently, due to the installation of a protective soil cover and new stormwater control structures. Dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events.	During closure, there would be minimal risk of dike failure occurring (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.	During closure, there would be minimal risk of dike failure occurring (due to, *e.g.*, flooding or seismic activity) and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Worker Risks (Section 2.2.4.1; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.17 injuries and 0.0011 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site will be re-developed for use in utility-scale solar generation. The simultaneous pursuit of two large construction projects may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The CIP scenario is expected to result in less traffic congestion – and, hence, a smaller increase in risks to workers – than the two CBR scenarios.	An estimated 0.30 injuries and 0.0020 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site will be re-developed for use in utility-scale solar generation. The simultaneous pursuit of two large construction projects may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The two CBR scenarios are expected to result in more traffic congestion – and, hence, a greater increase in risks to workers – than the CIP scenario.	An estimated 0.41 injuries and 0.0027 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. An additional estimated 0.42 injuries and 0.0096 fatalities would be expected to occur to workers due to off-Site hauling under this scenario. In total, a minimum of 0.84 worker injuries and 0.012 worker fatalities would be expected under this scenario. Overall, risks to workers would likely be highest under the CBR-Offsite scenario and lowest under the CIP scenario. Simultaneous with closure activities, the Site will be re-developed for use in utility-scale solar generation. The simultaneous pursuit of two large construction projects may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from either project alone. The two CBR scenarios are expected to result in more traffic congestion – and, hence, a greater increase in risks to workers – than the CIP scenario.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Community Risks (Section 2.2.4.2; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Off-Site Impacts on Nearby Residents and Environmental Justice (EJ) Communities*	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be small relative to off-Site impacts under the CBR-Offsite scenario, because no off-Site hauling is required under this scenario. The on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). All possible closure scenarios are therefore associated with potential negative impacts on this EJ community.	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be small relative to off-Site impacts under the CBR-Offsite scenario, because no off-Site hauling is required under this scenario. The on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). All possible closure scenarios are therefore associated with potential negative impacts on this EJ community.	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be large relative to off-Site impacts under the CIP and CBR-Onsite scenarios, because off-Site hauling is required under this scenario. In total, an estimated 1.2 injuries and 0.044 fatalities are expected to occur among community members due to off-Site hauling under this scenario. Additionally, a haul truck is likely to pass a location near the Site every 7.2 minutes on average during working hours for the duration of excavation activities, resulting in substantial traffic demands for an extended period of time. The on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). This EJ community is also located along the primary haul routes from the Site to the off-Site landfill. All possible closure scenarios are therefore associated with potential negative impacts on this EJ community.
Impacts on Scenic, Historical, and Recreational Value	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under any closure scenario.	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under any closure scenario.	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under any closure scenario.

Evaluation Factor (Report Section; Part 845 Section)	**GMF Closure Scenario**		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Environmental Risks (Section 2.2.4.3; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Impacts on Greenhouse Gas Emissions and Energy Consumption*	Total energy demands and GHG emissions would be smaller under this closure scenario than under the two CBR scenarios, because the CIP scenario would have the shortest duration of construction activities and require the least amount of CCR dewatering and handling. The CIP scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for the new GMF berm and the final GMF cover system. At the grid scale, construction of a solar facility at the Site will put energy back on the grid and reduce reliance on non-renewable energy sources. Re-development of the Site for solar would occur more rapidly under the CIP scenario than under the two CBR scenarios.	Total energy demands and GHG emissions would be greater under the two CBR closure scenarios than under the CIP scenario, because the two CBR scenarios would have longer durations of construction activities and require a greater amount of CCR dewatering and handling. Because expansion of the on-Site landfill would be necessary in order to accept all of the CCR and liner materials from the GMF, the CBR-Onsite scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the expanded landfill liner. At the grid scale, construction of a solar facility at the Site will put energy back on the grid and reduce reliance on non-renewable energy sources. Re-development of the Site for solar would occur more slowly under the two CBR scenarios than under the CIP scenario.	Total energy demands and GHG emissions would be greater under the two CBR closure scenarios than under the CIP scenario, because the two CBR scenarios would have longer durations of construction activities and require a greater amount of CCR dewatering and handling. If expansion of the off-Site landfill became necessary in order to accept all of the CCR and liner materials from the GMF, then the CBR-Offsite scenario would have an additional, unquantified carbon footprint due to the need to manufacture geomembranes for use in the expanded landfill liner. At the grid scale, construction of a solar facility at the Site will put energy back on the grid and reduce reliance on non-renewable energy sources. Re-development of the Site for solar would occur more slowly under the two CBR scenarios than under the CIP scenario.
Impacts on Natural Resources and Habitat	Construction may have a negative short-term impact on terrestrial species in the vicinity of the GMF and the on-Site borrow soil location. The duration of time over which impacts will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months).	Construction may have a negative short-term impact on terrestrial species in the vicinity of the GMF and the on-Site borrow soil location. The duration of time over which impacts will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months).	Construction may have a negative short-term impact on terrestrial species in the vicinity of the GMF and the on-Site borrow soil location. The duration of time over which impacts will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months).

Evaluation Factor (Report Section; Part 845 Section)	**GMF Closure Scenario**		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Time Until Groundwater Protection Standards Are Achieved (Section 2.2.5; IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))	Based on statistical analysis and evaluation of potential exceedances, it has been determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF.	Based on statistical analysis and evaluation of potential exceedances, it has been determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF.	Based on statistical analysis and evaluation of potential exceedances, it has been determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF.
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.7; IAC Section 845.710(b)(1)(G))	CIP would be expected to be a reliable closure alternative over the long term.	CBR-Onsite would be expected to be a reliable closure alternative over the long term.	CBR-Offsite would be expected to be a reliable closure alternative over the long term.
Potential Need for Future Corrective Action (Section 2.2.8; IAC Section 845.710(b)(1)(H))	Corrective action is not expected to be required at this Site.	Corrective action is not expected to be required at this Site.	Corrective action is not expected to be required at this Site.
Effectiveness of the Alternative in Controlling Future Releases (Section 2.3; IAC Section 845.710(b)(2)(A and B))	There are no current or future risks to any human or ecological receptors associated with the GMF. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure would be even smaller than they are currently, due to the installation of a protective soil cover and new stormwater control structures. Dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events.	There are no current or future risks to any human or ecological receptors associated with the GMF. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.	There are no current or future risks to any human or ecological receptors associated with the GMF. During closure, there would be minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Following excavation, there would be no risk of CCR releases due to dike failure.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Ease or Difficulty of Implementing the Alternative (Section 2.4; IAC Section 845.710(b)(3))	CIP is a reliable and standard method for closing impoundments. However, dewatering and relocating saturated gypsum as part of closure activities at the GMF may be moderately challenging. Careful planning would be required to work safely on the wet gypsum within the GMF.	Relative to CIP, CBR-Onsite and CBR-Offsite pose additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, and longer construction schedules, and the need to remove and dispose of the existing bottom liner geomembrane. The construction schedule for excavation may be negatively impacted under the CBR-Onsite scenario, because the on-Site landfill will need to be expanded in order to receive all of the materials excavated from the GMF.	Relative to CIP, CBR-Onsite and CBR-Offsite pose additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, and longer construction schedules, and the need to remove and dispose of the existing bottom liner geomembrane. Hauling would be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, due to the need to use public roadways for hauling. Because the CCR would be hauled on public roads (*i.e.*, intrastate travel), it would also need to be dewatered to a greater extent than would be necessary under the CBR-Onsite scenario. Off-Site landfilling would additionally require the development of a disposal plan and could raise issues related to the co-disposal of CCR and other non-hazardous wastes. The construction schedule for excavation may be negatively impacted under the CBR-Offsite scenario if, during the course of closure, it is determined that the off-Site landfill must be expanded in order to receive all of the materials excavated from the GMF.
Degree of Difficulty Associated with Construction			
Expected Operational Reliability	Operational reliability would be expected under all closure scenarios.	Operational reliability would be expected under all closure scenarios.	Operational reliability would be expected under all closure scenarios.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Need for Permits and Approvals	Permits required under all closure scenarios include: a modification to the existing NPDES permit; a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the impoundment to be modified; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit.	Permits required under all closure scenarios include: a modification to the existing NPDES permit; a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the impoundment to be modified; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit. The existing on-Site landfill will also require expansion under the CBR-Onsite scenario; however, the on-Site landfill has already been permitted for an expansion of an additional 2 acres of waste disposal area.	Permits required under all closure scenarios include: a modification to the existing NPDES permit; a construction permit from the IDNR Dam Safety Program to allow the embankment and spillways of the impoundment to be modified; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit. Under the CBR-Offsite scenario, additional permitting may be required for transport of the CCR and to expand the off-Site landfill.
Availability of Equipment and Specialists	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under all scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the two CBR scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site.	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under all scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the two CBR scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site.	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under all scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the two CBR scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Available Capacity and Location of Treatment, Storage, and Disposal Services	Under the CIP scenario, the gypsum currently within the GMF will be consolidated and stored within the existing footprint of the impoundment. The GMF will be unwatered at the start of construction *via* pumping. Pumped water will be managed in accordance with the facility's NPDES permit.	The on-Site landfill does not have sufficient capacity to receive all of the CCR and liner materials that are currently slated for landfilling under the CBR-Onsite scenario. Expansion of the on-Site landfill would thus be necessary. The on-Site landfill is already permitted for a potential expansion, which would create an additional 2 acres of waste disposal area. The landfill expansion could be completed in a single construction season during the removal of ponded water at the GMF.	The Peoria City-County Landfill in Brimfield, Illinois, has sufficient capacity to receive all of the CCR and liner materials from the GMF. However, due to the limited space remaining in this landfill and the short time frame over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that will be received and the unique CCR waste characteristics. If expansion of the Peoria City-County Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A likely alternative to the Peoria City-County Landfill is the Envirofil of IL Landfill in Macomb, Illinois.
Impact of Alternative on Waters of the State (Section 2.5; IAC Section 845.710(d)(4))	No current or future exceedances of any screening benchmarks for surface water would be anticipated.	No current or future exceedances of any screening benchmarks for surface water would be anticipated.	No current or future exceedances of any screening benchmarks for surface water would be anticipated.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	CBR-Onsite	CBR-Offsite
Potential Modes of Transportation Associated with CBR (Section 2.1; IAC Section 845.710(c)(1))	This factor is not relevant for CIP.	This factor is not relevant for CBR-Onsite.	Loadout facilities do not exist on-Site that would facilitate off-Site rail or barge CCR transport. Rail lines or waterbodies connecting to a potential off-Site disposal location also do not exist. Thus, transport *via* rail or barge is considered infeasible. Only transport *via* on-road haul trucks was assumed for the CBR-Offsite scenario. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.
Concerns of Residents Associated with Alternatives (Section 2.6; IAC Section 845.710(b)(4))	Despite the preference for CBR that has been expressed by nonprofits representing community interests near the Site, CIP will effectively address residents' concerns regarding potential impacts to groundwater and surface water quality associated with the GMF. Relative to CBR-Offsite, CIP also presents fewer risks to workers and community members during construction in the form of accidents, traffic, and air pollution. Moreover, under the CIP scenario, the Site could be more rapidly re-developed for use in utility-scale solar generation. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. However, CBR has several disadvantages with regard to potential community concerns. Relative to CIP, the two CBR scenarios present greater risks to workers and community members during construction in the form of accidents, traffic, and air pollution. Moreover, under the two CBR scenarios, the Site could take longer to re-develop for use in utility-scale solar generation. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. However, CBR has several disadvantages with regard to potential community concerns. Relative to CIP, the two CBR scenarios presents greater risks to workers and community members during construction in the form of accidents, traffic, and air pollution. Moreover, under the two CBR scenarios, the Site could take longer to re-develop for use in utility-scale solar generation. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

Evaluation Factor (Report Section; Part 845 Section)	GMF Closure Scenario		
	CIP	**CBR-Onsite**	**CBR-Offsite**
Class 4 Cost Estimate (Section 2.7; IAC Section 845.710(d)(1))	The CIP scenario can be implemented at a lower total cost (approximately $6.21 million) than the CBR-Onsite scenario (approximately $8.87 million) and the CBR-Offsite scenario (approximately $82.4 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CIP scenario can be implemented at a lower total cost (approximately $6.21 million) than the CBR-Onsite scenario (approximately $8.87 million) and the CBR-Offsite scenario (approximately $82.4 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CIP scenario can be implemented at a lower total cost (approximately $6.21 million) than the CBR-Onsite scenario (approximately $8.87 million) and the CBR-Offsite scenario (approximately $82.4 million). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.

Notes:

AACE = Association for the Advancement of Cost Engineering; CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place; EJ = Environmental Justice; GHG = Greenhouse Gas; GMF = Gypsum Management Facility; IAC = Illinois Administrative Code; IDNR = Illinois Department of Natural Resources; IEPA = Illinois Environmental Protection Agency; NPDES = National Pollutant Discharge Elimination System.

Table S.2 Comparison of Proposed Closure Scenarios for the BAB

Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Closure Alternative Descriptions (Section 3.1; IAC Section 845.710(c))	For CBR-Onsite, the concrete, compacted clay, and geomembrane components of the existing liner system, and any remaining CCR, will be excavated from the BAB and sent *via* truck to the on-Site landfill for disposal. This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a), which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.	For CBR-Offsite, the concrete, compacted clay, and geomembrane components of the existing liner system, and any remaining CCR, will be excavated from the BAB and sent *via* truck to an off-Site landfill for disposal.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 3.2.3; IAC Section 845.710(b)(1)(C))	Monitoring would be performed at the BAB for at least 3 years post-closure, or until GWPSs have been achieved.	Monitoring would be performed at the BAB for at least 3 years post-closure, or until GWPSs have been achieved.
Magnitude of Reduction of Existing Risks (Section 3.2.1; IAC Sections 845.710(b)(1)(A) and 845.710(b)(1)(F))	There are no current risks to any human or ecological receptors associated with the BAB. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.	There are no current risks to any human or ecological receptors associated with the BAB. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, no risks to human or ecological receptors are expected post-closure.
Likelihood of Future Releases of CCR (Section 3.2.2; IAC Sections 845.710(b)(1)(B) and 845.710(b)(1)(F))	There is no current or future risk of CCR releases occurring at the BAB under either closure scenario. No significant volume of CCR currently remains in the BAB.	There is no current or future risk of CCR releases occurring at the BAB under either closure scenario. No significant volume of CCR currently remains in the BAB.
Worker Risks (Section 3.2.4.1; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.056 injuries and 0.00036 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. Overall, risks to workers would likely be of similar magnitude for both closure scenarios.	An estimated 0.050 injuries and 0.00033 fatalities would be expected to occur to workers due to major on-Site construction activities under this scenario. An additional estimated 0.0041 injuries and 0.000093 fatalities would be expected to occur to workers due to off-Site hauling. In total, a minimum of 0.054 worker injuries and 0.00042 worker fatalities would be expected under this scenario. Overall, risks to workers would likely be of similar magnitude for both closure scenarios.

Evaluation Factor (Report Section; Part 845 Section)	**BAB Closure Scenario**	
	CBR-Onsite	**CBR-Offsite**
Community Risks (Section 3.2.4.2; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Off-Site Impacts on Nearby Residents and Environmental Justice (EJ) Communities*	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be smaller than off-Site impacts under the CBR-Offsite scenario, because no off-Site hauling is required under this scenario. The on-Site landfill and the borrow site are both located within the one-mile buffer zone of the nearest EJ community (near Canton). Both closure scenarios are therefore associated with potential negative impacts on this EJ community.	Off-Site impacts on nearby residents under this scenario (including accidents, traffic, noise, and air pollution) will be larger than off-Site impacts under the CBR-Onsite scenario, because off-Site hauling is required under this scenario. In total, an estimated 0.012 injuries and 0.00043 fatalities are expected to occur among community members due to off-Site hauling under this scenario. A haul truck is likely to pass a location near the Site every 49 minutes on average during working hours for the duration of excavation activities under this scenario. The on-Site landfill and the borrow site are both located within the one-mile buffer zone of the nearest EJ community (near Canton). This EJ community is also located along the primary haul routes from the Site to the off-Site landfill. Both closure scenarios are therefore associated with potential negative impacts on this EJ community.
Impacts on Scenic, Historical, and Recreational Value	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the BAB, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under either closure scenario.	There are no notable scenic, historical, or recreational areas located in the immediate vicinity of the BAB, the borrow soil location, or the on-Site landfill. Construction activities at the Site are therefore not expected to have direct negative impacts on any scenic, historical, or recreational areas under either closure scenario.
Environmental Risks (Section 3.2.4.3; IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F)) *Impacts on Greenhouse Gas Emissions and Energy Consumption*	Total energy demands and GHG emissions would likely be similar under the CBR-Onsite and CBR-Offsite scenarios, because both scenarios would have the same expected duration of construction activities and required earthwork volumes.	Total energy demands and GHG emissions would likely be similar under the CBR-Onsite and CBR-Offsite scenarios, because both scenarios would have the same expected duration of construction activities and required earthwork volumes.

Evaluation Factor (Report Section; Part 845 Section)	**BAB Closure Scenario**	
	CBR-Onsite	**CBR-Offsite**
Impacts on Natural Resources and Habitat	Construction may have a negative short-term impact on terrestrial species in the vicinity of the BAB and the on-Site borrow soil location and may also cause long-term shifts in the habitat atop these locations. Both BAB closure scenarios are expected to have similar short- and long-term impacts on natural resources and habitat.	Construction may have a negative short-term impact on terrestrial species in the vicinity of the BAB and the on-Site borrow soil location and may also cause long-term shifts in the habitat atop these locations. Both BAB closure scenarios are expected to have similar short- and long-term impacts on natural resources and habitat.
Time Until Groundwater Protection Standards Are Achieved (Section 3.2.5; IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))	There are no exceedances of potentially applicable groundwater standards attributable to the BAB.	There are no exceedances of potentially applicable groundwater standards attributable to the BAB.
Long-Term Reliability of the Engineering and Institutional Controls (Section 3.2.7; IAC Section 845.710(b)(1)(G))	CBR-Onsite would be expected to be a reliable closure alternative over the long term.	CBR-Offsite would be expected to be a reliable closure alternative over the long term.
Potential Need for Future Corrective Action (Section 3.2.8; IAC Section 845.710(b)(1)(H))	Corrective action is not expected to be required at this Site.	Corrective action is not expected to be required at this Site.
Effectiveness of the Alternative in Controlling Future Releases (Section 3.3; IAC Section 845.710(b)(2)(A and B))	There are no current or future risks to any human or ecological receptors associated with the BAB. There is no current or future risk of sudden CCR releases occurring at the BAB under either closure scenario. There is no significant volume of CCR remaining in the BAB.	There are no current or future risks to any human or ecological receptors associated with the BAB. There is no current or future risk of sudden CCR releases occurring at the BAB under either closure scenario. There is no significant volume of CCR remaining in the BAB.
Ease or Difficulty of Implementing the Alternative (Section 3.4; IAC Section 845.710(b)(3))	Hauling would be easier to implement under the CBR-Onsite scenario than under the CBR-Offsite scenario, since it would not require the use of public roadways.	Hauling would be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, since it would require the use of public roadways.
Degree of Difficulty Associated with Construction		

Evaluation Factor (Report Section; Part 845 Section)	**BAB Closure Scenario**	
	CBR-Onsite	**CBR-Offsite**
Expected Operational Reliability	Operational reliability would be expected under both closure scenarios.	Operational reliability would be expected under both closure scenarios.
Need for Permits and Approvals	A construction stormwater permit through IEPA may be required for closure. A joint water pollution control construction and operating permit may also be needed. Under the CBR-Onsite scenario, a landfill permit modification would be needed for the landfill to receive the BAB contents.	A construction stormwater permit through IEPA may be required for closure. A joint water pollution control construction and operating permit may also be needed. Additional permitting and approvals may be required under the CBR-Offsite scenario for waste transport.
Availability of Equipment and Specialists	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under both closure scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the materials that will be hauled from the Site.	Global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment or delays in the construction schedule under both closure scenarios, if supply chain resilience does not improve by the time of construction. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the materials that will be hauled from the Site.
Available Capacity and Location of Treatment, Storage, and Disposal Services	The on-Site landfill has sufficient capacity to receive all of the materials that would be excavated from the BAB.	The Peoria City-County Landfill in Brimfield, Illinois has sufficient capacity to receive all of the materials that would be excavated from the BAB.
Impact of Alternative on Waters of the State (Section 3.5; IAC Section 845.710(d)(4))	No current or future exceedances of any screening benchmarks for surface water would be anticipated.	No current or future exceedances of any screening benchmarks for surface water would be anticipated.

Evaluation Factor (Report Section; Part 845 Section)	BAB Closure Scenario	
	CBR-Onsite	**CBR-Offsite**
Potential Modes of Transportation Associated with CBR (Section 3.1; IAC Section 845.710(c)(1)	This factor is not relevant for CBR-Onsite.	Loadout facilities do not exist on-Site that would facilitate off-Site rail or barge transport of materials excavated from the BAB. Rail lines or waterbodies connecting to a potential off-Site disposal location also do not exist. Thus, transport *via* rail or barge is considered infeasible. Only transport *via* on-road haul trucks was assumed for the CBR-Offsite scenario. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.
Concerns of Residents Associated with Alternatives (Section 3.6; IAC Section 845.710(b)(4))	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. Both closure scenarios are equally responsive to this concern. Nearly all of the CCR that was historically contained within the BAB has already been excavated from the impoundment. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.	Nonprofits representing community interests near the Site have expressed a preference for CBR over CIP. Both closure scenarios are equally responsive to this concern. Nearly all of the CCR that was historically contained within the BAB has already been excavated from the impoundment. A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.
Class 4 Cost Estimate (Section 3.7; IAC Section 845.710(d)(1))	The CBR-Onsite scenario can be implemented at a lower total cost (approximately $479,000) than the CBR-Offsite scenario (approximately $1,360,000). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.	The CBR-Onsite scenario can be implemented at a lower total cost (approximately $479,000) than the CBR-Offsite scenario (approximately $1,360,000). Cost estimates were prepared consistent with a Class 4 Estimate under the AACE Classification Standard.

Notes:
AACE = Association for the Advancement of Cost Engineering; BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place; CY = Cubic Yard; EJ = Environmental Justice; GHG = Greenhouse Gas; IAC = Illinois Administrative Code; IEPA = Illinois Environmental Protection Agency; NPDES = National Pollutant Discharge Elimination System.

1 Introduction

1.1 Site Description and History

1.1.1 Site Location and History

The Illinois Power Resources Generating, LLC (IPRG) Duck Creek Power Plant is an electric-power-generating facility with coal-fired units located approximately 9 miles southeast of the City of Canton in Fulton County, Illinois (AECOM, 2016a; Ramboll, 2021a). Beginning in the 1930s, strip mining took place within the boundaries of the Site. Mining operations on the property have since ceased (AECOM, 2016a; Ramboll, 2021b). The Duck Creek Power Plant began operating in 1976 and was retired in December 2019 (AECOM, 2016a; Appendix B).

1.1.2 CCR Impoundments

The Duck Creek Power Plant produced and stored coal combustion residuals (CCRs) as a part of its historical operations. The subjects of this report are the Gypsum Management Facility (GMF; Vistra CCR Unit ID No. 203; Illinois Environmental Protection Agency [IEPA] ID No. W0578010001-04; National Inventory of Dams [NID] No. IL50573) and the Bottom Ash Basin (BAB; Vistra CCR Unit ID No. 205; IEPA ID No. W0578010001-03; NID No. 50716) (Figure 1.1).

The GMF is a 31-acre lined surface impoundment constructed between 2007 and 2009 that operated from 2009 until the plant was retired in 2019. This facility was historically used to store gypsum and to clarify gypsum transport water for reuse (Appendix B; Golder, 2022a). The GMF has a dual-composite liner system with a leak detection layer (Appendix B). The GMF Recycle Pond, which is located immediately south of the GMF, historically received decanted water from the GMF and leachate from the on-Site landfill (described below). The GMF Recycle Pond never received CCR. A set of pumps on the western side of the GMF Recycle Pond were used to transport decanted water back to the flue gas desulfurization system for re-use (Appendix B). The GMF Recycle Pond has a liner system consisting of a 60-mil high-density polyethylene (HDPE) geomembrane, a reinforced bentonite mat, and a 36-inch layer of compacted clay (Natural Resource Technology, 2017). The GMF Recycle Pond has been closed, and the closure was approved by IEPA.

The BAB is a 2.2-acre lined surface impoundment constructed in late 2007 or early 2008 for the management of sluiced bottom ash. It operated from 2008 until the plant was retired in 2019 (Appendix B; Golder, 2022b). There are three cells within the BAB: Primary Pond 1, Primary Pond 2, and the Secondary Pond (Appendix B). Historically, ash was sluiced to either Primary Pond 1 or Primary Pond 2. The Secondary Pond received decanted water from the two primary ponds (Appendix B; Golder, 2022b). Decanted water from the Secondary Pond flowed to the Duck Creek Cooling Pond *via* a discharge channel to the south of the pond (Appendix B). During operation of the BAB, Primary Ponds 1 and 2 were cleaned out frequently *via* excavation, and excavated bottom ash was sent to the on-Site landfill for disposal (Appendix B; Golder, 2022b). Bottom ash was also removed from the BAB when the plant was retired in 2019, such that no significant bottom ash currently remains (Appendix B). The BAB is a lined impoundment. The components of the liner system include (from bottom to top): compacted native soils, a 60-mil HDPE geomembrane, a 1-foot compacted clay layer, and an 8-inch reinforced concrete layer (Appendix B).

Figure 1.1 Site Location Map. Adapted from Stantec (2017).

1.1.3 Surface Water Hydrology

Surface water bodies on the Site include the Duck Creek Cooling Pond, which is the cooling water impoundment for the plant, and various small ponds resulting from historical surface mining on the property, including Long Lake (AECOM, 2016a; Natural Resource Technology, 2017). Surface water in the vicinity of the GMF and the BAB drains into the Duck Creek Cooling Pond (Natural Resource Technology, 2017), which drains to the Illinois River *via* National Pollutant Discharge Elimination System (NPDES)-permitted outfalls (IEPA, 2013). Other surface water bodies in the vicinity of the Site include various backwater lakes of the Illinois River, including Buckheart Creek to the west and Rice Lake, Miserable Lake, Big Lake, and Goose Lake to the east (Ramboll, 2021b,c).

1.1.4 Hydrogeology

1.1.4.1 GMF

Three major hydrostratigraphic units have been identified near the GMF: (a) the uppermost aquifer, (b) the lower Radnor till/lower confining unit, and (c) the bedrock confining unit. The first of these layers, the uppermost aquifer, is composed of three units: (i) the Peoria/Roxanna loess, (ii) the upper Radnor till, and (iii) the shallow sand unit (Ramboll, 2021c). The Peoria/Roxanna loess zone is composed of silt, clayey silt, and minor amounts of sand. The upper Radnor till is composed of clayey silt with minor amounts of sand and gravel. The shallow sand unit is composed of medium-grained sand and silt with interbedded till seams. The shallow sand unit, which varies from less than 1- to 18-feet thick in the vicinity of the GMF, is the primary conduit for horizontal migration of shallow groundwater near the impoundment (Ramboll, 2021c). The Peoria/Roxanna loess has also been identified as a potential migration pathway (Ramboll, 2021c). The lower Radnor till layer has high silt content with varying amounts of clay, sand, and gravel. The bedrock confining unit is composed primarily of low-permeability, shaley siltstone and silty shale. The Hydrogeological Site Characterization Report prepared by Ramboll for the GMF (Ramboll, 2021c) provides more details regarding the hydrostratigraphic units in the vicinity of the GMF.

Near the GMF, shallow groundwater flows southeast through the uppermost aquifer toward the Duck Creek Cooling Pond (Natural Resource Technology, 2017; Ramboll, 2021a,c). The preferential flow of groundwater is horizontal rather than vertical because the underlying till and shale bedrock layers restrict vertical groundwater flow (Natural Resource Technology, 2017). Groundwater within the uppermost aquifer near the GMF flows into the Duck Creek Cooling Pond. No other potential groundwater transport pathways exist. Because the Duck Creek Cooling Pond serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the Duck Creek Cooling Pond is unlikely (Ramboll, 2021c).

Groundwater monitoring is ongoing at the GMF. The Hydrogeologic Site Characterization Report prepared by Ramboll for the GMF includes a summary of the groundwater data collected from GMF monitoring wells between 2015 and 2021 (Ramboll, 2021c).

1.1.4.2 BAB

Two distinct hydrostratigraphic units have been identified near the BAB: the uppermost aquifer and a confining shale bedrock unit (Ramboll, 2021b). The first of these layers, the uppermost aquifer, consists of the Peoria/Roxanna loess, which is characterized by medium to very stiff silt with little clay and trace very fine- to fine-grained sand, and the Radnor till, which is characterized by silty clay with trace very fine- to coarse-grained sand and trace small gravel to hard clay with little silt, few very fine- to coarse-grained sand, and trace small gravel (Ramboll, 2021b). The most permeable portion of the uppermost aquifer is the shallow sand unit, a two- to seven-foot-thick sand zone located within the Radnor till. The shallow sand unit, which is encountered at a depth of 18-40 feet below ground surface (bgs), forms the primary conduit for horizontal migration of shallow groundwater near the BAB (Ramboll, 2021b). The Peoria/Roxanna loess has also been identified as a potential migration pathway. A confining unit composed of Pennsylvanian shaley siltstone and silty shale bedrock underlies the uppermost aquifer from approximately 26-46 feet bgs (top of bedrock; Ramboll, 2021b). The bedrock acts as an aquitard due to its low hydraulic conductivity (AECOM, 2016a; Ramboll, 2021b). The Hydrogeological Site Characterization Report prepared by Ramboll for the BAB (Ramboll, 2021b) provides more details regarding the hydrostratigraphic units in the vicinity of the BAB.

Near the BAB, shallow groundwater flows southwards through the uppermost aquifer toward an unnamed drainage channel, which leads to the Duck Creek Cooling Pond (Ramboll, 2021b). Groundwater flows horizontally rather than vertically through the uppermost aquifer because: (i) vertical hydraulic conductivities within the uppermost aquifer are several orders of magnitude lower than horizontal hydraulic conductivities, and (ii) the underlying shale bedrock acts as an aquitard (AECOM, 2016a; Ramboll, 2021b). Groundwater within the uppermost aquifer near the BAB flows into the Duck Creek Cooling Pond. No other potential groundwater transport pathways exist. Because the Duck Creek Cooling Pond serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the Duck Creek Cooling Pond is unlikely (Ramboll, 2021b).

Groundwater monitoring is ongoing at the BAB. The Hydrogeologic Site Characterization Report prepared by Ramboll for the BAB includes a summary of the groundwater data collected from BAB monitoring wells between 2015 and 2021 (Ramboll, 2021b).

1.1.5 Site Vicinity

The Duck Creek property is surrounded by agricultural fields, pastures, and forests (Ramboll, 2021b). There are several scenic, recreational, and historical areas within a few miles of the Site, including the Rice Lake State Fish and Wildlife Area (SFWA) to the east and the Orendorf and Rice Lake Terrace Archaeological Sites to the east/northeast. The Rice Lake SFWA, which spans approximately 5,660 acres, was established in 1945 and includes Big Lake, Slim Lake, Goose Lake, Pond Lily Lake, Lock Pond, and the Copperas Creek Management Unit. Popular activities at the Rice Lake SFWA include picnicking, fishing, camping, and hunting (IDNR, c. 2008). The Orendorf Archaeological Site, which was added to the National Register of Historic Places in 1977 (National Park Service, 2021), encompasses at least four distinct Middle Mississippian settlement areas with known trade and migration linkages to the Mississippian city of Cahokia, the largest archaeological site in North America (Archaeological Institute of America, 2021; Emerson, c. 2016). The Rice Lake Terrace Archaeological Site is located south of the Orendorf Archaeological Site on the shore of Rice Lake and includes evidence of Archaic (8000-500 BC), Woodland (500 BC-1000 AD) and Mississippian (1000-1673 AD) cultures (Archaeological Institute of America, 2021). In addition to the sites listed above, there are several high-value scenic and recreational areas within 10 miles downstream along the Illinois River, including the Spring Lake SFWA, the Sand Ridge State Forest, the Chautauqua National Wildlife Refuge, and the Emiquon Preserve.

1.2 Part 845 Regulatory Review and Requirements

Title 35, Part 845, of the Illinois Administrative Code (IAC; IEPA, 2021a) requires the development of a Closure Alternatives Analysis (CAA) prior to undertaking closure activities at certain CCR-containing surface impoundments in the State of Illinois. Section 2 of this report presents a CAA for the GMF pursuant to requirements under IAC Section 845.710. Section 3 of this report presents a CAA for the BAB. The goal of a CAA is to holistically evaluate each potential closure scenario with respect to a wide range of factors, including the efficiency, reliability, and ease of implementation of the closure scenario; its potential positive and negative short- and long-term impacts on human health and the environment; and its ability to address concerns raised by residents (IEPA, 2021a). A CAA is a decision-making tool that is designed to aid in the selection of an optimal closure alternative for the impoundments at a site.

2 Closure Alternatives Analysis – GMF

2.1 Closure Alternative Descriptions (IAC Section 845.710(c))

This section of the report presents a CAA for the GMF pursuant to requirements under IAC Section 845.710 (IEPA, 2021a). Gradient evaluated three closure scenarios: Closure-in-Place (CIP), Closure-by-Removal with On-Site CCR Disposal (CBR-Onsite), and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). Sections 2.1.1 through 2.1.3 describe the CIP, CBR-Onsite, and CBR-Offsite closure scenarios. These scenarios are based on information conveyed to Gradient by Golder (Appendix B; Golder, 2022c,d).

2.1.1 Closure-in-Place

Under the CIP scenario, the gypsum in the GMF will be consolidated in the northern portion of the impoundment and the impoundment will be capped with a new cover system. This scenario includes the following work elements for the closure of the GMF (Appendix B; Golder, 2022c):

- Elimination of free liquids by solidifying waste residues, as needed, or by removing liquid waste, including *via* pumping. Water will be managed in accordance with the NPDES permit for the facility.
- Dewatering of the upper gypsum layer within the northern portion of the GMF *via* trenches and sumps in order to support construction traffic across the surface.
- Construction of a new internal berm with an east-west orientation. The upstream slope of the berm will be lined with a new composite liner, which will tie into the existing primary composite liner system for the facility.
- Consolidation of all gypsum in an approximately 15-acre area north of the berm. All gypsum from the area south of the berm will be removed and placed north of the berm.
- Contouring and grading to promote stormwater management.
- Construction of an alternative cover system north of the berm that will consist of a 40-mil linear low-density polyethylene (LLDPE) geomembrane layer, a geocomposite layer, and 24 inches of protective soil cover suitable for supporting vegetative growth. The performance of this alternative cover system relative to a default cover is presented in Geosyntec Consultants (2022).
- Removal of the geosynthetic components of the dual-composite liner system south of the berm. Liner system materials will be disposed of in the northern portion of the capped GMF. Soil materials located between these components will be removed and stockpiled south of the GMF.
- Excavation of a surface water channel south of the GMF, including removal of sections of the GMF Recycle Pond perimeter dike, in order to promote passive stormwater drainage to the southeast of the impoundment.
- Long-term (post-closure) monitoring and maintenance, including:
    - Groundwater monitoring at the impoundment for a minimum of 30 years, or until groundwater protection standards (GWPSs) are achieved.

- Post-closure care for the final cover system, including cap inspections, mowing, and maintenance, for a minimum of 30 years.

This CIP plan meets all closure requirements of Part 845.750 (Golder, 2022a). Key closure elements that address the Part 845 closure requirements are summarized below. Further details are provided in the Closure Plan (Golder, 2022a).

- An alternative cover system will be installed over the CCR that remains in the GMF. The cover, consisting of a 40-mil LLDPE geomembrane low-permeability layer, a geocomposite cushion if needed, and 24 inches of soil, will minimize vertical infiltration of precipitation into the basin [Part 845.750(a)(1)].
- The final cover system will be crowned with 4% slopes to direct surface water away from the facility. Beyond the final cover system, channels will direct surface water away from the GMF to existing site drainages [Part 845.750(a)(2)].
- Impounded water will be removed from the GMF and managed in accordance with the NPDES permit for the facility [845.750(b)(1) and 845.750(b)(2)].
- Free liquids in the CCR will be eliminated by removing liquid wastes or solidifying the remaining wastes. Trenches will facilitate gravity drainage of liquid wastes in the gypsum and direct the liquid wastes to sumps. Other engineering measures may be considered to facilitate removal of liquid wastes and stabilization of wastes. Sumps will be used to collect liquid wastes which will be managed in accordance with the NPDES permit for the site [845.750(b)(1) and 845.750(b)(2)].

As an additional consideration, the proposed alternative cover system and the existing bottom liner system will provide complete encapsulation of the CCR, physically isolating it from contact with surrounding soils, groundwater, surface water and the atmosphere. Lateral infiltration of groundwater into the basin will also be controlled due to the presence of the existing dual-composite bottom liner system which will prevent groundwater from flowing into the basin (Golder, 2022a).

Approximately 85,000 cubic yards of gypsum will be relocated from south of the berm to north of the berm under this scenario (an assumed travel distance of 0.2 miles; Appendix B). Hauling will also be required to relocate 17 acres of geosynthetic liner materials north of the berm and 55,700 cubic yards of liner soils excavated from south of the berm to a stockpile located south of the closure footprint (an assumed travel distance of 0.2 miles).

Soil required for construction of the new berm and the final GMF cover system will be sourced from a location on the property; a borrow location will not need to be established off-Site. The selected borrow soil location is approximately 0.4 miles north of the GMF (Appendix B). The estimated volume of borrow soil required for GMF closure *via* CIP is 76,100 cubic yards (Appendix B). Additionally, approximately 81,000 cubic yards of soil will be excavated during construction of the stormwater channel south of the GMF during Site restoration. This material will be hauled to the borrow soil location for stockpiling (Appendix B).

Under the CIP scenario, the expected duration of major construction activities at the GMF is 12-24 months (Appendix B; Golder, 2022c). Key parameters for the CIP scenario are shown in Table 2.1.

Table 2.1 Key Parameters for the Closure-in-Place Scenario – GMF

Parameter	Value	Notes
Surface Area of Impoundment (acres)	31	
Surface Area of Final Cover System (acres)	15	Area north of the proposed berm.
In-Place Volume of CCR (CY)	400,000	CCR contained in the GMF is gypsum from flue gas desulfurization.
Volume of CCR to be Relocated (CY)	85,000	Amount of gypsum to be removed from the southern portion of the GMF and relocated north of the berm.
Travel Distance for Relocation of CCR (miles)	0.2	
Required Volume of Borrow Soil (CY)	76,100	Required for berm construction and the final cover system.
Volume of Material Stockpiled On-Site (CY)	137,000	Excavated during construction of the stormwater channel and removal of existing liner system components south of the berm (Site restoration).
Distance to the Borrow Soil Location (miles)	0.4	
Duration of Construction Activities (months)	12-24	
Total On-Site Labor Hours for Major Construction[a]	14,600	
Required On-Site Hauling Truckloads (Loaded)	10,200	
Required Off-Site Hauling Truckloads (Loaded)	0	
Required On-Site Hauling Miles	6,270	
Required Off-Site Hauling Miles	0	

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yards; GMF = Gypsum Management Facility.
Sources: Appendix B; Golder (2022c).
(a) Major construction is defined as any operation occurring on-Site that requires one or more of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor is not included if it is limited to the use of one or more of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators is only included in calculations if the hauling occurs on-Site. Workers assigned to relevant activities are assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

2.1.2 Closure-by-Removal with On-Site Disposal

Under the CBR-Onsite scenario, CCR and existing liner system materials will be excavated from the GMF and sent to the on-Site landfill for final disposal. Excavation at the GMF will include all of the gypsum in the impoundment and the existing dual-composite liner system. The gypsum excavated from the GMF is currently expected to be hauled to the on-Site landfill. IPRG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the GMF as an alternative to disposal. The primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the 3-foot compacted clay layer beneath the GMF will also be hauled to the on-Site landfill for disposal.

This scenario includes the following work elements for the closure of the GMF (Appendix B; Golder, 2022c,d):

- Free water removal and dewatering of the GMF.
- Excavation and transport of CCR and liner system materials to the on-Site landfill, as detailed above. All areas affected by CCR releases will be decontaminated, including potential over-excavation below the bottom of the liner system.

- Grading and filling to convey runoff away from the impoundments. This process will include excavation of a surface water channel south of the GMF and removal of sections of the GMF Recycle Pond perimeter dike in order to promote passive stormwater drainage to the southeast of the impoundment.
- Site restoration, including revegetation with native grasses.
- Monitoring at the impoundments for at least 3 years, or until GWPSs are achieved.

Approximately 31 acres of geosynthetic liner system materials, 283,000 cubic yards of earthen liner system materials, 50,000 cubic yards of subsoil overexcavation, and 400,000 cubic yards of gypsum will be excavated from the GMF and hauled to the on-Site landfill for disposal. The on-Site landfill is located approximately 1.2 miles north of the GMF (Appendix B). Excavated materials will be hauled to the landfill using off-road haul trucks with an assumed capacity of 34 cubic yards. The on-Site landfill currently has approximately 445,000 cubic yards of available capacity. Of this, approximately 7,000 cubic yards may be used for the disposal of materials associated with excavation of the BAB. Thus, the on-Site landfill does not have sufficient capacity to receive all of the CCR and liner materials from the GMF that are slated for disposal under the CBR-Onsite scenario. Expansion of the landfill would thus be necessary. The on-Site landfill is already permitted for a potential expansion, which could create an additional 2-acre landfill cell (Appendix B). This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a), which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.

No borrow soil is required for grading and filling the GMF under the CBR-Onsite scenario (Appendix B). However, approximately 9,700 cubic yards of compacted clay is required for landfill expansion; this material will be hauled in from the borrow site, which is located 0.7 miles from the landfill. Finally, approximately 86,000 cubic yards of soil will be excavated during construction of the stormwater channel south of the GMF during Site restoration. This material will be hauled to the borrow soil location for stockpiling (Appendix B).

Under the CBR-Onsite scenario, the expected duration of major construction activities is expected to be 24-36 months at the GMF (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Onsite scenario are shown in Table 2.2.

Table 2.2 Key Parameters for the Closure-by-Removal with On-Site Disposal Scenario – GMF

Parameter	Value	Notes
Surface Area of Impoundment (acres)	31	
In-Place Volume of CCR (CY)	400,000	CCR contained in the GMF is gypsum from flue gas desulfurization.
Volume of Earthen Components of Existing Liner System (CY)	283,000	
Distance to the On-Site Landfill (miles)	1.2	
Required Volume of Borrow Soil (CY)	9,700	Required for landfill expansion.
Volume of Soil Stockpiled at Borrow Soil Location (CY)	86,000	Soil excavated south of the impoundment during construction of the stormwater channel (Site restoration).
Distance to the Borrow Soil Location from the GMF (miles)	0.4	
Distance to the Borrow Soil Location from the On-Site Landfill (miles)	0.7	
Duration of Construction Activities (months)	24-36	
Total On-Site Labor Hours for Major Construction[a]	26,400	
Required On-Site Hauling Truckloads (Loaded)	28,000	
Required Off-Site Hauling Truckloads (Loaded)	0	
Required On-Site Hauling Miles	62,100	
Required Off-Site Hauling Miles	0	

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yards; GMF = Gypsum Management Facility.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction is defined as any operation occurring on-Site that requires one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor is not included if it is limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators is only included in calculations if the hauling occurs on-Site. Workers assigned to relevant activities are assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

2.1.3 Closure-by-Removal with Off-Site Disposal

Under the CBR-Offsite scenario, CCR and existing liner system materials will be excavated from the GMF and sent to an off-Site landfill for final disposal. All of the gypsum in the GMF and the primary composite liner system, the leachate collection and removal system, the geosynthetic components of the secondary composite liner system, and the 3-feet-thick compacted clay layer underlying the GMF will be hauled to the off-Site landfill for disposal (Golder, 2022c,d). IPRG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the GMF as an alternative to disposal.

Excavated materials will be sent to the Peoria City-County Landfill in Brimfield, Illinois (11501 W Cottonwood Road), which is approximately 33 miles from the Site (Appendix B). As is described below in Section 2.4.5, it is possible that the Peoria City-County Landfill will have to be expanded in order to accept all of the CCR and liner materials.

IAC Section 845.710(c)(1) requires Closure-by-Removal (CBR) alternatives to consider multiple methods for transporting CCR off-site, including rail, barge, and trucks. Golder evaluated the feasibility of transporting CCR to the off-Site landfill *via* rail or barge and found that neither option is viable at this Site. Existing loadout facilities, which would facilitate off-Site rail or barge CCR transport, are not present on the property, and the construction of new loadout facilities is considered infeasible. Only transport *via* on-road haul trucks (with a 16.5-cubic-yard capacity) is considered feasible for CBR-Offsite.

The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

The work elements included in this scenario are largely the same as those listed above in Section 2.1.2 for the CBR-Onsite scenario (Appendix B; Golder, 2022c,d):

- Free water removal and dewatering of the GMF.
- Excavation and transport of CCR and liner system materials to the off-Site landfill, as detailed above. All areas affected by CCR releases will be decontaminated, including potential over-excavation below the bottom of the liner system.
- Grading and filling to convey runoff away from the impoundments. This process will include excavation of a surface water channel south of the GMF and removal of sections of the GMF Recycle Pond perimeter dike in order to promote passive stormwater drainage to the southeast of the impoundment.
- Site restoration, including revegetation with native grasses.
- Monitoring at the impoundments for at least 3 years, or until GWPSs are achieved.

Approximately 31 acres of geosynthetic liner system materials, 283,000 cubic yards of earthen liner system materials, 50,000 cubic yards of subsoil overexcavation, and 400,000 cubic yards of gypsum will be excavated from the GMF and hauled to the off-Site landfill for disposal. No borrow soil is required for grading and filling of the GMF under the CBR-Offsite scenario (Appendix B). Finally, approximately 86,000 cubic yards of soil will be excavated during construction of the stormwater channel south of the GMF during Site restoration. This material will be hauled to the borrow soil location for stockpiling (Appendix B).

Under the CBR-Offsite scenario, the expected duration of major construction activities is expected to be 36-48 months at the GMF (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Offsite scenario are shown in Table 2.3.

Table 2.3 Key Parameters for the Closure-by-Removal with Off-Site Disposal Scenario – GMF

Parameter	Value	Notes
Surface Area of Impoundment (acres)	31	
In-Place Volume of CCR (CY)	400,000	CCR contained in the GMF is gypsum from flue gas desulfurization.
Volume of Earthen Components of Existing Liner System (CY)	283,000	
Distance to the Off-Site Landfill (miles)	33	Peoria City-County Landfill in Brimfield, IL.
Required Volume of Borrow Soil (CY)	0	
Volume of Soil Stockpiled at Borrow Soil Location (CY)	86,000	Soil excavated south of the impoundment during construction of the stormwater channel (Site restoration).
Distance to the Borrow Soil Location (miles)	0.4	
Duration of Construction Activities (months)	36-48	
Total On-Site Labor Hours for Major Construction[a]	35,700	
Required On-Site Hauling Truckloads (Loaded)	2,980	
Required Off-Site Hauling Truckloads (Loaded)	50,900	
Required On-Site Hauling Miles	2,380	
Required Off-Site Hauling Miles	3,320,000	

Notes:
CCR = Coal Combustion Residual; CY = Cubic Yards; GMF = Gypsum Management Facility.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction is defined as any operation occurring on-Site that requires one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor is not included if it is limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators is only included in calculations if the hauling occurs on-Site. Workers assigned to relevant activities are assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

2.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1))

2.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))

This section of the report addresses the potential risks to human and ecological receptors due to exposure to CCR-associated constituents in groundwater or surface water. Gradient has performed a Human Health and Ecological Risk Assessment for the Site (Appendix A of this report), which provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors associated with the GMF. This report concluded that there are no current unacceptable risks to any human or ecological receptors. Because groundwater concentrations are expected to remain stable and/or decline under all closure scenarios, there will also be no unacceptable risks to human health or the environment during or following closure at the GMF. Thus, there is no current risk or future risk under any closure scenario at the GMF, and the magnitude of reduction of existing risks is the same under all scenarios.

2.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))

This section of the report quantifies the risk of future CCR releases that may occur during dike failure and storm-related events.

Storm-Related Releases and Dike Failure During Flood Conditions

Engineering analyses show that the existing dikes at the GMF are expected to remain stable under static, seismic, and flood conditions (AECOM, 2016b; Burns & McDonnell, 2021a). Prior to closure (*i.e.*, under current conditions), the risk of dike failure occurring during floods or other storm-related events is therefore minimal. Engineering analyses similarly show that the current risk of sudden CCR releases occurring at the GMF due to overtopping during flood conditions is minimal (AECOM, 2016c; Burns & McDonnell, 2021a). Post-closure, the risks of overtopping and dike failure occurring at the GMF will be even smaller than they are currently. Under the CIP scenario, all free water will be pumped from the GMF and a new cover system will be installed, which will include 24 inches of soil and a geomembrane liner. Construction activities at the GMF under the CIP scenario will also result in improved stormwater management. Relative to current conditions, this cover system and the associated stormwater management improvements will provide increased protection against berm and surface erosion, groundwater infiltration, and other adverse effects that could potentially trigger a dike slope failure event. Under the CBR-Onsite and CBR-Offsite scenarios, all of the CCR in the GMF will be excavated and relocated, eliminating the risk of a sudden CCR release occurring under a dike failure or flood overtopping event. In summary, there is minimal risk of sudden CCR releases occurring during or prior to closure (*i.e.*, under current conditions). Additionally, post-closure there is minimal risk of sudden CCR releases occurring under the CIP scenario, and there is no risk of sudden CCR releases occurring under the CBR-Onsite or CBR-Offsite scenarios.

Dike Failure Due to Seismicity

Sites in Illinois may be subject to seismic risks arising from the Wabash Valley Seismic Zone and the New Madrid Seismic Zone (IEMA, 2020). However, the Duck Creek property does not lie within a seismic impact zone. The property is also believed to have a "low risk level" for seismic risks based on the 2018 United States Geological Survey (USGS) National Seismic Hazard Map. Additionally, the GMF does not lie within 200 feet of an active fault or fault damage zone at which displacement has occurred within the current geological epoch (*i.e.*, within the last ~11,650 years; Burns & McDonnell, 2021b,c; Haley & Aldrich, Inc., 2018a,b). The nearest known fault is the Sicily Fault, which is located about 66 miles southeast of the GMF. The Sicily Fault does not have known recent activity (Haley & Aldrich, Inc., 2018a,b). Thus, the risk of dike failure occurring during or following closure activities due to seismic activity is exceedingly low at the GMF.

2.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C))

The long-term operation and management plans for the GMF are described in Section 2.1 for each closure scenario. In summary, under the CIP scenario, the GMF will undergo monitoring for at least 30 years post-closure, or until such time as GWPSs are achieved. The post-closure care plan under the CIP scenario additionally includes periodic inspections and mowing and maintenance of the final cover system for the GMF. Under the CBR-Onsite and CBR-Offsite scenarios, the GMF will undergo monitoring for 3 years post-closure, or until such time as GWPSs are achieved.

2.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D))

2.2.4.1 Worker Risks

Best practices will be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate risks to workers during construction activities, both on- and off-Site. On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during construction activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization and demobilization, material deliveries, and the hauling of CCR and liner system materials to the on-Site landfill and the off-Site landfill.

Risk of Worker Accidents Occurring On-Site

For the GMF, three closure scenarios were considered: CIP, CBR-Offsite, and CBR-Onsite. Based on labor requirements reported in Appendix B of this report, Gradient estimates that 14,600 total on-Site labor hours are required for major construction activities under the CIP scenario, 26,400 on-Site labor hours are required for major construction activities under the CBR-Onsite disposal scenario, and 35,700 on-Site labor hours are required for major construction activities under the CBR-Offsite scenario. The CIP scenario therefore requires the smallest number of on-Site labor hours for major construction activities across all scenarios.

The United States Bureau of Labor Statistics (US BLS) (US DOL, 2020a,b) provides an estimate of the hourly fatality and injury rates for construction workers. Based on the accident rates reported by US BLS and the on-Site labor hours reported above, we estimate that approximately 0.17 worker injuries and 0.0011 worker fatalities will occur on-Site under the CIP scenario due to major construction activities at the GMF (Table 2.4). Approximately 0.30 worker injuries and 0.0020 worker fatalities are expected to occur under the CBR-Onsite scenario, and approximately 0.41 worker injuries and 0.0027 worker fatalities are expected to occur under the CBR-Offsite scenario (Table 2.4). Thus, the expected number of worker accidents occurring on-Site due to major construction activities is smallest under the CIP scenario and is largest under the CBR-Offsite scenario. Note that the calculations presented here focus on major construction activities (*e.g.*, excavation, loading, and hauling). They therefore do not account for the additional accidents that could occur on-Site during less intensive construction activities (*e.g.*, surveying, erosion control, and hydroseeding).

Table 2.4 Expected Number of On-Site Worker Accidents Under Each Closure Scenario – GMF

Closure Scenario	Injuries	Fatalities
CIP	0.17	0.0011
CBR-Onsite	0.30	0.0020
CBR-Offsite	0.41	0.0027

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CIP = Closure-in-Place; GMF = Gypsum Management Facility.

Concurrently with closure activities, a utility-scale solar facility will be constructed on the Duck Creek Site. The simultaneous pursuit of closure-related construction and solar facility construction may lead to significant traffic congestion on Site access roads, resulting in greater overall risks to workers than would result from closure or solar re-development alone. Conflicts are particularly likely to arise during GMF closure (relative to BAB closure), because it is expected to take 1-4 years to complete and involve major earthmoving operations. For the GMF, the CIP scenario requires less total hauling activity than either of the two CBR scenarios (Tables 2.1-2.3). The CIP scenario can also be completed within a shorter time frame than the two CBR scenarios (12-24 months *versus* 24-48 months). The CIP scenario is therefore expected to result in less congestion on Site access roads during Site re-development – and, hence, a smaller increase in the risks to workers – than either the CBR-Onsite or CBR-Offsite scenarios.

Risk of Worker Accidents Occurring Off-Site

The CBR-Offsite scenario is the only scenario which requires any off-Site hauling. Under the CBR-Offsite scenario, 3,320,000 vehicle travel miles are required to haul excavated materials from the GMF to the off-Site landfill (Tables 2.1-2.3). The United States Department of Transportation (US DOT, 2020) provides an estimate of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks. Based on US DOT's statistics, an estimated 0.42 injuries and 0.0096 fatalities are expected to occur to drivers and passengers of haul trucks due to off-Site hauling under the CBR-Offsite scenario during closure of the GMF (Table 2.5).

Table 2.5 Expected Number of Off-Site Worker Accidents Due to Hauling Under Each Closure Scenario – GMF

Closure Scenario	Injuries	Fatalities
CIP	0	0
CBR-Onsite	0	0
CBR-Offsite	0.42	0.0096

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CIP = Closure-in-Place; Gypsum Management Facility.

These estimates reflect the minimum number of worker accidents that are likely to occur off-Site under each scenario, because they do not account for the additional vehicle accidents that may occur during non-hauling activities such as labor mobilization and demobilization, equipment mobilization and demobilization, and material deliveries. The vehicle mileages associated with these off-Site activities are not known. However, the mileages associated with these activities are expected to scale with the duration and intensity of the planned construction activities under each scenario. The CIP scenario is the closure scenario with the shortest expected duration of construction activities, the smallest required volume of CCR dewatering and handling, the least amount of total on-Site labor hours for major construction, and the least amount of required hauling truckloads (Tables 2.1-2.3). This scenario is therefore also likely to have the smallest amount of off-Site activity due to labor and equipment mobilization/demobilization and material deliveries – and, hence, the smallest number of off-Site vehicle accidents arising from these activities.

Taking into account both (i) accidents occurring on-Site due to major construction activities and (ii) accidents occurring off-Site due to hauling, a minimum of 0.17 worker injuries and 0.0011 worker fatalities are expected to occur during GMF closure under the CIP scenario. An estimated 0.30 worker injuries and 0.0020 worker fatalities are expected to occur during GMF closure under the CBR-Onsite scenario, and an estimated 0.84 worker injuries and 0.012 worker fatalities are expected to occur during GMF closure under the CBR-Offsite scenario. Thus, for the GMF, the overall risks to workers are likely to be highest under the CBR-Offsite scenario and lowest under the CIP scenario.

2.2.4.2 Community Risks

Accidents

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members, as well as workers. Based on the accident statistics for large trucks reported by US DOT (2020) and the off-Site haul truck mileages reported above for the GMF, haul truck accidents could result in an estimated 1.2 injuries and 0.044 fatalities among community members (*i.e.*, people involved in haul truck accidents that are neither haul truck drivers nor passengers, including pedestrians, drivers of other vehicles, *etc.*) under the CBR-Offsite scenario due to hauling of excavated materials from the GMF (Table 2.6). In contrast, no fatalities or injuries are expected to occur among community members under the CBR-Onsite or CIP scenarios due to haul truck accidents, because borrow soil will be taken from a location on the property and any excavated materials will be hauled to an off-Site landfill.

Table 2.6 Expected Number of Community Accidents Due to Hauling Under Each Closure Scenario – GMF

Closure Scenario	Injuries	Fatalities
CIP	0	0
CBR-Onsite	0	0
CBR-Offsite	1.2	0.044

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal; CIP = Closure-in-Place; GMF = Gypsum Management Facility.

In addition to impacts due to off-Site hauling, all scenarios may have off-Site impacts due to labor mobilization and demobilization, equipment and vehicle mobilization and demobilization, and material deliveries. As described above (Risk of Worker Accidents Occurring Off-Site), the CIP scenario is likely to require the smallest amount of off-Site activity due to these off-Site vehicle uses – and, hence, the smallest number of off-Site vehicle accidents arising from these activities – across all scenarios evaluated for the GMF.

Traffic

Haul routes are expected to use major arterial roads and highways wherever possible, which will reduce the incidence of traffic. However, the heavy use of local roads for construction operations may result in traffic near the Site and, in the case of the CBR-Offsite scenario, the off-Site landfill.

Traffic may increase temporarily around the Site under all three closure scenarios due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts are expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries). These impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site under the CBR-Offsite scenario.

Under the CBR-Offsite scenario, Golder estimates that approximately 50,900 truckloads will be required to transport excavated materials from the GMF to the off-Site landfill over 1,220 hauling days (Appendix B). Assuming a 10-hour work day, 6 work days per week, and 26 work days per month, a haul truck would therefore need to pass a given location near the Site once every 7.2 minutes on average for the duration of excavation activities under the CBR-Offsite scenario for the GMF. Thus, traffic demands are considerable. This level of traffic (one truck passing a location approximately once every 7.2 minutes) could potentially cause traffic delays on local roads and cause damage to local roadways. It could also cause delays in the re-development of the Site for use in utility-scale solar generation.

Noise

Construction generates a great deal of noise, both in the vicinity of the Site and along haul routes. In a closure impact analysis performed by the Tennessee Valley Authority (TVA, 2015), the authors found that "[T]ypical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance … at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft." Because there are no residences or businesses within 1,500 feet of any of the construction areas on the Site (the GMF, the proposed borrow site, and the on-Site landfill), we do not anticipate that any residences or businesses will be adversely impacted by noise pollution at the Site under any closure scenario. Moreover, although there are several scenic, recreational, and historical areas located within a few miles of the Site (the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites), there are no notable scenic or recreational areas located within 1,500 feet of any of the construction areas on the Site. Noise impacts are therefore expected to be relatively minor under all closure scenarios.

In addition to impacts in the immediate vicinity of the GMF, local roads near the Site and the off-Site landfill (CBR-Offsite scenario only) may experience noise pollution due to high volumes of truck traffic. As described above (Traffic), the construction schedule under the CBR-Offsite scenario requires haul trucks to pass by a given location every 7.2 minutes on average for 10 hours each day while excavation is occurring at the GMF. Dump trucks generate significant noise pollution, with noise levels of approximately 88 decibels or higher expected within a 50-foot radius of the truck (Exponent, 2018). This noise level is similar to the noise level of a gas-powered lawnmower or leaf blower (CDC, 2019). Decibel levels above 80 can damage hearing after 2 hours of exposure (CDC, 2019). In addition to haul truck impacts, noise pollution may also arise along local roads from the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. These impacts are expected to largely occur at the beginning or end of each work day (for the arrival/departure of the work force), at the beginning or end of the construction period (for equipment mobilization/demobilization), and at specific times throughout the construction period (for material deliveries); these impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site.

Air Quality

Construction can adversely impact air quality. Air pollution can occur both on-Site and off-Site (*e.g.*, along haul routes), potentially impacting workers as well as community members. With regards to construction activities, two categories of air pollution are of particular concern: equipment emissions and fugitive dust. The equipment emissions of greatest concern are those found in diesel exhaust. Most construction equipment is diesel-powered, including the dump trucks used to haul material to and from the Site. Diesel exhaust contains hundreds of air pollutants, including nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOCs) (Hesterberg *et al.*, 2009; Mauderly and Garshick, 2009). Fugitive dust, another major air pollutant at construction sites, is generated by earthmoving operations and other soil- and CCR-handling activities. Along haul routes, an additional source of fugitive dust is road dust along unpaved dirt roads. Careful planning and the use of Best Management Practices (BMPs) such as wet suppression are used to minimize and control fugitive dust during construction activities; however, it is not possible to prevent dust generation entirely.

The air pollutant mass released under a given closure scenario will be proportional to the expected duration and intensity of construction activities under that scenario. As initially described in Section 2.2.4.1 (Worker Risks), the CIP scenario is the GMF closure scenario with the shortest expected duration of construction activities, the smallest required volumes of CCR dewatering and handling, the least amount of total on-Site labor hours for major construction, and the least amount of required hauling truckloads. This scenario is therefore likely to result in the least amount of air emissions of the three closure scenarios.

Environmental Justice

The State of Illinois defines environmental justice (EJ) communities to be those communities with a minority population above twice the state average and/or a total population below twice the state poverty rate (IEPA, 2019). Relative to other communities, EJ communities experience an increased risk of adverse health impacts due to environmental pollution and other factors associated with remediation activities (US EPA, 2016).

As shown in a map of EJ communities throughout the state (Figure 2.1; IEPA, 2019), the on-Site landfill, the borrow site, and a portion of the GMF are all located within the one-mile buffer zone of the nearest EJ community (near Canton). Due to its close proximity to the Site, the EJ community near Canton may be disproportionately impacted by air emissions, traffic, accidents and other factors arising from various closure activities occurring on or near the Site. Activities occurring near the GMF, the borrow site, and the on-Site landfill may have particularly negative impacts. Unfortunately, each of the evaluated closure scenarios requires significant construction activity in at least one of these three on-Site areas.

In addition to impacts arising from construction activity on or near the Site, EJ communities may be also impacted by off-Site activities, including the hauling of CCR and liner materials from the Site to the off-Site landfill, labor and equipment mobilization/demobilization, and material deliveries. Unfortunately, in addition to being located near the on-Site landfill, the borrow site, and the GMF, the EJ community near Canton is also located along the three primary haul routes from the Site to the off-Site landfill suggested by Google Maps (Google LLC, 2021). In summary, due to both on-Site and off-Site activities, all possible closure scenarios are associated with potential negative impacts on the EJ community near Canton (Figure 2.1).

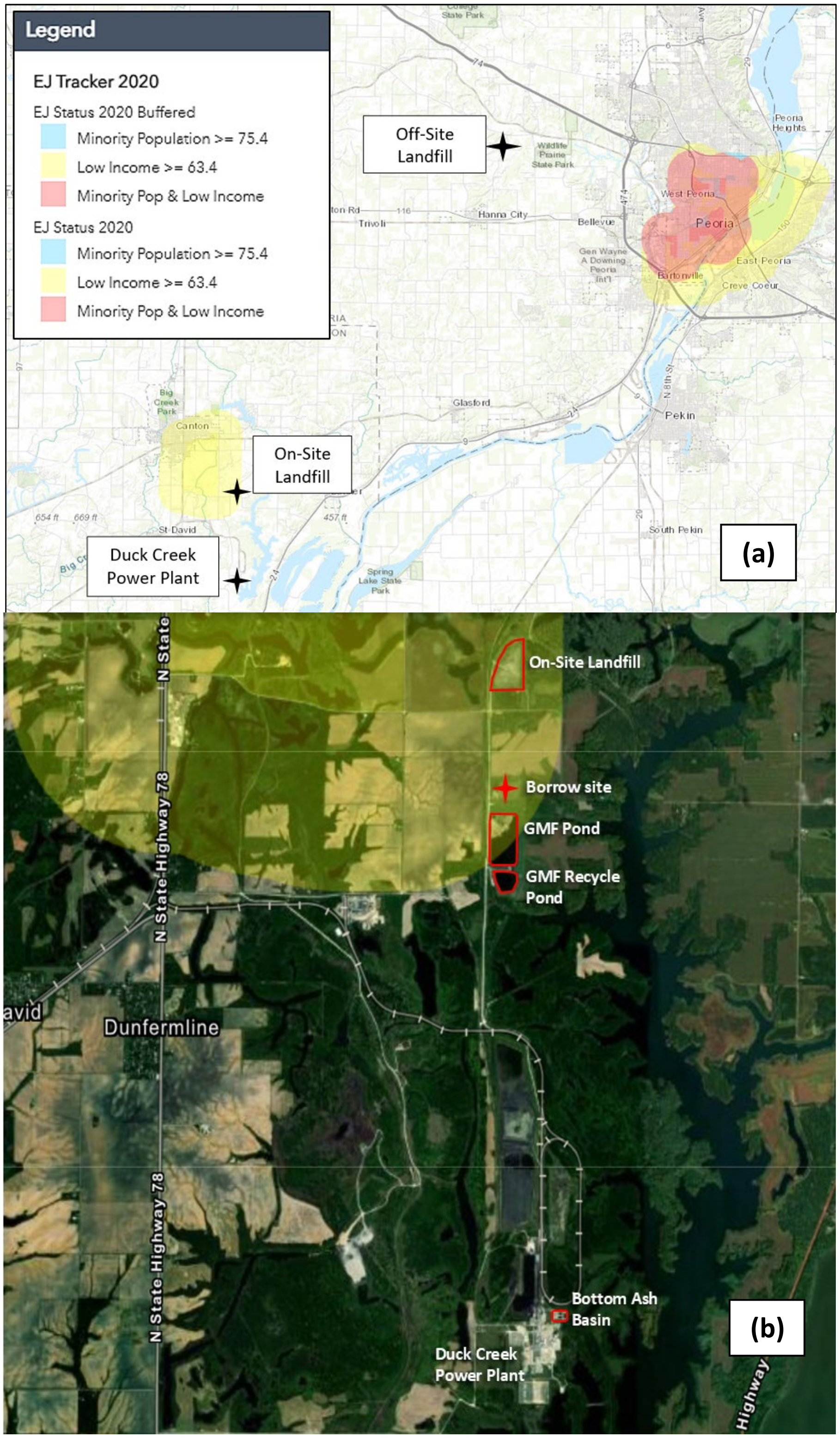


Figure 2.1 Environmental Justice Communities in the Vicinity of Site Features and the Off-Site Landfill – GMF. Adapted from IEPA (2019). (a) Regional map. (b) Site map.

Scenic, Historical, and Recreational Value

There are several scenic, recreational, and historical areas located within a few miles of the Site, including the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites (Google LLC, 2021; Ramboll, 2021b,c). However, there are no notable scenic or recreational areas located in the immediate vicinity of the GMF, the borrow soil location, or the on-Site landfill. The nearest scenic, recreational, or historical area is the Rice Lake SFWA, which is located over 2.5 miles from the GMF, the borrow soil location, and the on-Site landfill. We therefore do not expect construction activities at the Site to have any direct negative impacts on the scenic, historical, or recreational value of the areas listed above (due to, *e.g.*, noise, obstructions of the view, or restricted access), regardless of the closure scenario.

2.2.4.3 Environmental Risks

Greenhouse Gas Emissions

In addition to the air pollutants listed above in Section 2.2.4.2, construction equipment emits greenhouse gas emissions (GHGs), including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each closure scenario on GHG emissions is similar to the potential impact of each closure scenario on other emissions from construction vehicles and equipment, as described above in Section 2.2.4.2. For the GMF, the CIP scenario has the shortest duration of construction activities and requires the least amount of CCR dewatering and handling; this scenario is therefore likely to have the lowest amount of predicted GHG emissions.

We did not quantify the carbon footprint of the approximately 31 acres of 40-mil LLDPE geomembrane liner required for the final GMF cover system under the CIP scenario, or the carbon footprint of the additional composite liner that will be required for the upstream slope of the berm to be constructed under this scenario (Appendix B). The carbon footprint of these geomembranes (*i.e.*, the fossil fuel emissions required to manufacture them) is an additional source of GHG emissions at the Site under the CIP scenario. Expansion of the on-Site landfill and the potential expansion of the off-Site landfill under the CBR-Onsite and CBR-Offsite scenarios would have an additional, unquantified carbon footprint due to the manufacture of geomembranes used in the expanded landfill liners.

Energy Consumption

Energy consumption at a construction site is synonymous with fossil fuel consumption, because the energy to power construction vehicles and equipment comes from the burning of fossil fuels. Fossil fuel demands considered in this analysis include the burning of diesel fuel during construction activities and the carbon footprint of manufacturing geomembrane textiles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed above with respect to GHG emissions also apply to the evaluation of energy demands. In summary, for the GMF, the energy requirements of construction are expected to be smallest under the CIP scenario. We did not quantify the energy demands of the geomembranes required for the construction of the final GMF cover system or the new GMF berm under the CIP scenario, the geomembranes required for the expansion of the on-Site landfill under the CBR-Onsite scenario, or, potentially, the geomembranes required for expansion of the off-Site landfill under the CBR-Offsite scenario.

The Duck Creek Site is slated for re-development as a utility-scale solar power generating facility. At the grid scale, solar generation will add energy back onto the grid and reduce reliance on non-renewable energy sources. In the short-term, closure activities at the Site may delay and obstruct these re-development efforts. The magnitude of expected delays will scale with the expected duration and intensity of construction activities during closure. For the GMF, the CIP scenario requires less total hauling activity than either of the two CBR scenarios (Tables 2.1-2.3). The CIP scenario can also be completed within a shorter time frame than the two CBR scenarios (12-24 months *versus* 24-48 months). The CIP scenario is therefore expected to result in fewer delays to re-development than either the CBR-Onsite or CBR-Offsite scenarios.

Natural Resources and Habitat

Construction is likely to have a negative short-term impact on the natural resources and habitat in the vicinity of the GMF and the on-Site borrow soil location. For example, excavation of the impoundment and the borrow soil location could result in the destruction of some habitat that may currently overlie these areas under all closure scenarios. Closure could also result in long-term shifts in the habitat overlying the impoundment and the borrow soil location (*e.g.*, areas of the impoundment that are not currently grassland would be converted to grassland). Use of the on-Site and off-Site landfill under the CBR-Onsite and CBR-Offsite scenarios, in contrast, is not expected to result in significant habitat changes, because these landfills are already in use.

In addition to direct impacts on the existing habitat atop the impoundment and the borrow soil location, construction activities may have indirect impacts by causing alarm and escape behavior in wildlife near these locations. For the GMF, the duration of time over which the direct and indirect habitat impacts of construction will occur (*i.e.*, the duration of construction activities) is longest under the two CBR scenarios (24-48 months) and shortest under the CIP scenario (12-24 months). Thus, negative short-term impacts on natural resources and habitat are expected to be smallest under the CIP scenario.

The GMF is not located immediately adjacent to wetlands or notable surface water bodies, such as rivers or lakes (US FWS, 2021). For this reason, construction activities in the vicinity of the GMF are not expected to have a significant negative impact on any wetland or aquatic species (due to, *e.g.*, erosion and sediment runoff). Impacts are expected to be limited to terrestrial species. According to the Illinois Department of Natural Resources (IDNR) Natural Heritage Database and the United States Fish & Wildlife Service (US FWS) Environmental Conservation Online System, there are 11 state threatened species, 12 state endangered species, three federally threatened species, and one federally endangered species within Fulton County (Ramboll, 2021b,c). To our knowledge, however, no threatened or endangered species have been identified at the Site (Ramboll, 2021b,c). Based on the information that is currently available, we do not expect construction activities to have negative impacts on any threatened or endangered species.

2.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))

The primary groundwater migration pathway near the GMF is within the shallow sand unit within the uppermost aquifer. Groundwater flow in the shallow sand unit is generally in a northwest to southeast direction. Seasonal variation in groundwater levels at the GMF occurs and can result in groundwater elevation fluctuations of approximately 1-10 feet. There is no observable seasonal variation in groundwater flow direction at the GMF associated with these groundwater elevation changes. Groundwater flows toward the Duck Creek Cooling Pond, which is located approximately 2,100 feet east of the GMF (Ramboll, 2022).

Based on a statistical analysis and evaluation of potential exceedances, it was determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the GMF (Ramboll, 2022). However, a groundwater model was developed to evaluate whether groundwater concentrations would maintain compliance with the GWPSs post-closure under the CIP scenario. For this evaluation, a groundwater flow model was developed and calibrated in MODFLOW. Contaminant transport was evaluated using MODPATH, and vertical percolation from the GMF into groundwater was evaluated using the HELP model (Ramboll, 2022).

The results of contaminant transport modeling *via* particle tracking for the CIP scenario at the GMF indicate that all particles will remain within the footprint of the GMF. Over a model-simulated period of 100 years following closure by CIP, the mean travel distance of all particles within the liner system and gypsum in the GMF was 0.29 feet horizontally and 0.03 feet vertically (Ramboll, 2022). Based on these modeling results, it was concluded that groundwater concentrations under the CIP scenario are expected to maintain compliance with the GWPSs well into the future (Ramboll, 2022).

2.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F))

Section 2.2.1 evaluates potential risks to human and ecological receptors arising from the potential leaching of CCR-associated constituents from the GMF. Section 2.2.2 evaluates the potential for sudden CCR releases to occur at the GMF due to, *e.g.*, dike failure or overtopping during floods or other storm-related events. In summary, under all evaluated closure scenarios, there is no current or future risk to any human or ecological receptors associated with the GMF. Additionally, there is minimal current or future risk of overtopping due to flood conditions. Dike failure due to, *e.g.*, seismic activity and storm-related events is also exceedingly unlikely.

Section 2.2.4 evaluates several potential risks to human health and the environment during closure activities, including risks of accidents occurring among workers; risks to nearby residents and EJ communities related to accidents, traffic, noise, and air pollution; and risks to natural resources and wildlife. The findings from this section of the text are summarized in Table S.1.

2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

As described in Section 2.2.2, there is minimal risk of engineering or institutional failures leading to sudden releases of CCR from the GMF post-closure under the CIP scenario. Under the CBR-Onsite and CBR-Offsite scenarios, there is no risk of engineering or institutional failures leading to sudden releases of CCR post-closure. Additionally, there are no current or future unacceptable risks to any human or ecological receptors associated with the GMF under any of the closure scenarios (see Section 2.2.1 above). Moreover, reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will be implemented at the on-Site and off-Site landfills under the CBR-Onsite and CBR-Offsite scenarios. All of the evaluated closure scenarios are therefore reliable with respect to long-term engineering and institutional controls.

2.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H))

At this time, we do not anticipate a need for corrective action at the GMF under any closure scenario.

2.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))

2.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))

The gypsum in the GMF currently poses no unacceptable risks to human health or the environment (Section 2.2.1). Because current conditions do not present a risk to human health or the environment, and groundwater concentrations are expected to remain stable and/or decline post-closure, there will also be no unacceptable risks to human health or the environment following closure of the impoundments, regardless of the closure scenario.

Section 2.2.2 discussed the potential for dike failure or flood overtopping to occur during or following closure activities, resulting in a sudden release of CCR. That analysis showed that there is minimal risk of CCR releases occurring at the GMF following closure under any closure scenario.

2.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))

At this time, we do not anticipate a need for the use of treatment technologies other than source control (*i.e.*, CIP, CBR-Onsite, and CBR-Offsite) at the GMF under any closure scenario.

2.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))

2.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative

CIP using a final cover system is a reliable and standard method for closing impoundments. However, dewatering and relocating saturated gypsum as part of closure activities at the GMF may be moderately challenging. Careful planning will be required to work safely on the wet gypsum within the GMF.

Excavation and landfilling of CCR is also a reliable and standard method for closing impoundments. However, relative to CIP, CBR-Onsite, and CBR-Offsite pose additional implementation difficulties due to higher earthwork volumes, higher dewatering volumes, and longer construction schedules. Dewatering the gypsum in the GMF prior to excavation will require considerable effort and time. Removal and disposal of the existing bottom liner geomembranes may also prove challenging during CBR activities. Specifically, it may be difficult to remove and handle the geomembranes. Additionally, the geomembranes may need to be decontaminated prior to disposal. Finally, the geomembranes may not be accepted for disposal at the off-Site landfill.

Hauling will be easier to implement under the CBR-Onsite scenario than under the CBR-Offsite scenario, due to less haul traffic on public roadways. Additionally, because the CBR-Offsite scenario involves hauling CCR off-Site (*i.e.*, intrastate travel), a higher level of dewatering will be required compared to the CBR-Onsite scenario. As described in Section 2.2.4.2 ("Community Risks"), off-Site hauling may also have detrimental community impacts due to an increased incidence of vehicle accidents, truck traffic, noise, and air pollution.

In addition to off-Site hauling, off-Site landfilling under the CBR-Offsite scenario may pose particular challenges. A disposal plan will need to be developed between IPRG and the owner/operator of the third-party landfill in order to outline acceptable waste conditions upon delivery, daily waste production rates, and the expected duration of the project. Off-Site landfilling may additionally raise issues related to the co-disposal of CCR and liner materials and other non-hazardous wastes. Finally, the construction schedule for excavation may be negatively impacted if, during the course of closure, it is determined that the off-Site landfill must be expanded in order to receive all of the materials excavated from the GMF.

2.4.2 Expected Operational Reliability of the Closure Alternative

The operational reliability of the CIP scenario, the CBR-Onsite scenario, and the CBR-Offsite scenario is expected to be similar. The GMF currently includes a bottom liner system, and CIP will utilize a final cover system that includes a geomembrane. Under the CIP scenario, the gypsum in the GMF will therefore be surrounded by an engineered containment system on the top, sides, and bottom. The CBR-Offsite and CBR-Onsite scenarios similarly involve placing the gypsum from the GMF in an engineered landfill system that has a bottom liner, leachate collection system, and final cover system, resulting in the gypsum being surrounded by an engineered containment system on the top, sides, and bottom. The operational reliability of all three closure scenarios is therefore expected to be similar for both impoundments. Moreover, high operational reliability is expected under all scenarios due to the full containment of CCR and liner materials.

2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

Permits and approvals will be needed under all closure scenarios. Components of the three closure scenarios that are expected to require a permit include:

- A modification to the existing NPDES permit through IEPA to allow the disposal of water generated from unwatering and dewatering operations to the Illinois River *via* the existing NPDES-permitted outfall for the Site;
- A construction permit from the IDNR, Office of Water Resources, Dam Safety Program to allow the embankment and spillways of the impoundment to be modified as part of closure;
- A construction stormwater permit through IEPA, including construction stormwater controls and other BMPs such as silt fences and other measures; and
- A joint water pollution control construction and operating permit (WPC permit).

As discussed below in Section 2.4.5, the existing on-Site landfill will require expansion under the CBR-Onsite scenario in order to accommodate all of the material excavated from the GMF. The on-Site landfill has already been permitted for an expansion of an additional 2 acres of waste disposal area. Under the CBR-Offsite scenario, it may similarly be necessary to expand the off-Site landfill. Additional permitting may be required under this scenario for transport of the CCR and to expand the off-Site landfill. It may also be necessary to modify the operating plan for the off-Site landfill in order to accommodate the increased rate of filling of the landfill and the likely need for additional equipment and personnel to manage the receipt and disposal of the CCR and liner system materials.

2.4.4 Availability of Necessary Equipment and Specialists

CIP, CBR-Onsite, and CBR-Offsite are reliable and standard methods for managing waste that rely on common construction equipment and materials and typically do not require the use of specialists, outside of typical construction labor and equipment operators. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment under all scenarios, if supply chain resilience does not improve by the time of construction. Alternatively, extended downtime may be required for equipment repairs and maintenance. A national shortage of truck drivers has also developed during the COVID-19 pandemic. Due to higher earthwork volumes and a longer construction schedule under the CBR-Onsite and CBR-Offsite scenarios than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR-Onsite and CBR-Offsite scenarios than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volume of CCR and liner materials to be hauled from the Site. If sufficient trucks and truck drivers are not available, the construction schedule at both impoundments may lengthen based on hauling-related delays.

The availability of critical materials such as metal, wood, and electronic chips has also been impacted by the COVID-19 pandemic. However, soil materials and geomembrane liner materials have generally been available during 2021 for landfill development and closure projects.

2.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

Under the CIP scenario, the gypsum currently within the GMF will be consolidated and stored within the existing footprint of the impoundment. The GMF will be unwatered at the start of construction *via* pumping. Pumped water will be managed in accordance with the facility's NPDES permit. Treatment is not expected to be necessary prior to discharge.

The existing landfill on the Duck Creek property does not have sufficient capacity to receive all of the CCR and liner materials that are currently slated for landfilling under the CBR-Onsite scenario. Expansion of the on-Site landfill would thus be necessary. The on-Site landfill is already permitted for added waste disposal capacity, which would create an additional 2 acres of landfill area (Appendix B). The landfill expansion could be completed in a single construction season during the removal of ponded water at the GMF.

Under the CBR-Offsite scenario, up to 733,000 cubic yards of gypsum, liner materials, and additional subsoil overexcavation and 31 acres of geosynthetic liner system materials excavated from the GMF will require disposal at an off-Site landfill. An additional 7,000 cubic yards of material excavated from the BAB would also require disposal at the off-Site landfill, if CBR-Offsite were selected for the BAB. According to the IEPA "Illinois Landfill Disposal Capacity Report" for 2020 (IEPA, 2021b), the closest third-party landfill with the ability to receive and dispose of CCR from the Site is the Peoria City-County Landfill in Brimfield, Illinois. This facility has 750,000 cubic yards of remaining capacity in its current permitted footprint. It receives 230,000 cubic yards of waste annually, and is located 33 miles from the Site. The Peoria City-County Landfill therefore has sufficient capacity to receive all of the CCR and liner materials from the GMF. However, due to the limited space remaining in this landfill and the short time frame over which CCR would be received at the landfill, vertical and/or lateral expansions may become necessary. Additionally, the landfill operators may need to develop a disposal plan to account for the increased volume of material that will be received and the unique CCR and liner system waste characteristics. Elements of this disposal plan might include increasing daily operational capacity and procedures, expediting planned airspace construction, and potentially expediting landfill expansion. If expansion of the Peoria City-County Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A likely alternative to the Peoria City-County Landfill is the Envirofil of IL Landfill in Macomb, Illinois. It has 7,700,000 cubic yards of remaining capacity in its current permitted footprint, receives 97,000 cubic yards of waste annually, and is located approximately 45 miles from the Site (IEPA, 2021b).

2.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))

As demonstrated in Gradient's Human Health and Ecological Risk Assessment (Appendix A of this report), modeled surface water concentrations in the Illinois River in the vicinity of the Site are all below relevant human health and ecological screening benchmarks. Due to closure activities, surface water concentrations of CCR-associated constituents are expected to remain stable and/or decline over time under all three closure scenarios. Thus, no future exceedances of any human health or ecological screening benchmarks are anticipated under any closure scenario. Additionally, the lined landfills that will receive any materials excavated from the GMF under the CBR-Onsite and CBR-Offsite scenarios will be managed to ensure that no surface water impacts occur in the vicinity of the landfills.

2.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))

Several nonprofits representing community interests near the Site have raised concerns regarding the potential impacts of coal ash impoundments at this Site on groundwater and surface water quality, including Earthjustice, the Prairie Rivers Network, and the Sierra Club (Earthjustice *et al*., 2018; Sierra Club, 2014; Sierra Club and CIHCA, 2014). These parties generally prefer CBR to CIP, citing fears that allowing CCR to remain in place "allows the widespread groundwater contamination to continue indefinitely" (Earthjustice *et al*., 2018, p. 24). For the GMF, both CIP and CBR are being considered; however, it is not the case that closing the GMF *via* CIP rather than CBR would result in undue risks to groundwater and surface water post-closure. As described in Sections 2.2.1 and 2.2.2, no current or future unacceptable risks to human or ecological receptors are associated with the GMF under any closure scenario. There is also minimal risk of future CCR releases occurring under any closure scenario. Furthermore, based on a model-simulated period of 100 years, groundwater concentrations under the CIP scenario are expected to maintain compliance with the GWPSs post-closure (Ramboll, 2022). In summary, all closure scenarios are responsive to residents' concerns regarding groundwater and surface water quality.

For the GMF, the CIP scenario has advantages over the CBR-Offsite and CBR-Onsite scenarios with regard to likely community concerns. Specifically, compared to the other evaluated alternatives, CIP presents fewer risks to workers and community members during construction in the form of accidents, traffic, and air pollution (Section 2.2.4 above) and is also associated with the shortest time to closure. By minimizing the expected time to closure, CIP minimizes the duration of negative impacts arising from construction activities and minimizes the time required to re-develop the Site for use in utility-scale solar generation. Re-development of the Site for use in solar generation and storage will bring new jobs to the community and contribute positively to Illinois's growing renewable energy portfolio.

A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

2.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1))

A cost estimate has been prepared for each of the closure scenarios (Appendix B). A summary of these estimates is provided in Table 2.7. The total expected cost of closure under the CIP scenario is $6,210,000. The total expected cost of closure under the CBR-Onsite scenario is $8,870,000. The total expected cost of closure under the CBR-Offsite scenario is $82,400,000. Costs under the CIP scenario are therefore considerably smaller than costs under the CBR-Onsite and CBR-Offsite scenarios.

Table 2.7 Expected Costs of Closure – GMF

Work Element	CIP	CBR-Onsite	CBR-Offsite
Mobilization/Demobilization	$488,000	$727,000	$6,810,000
Surveying and Site Preparation	$125,000	$50,000	$25,000
Dewatering, Unwatering, and Stormwater Management	$2,260,000	$2,310,000	$2,280,000
Impoundment Closure and Site Restoration	$2,800,000	$4,660,000	$65,800,000
Landfill Expansion	$0	$331,000	$0
Miscellaneous Construction	$537,000	$800,000	$7,490,000
Total:	**$6,210,000**	**$8,870,000**	**$82,400,000**

Notes:
CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal; CIP = Closure-in-Place; GMF = Gypsum Management Facility.
Costs are for comparative purposes only. Actual costs will be paid based on actual quantities and may vary from those calculated.
Source: Appendix B.

All three closure scenarios meet or exceed a Class 4 estimate under the Association for the Advancement of Cost Engineering (AACE) Classification Standard (or a comparable classification practice as provided in the AACE Classification Standard), as required by IAC Section 845.710 (IEPA, 2021a).

2.8 Summary

Table S.1 (Summary of Findings) summarizes the expected impacts of the CIP, CBR-Onsite, and CBR-Offsite closure scenarios with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on this evaluation and the details provided in Section 2 above, CIP has been identified as the most appropriate closure scenario for the GMF. Key benefits relative to other closure scenarios include the more rapid re-development of the Site for use in utility-scale solar generation and reduced impacts on workers, community members, and the environment during construction (*e.g.*, fewer constructed-related accidents, lower energy demands, less air pollution and GHG emissions, and less traffic).

3 Closure Alternatives Analysis – BAB

3.1 Closure Alternative Descriptions (IAC Section 845.710(c))

This section of the report presents a CAA for the BAB pursuant to requirements under IAC Section 845.710 (IEPA, 2021a). For the BAB, Gradient evaluated two closure scenarios: CBR-Onsite and CBR-Offsite. CIP was not evaluated for the BAB because no significant CCR remains in the impoundment. Sections 3.1.1 and 3.1.2 describe the CBR-Onsite and CBR-Offsite closure scenarios. These scenarios are based on information and analyses conveyed to Gradient by Golder (Appendix B; Golder, 2022c,d).

3.1.1 Closure-by-Removal with On-Site Disposal

Under the CBR-Onsite scenario, CCR and existing liner system materials will be excavated from the BAB and sent to the on-Site landfill for final disposal. Excavation activities at the BAB will include any residual CCR that is still present in the impoundment; the concrete, compacted clay, and geomembrane components of the existing liner system; and additional subsoil overexcavation (Golder, 2022c,d). Excavated materials from the BAB will be hauled to the on-Site landfill (Appendix B; Golder, 2022d).

The on-Site landfill is located approximately 3.7 miles north of the BAB *via* Site roads (Appendix B). Excavated materials will be hauled to the landfill using haul trucks. The landfill on the property is currently expected to have sufficient capacity to receive all of the materials from the BAB slated for disposal under the CBR-Onsite scenario. This scenario meets the requirements of IAC Section 845.710(c)(2) (IEPA, 2021a) which requires an assessment be included in the CAA of whether the Site has an on-Site landfill with available capacity or whether an on-Site landfill can be constructed.

This scenario includes the following work elements for the closure of the BAB (Appendix B; Golder, 2022c,d):

- Excavation and transport of CCR and liner system materials to the on-Site landfill, as detailed above.
- Grading and filling to convey runoff away from the impoundments.
- Site restoration, including revegetation with native grasses.
- Three years of monitoring at the impoundments, or until such time as GWPSs are achieved.

In total, approximately 3,550 cubic yards of concrete and compacted clay, 1 acre of geomembrane materials from the existing liner system, and 3,200 cubic yards of overexcavated subsoil will be excavated from the BAB under the CBR-Onsite scenario and hauled to the on-Site landfill for disposal. The selected borrow soil location is approximately 3.4 miles north of the BAB *via* Site roads (Appendix B). A total of 17,500 cubic yards of borrow soil are required for grading and filling of the BAB (Appendix B).

Under the CBR-Onsite scenario, the expected duration of major construction activities is approximately 12-18 weeks (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Onsite scenario are shown in Table 3.1.

Table 3.1 Key Parameters for the Closure-by-Removal with On-Site Disposal Scenario – BAB

Parameter	Value	Notes
Surface Area of Impoundment (acres)	2.2	Includes all three cells and the area around the cells.
In-Place Volume of CCR (CY)	Minimal	The CCR in the impoundment has been excavated previously.
Distance to the On-Site Landfill (miles)	3.7	
Required Volume of Borrow Soil (CY)	17,500	Required for grading and filling.
Volume of Soil Stockpiled at Borrow Soil Location (CY)	0	
Distance to the Borrow Soil Location (miles)	3.4	
Duration of Construction Activities (weeks)	12-18	
Total On-Site Labor Hours for Major Construction[a]	4,820	
Required On-Site Hauling Truckloads (Loaded)	843	
Required Off-Site Hauling Truckloads (Loaded)	0	
Required On-Site Hauling Miles	5,870	
Required Off-Site Hauling Miles	0	

Notes:
BAB = Bottom Ash Basin; CCR = Coal Combustion Residual; CY = Cubic Yards.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction was defined as any operation occurring on-Site that required one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor was not included if it was limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators was only included in calculations if the hauling occurred on-Site. Workers assigned to relevant activities were assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

3.1.2 Closure-by-Removal with Off-Site Disposal

Under the CBR-Offsite scenario, CCR and existing liner system materials will be excavated from the BAB and sent to an off-Site landfill for final disposal. Excavation activities at the BAB will include any residual CCR that is still present in the impoundment; the concrete, compacted clay, and geomembrane components of the existing liner system; and additional subsoil overexcavation (Golder, 2022c,d). Excavated materials in the BAB will be sent to the Peoria City-County Landfill (11501 W Cottonwood Road, Brimfield, IL 61517), which is approximately 33 miles from the Site (Appendix B).

IAC Section 845.710(c)(1) requires CBR alternatives to consider multiple methods for transporting excavated materials off-Site, including rail, barge, and trucks. Golder evaluated the feasibility of transporting excavated materials to the off-Site landfill *via* rail or barge and found that neither option is viable at this Site. Existing loadout facilities, which would facilitate off-Site rail or barge transport, are not present on the property, and the construction of new loadout facilities is considered infeasible. Only transport *via* on-road haul trucks (with a 16.5-cubic-yard capacity) is considered feasible for CBR-Offsite. The local availability and use of natural gas-powered trucks, or other low-polluting trucks, will be evaluated prior to the start of construction.

The work elements included in this scenario are largely the same as those listed above in Section 3.1.1 for the CBR-Onsite scenario (Appendix B; Golder, 2022c,d):

- Excavation and transport of CCR and liner system materials to the off-Site landfill, as detailed above. All areas affected by CCR releases will be decontaminated, including potential over-excavation below the bottom of the liner system.
- Grading and filling to convey runoff away from the impoundments.
- Site restoration, including revegetation with native grasses.
- Three years of monitoring at the impoundments, or until such time as GWPSs are achieved.

In total, approximately 3,550 cubic yards of concrete and compacted clay, 1 acre of geomembrane materials from the existing liner system, and 3,200 cubic yards of overexcavated subsoil will be excavated from the BAB under the CBR-Offsite scenario and hauled to the off-Site landfill for disposal. The selected borrow soil location is approximately 3.4 miles north of the BAB *via* Site roads (Appendix B). A total of 17,500 cubic yards of borrow soil are required for grading and filling of the BAB (Appendix B).

Under the CBR-Offsite scenario, the expected duration of major construction activities is expected to be approximately 12 to 18 weeks for the BAB (Appendix B; Golder, 2022c,d). Key parameters for the CBR-Offsite scenario are shown in Table 3.2.

Table 3.2 Key Parameters for the Closure-by-Removal with Off-Site Disposal Scenario – BAB

Parameter	Value	Notes
Surface Area of Impoundment (acres)	2.2	Includes all three cells and the area around the cells.
In-Place Volume of CCR (CY)	Minimal	The CCR in the impoundment has been excavated previously.
Distance to the Off-Site Landfill (miles)	33	Peoria City-County Landfill in Brimfield, IL.
Required Volume of Borrow Soil (CY)	17,500	Required for grading and filling.
Volume of Soil Stockpiled at Borrow Soil Location (CY)	0	
Distance to the Borrow Soil Location (miles)	3.4	
Duration of Construction Activities (weeks)	12 to 18	
Total On-Site Labor Hours for Major Construction[a]	4,360	
Required On-Site Hauling Truckloads (Loaded)	606	
Required Off-Site Hauling Truckloads (Loaded)	489	
Required On-Site Hauling Miles	4,120	
Required Off-Site Hauling Miles	31,900	

Notes:
BAB = Bottom Ash Basin; CCR = Coal Combustion Residual; CY = Cubic Yards.
Sources: Appendix B; Golder (2022c,d).
(a) Major construction was defined as any operation occurring on-Site that required one of the following equipment types: breaker, compactor, dozer, excavator, haul truck, loader, and telehandler. Labor was not included if it was limited to use of the following equipment types: diesel pump, flatbed truck, generator, miscellaneous, pickup truck, and seed drill or hydroseeder. Labor performed by haul truck operators was only included in calculations if the hauling occurred on-Site. Workers assigned to relevant activities were assumed to work full-time (40 hours per week) on that activity for the duration of the activity.

3.2 Long- and Short-Term Effectiveness of Closure Alternative (IAC Section 845.710(b)(1))

3.2.1 Magnitude of Reduction of Existing Risks (IAC Section 845.710(b)(1)(A))

This section of the report addresses the potential risks to human and ecological receptors due to exposure to CCR-associated constituents in groundwater or surface water. Gradient has performed a Human Health and Ecological Risk Assessment for the Site (Appendix A of this report), which provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors associated with the BAB. This report concluded that there are no current unacceptable risks to any human or ecological receptors associated with the BAB. Moreover, because groundwater concentrations are expected to remain stable and/or decline over time under both closure scenarios, there will also be no unacceptable risks to human health or the environment during or following closure. Thus, there is no current risk or future risk under either closure scenario at the BAB, and the magnitude of reduction of existing risks is the same under both scenarios.

3.2.2 Likelihood of Future Releases of CCR (IAC Section 845.710(b)(1)(B))

This section of the report quantifies the risk of future releases of CCR that may occur during dike failure and storm-related events.

Storm-Related Releases and Dike Failure During Flood Conditions

There is no current or future risk of sudden CCR releases occurring at the BAB under either closure scenario. No significant amount of CCR remains in the impoundment.

Dike Failure Due to Seismicity

Sites in Illinois may be subject to seismic risks arising from the Wabash Valley Seismic Zone and the New Madrid Seismic Zone (IEMA, 2020). However, the Duck Creek property does not lie within a seismic impact zone. The property is also believed to have a "low risk level" for seismic risks based on the 2018 USGS National Seismic Hazard Map. Additionally, the BAB does not lie within 200 feet of an active fault or fault damage zone at which displacement has occurred within the current geological epoch (*i.e.*, within the last ~11,650 years; Burns & McDonnell, 2021b,c; Haley & Aldrich, Inc., 2018a,b). The nearest known fault is the Sicily Fault, which is located about 64 miles southeast of the BAB. The Sicily Fault does not have known recent activity (Haley & Aldrich, Inc., 2018a,b). Thus, the risk of dike failure occurring during or following closure activities due to seismic activity is exceedingly low at the BAB.

3.2.3 Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (IAC Section 845.710(b)(1)(C))

The long-term operation and management plans for the BAB are described in Section 3.1 for each closure scenario. Under both the CBR-Onsite and CBR-Offsite scenarios, the BAB will undergo monitoring for 3 years post-closure, or until such time as GWPSs are achieved.

3.2.4 Short-Term Risks to the Community or the Environment During Implementation of Closure (IAC Section 845.710(b)(1)(D))

3.2.4.1 Worker Risks

Best practices will be employed during construction in order to ensure worker safety and comply with all relevant regulations, permit requirements, and safety plans. However, it is impossible to completely eliminate risks to workers during construction activities, both on- and off-Site. On-Site accidents include injuries and deaths arising from the use of heavy equipment and/or earthmoving operations during construction activities. Off-Site accidents include injuries and deaths due to vehicle accidents during labor and equipment mobilization and demobilization, material deliveries, and the hauling of CCR and liner system materials to the on-Site landfill and the off-Site landfill.

Risk of Worker Accidents Occurring On-Site

For the BAB, two closure scenarios were considered: CBR-Offsite and CBR-Onsite. Based on labor requirements reported in Appendix B of this report, Gradient estimates that 4,820 total on-Site labor hours are required for major construction activities under the CBR-Onsite scenario and 4,360 total on-Site labor hours are required for major construction activities under the CBR-Offsite scenario. The labor requirements under both scenarios are therefore similar. Slightly fewer on-Site labor hours are required under the CBR-Offsite scenario than under the CBR-Onsite scenario, because a greater percentage of hauling (a major construction activity) occurs off-Site rather than on-Site under the former scenario. Based on these values and US BLS labor statistics (US DOL, 2020a,b), we estimate that approximately 0.056 worker injuries and 0.00036 worker fatalities will occur on-Site under the CBR-Onsite scenario due to major construction activities at the BAB (Table 3.3). A slightly smaller number of worker injuries and fatalities (0.050 worker injuries and 0.00033 worker fatalities) are expected to occur on-Site under the CBR-Offsite scenario (Table 3.3). Note that the calculations presented here focus on major construction activities (*e.g.*, excavation, loading, and hauling). They therefore do not account for the additional accidents that could occur on-Site during less intensive construction activities (*e.g.*, surveying, erosion control, and hydroseeding).

Table 3.3 Expected Number of On-Site Worker Accidents Under Each Closure Scenario – BAB

Closure Scenario	Injuries	Fatalities
CBR-Onsite	0.056	0.00036
CBR-Offsite	0.050	0.00033

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

Risk of Worker Accidents Occurring Off-Site

The CBR-Offsite scenario is the only scenario which requires any off-Site hauling. Under the CBR-Offsite scenario, 31,900 vehicle travel miles are required to haul excavated materials to the off-Site landfill (Table 3.2). The US DOT (2020) provides an estimate of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks. Based on US DOT's statistics, 0.0041 injuries and 0.000093 fatalities are expected to occur to drivers and passengers of haul trucks due to hauling under the CBR-Offsite scenario (Table 3.4).

Table 3.4 Expected Number of Off-Site Worker Accidents Due to Hauling Under Each Closure Scenario – BAB

Closure Scenario	Injuries	Fatalities
CBR-Onsite	0	0
CBR-Offsite	0.0041	0.000093

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

These estimates reflect the minimum number of worker accidents that are likely to occur off-Site under each scenario, because they do not account for the additional vehicle accidents that may occur during non-hauling activities such as labor mobilization and demobilization, equipment mobilization and demobilization, and material deliveries. The vehicle mileages associated with these off-Site activities are not known. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities, the same required earthwork volumes, similar on-Site labor hours for major construction, and a similar total number of required hauling truckloads (on-Site + off-Site). These two scenarios are therefore likely to have similar impacts with regard to off-Site vehicle accidents arising from labor and equipment mobilization/demobilization and material deliveries.

Taking into account both (i) accidents occurring on-Site due to major construction activities and (ii) accidents occurring off-Site due to hauling, an estimated 0.056 worker injuries and 0.00036 worker fatalities are expected under the CBR-Onsite scenario, and an estimated 0.054 worker injuries and 0.00042 worker fatalities are expected to occur under the CBR-Offsite scenario. Thus, overall risks to workers are likely to be of similar magnitude for both closure scenarios.

3.2.4.2 Community Risks

Accidents

Vehicle accidents that occur off-Site can result in injuries or fatalities among community members, as well as workers. Based on the accident statistics for large trucks reported by US DOT (2020) and the off-Site haul truck mileages reported above for the BAB, haul truck accidents could result in an estimated 0.012 injuries and 0.00043 fatalities among community members (Table 3.5). In contrast, no fatalities or injuries are expected to occur among community members under the CBR-Onsite scenarios due to haul truck accidents, because borrow soil will be taken from a location on the property and any excavated materials will be hauled to an on-Site landfill.

Table 3.5 Expected Number of Community Accidents Due to Hauling Under Each Closure Scenario – BAB

Closure Scenario	Injuries	Fatalities
CBR-Onsite	0	0
CBR-Offsite	0.012	0.00043

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal; CBR-Onsite = Closure-by-Removal with On-Site CCR Disposal.

In addition to impacts due to off-Site hauling, both scenarios may have off-Site impacts due to labor mobilization and demobilization, equipment and vehicle mobilization and demobilization, and material deliveries. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities, the same required earthwork volumes, similar on-Site labor hours for major construction, and a similar total number of required hauling truckloads (on-Site + off-Site). Both scenarios are therefore also likely to have similar impacts with regard to these off-Site activities.

Traffic

Haul routes are expected to use major arterial roads and highways wherever possible, which will reduce the incidence of traffic. However, the heavy use of local roads for construction operations may result in traffic near the Site and, in the case of the CBR-Offsite scenario, the off-Site landfill.

Traffic may increase temporarily around the Site under both closure scenarios due to the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. However, these impacts are expected to largely occur at the beginning or end of each work day (arrival/departure of the work force), at the beginning or end of the construction period (equipment mobilization/demobilization), and at specific times throughout the construction period (material deliveries). These impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site under the CBR-Offsite scenario.

Under the CBR-Offsite scenario, Golder estimates that approximately 489 truckloads will be required to transport materials excavated from the BAB to the off-Site landfill over approximately 80 hauling days (Appendix B). Assuming a 10-hour work day, 6 work days per week, and 26 work days per month, a haul truck would need to pass a given location near the Site once every 49 minutes on average for the duration of excavation activities.

Noise

Construction generates a great deal of noise, both in the vicinity of the Site and along haul routes. In a closure impact analysis performed by the TVA (2015), the authors found that "[T]ypical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance … at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft." Because there are no residences or businesses within 1,500 feet of any of the construction areas on the Site (the BAB, the proposed borrow site, and the on-Site landfill), we do not anticipate that any residences or businesses will be adversely impacted by noise pollution at the Site under either closure scenario. Moreover, although there are several scenic, recreational, and historical areas located within a few miles of the Site (the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites), there are no notable scenic or recreational areas located within 1,500 feet of any of the construction areas on the Site. Noise impacts are therefore expected to be relatively minor at the BAB under both closure scenarios.

In addition to impacts in the immediate vicinity of the BAB, local roads near the Site and the off-Site landfill (CBR-Offsite scenario only) may experience noise pollution due to truck traffic. As described above (Traffic), a haul truck must pass a given location every 49 minutes on average for 10 hours a day while excavation is occurring. Dump trucks generate significant noise pollution, with noise levels of approximately 88 decibels or higher expected within a 50-foot radius of the truck (Exponent, 2018). This noise level is similar to the noise level of a gas-powered lawnmower or leaf blower (CDC, 2019). Decibel levels above 80 can damage hearing after 2 hours of exposure (CDC, 2019). In addition to haul truck impacts, noise pollution may also arise along local roads from the daily arrival and departure of the workforce, equipment mobilization/demobilization, and material deliveries. These impacts are expected to largely occur at the beginning or end of each work day (arrival/departure of the work force), at the beginning or end of the construction period (equipment mobilization/demobilization), and at specific times throughout the construction period (material deliveries); these impacts will therefore likely be less disruptive to community members than the constant and steady movement of haul trucks to and from the Site.

Air Quality

Construction can adversely impact air quality. Air pollution can occur both on-Site and off-Site (*e.g.*, along haul routes), potentially impacting workers as well as community members. With regards to construction activities, two categories of air pollution are of particular concern: equipment emissions and fugitive dust. The equipment emissions of greatest concern are those found in diesel exhaust. Most construction equipment is diesel-powered, including the dump trucks used to haul material to and from the Site. Diesel exhaust contains hundreds of air pollutants, including NO_x, PM, CO, and VOCs (Hesterberg *et al*., 2009; Mauderly and Garshick, 2009). Fugitive dust, another major air pollutant at construction sites, is generated by earthmoving operations and other soil- and CCR-handling activities. Along haul routes, an additional source of fugitive dust is road dust along unpaved dirt roads. Careful planning and the use of BMPs such as wet suppression are used to minimize and control fugitive dust during construction activities; however, it is not possible to prevent dust generation entirely.

The air pollutant mass released under a given closure scenario will be proportional to the expected duration and intensity of construction activities under that scenario. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities, the same required earthwork volumes, similar on-Site labor hours for major construction, and a similar total number of required hauling truckloads (on-Site + off-Site). These two scenarios therefore most likely have similar impacts with regard to air emissions.

Environmental Justice

The State of Illinois defines EJ communities to be those communities with a minority population above twice the state average and/or a total population below twice the state poverty rate (IEPA, 2019). Relative to other communities, EJ communities experience an increased risk of adverse health impacts due to environmental pollution and other factors associated with remediation activities (US EPA, 2016).

As shown in a map of EJ communities throughout the state (Figure 3.1; IEPA, 2019), the on-Site landfill and the borrow site are located within the 1-mile buffer zone of the nearest EJ community (near Canton). The BAB lies approximately 2.5 miles from the outer perimeter of this buffer zone. Due to its close proximity to the Site, the EJ community near Canton may be disproportionately impacted by air emissions, traffic, accidents and other factors arising from various closure activities occurring on or near the Site. Each of the evaluated closure scenarios requires some construction activity in at least one of these on-Site areas.

In addition to impacts arising from construction activity on or near the Site, EJ communities may be also impacted by off-Site activities, including the hauling of CCR and liner materials from the Site to the off-Site landfill, labor and equipment mobilization/demobilization, and material deliveries. Unfortunately, in addition to being located near the on-Site landfill and the borrow site, the EJ community near Canton is also located along the three primary haul routes from the Site to the off-Site landfill suggested by Google Maps (Google LLC, 2021). In summary, due to both on-Site and off-Site activities, both closure scenarios are associated with potential negative impacts on the EJ community near Canton (Figure 3.1).

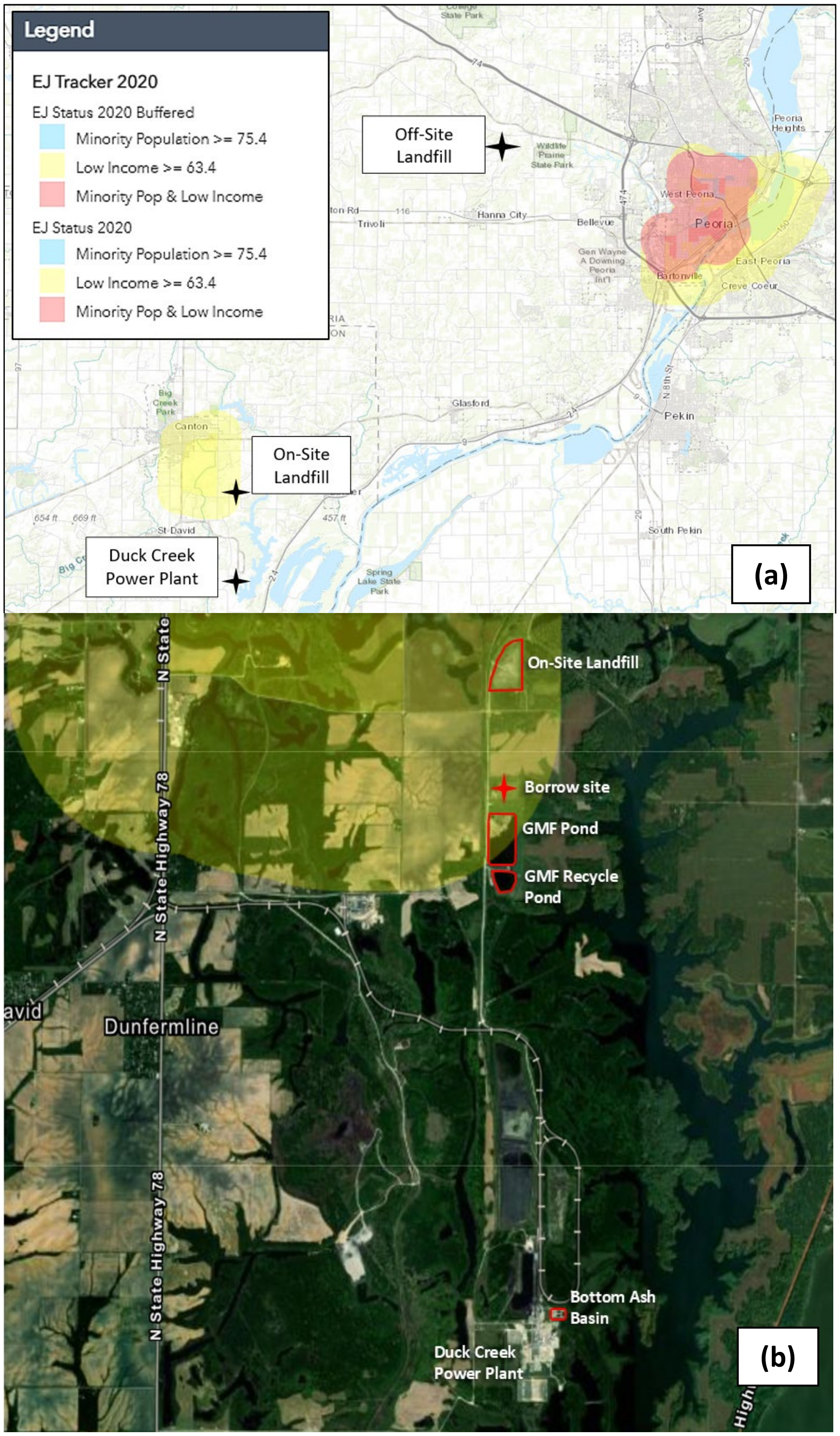


Figure 3.1 Environmental Justice Communities in the Vicinity of Site Features and the Off-Site Landfill – BAB. Adapted from IEPA (2019). (a) Regional map. (b) Site map.

Scenic, Historical, and Recreational Value

There are several scenic, recreational, and historical areas located within a few miles of the Site, including the Rice Lake SFWA and the Orendorf and Rice Lake Terrace Archaeological Sites (Google LLC, 2021; Ramboll, 2021b,c). However, there are no notable scenic or recreational areas located in the immediate vicinity of the BAB, the borrow soil location, or the on-Site landfill. The nearest scenic, recreational, or historical area is the Rice Lake SFWA, which is located over a mile away from the BAB and even further away from the borrow soil location and the on-Site landfill. We therefore do not expect construction activities at the Site to have any direct negative impacts on the scenic, historical, or recreational value of the areas listed above (due to, *e.g.*, noise, obstructions of the view, or restricted access), regardless of the closure scenario.

3.2.4.3 Environmental Risks

Greenhouse Gas Emissions

In addition to the air pollutants listed above in Section 3.2.4.2, construction equipment emits GHGs, including CO_2 and possibly N_2O. The potential impact of each closure scenario on GHG emissions is similar to the potential impact of each closure scenario on other emissions from construction vehicles and equipment, as described above in Section 3.2.4.2. For the BAB, both scenarios (CBR-Onsite and CBR-Offsite) have the same expected duration of construction activities and the same required earthwork volumes. These two scenarios therefore most likely have similar impacts with regard to GHG emissions.

Energy Consumption

Energy consumption at a construction site is synonymous with fossil fuel consumption, because the energy to power construction vehicles and equipment comes from the burning of fossil fuels. Fossil fuel demands considered in this analysis include the burning of diesel fuel during construction activities and the carbon footprint of manufacturing geomembrane textiles. Because GHG emission impacts and energy consumption impacts both arise from the same sources at construction sites, the trends discussed above with respect to GHG emissions also apply to the evaluation of energy demands. For the BAB, energy requirements are expected to be similar under both the CBR-Onsite and CBR-Offsite scenarios.

Natural Resources and Habitat

Construction is likely to have a negative short-term impact on the natural resources and habitat in the vicinity of the BAB and the on-Site borrow soil location (due to, *e.g.*, the temporary destruction of any existing habitat atop these locations, and/or alarm and escape behavior in wildlife found near these locations). For BAB closure, the duration of time over which short-term negative impacts will occur (*i.e.*, the duration of construction activities) is limited to 12-18 weeks under both closure scenarios. Because both closure scenarios have the same expected duration of construction, both scenarios are expected to have similar short-term impacts on natural resources and habitat.

In addition to short-term impacts, closure may also result in long-term shifts in the habitat overlying the BAB and the borrow soil location (*i.e.*, any areas that are not currently grassland will be converted to grassland). Since both BAB closure scenarios (CBR-Onsite and CBR-Offsite) entail excavation followed by site restoration, both scenarios are also expected to have similar long-term impacts on natural resources and habitat.

The BAB is not located immediately adjacent to wetlands or notable surface water bodies, such as rivers or lakes (US FWS, 2021). For this reason, construction activities are not expected to have a significant negative impact on any wetland or aquatic species (due to, *e.g.*, erosion and sediment runoff). Impacts are expected to be limited to terrestrial species. According to the IDNR Natural Heritage Database and the US FWS Environmental Conservation Online System, there are 11 state threatened species, 12 state endangered species, three federally threatened species, and one federally endangered species within Fulton County (Ramboll, 2021b,c). To our knowledge, however, no threatened or endangered species have been identified at the Site (Ramboll, 2021b,c). Based on the information that is currently available, we do not expect construction activities to have negative impacts on any threatened or endangered species.

3.2.5 Time Until Groundwater Protection Standards Are Achieved (IAC Sections 845.710(b)(1)(E) and 845.710(d)(2 and 3))

Based on a statistical analysis and evaluation of potential exceedances, it was determined that there are no potential groundwater exceedances of applicable groundwater standards attributable to the BAB. Because there are no exceedances of the GWPSs and there is no significant CCR remaining within the impoundment, modeling was not performed for either of the closure scenarios. Because groundwater concentrations are expected to remain stable and/or decline post-closure, groundwater exceedances of applicable groundwater standards that are attributable to the BAB are also not expected to occur in the future, regardless of the closure scenario.

3.2.6 Potential for Exposure of Humans and Environmental Receptors to Remaining Wastes, Considering the Potential Threat to Human Health and the Environment Associated with Excavation, Transportation, Re-disposal, Containment, or Changes in Groundwater Flow (IAC Section 845.710(b)(1)(F))

Section 3.2.1 evaluates potential risks to human and ecological receptors arising from the leaching of CCR-associated constituents from the BAB. Section 3.2.2 evaluates the potential for sudden CCR releases to occur at the BAB due to, *e.g.*, dike failure or overtopping during floods or other storm-related events. In summary, under both closure scenarios, there is no current or future risk to any human or ecological receptors associated with the BAB. Additionally, there is minimal current or future risk of overtopping due to flood conditions. Dike failure due to, *e.g.*, seismic activity and storm-related events is also exceedingly unlikely.

Section 3.2.4 evaluates several potential risks to human health and the environment during closure activities, including risks of accidents occurring among workers; risks to nearby residents and EJ communities related to accidents, traffic, noise, and air pollution; and risks to natural resources and wildlife. The findings from this section of the text are summarized in Table S.2.

3.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

As described in Section 3.2.2, there is no risk of engineering or institutional failures leading to sudden releases of CCR from the BAB post-closure under either closure scenario. Additionally, there are no current or future unacceptable risks to any human or ecological receptors associated with the BAB under either closure scenario (see Section 3.2.1 above). Moreover, reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will be implemented at the on-Site and off-Site landfills under the CBR-Onsite and CBR-Offsite scenarios. Both closure scenarios are therefore reliable with respect to long-term engineering and institutional controls.

3.2.8 Potential Need for Future Corrective Action Associated with the Closure (IAC Section 845.710(b)(1)(H))

At this time, we do not anticipate a need for corrective action at the BAB under any closure scenario.

3.3 Effectiveness of the Closure Alternative in Controlling Future Releases (IAC Section 845.710(b)(2))

3.3.1 Extent to Which Containment Practices Will Reduce Further Releases (IAC Section 845.710(b)(2)(A))

There are no unacceptable risks to human health or the environment associated with the BAB (Section 3.2.1). Because current conditions do not present a risk to human health or the environment, and because groundwater concentrations are expected to remain stable and/or decline post-closure, there will also be no unacceptable risks to human health or the environment following closure of the BAB, regardless of the closure scenario.

Section 3.2.2 discussed the potential for dike failure or flood overtopping to occur during or following closure activities, resulting in a sudden release of CCR. That analysis showed that there is no risk of CCR releases occurring at the BAB following closure under either closure scenario.

3.3.2 Extent to Which Treatment Technologies May Be Used (IAC Section 845.710(b)(2)(B))

At this time, we do not anticipate a need for the use of treatment technologies other than source control (*i.e.*, CBR-Onsite and CBR-Offsite) at the BAB under either closure scenario.

3.4 Ease or Difficulty of Implementing Closure Alternative (IAC Section 845.710(b)(3))

3.4.1 Degree of Difficulty Associated with Constructing the Closure Alternative

Excavation and landfilling are reliable and standard methods for closing impoundments; we therefore do not expect these activities to pose any special challenges during BAB closure.

Hauling will be more difficult to implement under the CBR-Offsite scenario than under the CBR-Onsite scenario, due to greater haul traffic on public roadways. As described in Section 3.2.4.2 ("Community Risks"), off-Site hauling may also have detrimental community impacts due to an increased incidence of vehicle accidents, truck traffic, noise, and air pollution.

3.4.2 Expected Operational Reliability of the Closure Alternative

CCR and liner system materials excavated from the BAB will be fully contained after final disposal, regardless of which closure scenario is chosen (CBR-Onsite or CBR-Offsite). The operational reliability of both closure scenarios is therefore expected to be similar. Moreover, high operational reliability is expected under both scenarios due to the full containment of CCR and liner materials.

3.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

A construction stormwater permit through IEPA may be needed under both closure scenarios; this permit would include construction stormwater controls and BMPs such as silt fences and other measures. A joint WPC permit may also be needed under both closure scenarios. Under the CBR-Onsite scenario, a landfill permit modification would additionally be needed for the landfill to receive the material excavated from the BAB. Under the CBR-Offsite scenario, an additional permit and approval may be required for waste transport.

3.4.4 Availability of Necessary Equipment and Specialists

CBR-Onsite and CBR-Offsite are reliable and standard methods for managing waste that rely on common construction equipment and materials and typically do not require the use of specialists, outside of typical construction labor and equipment operators. However, global supply chains have been disrupted due to the COVID-19 pandemic, resulting in shortages in the availability of construction equipment and parts. There may be some shortages in construction equipment under all scenarios, if supply chain resilience does not improve by the time of construction. Alternatively, extended downtime may be required for equipment repairs and maintenance. A national shortage of truck drivers has also developed during the COVID-19 pandemic. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the materials that will be hauled from the Site. If sufficient trucks and truck drivers are not available, delays in the construction schedule may arise.

3.4.5 Available Capacity and Location of Needed Treatment, Storage, and Disposal Services

The existing landfill on the Duck Creek property has sufficient capacity to receive all of the CCR and liner materials that are currently slated for landfilling under the CBR-Onsite scenario. Under the CBR-Offsite scenario, approximately 7,000 cubic yards of materials excavated from the BAB will require disposal at an off-Site landfill. According to the IEPA "Landfill Disposal Capacity Report" for 2020 (IEPA, 2021b), the closest nearby third-party landfill with the ability to receive and dispose of CCR from the Site is the Peoria City-County Landfill in Brimfield, Illinois. This facility has 750,000 cubic yards of remaining capacity in its current permitted footprint. It receives 230,000 cubic yards of waste annually and is located 33 miles from the Site. The Peoria City-County Landfill therefore has sufficient capacity to receive all of the CCR and liner materials excavated from the BAB.

3.5 Impact of Closure Alternative on Waters of the State (IAC Section 845.710(d)(4))

As demonstrated in Gradient's Human Health and Ecological Risk Assessment (Appendix A of this report), modeled surface water concentrations in the Illinois River in the vicinity of the Site are all below relevant human health and ecological screening benchmarks. Post-closure, surface water concentrations of CCR-associated constituents are expected to remain stable and/or decline over time under both closure scenarios. Thus, no future exceedances of any human health or ecological screening benchmarks are anticipated under either closure scenario. Additionally, the lined landfills that will receive any materials excavated from the BAB under the CBR-Onsite and CBR-Offsite scenarios will be managed to ensure that no surface water impacts occur in the vicinity of the landfills.

3.6 Concerns of Residents Associated with Closure Alternatives (IAC Section 845.710(b)(4))

Several nonprofits representing community interests near the Site have raised concerns regarding the potential impacts of coal ash impoundments at this Site on groundwater and surface water quality, including Earthjustice, the Prairie Rivers Network, and the Sierra Club (Earthjustice *et al*., 2018; Sierra Club, 2014; Sierra Club and CIHCA, 2014). These parties generally prefer CBR to CIP, citing fears that allowing CCR to remain in place "allows the widespread groundwater contamination to continue indefinitely" (Earthjustice *et al*., 2018, p. 24). Most of the CCR that was historically contained within the BAB has already been excavated from the impoundment; no significant CCR remains. Moreover, only CBR is being considered at this impoundment. Thus, both closure scenarios (CBR-Offsite and CBR-Onsite) are equally responsive to community concerns regarding potential groundwater and surface water impacts.

A public meeting was held on December 7, 2021, pursuant to requirements under IAC Section 845.710(e) (IEPA, 2021a). Questions raised by attendees were answered at the meeting; subsequently, a written summary of all questions and responses was emailed to interested parties.

3.7 Class 4 Cost Estimate (IAC Section 845.710(d)(1))

A cost estimate has been prepared for each of the closure scenarios (Appendix B). A summary of these estimates is provided in Table 3.6. The total expected cost of closure under the CBR-Onsite scenario is $479,000; the total expected cost of closure under the CBR-Offsite scenario is $1,360,000. Costs under the CBR-Onsite scenario are smaller than costs under the CBR-Offsite scenario.

Table 3.6 Expected Costs of Closure – BAB

Work Element	CBR-Onsite	CBR-Offsite
Mobilization/Demobilization	$37,500	$110,000
Surveying and Site Preparation	$25,000	$25,000
Dewatering, Unwatering, and Stormwater Management	$5,000	$5,000
Impoundment Closure and Site Restoration	$370,000	$1,100,000
Miscellaneous Construction	$41,300	$122,000
Total:	**$479,000**	**$1,360,000**

Notes:
BAB = Bottom Ash Basin; CBR-Offsite = Closure-by-Removal with Off-Site Disposal; CBR-Onsite = Closure-by-Removal with On-Site Disposal.
Costs are for comparative purposes only. Actual costs will be paid based on actual quantities, and may vary from those calculated.
Source: Appendix B.

Both closure scenarios meet or exceed a Class 4 estimate under the AACE Classification Standard (or a comparable classification practice as provided in the AACE Classification Standard), as required by IAC Section 845.710 (IEPA, 2021a).

3.8 Summary

Table S.2 (Summary of Findings) summarizes the expected impacts of the CBR-Onsite and CBR-Offsite closure scenarios for the BAB with regard to each of the factors specified under IAC Section 845.710 (IEPA, 2021a). Based on this evaluation and the details provided in Section 3 above, the CBR-Onsite scenario has been identified as the most appropriate closure scenario for the BAB. Key benefits of the CBR-Onsite scenario at the BAB include that off-Site hauling would not be required and, consequently, this scenario would result in reduced impacts to the community (due to, *e.g.*, accidents, traffic, noise, and air pollution) compared to the CBR-Offsite scenario.

References

AECOM. 2016a. "Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2 at Illinois Power Resources Generating, LLC, Duck Creek Power Station, 17751 North Cilco Road, Canton, IL 61520." Report to Illinois Power Resources Generating, LLC, March.

AECOM. 2016b. "CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station." Report to Illinois Power Resource Generating, LLC, October.

AECOM. 2016c. "CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station." Report to Illinois Power Resource Generating, LLC, October.

Archaeological Institute of America. 2021. "The Orendorf and Rice Lake Terrace Prehistoric Archaeological Sites [Western Illinois University (WIU) Archaeological Field School project description]." Accessed on September 28, 2021 at https://www.archaeological.org/fieldwork/western-illinois-university-archaeological-field-school.

Burns & McDonnell. 2021a. "Initial Operating Permit, Duck Creek Gypsum Pond." Report to Dynegy Midwest Generation.

Burns & McDonnell. 2021b. Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: IEPA Part 845 – Seismic Impact Zone Certification for GMF Pond at Duck Creek Power Plant.

Burns & McDonnell. 2021c. Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: IEPA Part 845 – Seismic Impact Zone Certification for Bottom Ash Basin at Duck Creek Power Plant.

Centers for Disease Control and Prevention (CDC). 2019. "What noises cause hearing loss?" National Center for Environmental Health (NCEH), October 7. Accessed on April 30, 2021 at https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html.

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

Emerson, TE. [Illinois State Archaeological Survey (ISAS)]. c. 2016. "Memorable Emerson Milestones: Commemorating over 40 Years in Cultural Resource Management [Orendorf Site Significance]." Accessed at https://www.isas.illinois.edu/UserFiles/Servers/Server_260627/File/pdfs/news/TEE-Timeline.pdf.

Exponent. 2018. "Community Impact Analysis of Ash Basin Closure Options at the Allen Steam Station." Report to Duke Energy Carolinas, LLC. November 15.

Geosyntec Consultants. 2022. Technical Memorandum to V. Modeer (Dynegy Midwest Generation, LLC) re: Proposed Alternative Protective Layer Equivalency Demonstration, Hennepin East Ash Pond and Duck Creek GMF Pond CCR Surface Impoundments.

Golder Associates Inc. (Golder). 2022a. "Part 845 Construction Permit Application for the Gypsum Management Facility Pond, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Golder Associates Inc. (Golder). 2022b. "Part 845 Construction Permit Application for the Bottom Ash Basin, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Golder Associates Inc. (Golder). 2022c. "Final Closure Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Golder Associates Inc. (Golder). 2022d. "Final Closure Plan for the Bottom Ash Basin, Duck Creek Power Plant." Report to Illinois Power Resource Generating, LLC. Submitted to Illinois Environmental Protection Agency (IEPA).

Google LLC. 2021. "Google Maps." Accessed on April 30, 2021 at https://www.google.com/maps.

Haley & Aldrich, Inc. 2018a. "Location Restriction Demonstration - Fault Areas, Duck Creek Power Station GMF Pond, Canton, Illinois [Fault area certification]." October 16.

Haley & Aldrich, Inc. 2018b. "Location Restriction Demonstration - Fault Areas, Duck Creek Power Station Bottom Ash Basin, Canton, Illinois [Fault area certification]." October 16.

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

Illinois Dept. of Natural Resources (IDNR). c. 2008. "Rice Lake State Fish & Wildlife Area."

Illinois Emergency Management Agency (IEMA). 2020. "Earthquake preparedness." Accessed on September 7, 2021 at https://www2.illinois.gov/iema/Preparedness/Pages/Earthquake.aspx.

Illinois Environmental Protection Agency (IEPA). 2013. "Public Notice/Fact Sheet [re: Draft reissued NPDES Permit No. IL0055620, Duck Creek Power Plant, 17751 North CILCO Road, Canton, Illinois 61520 (Fulton County)]." Bureau of Water, Division of Water Pollution Control, Permit Section. Submitted to Ameren Energy Resources Co., LLC. August 15.

Illinois Environmental Protection Agency (IEPA). 2019. "Illinois EPA Environmental Justice (EJ) Start." Accessed on April 30, 2021 at https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c.

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

Illinois Environmental Protection Agency (IEPA). 2021b. "Illinois Landfill Disposal Capacity Report." August. Accessed at https://www2.illinois.gov/epa/topics/waste-management/landfills/landfill-capacity/Documents/landfill-capacity-report-2021.pdf.

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

National Park Service. 2021. "National Register of Historic Places asset record for the Orendorf Site, Fulton County, Illinois." Accessed on September 28, 2021 at https://npgallery.nps.gov/NRHP/AssetDetail/7550faf8-14bc-4132-a799-44d14d8fa364.

Natural Resource Technology. 2017. "Hydrogeologic Monitoring Plan, Duck Creek GMF Pond - CCR Unit ID 203, Duck Creek Landfill - CCR Unit ID 204, Duck Creek Power Station, Canton, Illinois." Report to Illinois Power Resources Generating, LLC, October 17.

Ramboll. 2021a. "40 C.F.R. 257.95(g)(3)(ii): Alternative Source Demonstration, Duck Creek Gypsum Management, Facility Pond." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021b. "Hydrogeologic Site Characterization Report, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021c. "Hydrogeologic Site Characterization Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2022. "Groundwater Modeling Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Sierra Club. 2014. "Dangerous Waters: America's Coal Ash Crisis."

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

Stantec Consulting Services Inc. (Stantec). 2017. "Duck Creek Power Station, Fulton County Illinois Emergency Action Plan (EAP) (40 CFR § 257.73(a)(3) Coal Combustion Residual (CCR) Impoundments & Related Facilities: Ash Pond No. 1 (NID # IL50715); Ash Pond No. 2 (NID # IL50014); Gypsum Management Facility (GMF) Pond (NID # IL50573)) (Revised)." Report to Illinois Power Resources Generating, LLC, April 13.

Tennessee Valley Authority (TVA). 2015. "Draft Ash Impoundment Closure Environmental Impact Statement. Part I - Programmatic NEPA Review." December.

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

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

US Dept. of Transportation (US DOT). 2020. "Large Truck and Bus Crash Facts 2018." Federal Motor Carrier Safety Administration, Analysis Division, FMCSA-RRA-19-018, September.

United States Environmental Protection Agency (US EPA). 2016. "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis." June.

US Fish & Wildlife Service (US FWS). 2021. "Wetlands Mapper." National Wetlands Inventory, May 3. Accessed on October 13, 2021 at https://www.fws.gov/wetlands/data/mapper.html.

Appendix A

Human Health and Ecological Risk Assessment

Appendix A

Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
Duck Creek Power Plant
Gypsum Management Facility (GMF) and
Bottom Ash Basin (BAB)
Canton, Illinois

January 28, 2022

GRADIENT

www.gradientcorp.com
One Beacon Street, 17th Floor
Boston, MA 02108
617-395-5000

Table of Contents

1 Introduction 1

2 Site Overview 5
2.1 Site Description 5
2.1.1 Bottom Ash Basin (BAB) 5
2.1.2 Gypsum Management Facility (GMF) 6
2.2 Conceptual Site Model 6
2.3 Groundwater Monitoring 7

3 Risk Evaluation 14
3.1 Risk Evaluation Process 14
3.2 Human Conceptual Exposure Model 15
3.2.1 Exposure from Recreational Activities in Surface Water 16
3.2.2 Exposure from Groundwater or Surface Water as a Drinking Water/Irrigation Source 16
3.2.2.1 BAB 16
3.2.2.2 GMF 17
3.3 Ecological Conceptual Exposure Model 18
3.4 Identification of Ecological Constituents of Interest 19
3.4.1 Ecological Constituents of Interest 19
3.4.2 Surface Water and Sediment Modeling for the GMF and BAB 23
3.5 Ecological Risk Evaluation 26
3.5.1 Ecological Receptors Exposed to Surface Water 26
3.5.2 Ecological Receptors Exposed to Sediment 27
3.5.3 Ecological Receptors Exposed to Bioaccumulative Constituents of Interest 28
3.6 Uncertainties and Conservatisms 28

4 Summary and Conclusions 31

References 33

Appendix A Surface Water and Sediment Modeling

List of Tables

Table 2.1 Groundwater Monitoring Wells Related to the BAB

Table 2.2 Groundwater Monitoring Wells Related to the GMF

Table 2.3 Groundwater Data Summary – BAB, 2015-2021

Table 2.4 Groundwater Data Summary – GMF, 2015-2021

Table 3.1 Ecological Constituents of Interest – BAB

Table 3.2 Ecological Constituents of Interest – GMF

Table 3.3 Groundwater and Surface Water Properties Used in Modeling – BAB

Table 3.4 Sediment Properties Used in Modeling – BAB

Table 3.5 Groundwater and Surface Water Properties Used in Modeling – GMF

Table 3.6 Sediment Properties Used in Modeling – GMF

Table 3.7 Risk Evaluation for Ecological Receptors Exposed to Surface Water

Table 3.8 Risk Evaluation for Ecological Receptors Exposed to Sediment

List of Figures

Figure 1.1 Location of BAB

Figure 1.2 Location of GMF

Figure 2.1 Groundwater Monitoring Well Locations – BAB

Figure 2.2 Groundwater Monitoring Well Locations – GMF

Figure 3.1 Overview of Risk Evaluation Methodology

Figure 3.2 Human Conceptual Exposure Model

Figure 3.3 Ecological Conceptual Exposure Model

Abbreviations

BAB	Bottom Ash Basin
bgs	Below Ground Surface
CAA	Closure Alternatives Assessment
CCR	Coal Combustion Residual
CEM	Conceptual Exposure Model
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSM	Conceptual Site Model
DCCP	Duck Creek Cooling Pond
DCPP	Duck Creek Power Plant
DWW	Drinking Water Watch
ESV	Ecological Screening Value
GMF	Gypsum Management Facility
GWPS	Groundwater Protection Standard
IAC	Illinois Administrative Code
ID	Identification
IEPA	Illinois Environmental Protection Agency
ILWATER	Illinois Water and Related Wells
IPRG	Illinois Power Resources Generating, LLC
ISGS	Illinois State Geological Survey
K_d	Equilibrium Partitioning Coefficient
NGWMN	National Groundwater Monitoring Network
NID	National Inventory of Dams
No.	Number
NPDES	National Pollutant Discharge Elimination System
SDWIS	Safe Drinking Water Information System
SI	Surface Impoundment
TEC	Threshold Effect Concentration
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1 Introduction

The Duck Creek Power Plant (DCPP, or "the Site") is an electric power-generating facility with coal-fired units located in Fulton County, Illinois, approximately 6 miles southeast of the town of Canton. The DCPP is owned by Illinois Power Resources Generating, LLC (IPRG). The facility began operation in 1976 and was retired in December 2019 (AECOM, 2016). The DCPP produced and stored coal combustion residuals (CCRs) as a part of its historical operations in several CCR ash ponds located north and east of the power plant. Two ash ponds are planned for closure and are the subject of this report; these include the Gypsum Management Facility (GMF; Vistra identification [ID] number [No.] 203, Illinois Environmental Protection Agency (IEPA) ID No. W0578010001-04, and National Inventory of Dams [NID] No. IL50573) and the Bottom Ash Basin (BAB; Vistra ID No. 205, IEPA ID No. W0578010001-03, and NID No. IL50716). The BAB is an inactive 2.2-acre lined CCR surface impoundment (SI) formerly used to manage CCR and non-CCR waste streams at the DCPP. The BAB consisted of three cells; the bottom and side slopes of all three cells are concrete lined. All bottom ash (*i.e.,* CCR) was removed from the BAB when the plant was retired; thus, the BAB currently contains no impounded water or CCR materials (Ramboll, 2021a). The GMF is located 2.4 miles north of the power plant, in Section 18 of Township 6 North, Range 5 East. The GMF is a 1,500 ft × 900 ft earthen berm double-lined CCR SI, which retains wet-sluiced gypsum produced in the flue-gas scrubber. The decant water from the GMF discharges to the lined GMF Recycle Pond located to the south of the GMF (Ramboll, 2021b). The Duck Creek Cooling Pond (DCCP) is a 719-acre surface water body (US Fish and Wildlife Service, 1983) located downgradient of the BAB and GMF. The DCCP was formed by damming Duck Creek (Ramboll, 2021a,b). The DCCP is part of the plant property and was used as a source of cooling water for the power plant when it was active. Currently, land adjacent to the DCPP is used for agriculture, pasture, and forest with minimal development (Ramboll, 2021b).

This report presents the results of an evaluation that characterizes potential risks to human and ecological receptors that may be exposed to CCR constituents in environmental media potentially impacted by the GMF and BAB. This risk evaluation was performed to support the Closure Alternatives Assessment (CAA) for the GMF and BAB in accordance with requirements in Title 35, Part 845, of the Illinois Administrative Code (IAC) (IEPA, 2021a). While this report specifically evaluates current risks, it also informs potential future risks under the different closure scenarios. Human and ecological risks were evaluated for Site-specific constituents of interest (COIs) that have the potential to migrate to the DCCP and affect DCCP surface water and sediment.

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

1. Identify complete exposure pathways and develop a conceptual exposure model (CEM).
2. Identify Site-related COIs: Compare maximum detected groundwater concentrations over the period from 2015 to 2021 to groundwater protection standards (GWPSs) listed in Title 35, Part 845.600 of the IAC (IEPA, 2021a), and relevant surface water quality standards (IEPA, 2019; US EPA, 2018).
3. Screening-level Risk Analysis: Compare maximum measured or modeled COI concentrations in surface water and sediment to conservative, health-protective benchmarks to determine constituents of potential concern (COPCs).

4. Refined Risk Analysis: If COPCs are identified, perform a refined analysis to evaluate potential risks associated with the COPCs.
5. Formulate risk conclusions and discuss any associated uncertainties.

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

Based on the evaluation presented in this report, no unacceptable risks to human and ecological receptors resulting from CCR exposures associated with either the GMF or the BAB were identified. Specific risk assessment results include the following:

- No complete exposure pathways were identified for human receptors such as recreators.
- No unacceptable risks were identified for ecological receptors exposed to surface water or sediment.
- No bioaccumulative ecological risks were identified.

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

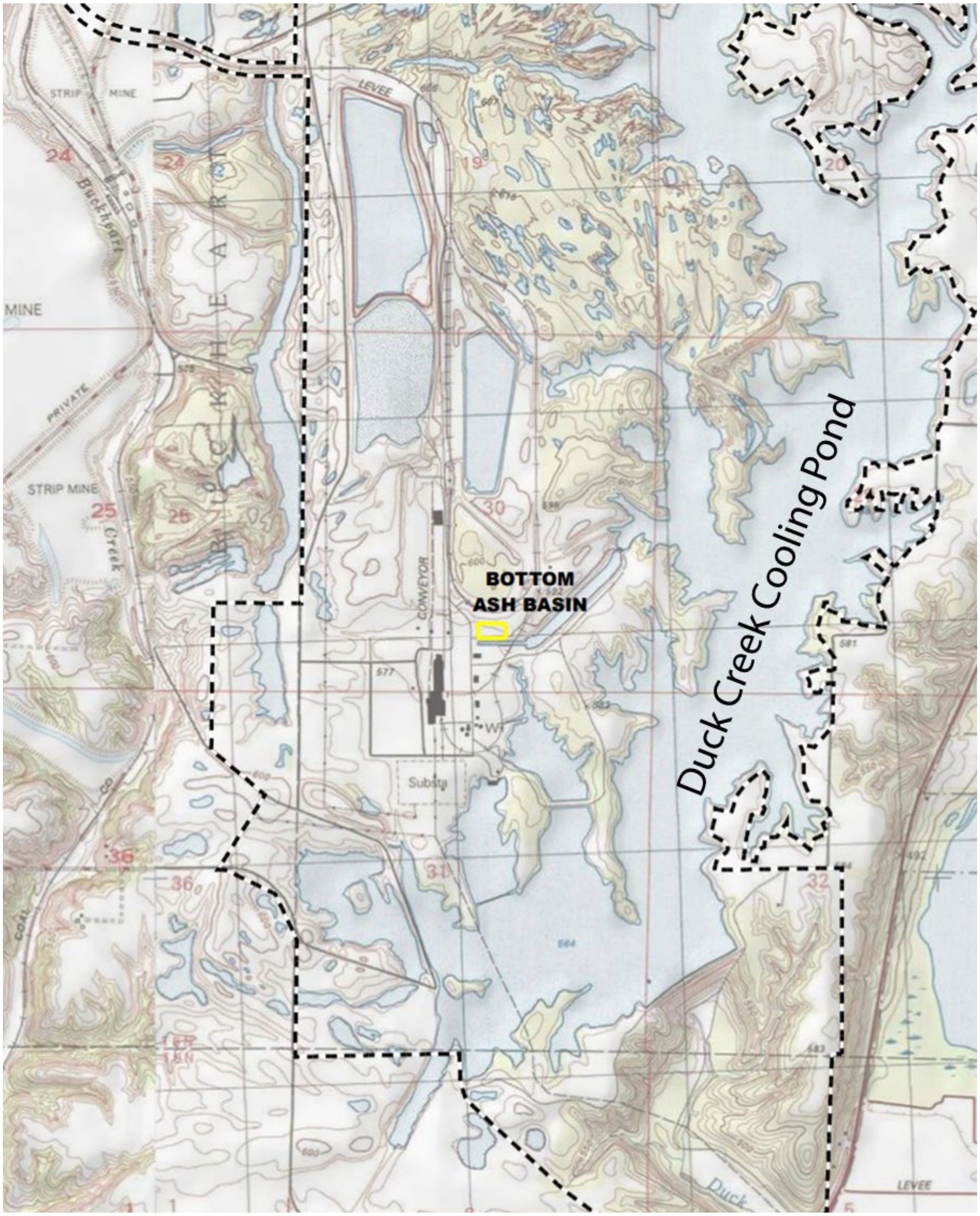


Figure 1.1 Location of BAB. BAB = Bottom Ash Basin; DCPP = Duck Creek Power Plant. DCPP property outline is shown with a dashed line. Source: Ramboll (2021c).

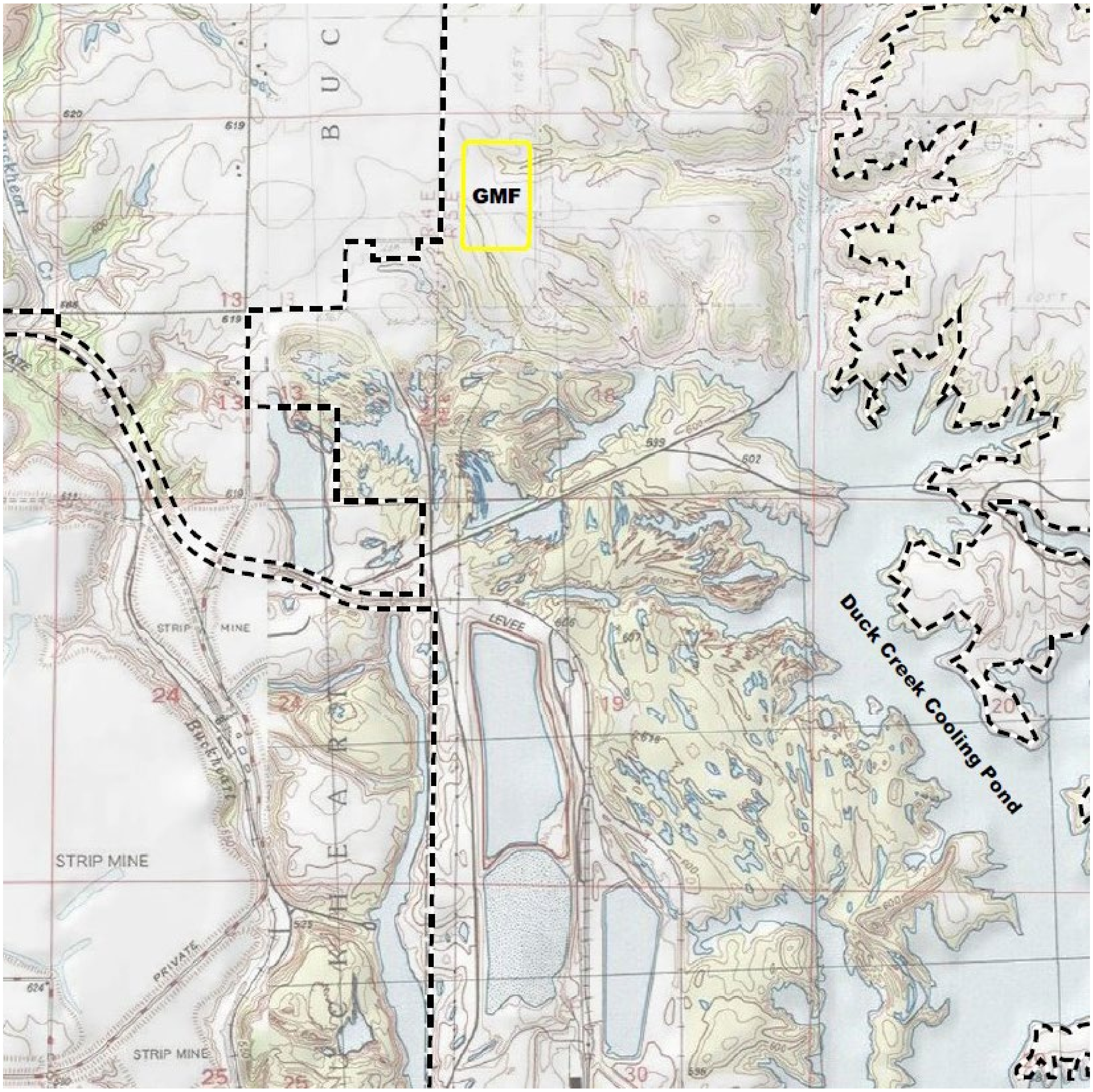


Figure 1.2 Location of GMF. DCPP = Duck Creek Power Plant; GMF = Gypsum Management Facility. DCPP property outline is shown with a dashed line. Source: Ramboll (2021d).

2 Site Overview

2.1 Site Description

2.1.1 Bottom Ash Basin (BAB)

Geology/Hydrogeology

The BAB is located just northeast of the DCPP. The geology underlying the Site in the vicinity of the BAB primarily consists of unconsolidated unlithified materials of loess and till deposits that overlie a Pennsylvanian-age shale bedrock unit (Ramboll, 2021a). Previous investigations completed outside of the BAB indicate that bedrock in the area is overlain by deposits of coal mine spoils[1] (AECOM, 2016). The DCCP, located approximately 500 ft to the east of the BAB, is the nearest major surface water body that is hydraulically downgradient of the BAB. The DCCP water flows south into Duck Creek *via* National Pollutant Discharge Elimination System (NPDES) outfalls and ultimately drains into the Illinois River (IEPA, 2013b).

Two distinct hydrostratigraphic units were identified near the BAB: (a) the uppermost aquifer and (b) a confining shale bedrock unit. A detailed description of these two units is provided below.

The uppermost aquifer consists of loess and till (Ramboll, 2021a). The most permeable portion of the uppermost aquifer is a 2- to 7-feet-thick sand layer located within the till. This sand unit, encountered at a depth of 18-40 ft below ground surface (bgs), forms the primary conduit for horizontal migration of shallow groundwater near the BAB (Ramboll, 2021a).

The geometric mean of field hydraulic conductivities measured in the uppermost aquifer is about 6.33×10^{-4} cm/sec (Ramboll, 2021a). However, the more permeable sand layer within the till has an average conductivity value of 3.4×10^{-2} cm/sec. Groundwater in the uppermost aquifer flows in the south-southeasterly direction toward the DCCP at a velocity of approximately 0.04 ft/day[2] (Ramboll, 2021a). An average horizontal hydraulic head gradient of approximately 0.01 ft/ft was estimated within the uppermost aquifer near the BAB[3] (Ramboll, 2021a).

Shale bedrock lies beneath the unconsolidated deposits between 26 and 46 ft bgs (Ramboll, 2021a). The bedrock acts as an aquitard with mean hydraulic conductivity values ranging between 2×10^{-6} and 9×10^{-6} cm/sec (AECOM, 2016; Ramboll, 2021a). Bedrock packer tests within the top 100 ft yielded virtually no water (AECOM, 2016). These results, indicate that the shale bedrock is a significant barrier to vertical migration of groundwater.

[1] Several large-scale surface water coal mine operations had been reported in the vicinity of the BAB since the 1930s (AECOM, 2016; Ramboll, 2021); however, those mining activities ceased by 1984 (AECOM, 2016).
[2] The average velocities measured between BA05 and BA04, BA01 and BA03, and BA06 and BA02 were 0.032, 0.050, and 0.030 ft/day, respectively (Ramboll, 2021).
[3] The average head gradients measured between BA05 and BA04, BA01 and BA03, and BA06 and BA02 were 0.0132, 0.0062, and 0.0078 ft/ft, respectively (Ramboll, 2021).

2.1.2 Gypsum Management Facility (GMF)

Geology/Hydrogeology

The GMF is located 2.4 miles north of the DCPP. The geology underlying the Site near the GMF primarily consists of unlithified materials of loess and till deposits that overlie a Pennsylvanian-age shale bedrock unit (Ramboll, 2021b,e; Natural Resource Technology, 2017). The unlithified deposits are present in former coal mine spoils and form shallow water-bearing units beneath the GMF (Ramboll, 2021e; Natural Resource Technology, 2017).

Much of the surface water drainage in the vicinity of the GMF flows into the DCCP (Natural Resource Technology, 2017). The DCCP water drains into Duck Creek *via* NPDES-permitted outfalls and ultimately discharges to the Illinois River (IEPA, 2013b).

The three major hydrostratigraphic units near the GMF are: (a) the uppermost aquifer, (b) the lower confining unit, and (c) the shale bedrock confining unit. A detailed description of these three units is provided below.

Shallow groundwater occurs within two unconsolidated water-bearing units that form the uppermost aquifer: (i) the Peoria/Roxanna loess zone and (ii) the shallow sand unit (Ramboll, 2021b,e; Natural Resource Technology, 2017). The Peoria/Roxanna loess zone, composed of silt, silty-clay, and minor amounts of sand, is hydraulically connected to the 1- to 18-ft-thick shallow sand unit that is laterally extensive across the Site (Ramboll, 2021b,e; Natural Resource Technology, 2017). The shallow sand unit is the primary conduit for horizontal migration of shallow groundwater (Ramboll, 2021b). The geometric mean of field-measured hydraulic conductivities within the uppermost aquifer in the GMF area is 3.58×10^{-4} cm/sec (Ramboll, 2021b).

Groundwater in the uppermost aquifer flows to the east-southeast toward the DCCP from topographically high- to low-lying areas (Ramboll, 2021b; Natural Resource Technology, 2017). Groundwater in the uppermost aquifer flows at a velocity of approximately 0.24 ft/day[4] (Ramboll, 2021b). An average horizontal hydraulic head gradient of approximately 0.02 ft/ft was estimated within the uppermost aquifer near the GMF[5] (Ramboll, 2021b).

The lower confining unit consists of till that underlies the uppermost aquifer (Natural Resource Technology, 2017). The till layer restricts vertical migration of groundwater due to its low hydraulic conductivity value of 1.9×10^{-7} cm /sec (Ramboll, 2021b; Natural Resource Technology, 2017). Shale bedrock lies beneath the till in this area (Natural Resource Technology, 2017; Ramboll, 2021e). The bedrock is not hydraulically connected to the uppermost aquifer due to the presence of the till (Natural Resource Technology, 2017).

2.2 Conceptual Site Model

A Conceptual Site Model (CSM) describes the sources of contamination, hydrogeological units, and physical processes that control the transport of water and solutes. In this case, the CSM describes how groundwater underlying the BAB and GMF may migrate and interact with surface water and sediment in

[4] The average groundwater velocities measured between G50S and G64S, G50S and G60S, and G51S and G54S were 0.045, 0.625, and 0.041 ft/day, respectively (Ramboll, 2021b). [5] The average head gradients measured between G50S and G64S, G50S and G60S, and G51S and G54S were 0.0121, 0.0172, and 0.0199 ft/ft, respectively (Ramboll, 2021b).

[5] The average head gradients measured between G50S and G64S, G50S and G60S, and G51S and G54S were 0.0121, 0.0172, and 0.0199 ft/ft, respectively (Ramboll, 2021b).

the adjacent DCCP. The CSM was developed using available hydrogeological data (Natural Resource Technology, 2017; Ramboll, 2021e), including information on groundwater flow and surface water characteristics.

Near the BAB, shallow groundwater flows through the uppermost aquifer in a southward direction toward a surface water channel, located about 50 ft to the south, that leads to the DCCP (Ramboll, 2021a). The primary horizontal migration pathway is within the sand layers of the uppermost aquifer. Groundwater flows horizontally rather than vertically through the uppermost aquifer because: (i) vertical hydraulic conductivities within the uppermost aquifer are several orders of magnitude lower than horizontal hydraulic conductivities, and (ii) the underlying shale bedrock acts as an aquitard preventing downward migration (AECOM, 2016; Ramboll, 2021a). Groundwater within the uppermost aquifer near the BAB flows into the DCCP. No other potential groundwater transport pathways exist. At its discharge location, groundwater mixes with surface water in the DCCP. Because the DCCP serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the DCCP is unlikely.

Near the GMF, shallow groundwater flows horizontally through the uppermost aquifer from northwest to southeast toward the DCCP (Natural Resource Technology, 2017; Ramboll, 2021b,e). The preferential flow of groundwater is horizontal rather than vertical because the underlying till and shale bedrock restrict groundwater flow (Natural Resource Technology, 2017). Groundwater within the uppermost aquifer near the GMF flows into the DCCP. No other potential groundwater transport pathways exist. At its discharge location, groundwater mixes with surface water in the DCCP. Because the DCCP serves as a sink for groundwater discharge in the area, shallow groundwater migration beneath or beyond the DCCP is unlikely.

2.3 Groundwater Monitoring

The analyses presented in this report relied upon the data from the wells used to monitor the BAB and GMF. A total of ten wells were used to monitor the BAB (Table 2.1); of these, six wells are screened in the uppermost aquifer (UA), one well is screened in the bedrock unit (BR), and three wells are screened in a sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow (Ramboll, 2021a). A total of 31 wells were used to monitor the GMF (Table 2.2); of these, 15 wells are screened in the uppermost aquifer (UA), 1 well is screened in the BR, 13 wells are screened in a sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow; and the location of 2 wells is unspecified (Ramboll, 2021b).

The analyses presented in this report relied on all available data from the specified wells collected between 2015 and 2021, which is the period subsequent to the promulgation of the Federal CCR Rule (US EPA, 2015). Groundwater samples were analyzed for a suite of constituents specified in Illinois CCR Rule Part 845.600 (IEPA, 2021a). A summary of the groundwater data used in this risk evaluation is presented in Table 2.3 (for the BAB) and Table 2.4 (for the GMF).

Table 2.1 Groundwater Monitoring Wells Related to the BAB

Well	Date Constructed	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Well Depth from Ground Surface (ft bgs)	Hydrogeologic Unit[a]
BA01	12/16/2015	33.06	37.73	38.20	UA
BA01C	02/08/2021	35.81	45.26	45.90	BR
BA01L	02/05/2021	11.90	21.37	22.15	UA-PMP
BA02	12/30/2015	23.63	28.43	28.80	UA
BA02L	02/04/2021	6.98	11.66	12.09	UA-PMP
BA03	12/29/2015	16.11	25.57	26.20	UA
BA03L	02/02/2021	5.25	9.94	10.29	UA-PMP
BA04	12/29/2015	24.58	29.38	29.80	UA
BA05	07/28/2016	36.48	46.08	46.60	UA
BA06	08/03/2016	32.32	41.93	42.40	UA

Notes:

BAB = Bottom Ash Basin; bgs = Below Ground Surface.

(a) BR = bedrock unit; UA = uppermost aquifer; UA-PMP = sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow.

Table 2.2 Groundwater Monitoring Wells Related to the GMF

Well Number	Date Constructed	Screen Top Depth (ft bgs)	Screen Bottom Depth (ft bgs)	Well Depth (ft bgs)	Hydrogeologic Unit[a]
G02S	09/29/2003	23.00	28.00	28.00	UA
G50S	03/13/2007	–	33.98	34.30	UA
G51L	01/28/2008	12.04	16.83	17.21	UA-PMP
G51S	01/28/2008	24.01	28.79	29.16	UA
G52L	01/22/2008	29.21	33.80	34.17	UA-PMP
G52S	01/22/2008	39.15	43.93	44.20	UA
G53L	02/05/2009	16.97	26.32	26.79	UA-PMP
G53S	02/05/2009	30.64	35.13	35.56	UA
G54C	02/05/2021	91.59	101.50	102.00	BR
G54L	02/12/2009	27.32	36.75	37.22	UA-PMP
G54S	02/12/2009	43.50	47.97	48.41	UA
G55L	02/19/2009	36.12	36.60	36.60	UA-PMP
G55S	02/19/2009	41.04	45.49	45.96	UA
G56L	02/16/2009	13.77	22.11	22.89	UA-PMP
G56S	02/16/2009	33.17	37.66	38.29	UA
G57L	01/30/2009	16.17	25.62	26.00	UA-PMP
G57S	01/30/2009	29.65	34.18	34.62	UA
G58L	01/26/2009	20.69	30.10	30.56	UA-PMP
G58S	01/26/2009	31.32	35.80	36.43	UA
G59L	01/23/2009	22.91	32.33	33.03	UA-PMP
G59S	01/23/2009	37.38	41.88	42.49	UA
G60L	01/17/2008	20.12	24.91	25.28	UA-PMP
G60S	01/16/2008	31.12	35.91	36.29	UA
G61S	01/21/2009	30.19	34.63	35.26	UA
G62L	01/22/2009	20.31	29.66	30.12	UA-PMP
G63L	02/02/2009	18.47	27.89	28.36	UA-PMP
G63S	02/02/2009	34.52	39.01	39.47	UA
G64L	01/22/2009	18.12	27.48	27.95	UA-PMP
G64S	01/22/2009	34.50	38.99	39.48	UA
P60	03/15/2017	29.55	34.14	34.60	–
R61L	03/14/2017	18.54	28.17	28.70	–

Notes:
bgs = Below Ground Surface; GMF = Gypsum Management Facility.
(a) – = data not available; BR = bedrock; UA = uppermost aquifer; UA-PMP = sandy layer within the uppermost aquifer that has been identified as the primary conduit for groundwater flow.

Figure 2.1 Groundwater Monitoring Well Locations – BAB. BAB = Bottom Ash Basin. Source: Ramboll US Corp. (2021a).

Figure 2.2 Groundwater Monitoring Well Locations – GMF. GMF = Gypsum Management Facility. Adapted from: Ramboll US Corp. (2021b).

Table 2.3 Groundwater Data Summary – BAB, 2015-2021

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detect	Maximum Detect	Maximum Detection Limit
Total Metals (mg/L)					
Antimony	0	80	–	–	0.003
Arsenic	61	80	0.001	0.024	0.001
Barium	80	80	0.046	0.48	0.001
Beryllium	4	80	0.0015	0.0068	0.001
Boron	128	128	0.017	7.8	0.015
Cadmium	0	80	–	–	0.001
Chromium	17	80	0.0044	0.073	0.004
Cobalt	29	80	0.002	0.037	0.002
Lead	34	80	0.0011	0.042	0.001
Lithium	10	80	0.011	0.068	0.02
Mercury	3	80	0.0002	0.0012	0.0002
Molybdenum	77	80	0.001	0.015	0.001
Selenium	12	80	0.0011	0.015	0.001
Thallium	1	80	0.001	0.001	0.001
Dissolved Metals (mg/L)					
Arsenic	1	2	0.0045	0.0045	0.001
Radionuclides (pCi/L)					
Radium-226+228	76	76	0.0508	9.64	0.944
Other (mg/L, unless otherwise specified)					
Chloride	127	128	2	700	250
Fluoride	71	128	0.25	0.692	0.25
pH (SU)	136	136	6.2	7.7	–
Sulfate	128	128	1.3	890	250
Total Dissolved Solids	128	128	200	2,300	26

Note:
– = Not Applicable; BAB = Bottom Ash Basin; SU = Standard Unit.

Table 2.4 Groundwater Data Summary – GMF, 2015-2021

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detect	Maximum Detect	Maximum Detection Limit
Total Metals (mg/L)					
Antimony	2	82	0.0037	0.0064	0.003
Arsenic	118	182	0.001	0.051	0.001
Barium	82	82	0.014	0.47	0.001
Beryllium	2	82	0.0013	0.0027	0.001
Boron	217	237	0.01	1.9	0.01
Cadmium	1	83	0.0016	0.0016	0.001
Chromium	7	82	0.0052	0.015	0.004
Cobalt	11	82	0.0021	0.0052	0.002
Lead	79	182	0.0011	0.041	0.001
Lithium	4	82	0.01	0.018	0.02
Mercury	4	82	0.00021	0.0004	0.0002
Molybdenum	42	82	0.001	0.041	0.001
Selenium	4	82	0.0013	0.0031	0.001
Thallium	3	82	0.001	0.0033	0.001
Dissolved Metals (mg/L)					
Antimony	4	665	0.0034	0.012	0.003
Arsenic	209	672	0.001	0.035	0.002
Barium	665	665	0.0076	0.47	0.001
Beryllium	0	18	–	–	0.001
Boron	561	666	0.011	3	0.02
Cadmium	7	666	0.0012	0.0085	0.002
Chromium	20	665	0.0043	0.041	0.004
Cobalt	63	642	0.0021	0.028	0.002
Lead	20	666	0.0011	0.19	0.002
Lithium	0	5	–	–	0.01
Mercury	2	665	0.00024	0.00026	0.0002
Selenium	19	107	0.0011	0.25	0.001
Radionuclides (pCi/L)					
Radium-226+228	83	83	0	5.38	5
Other (mg/L, unless otherwise specified)[a]					
Chloride	228	230	1.1	75	50
Fluoride	86	139	0.25	0.465	0.25
pH (SU)	299	299	6.1	7.5	–
Sulfate	231	232	1.2	540	250
Total Dissolved Solids	134	134	280	900	26

Notes:
– = Not Applicable; GMF = Gypsum Management Facility; SU = Standard Unit
(a) Results for analytes in the "other" group are based on unfiltered samples.

3 Risk Evaluation

3.1 Risk Evaluation Process

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

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

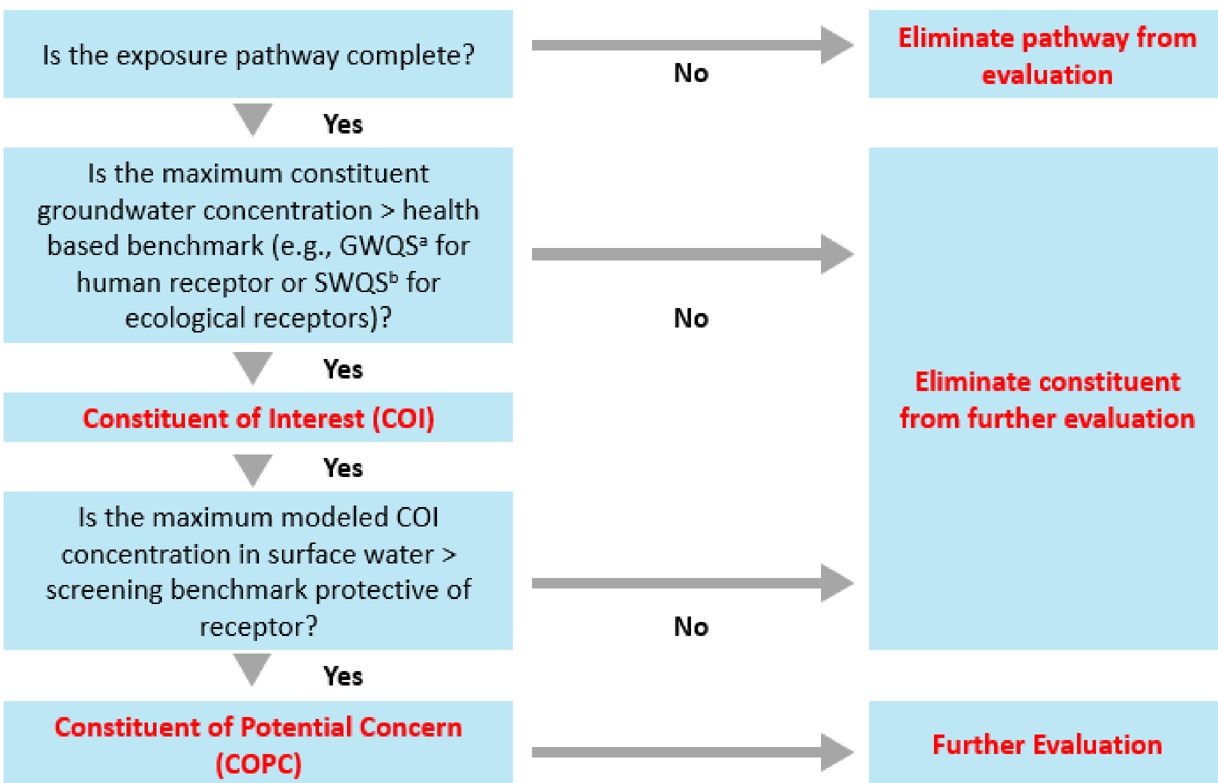


Figure 3.1 Overview of Risk Evaluation Methodology. CCR = Coal Combustion Residuals; COI = Constituent of Interest; IEPA = Illinois Environmental Protection Agency; GWQS = Groundwater Quality Standard; SWQS = Surface Water Quality Standard; US EPA = United States Environmental Protection Agency. (a) The Illinois CCR Rule Part 845.600 GWPS are used to identify human health COIs if human health exposure pathways are complete. (b) IEPA SWQS protective of chronic exposures are used to identify ecological COIs. In the absence of a SWQS, US EPA Region IV ecological screening values are used.

The first step in the risk evaluation was to develop the CEMs and identify complete exposure pathways. All potential receptors and exposure pathways based on groundwater use and surface water use in the vicinity of the Site were considered. Exposure pathways that are incomplete were excluded from the evaluation. As described in Section 3.2, none of the human exposure pathways were considered complete; therefore, risks to human health were not evaluated further.

The risk assessment evaluated ecological risks in the DCCP. Ecological COIs were identified as constituents with maximum concentrations in groundwater in excess of a surface water quality standard (SWQS) for ecological receptors. Based on the CSM (Section 3.2.2), groundwater underlying the BAB and GMF flows east into the DCCP. Therefore, any potential CCR-related constituents in groundwater would flow toward and discharge into the DCCP.

Surface water and sediment samples have not been collected from the DCCP. Therefore, Gradient modeled the potential migration of COIs from groundwater to surface water and sediment to evaluate potential risks to ecological receptors (see Section 3.3.3). Gradient modeled the COI concentrations in surface water and sediment separately for BAB and GMF, based on the groundwater data from the wells associated with those two CCR management units. The modeled COI concentrations in surface water and sediment were compared to conservative, generic risk-based screening benchmarks for ecological receptors. These generic screening benchmarks rely on default assumptions with limited consideration of Site-specific characteristics. Ecological benchmarks are medium-specific values designed to be protective of all potential ecological receptors exposed to surface water. Ecological screening benchmarks are inherently conservative because they are intended to screen out chemicals that are of no concern with a high level of confidence. Therefore, a modeled COI concentration exceeding a screening benchmark does not indicate an unacceptable risk, but does indicate that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as COPCs requiring further evaluation.

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

3.2 Human Conceptual Exposure Model

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

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

- Residents – exposure to groundwater/surface water as drinking water
- Residents – exposure to groundwater/surface water used for irrigation
- Recreators in the DCCP to the east of the Site
    - Boaters – exposure to surface water and sediment while boating
    - Swimmers – exposure to surface water and sediment while swimming
    - Anglers – exposure to surface water and sediment *via* consumption of locally caught fish

3.2.1 Exposure from Recreational Activities in Surface Water

As shown in Figure 3.2, all of the exposure pathways related to recreational activities in surface water were considered incomplete, and thus were not evaluated in this risk assessment. Groundwater beneath the BAB and GMF flows into the DCCP. The DCCP is owned by IPRG, and access to it is restricted, thus the DCCP is not used for any recreational activities, including boating, swimming, or fishing.

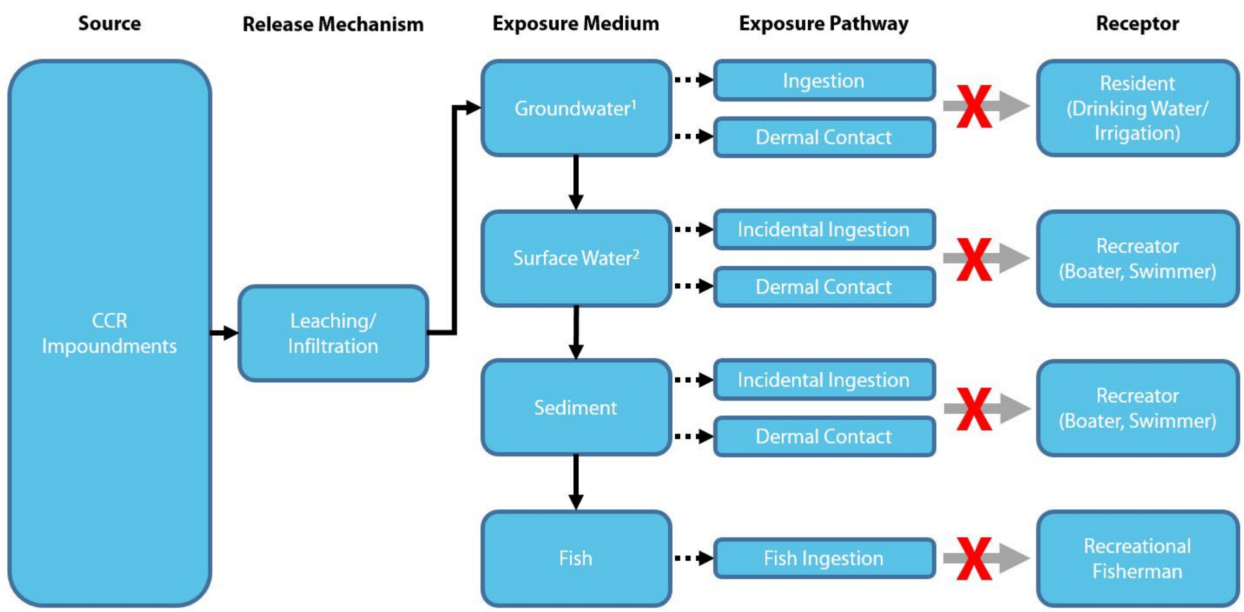


Figure 3.2 Human Conceptual Exposure Model. CCR = Coal Combustion Residual. Dashed line/Red X = Incomplete or insignificant exposure pathway. (1) Groundwater in the vicinity of the Site is not used as a drinking water or irrigation source. (2) Surface water is not used as a drinking water source.

3.2.2 Exposure from Groundwater or Surface Water as a Drinking Water/Irrigation Source

The following sections explain why the residential drinking water and irrigation pathways are incomplete.

3.2.2.1 BAB

Groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for potential CCR-related constituents that originated from the BAB. Specifically, shallow groundwater from the uppermost aquifer in the vicinity of the BAB is not used as a source of drinking water, and no public groundwater systems are downgradient of the DCPP. Further, the downward migration of groundwater from the uppermost aquifer is largely restricted due to the presence of a thick, shale bedrock unit (Ramboll, 2021a; AECOM, 2016). A summary of the evidence supporting the conclusion that residential uses of the shallow groundwater and DCCP water adjacent to the BAB as sources of drinking water are incomplete exposure pathways is presented below.

- **No potential groundwater receptors are in the vicinity of the BAB**. To identify drinking water receptors within a 1,000 m radius of the BAB, a potable water well survey was completed in 2021 utilizing the following federal and state databases (as cited in Ramboll, 2021a): United States Geological Survey (USGS) National Groundwater Monitoring Network (NGWMN) (USGS, 2021); Illinois State Geological Survey (ISGS) Illinois Water and Related Wells (ILWATER) Map (ISGS, 2020); US EPA Safe Drinking Water Information System (SDWIS) (US EPA, 2021); and IEPA Illinois Drinking Water Watch (DWW) (IEPA, 2021b).
  - No potable public supply wells or intakes were identified within a 1,000 m radial distance from the BAB (Ramboll, 2021a).
  - In a prior investigation, only one water supply well was detected one mile north-northwest of Ash Pond 2, but that well is not located downgradient of the BAB (AECOM, 2016).
- **There is no potential off-Site migration of constituents in groundwater to nearby wells because all shallow groundwater discharges into the DCCP.** The DCCP is the discharge point for groundwater from the uppermost aquifer. Groundwater hydraulic head measurements in the uppermost aquifer indicate that groundwater flows southward toward a channel that is connected to the DCCP (Ramboll, 2021a). Because the DCCP serves as the regional groundwater discharge location in the area, constituents present in groundwater are not likely to migrate underneath or beyond the DCCP.
- **The DCCP adjacent to the Site is not used as a public water supply.** The DCCP is owned and maintained by IPRG. IPRG restricts the use of the pond as a source of drinking water or for recreation. Therefore, the human exposure pathway *via* surface water ingestion in the DCCP was not evaluated further.
- **The uppermost aquifer has a limited hydraulic connection to the underlying bedrock unit.** The bedrock acts as an aquitard with mean hydraulic conductivity values ranging between 2×10^{-6} and 9×10^{-6} cm /sec (AECOM, 2016; Ramboll, 2021a) and bedrock packer tests within the top 100 ft yielded virtually no water (AECOM, 2016). Based on these results, it was concluded that the shale bedrock is a significant barrier to groundwater migration.

3.2.2.2 GMF

Groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for CCR-related constituents originating from the GMF. Specifically, shallow groundwater from the uppermost aquifer in the vicinity of the GMF is not used as a source of drinking water, and no public groundwater systems are downgradient of Duck Creek. Additionally, the downward migration of groundwater from the uppermost water-bearing unit is largely restricted due to the presence of underlying low-permeability till and shale bedrock. A summary of the evidence supporting the conclusion that residential uses of the shallow groundwater and DCCP water adjacent to the GMF as sources of drinking water are incomplete exposure pathways is presented below.

- **No potential groundwater receptors are in the vicinity of the GMF.** To identify drinking water receptors within a 1,000 m radius of the GMF, a potable water well survey was completed in 2021 utilizing the following federal and state databases (Ramboll, 2021b): USGS NGWMN (USGS, 2021); ISGS ILWATER Map (ISGS, 2020); US EPA SDWIS (US EPA, 2021); and IEPA Illinois DWW (IEPA, 2021b).
  - One private well was identified within a 1,000 m radial distance from the GMF (Ramboll, 2021b). However, the well is located southwest of the GMF, while the groundwater flow within the uppermost aquifer is toward the southeast (Ramboll, 2021b); therefore, this well is not considered to be downgradient of the GMF (Ramboll, 2021b).
- **There is no off-Site groundwater migration to any off-Site wells because all shallow groundwater flows into the DCCP.** The DCCP is the discharge point for groundwater from the uppermost aquifer. Groundwater hydraulic head measurements in a total of 7 wells[6] screened within the uppermost aquifer at the GMF indicate that groundwater flows toward the DCCP (Ramboll, 2021b,e). Because the DCCP serves as the regional groundwater discharge location, shallow groundwater near the GMF is not likely to migrate underneath or beyond the DCCP.
- **The DCCP adjacent to the Site is not used as a public water supply.** The DCCP is owned and maintained by IPRG. IPRG restricts the use of the pond as a source of drinking water and/or for recreation. Therefore, the human exposure pathway *via* surface water ingestion adjacent to the GMF was not evaluated further.
- **The GMF has a limited hydraulic connection to deep groundwater.** Three laboratory permeability tests on the lower confining till unit underlying the uppermost aquifer yielded a low mean hydraulic conductivity value of 1.9×10^{-7} cm/sec (Natural Resource Technology, 2017). In addition, the underlying shale bedrock acts as a low-permeability aquitard that restricts vertical intrusion of shallow groundwater. These results indicate that the till and shale bedrock are a significant barrier to groundwater migration.

3.3 Ecological Conceptual Exposure Model

The ecological CEM for the Site depicts the relationships between off-Site environmental media (surface water and sediment) potentially impacted by COIs in groundwater and ecological receptors that may be exposed to these media. The ecological risk evaluation considered both direct toxicity as well as secondary toxicity *via* bioaccumulation. Figure 3.3 presents the ecological CEM for the Site. The following ecological receptor groups and exposure pathways were considered.

- **Ecological Receptors Exposed to Surface Water:**
  - Aquatic plants, amphibians, reptiles, and fish.
- **Ecological Receptors Exposed to Sediment:**
  - Benthic invertebrates (*e.g.*, insects, crayfish, mussels).

[6] Three CCR Rule background monitoring wells (G02S, G50S, and G51S), four CCR Rule downgradient monitoring wells (G54S, G57S, G60S, and G64S) (Ramboll, 2021e).

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

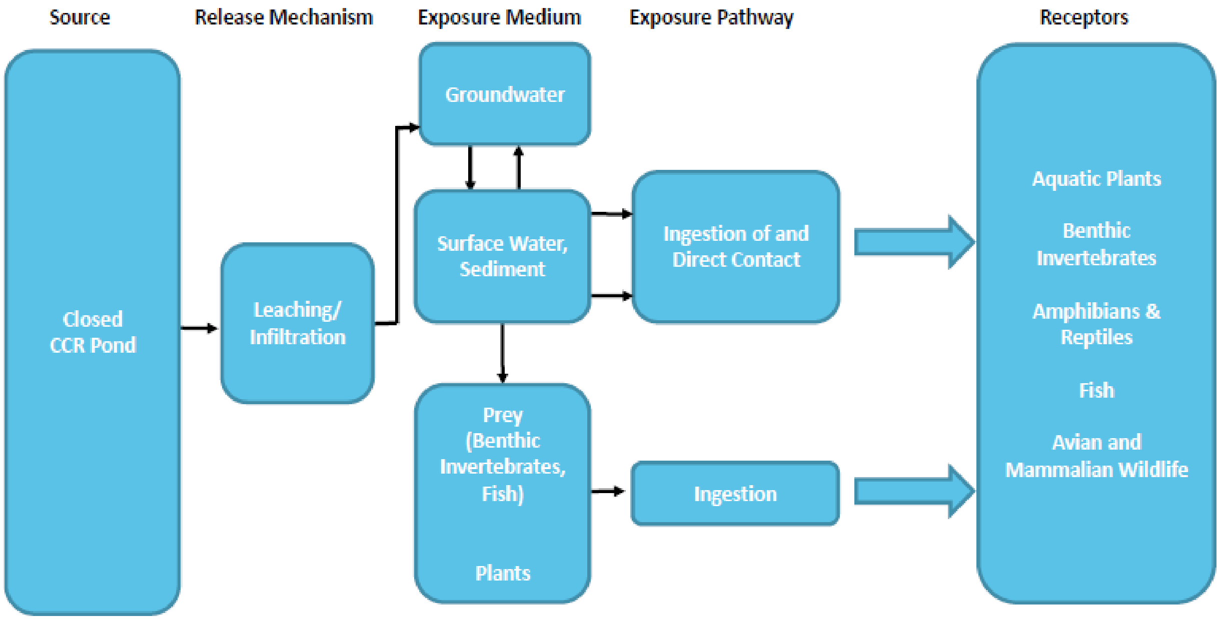


Figure 3.3 Ecological Conceptual Exposure Model. CCR = Coal Combustion Residual.

3.4 Identification of Ecological Constituents of Interest

Risks were evaluated for ecological COIs. A constituent was considered a COI if the maximum detected constituent concentration in groundwater exceeded a benchmark protective of ecological receptors. According to US EPA Risk Assessment Guidance (US EPA, 1989), this screening step is designed to reduce the number of constituents carried through the risk evaluation that are anticipated to have a minimal contribution to the overall risk. Identified COIs are the constituents that are most likely to pose a risk concern in DCCP surface water and sediment. As described above, there were no complete human health exposure pathways. Therefore, COIs were identified to support an ecological risk evaluation only.

3.4.1 Ecological Constituents of Interest

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

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

- IEPA (2019) SWQSs. IEPA SWQSs are health-protective benchmarks for aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The SWQSs for several metals are hardness-dependent (in this case cadmium and lead). Screening benchmarks for these constituents were calculated assuming US EPA's (2019) default hardness of 100 mg/L because hardness data are not available for the DCCP.
- NRWQC – Aquatic Life Criteria Table (US EPA, 2019).
- US EPA Region IV (2018) surface water Ecological Screening Values (ESVs) for hazardous waste sites.

For radium, benchmarks from the United States Department of Energy (US DOE) guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019) were used. US DOE presents benchmarks for radium-226 and radium-228 separately (4 and 3 pCi/L, respectively) (US DOE, 2019). Given that radium concentrations are expressed as total radium (radium-226+228, *i.e.*, the sum of radium-226 and radium-228), Gradient used the lower of the two benchmarks (3 pCi/L for radium-228) to evaluate total radium concentrations. The IEPA (2019, Section 302.207) general Surface Water Quality Standard for radium notes that the annual average combined concentration of radium-226+228 must not exceed 3.75 pCi/L; however, this value is not necessarily based on protection of ecological receptors, therefore the benchmark of 3 pCi/L from US DOE (2019) was used.

Gradient used the maximum detected concentrations from groundwater samples collected from the wells associated with the BAB and GMF, without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation.

Boron, cobalt, lead, mercury, radium-226+228, and chloride were identified as COIs for ecological receptors in the BAB (Table 3.1). Cadmium and cobalt were identified as COIs for ecological receptors in the GMF (Table 3.2).

Table 3.1 Ecological Constituents of Interest – BAB

Analyte[a]	Maximum Detected Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Dissolved Metals (mg/L)				
Arsenic	0.0045	0.19	US EPA Region IV ESV	No
Total Metals (mg/L)				
Arsenic	0.024	0.19	IEPA SWQC	No
Barium	0.48	5	IEPA SWQC	No
Beryllium	0.0068	0.064	US EPA Region IV ESV	No
Boron	7.8	7.6	IEPA SWQC	Yes
Chromium	0.073	0.21	IEPA SWQC	No
Cobalt	0.037	0.019	US EPA Region IV ESV	Yes
Lead	0.042	0.02	IEPA SWQC	Yes
Lithium	0.068	0.44	US EPA Region IV ESV	No
Mercury	0.0012	0.0011	IEPA SWQC	Yes
Molybdenum	0.015	7.2	US EPA Region IV ESV	No
Selenium	0.015	1	IEPA SWQC	No
Thallium	0.001	0.006	US EPA Region IV ESV	No
Radionuclides (pCi/L)				
Radium-226+228	9.64	3	US DOE	Yes
Other (mg/L unless otherwise specified)				
Chloride	700	500	IEPA SWQC	Yes
Fluoride	0.692	4	US EPA Region IV ESV	No
pH (SU)	7.7	6.5-9	US EPA NRWQC	No
Sulfate	890	NA	NA	No
Total Dissolved Solids	2,300	NA	NA	No

Notes:

BAB = Bottom Ash Basin; COI = Constituent of Interest; DL = Detection Limit; ESV = Ecological Screening Value; IEPA = Illinois Environmental Protection Agency; NA = Not Applicable; NRWQC = National Recommended Water Quality Criteria; SU = Standard Units; SWQC = Surface Water Quality Criteria; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.

(a) The list of constituents includes those with IL Part 845.600 Groundwater Protection Standards (IEPA, 2021a).

(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQS (IEPA, 2019), US EPA Region IV "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018), US EPA NRWQC (2021), and US DOE's guidance document, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).

(c) COIs are constituents for which the maximum concentration exceeds the surface water criterion.

Table 3.2 Ecological Constituents of Interest – GMF

Analyte[a]	Maximum Detected Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Dissolved Metals (mg/L)				
Antimony	0.012	0.19	US EPA Region IV ESV	No
Arsenic	0.035	0.19	IEPA SWQC	No
Barium	0.47	5.00	IEPA SWQC	No
Boron	3	7.60	IEPA SWQC	No
Cadmium	0.0085	0.001	IEPA SWQC	Yes
Chromium	0.041	0.18	IEPA SWQC	No
Cobalt	0.028	0.02	US EPA Region IV ESV	Yes
Lead	0.19	0.02	IEPA SWQC	No
Mercury	0.00026	0.001	IEPA SWQC	No
Selenium	0.25	1.00	IEPA SWQC	No
Total Metals (mg/L)				
Antimony	0.0064	0.19	US EPA Region IV ESV	No
Arsenic	0.051	0.19	IEPA SWQC	No
Barium	0.47	5.00	IEPA SWQC	No
Beryllium	0.0027	0.06	US EPA Region IV ESV	No
Boron	1.9	7.60	IEPA SWQC	No
Cadmium	0.0016	0.001	IEPA SWQC	No
Chromium	0.015	0.21	IEPA SWQC	No
Cobalt	0.0052	0.02	US EPA Region IV ESV	No
Lead	0.041	0.02	IEPA SWQC	No
Lithium	0.018	0.44	US EPA Region IV ESV	No
Mercury	0.0004	0.001	IEPA SWQC	No
Molybdenum	0.041	7.20	US EPA Region IV ESV	No
Selenium	0.0031	1.00	IEPA SWQC	No
Thallium	0.0033	0.01	US EPA Region IV ESV	No
Radionuclides (pCi/L)				
Radium-226+228	5.38	3	US DOE	No[d]
Other (mg/L, unless otherwise specified)[e]				
Chloride	75	500	IEPA SWQC	No
Fluoride	0.465	4.0	IEPA SWQC	No
pH (SU)	7.5	5-9	US EPA NRWQC	No
Sulfate	540	NA	NA	No
Total Dissolved Solids	900	NA	NA	No

Notes:
COI = Constituent of Interest; DL = Detection Limit; ESV = Ecological Screening Value; GMF = Gypsum Management Facility; IEPA = Illinois Environmental Protection Agency; NA = Not Applicable; NRWQC = National Recommended Water Quality Criteria; SWQC = Surface Water Quality Criteria; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) The list of constituents includes those with IL Part 845.600 groundwater protection standards (IEPA, 2021a).
(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQS (IEPA, 2019), US EPA Region IV "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018), US EPA NRWQC (2021), and US DOE's guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).
(c) COIs are constituents for which the maximum concentration exceeds the surface water criterion.
(d) Of the 83 groundwater samples analyzed for radium-226+228, only 1 sample was detected above the ecological benchmark. Given that the maximum result is considered an outlier at the 1% and 5% significance levels, radium-226+228 was not considered an ecological COI.
(e) Results for analytes in the "other" group are based on unfiltered samples.

3.4.2 Surface Water and Sediment Modeling for the GMF and BAB

Surface water and sediment sampling has not been conducted in the DCCP. Many of the COIs are expected to be present in surface water or sediment from natural or non-Site-related anthropogenic sources. It would be difficult to attribute concentrations of these COIs to a particular source given the dynamic nature of the DCCP (as it flows south and discharges to Duck Creek, which drains into the Illinois River) and the multitude of potential sources. Gradient modeled concentrations in DCCP surface water and sediment as a result of groundwater discharge to the DCCP for all constituents that exceeded ecological benchmarks in groundwater. Surface water and sediment concentrations were modeled based on the maximum detected concentrations in groundwater[7] (from 2015 to 2021, regardless of well location).

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

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

The aquifer and surface water properties used to estimate the volume of groundwater flowing into the DCCP and surface water concentrations from the BAB and GMF are presented in Tables 3.3 and 3.5, respectively. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partition coefficients and the sediment properties presented in Tables 3.4 and 3.6 for the BAB and GMF, respectively. In the absence of Site-specific information for the DCCP, we used default assumptions (*e.g.*, depth of the upper benthic layer and bed sediment porosity) to model sediment concentrations. A description of the surface water and sediment modeling and the detailed results are presented in Appendix A.

The modeled surface water and sediment concentrations are discussed in Section 3.4. As described earlier, the modeled concentrations reflect conservative contributions from groundwater discharge.

[7] The maximum concentrations were taken, regardless of "total" or "dissolved" concentrations.

Table 3.3 Groundwater and Surface Water Properties Used in Modeling – BAB

Parameter	Unit	Value	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent-specific	Maximum detected dissolved or total concentration in groundwater.
Cross Section Area	m^2	260	Estimated by multiplying the maximum thickness of the permeable sand unit (7 ft or ~2.1 m) within the uppermost aquifer (Ramboll, 2021a) by the length of the BAB (400 ft or ~122 m).
Hydraulic Gradient	m/m	0.01	Average of field-measured hydraulic gradients reported in Ramboll (2021a).
Hydraulic Conductivity	cm/s	6.33×10^{-4}	Average of field-measured hydraulic conductivity values reported in Ramboll (2021a).
Surface Water			
Surface Water Flow Rate	L/yr	2.5×10^{10}	The rate of surface water discharge from the DCCP to Duck Creek *via* NPDES outfalls 1 and 2 (NPDES Permit No. IL0055620) (IEPA, 2013b).
TSS	mg/L	6	6 mg/L is the representative average river concentration (Hanson Professional Services Inc., 2019).
Depth of the Water Column	m	1.5	Conservative estimate of 5 ft or ~1.5 m near the edge of the DCCP (Bist LLC, 2021). Model results were not sensitive to an increase in the water column depth.
Suspended Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
BAB = Bottom Ash Basin; COI = Constituent of Interest; DCCP = Duck Creek Cooling Pond; NPDES = National Pollutant Discharge Elimination System; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.4 Sediment Properties Used in Modeling – BAB

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014).
Depth of Water Body	m	1.55	Sum of depth of the water column and depth of the upper benthic layer.
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014).
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014).
TSS Mass Per Unit Area	kg/m^2	0.009	Depth of the water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3).
Sediment Mass Per Unit Area	kg/m^2	30	Depth of the upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3).
Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
BAB = Bottom Ash Basin; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.5 Groundwater and Surface Water Properties Used in Modeling – GMF

Parameter	Unit	Values	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent-specific	Maximum detected dissolved or total concentration in groundwater.
Cross Section Area	m^2	2,488	Estimated by multiplying the maximum thickness of the "shallow sand unit" of the uppermost aquifer (18 ft or 5.5 m) (Ramboll, 2021b) and the diagonal (NE-SW) length of the GMF (~453.5 m).
Hydraulic Gradient	m/m	0.02	Average hydraulic gradient within the uppermost aquifer (Ramboll, 2021b).
Hydraulic Conductivity	cm/s	3.58×10^{-4}	As reported by Ramboll for the uppermost aquifer (Ramboll, 2021b).
Surface Water			
Surface Water Flow Rate	L/yr	2.5×10^{10}	The rate of surface water discharge from the DCCP to Duck Creek *via* NPDES outfalls 1 and 2 (NPDES Permit No. IL0055620) (IEPA, 2013b).
TSS	mg/L	6	6 mg/L is the representative average river concentration (Hanson Professional Services Inc., 2019).
Depth of the Water Column	m	1.5	Conservative estimate of 5 ft or ~1.5 m near the edge of the DCCP (Bist LLC, 2021). Model results were not sensitive to an increase in the depth of the water column.
Suspended Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
COI = Constituent of Interest; GMF = Gypsum Management Facility; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

Table 3.6 Sediment Properties Used in Modeling – GMF

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014).
Depth of Water Body	m	1.55	Sum of depth of water column and depth of upper benthic layer.
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014).
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014).
TSS Mass Per Unit Area	kg/m^2	0.009	Depth of water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3).
Sediment Mass Per Unit Area	kg/m^2	30	Depth of upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3).
Sediment to Water Partition Coefficients	mg/L	Constituent-specific	Values based on US EPA (2014).

Note:
GMF = Gypsum Management Facility; TSS = Total Suspended Solids; US EPA = United States Environmental Protection Agency.

3.5 Ecological Risk Evaluation

Based on the ecological CEM (Figure 3.3), ecological receptors could be exposed to surface water, sediment, and dietary items (*i.e.*, prey and plants) potentially impacted by identified COIs (boron, cobalt, lead, and mercury in the BAB; cadmium and cobalt in the GMF).

3.5.1 Ecological Receptors Exposed to Surface Water

Screening Exposures: The ecological evaluation considered aquatic communities in the DCCP potentially impacted by identified ecological COIs. In the absence of surface water data, the maximum of the total and dissolved COI concentrations detected in groundwater was used to model surface water concentrations. Modeled surface water concentrations were compared to risk-based ecological screening benchmarks.

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

- IEPA SWQS (IEPA, 2019), regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). For lead, the surface water benchmark is hardness-dependent and calculated using a default hardness of 100 mg/L. While IEPA's general water quality standard for chloride of 500 mg/L (IEPA, 2019) is not specified to be protective of ecological receptors, it was used because it is on the same order of magnitude as US EPA's NRWQC for chloride (230 and 860 mg/L for chronic and acute exposures, respectively), which is protective of aquatic life (US EPA, 2021).
- US EPA Region IV (2018) surface water ESVs for hazardous waste sites.
- For radium, US DOE presents benchmarks for radium-226 and radium-228 separately (4 and 3 pCi/L, respectively). Given that radium concentrations are expressed as total radium (the sum of radium-226 and radium-228), Gradient used the lower of the two US DOE benchmarks (3 pCi/L for radium-228) to evaluate the total radium concentrations. In addition, this benchmark is protective of bioaccumulative effects in higher trophic-level wildlife discussed further in Section 3.4.3.

Risk Evaluation: The maximum modeled COI concentrations in surface water were compared to the above hierarchy of benchmarks protective of aquatic life (Table 3.7). All modeled surface water concentrations were below their respective benchmarks. Thus, none of the COIs evaluated are expected to pose an unacceptable risk to aquatic life in the DCCP.

Table 3.7 Risk Evaluation for Ecological Receptors Exposed to Surface Water

COI[a]	Maximum Surface Water Concentration, Modeled	Ecological Freshwater Benchmark	Basis	COPC
BAB				
Boron (mg/L)	1.7×10^{-4}	7.6	IEPA (2019)	No
Cobalt (mg/L)	7.9×10^{-7}	0.019	US EPA Region IV (2018)	No
Lead[b] (mg/L)	8.9×10^{-7}	0.016	IEPA (2019)	No
Mercury (mg/L)	2.5×10^{-8}	0.8	US EPA Region IV (2018)	No
Chloride (mg/L)	1.5×10^{-2}	500	IEPA (2019)	No
Radium-226+228 (pCi/L)	2.1×10^{-4}	3	US DOE (2019)	No
GMF				
Cadmium[b] (mg/L)	2.0×10^{-6}	0.0009	IEPA (2019)	No
Cobalt (mg/L)	6.4×10^{-6}	0.019	US EPA Region IV (2018)	No

Notes:

BAB = Bottom Ash Basin; COI = Constituent of Interest; COPC = Constituent of Potential Concern; GMF = Gypsum Management Facility; IEPA = Illinois Environmental Protection Agency; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.

(a) Modeled COI concentrations reflect the potential maximum COI surface water concentrations from groundwater mixing with surface water.

(b) A default hardness value of 100 mg/L was used to calculate this hardness-dependent benchmark.

3.5.2 Ecological Receptors Exposed to Sediment

Screening Exposures: COIs in impacted groundwater discharging into the DCCP can sorb to sediments *via* chemical partitioning. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations. Therefore, the modeled COI sediment concentrations reflect the potential maximum Site-related sediment concentration from groundwater discharge. Chloride was not modeled in sediment as it does not have a K_d value and is not expected to partition into sediment.

Screening Benchmarks: Sediment screening benchmarks were obtained from US EPA Region IV (2018). The majority of the sediment ESVs are based on threshold effect concentrations (TECs) from MacDonald *et al.* (2000), which provide consensus values that identify concentrations below which harmful effects on sediment-dwelling organisms are unlikely to be observed.

For radium, benchmarks from US DOE's guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019), were used. US DOE (2019) presents benchmarks for radium-226 and radium-228 separately (101 and 876 pCi/kg, respectively). Similar to surface water, given that modeled radium is presented as the combined radium-226+228, the lower of the two benchmarks was used as the benchmark to be protective of ecological receptors for both radium-226 and radium-228. In addition, this benchmark is protective of bioaccumulative effects in the higher trophic-level wildlife discussed further in Section 3.4.3. The benchmarks used in this evaluation are listed in Table 3.8.

Screening Risk Results: The maximum modeled COI sediment concentrations were below their respective sediment screening benchmarks, for both the BAB and GMF (Table 3.8). The modeled sediment concentrations attributed to potential contributions from Site groundwater for all COIs were less than 1.5% of the sediment screening benchmark. Therefore, the modeled sediment concentrations attributed to potential contributions from Site groundwater are not expected to significantly contribute to ecological exposures in the DCCP adjacent to the Site.

Table 3.8 Risk Evaluation for Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration	ESV[a]	COPC	Percentage of Benchmark
BAB				
Boron (mg/kg)	0.00100	38[b]	No	0.0026%
Cobalt (mg/kg)	0.00072	50	No	0.0014%
Lead (mg/kg)	0.0089	35.8	No	0.025%
Mercury (mg/kg)	0.00092	0.18	No	0.51%
Radium-226+228 (pCi/kg)	1.5	101	No	1.4%
GMF				
Cadmium (mg/kg)	0.0026	0.99	No	0.27%
Cobalt (mg/kg)	0.0059	50	No	0.012%

Notes:
BAB = Bottom Ash Basin; COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value; GMF = Gypsum Management Facility; NOEC = No Observed Effect Concentration; US DOE = United States Department of Energy; US EPA = United States Environmental Protection Agency.
(a) ESVs were taken from US EPA Region IV (2018) for all metal COIs. The benchmark for radium-226+228 is the lower of the US DOE (2019) benchmarks for Ra-226 and Ra-228.
(b) Boron NOEC of 38 mg/kg was used as a conservative benchmark for boron in the absence of an ESV (ECHA, 2019).

3.5.3 Ecological Receptors Exposed to Bioaccumulative Constituents of Interest

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

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

Risk Evaluation: Mercury was the only COI[8] identified as having potential bioaccumulative effects. The modeled mercury concentration in surface water (1.3×10^{-8} mg/L) is well below the US EPA Region IV (2018) ecological benchmark for wildlife (0.0013 mg/L) that is protective of bioaccumulative effects. Therefore, mercury is not considered to pose an ecological risk *via* bioaccumulation.

Radium is not described in US EPA Region IV guidance, but it has been identified as bioaccumulative by other entities (*e.g.*, ATSDR, 1990). However, the benchmark used to screen radium concentrations in surface water and sediment already considers bioaccumulative exposures. Given that the modeled concentrations are below benchmarks which account for bioaccumulative exposures, radium-226+228 is not expected to pose a risk concern to ecological receptors based on its bioaccumulative properties.

3.6 Uncertainties and Conservatisms

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

[8] US EPA Region IV (2018) identifies only mercury (including methyl mercury) and selenium as having potential bioaccumulative effects. IEPA (2019) identifies mercury as the only metal with bioaccumulative properties.

Exposure Estimates:

- The risk evaluation included the Illinois Part 845.600 (IEPA, 2021a) constituents detected in groundwater samples collected from wells downgradient of the BAB and GMF. However, it is possible that none of the detected constituents are related specifically to these ash ponds.
- The ecological risk characterization was based on the maximum modeled COI concentrations, rather than on average concentrations. Thus, the variability in exposure concentrations was not considered. Assuming continuous exposure to the maximum concentration overestimates ecological exposures, given that receptors are mobile and concentrations change over time. For example, US EPA guidance states that risks should be estimated using average exposure concentrations as represented by the 95% upper confidence limit on the mean (US EPA, 1992). Given that exposure estimates based on the maximum concentrations did not exceed risk benchmarks, we have greater confidence that there is no risk concern.
- Only analytes detected in groundwater were used to identify COIs and model COI concentrations in surface water and sediment. For the constituents that were not detected in groundwater, the detection limits were below the Illinois Part 845.600 GWPS (IEPA, 2021a) and thus do not require further evaluation.
- COI concentrations in surface water were modeled using the maximum detected total or dissolved COI concentrations in groundwater. Surface water concentrations for the BAB were modeled using the maximum detected total groundwater COI concentrations, and maximum detected dissolved groundwater COI concentrations for the GMF. Modeling surface water concentrations using total metal concentrations for BAB COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.
- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-BAB/GMF related sources were not considered in the evaluation of modeled concentrations; only exposure contributions potentially attributable to Site groundwater mixing with surface water were evaluated. While not quantified, exposures from potential BAB/GMF-related groundwater contributions are likely to represent only a small fraction of the overall human and ecological exposure to COIs that also have natural or non-BAB/GMF-related sources.

Toxicity Benchmarks:

- Screening level ecological benchmarks were compiled from IEPA and US EPA guidance and designed to be protective of the majority of site conditions, leaving the option for site-specific refinement. In some cases, these benchmarks may not be representative of the Site-specific conditions or receptors found at the Site, or may not accurately reflect concentration-response relationships encountered at the Site. For example, the ecological benchmark for cadmium is hardness-dependent and US EPA's default hardness of 100 mg/L was used due to a lack of hardness data for the DCCP. Regardless of the hardness, the maximum modeled cadmium concentration is orders of magnitude below the SWQS.
- In addition, for the ecological evaluation, we conservatively assumed all constituents to be 100% bioavailable. Modeled COI concentrations in surface water are considered total COI concentrations. US EPA recommends using dissolved metals as a measure of exposure to ecological receptors because it represents the bioavailable fraction of metal in water (US EPA,

1993). Therefore, the modeled surface water COI concentrations may be an overestimation of exposure concentrations to ecological receptors.

- For radium, groundwater concentrations were calculated as the sum of radium-226 and radium-228. US DOE (2019) presents surface water and sediment benchmarks protective of ecological receptors for radium-226 and radium-228 separately. Gradient relied on the lower of the two benchmarks to evaluate risks for radium-226+228. By comparing the total radium-226+228 concentration to the most stringent benchmark, it is assuming that all of the total radium concentrations has the toxicity of the more toxic isotope, which is an overestimation of risk. Despite the overestimation, the modeled exposure estimates are at least an order of magnitude lower than the conservative benchmark.

4 Summary and Conclusions

A screening-level risk evaluation was performed for Site-related constituents in groundwater at the DCPP in Canton, Illinois. The CSM developed for the Site indicates that groundwater beneath the GMF and BAB flows into the DCCP and may potentially impact surface water and sediment.

CEMs were developed for human and ecological receptors. There are no complete exposure pathways for humans, because the DCCP is part of the Site and does not have any recreational uses. Based on the local hydrogeology, residential exposure to groundwater used for drinking water or irrigation is not a complete pathway and was not evaluated. The complete exposure pathways for ecological receptors include aquatic life (including aquatic and marsh plants, amphibians, reptiles, and fish) exposed to surface water; benthic invertebrates exposed to sediment; and avian and mammalian wildlife exposed to bioaccumulative COIs in surface water, sediment, and dietary items.

Groundwater data collected between 2015 and 2021 were used to estimate exposures. Gradient used the maximum detected concentrations from groundwater samples collected from the wells associated with the BAB and GMF, without considering spatial or temporal representativeness for ecological receptor exposures. The use of the maximum constituent concentrations in this evaluation is designed to conservatively identify COIs that warrant further investigation. For constituents identified as COIs for ecological receptors, surface water and sediment concentrations in the DCCP were modeled using the maximum detected groundwater concentration.

Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. Surface water and sediment exposure estimates were screened against benchmarks protective of ecological receptors for this risk evaluation. The risk evaluation showed that none of the modeled COIs in surface water exceeded protective screening benchmarks. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks, therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors. Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher-trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, fish). Based on the modeled concentration, mercury is not considered to pose an ecological risk *via* bioaccumulation. Overall, this evaluation demonstrated that none of the COIs evaluated are expected to pose an unacceptable risk to ecological receptors.

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

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

References

AECOM. 2016. "Closure and Post-Closure Care Plan for Ash Ponds Nos. 1 and 2 at Illinois Power Resources Generating, LLC, Duck Creek Power Station, 17751 North Cilco Road, Canton, IL 61520." Report to Illinois Power Resources Generating, LLC, Canton, IL. March.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. "Toxicological Profile for Radium." December.

Bist LLC. 2021. "Bathymetry figures for the Bottom Ash Basin and GMF Pond, Duck Creek Power Station, Canton, Illinois." Accessed at http://fishing-app.gpsnauticalcharts.com/i-boating-fishing-web-app/fishing-marine-charts-navigation.html.

Hanson Professional Services Inc. 2019. "Antidegradation Assessment for Management of Waters from Closure and Post-Closure Care of Ash Ponds, Vermilion Site, Dynegy Midwest Generation, LLC, NPDES Permit No. IL0004057." Report to Dynegy Midwest Generation, LLC, Collinsville, IL. June 1.

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

Illinois Environmental Protection Agency (IEPA). 2013b. "Public Notice/Fact Sheet [re: Draft reissued NPDES Permit No. IL0055620, Duck Creek Power Plant, 17751 North CILCO Road, Canton, Illinois 61520 (Fulton County)]." Bureau of Water, Division of Water Pollution Control, Permit Section. Submitted to Ameren Energy Resources Co., LLC, St. Louis, MO. August 15.

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

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

Illinois Environmental Protection Agency (IEPA). 2021b. "Public Water Supply Systems Search (SDWIS Version 3.02)." Accessed at http://water.epa.state.il.us/dww/index.jsp.

Illinois State Geological Survey (ISGS). 2020. "Illinois Water Well (ILWATER) Interactive Map." December 31. Accessed at https://prairie-research.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87.

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

Natural Resource Technology. 2017. "Hydrogeologic Monitoring Plan, Duck Creek GMF Pond - CCR Unit ID 203, Duck Creek Landfill - CCR Unit ID 204, Duck Creek Power Station, Canton, Illinois." Report to Illinois Power Resources Generating, LLC. October 17.

Ramboll. 2021a. "Hydrogeologic Site Characterization Report, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021b. "Hydrogeologic Site Characterization Report, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021c. "Groundwater Monitoring Plan, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021d. "Groundwater Monitoring Plan, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Ramboll. 2021e. "40 C.F.R. 257.95(g)(3)(ii): Alternative Source Demonstration, Duck Creek Gypsum Management, Facility Pond." Report to Illinois Power Resources Generating, LLC.

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

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

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

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

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

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

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

US EPA. 2019. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

US EPA. 2021. "Safe Drinking Water Information System (SDWIS) Search." Accessed on September 28, 2021 at https://www.epa.gov/enviro/sdwis-search.

US EPA. 2021. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." September 16. Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

US EPA Region IV. 2018. "Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018 Update)." Superfund Division, Scientific Support Section, March.

US Geological Survey (USGS). 2021. "National Ground-Water Monitoring Network (NGWMN)." Accessed at https://cida.usgs.gov/ngwmn/index.jsp.

Appendix A

Surface Water and Sediment Modeling

List of Tables

Table A.1	Parameters Used to Estimate Groundwater Discharge to Surface Water - BAB
Table A.2	Parameters Used to Estimate Groundwater Discharge to Surface Water - GMF
Table A.3	Partition Coefficients
Table A.4	Calculated Parameters for the BAB
Table A.5	Calculated Parameters for the GMF
Table A.6	Surface Water Parameters
Table A.7	Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations for the BAB
Table A.8	Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations for the GMF

Abbreviations

BAB	Bottom Ash Basin
CCR	Coal Combustion Residual
COI	Constituent of Interest
DCCP	Duck Creek Cooling Pond
GMF	Gypsum Management Facility
MGD	Million Gallons Per Day
NPDES	National Pollutant Discharge Elimination System
US EPA	United States Environmental Protection Agency

Gradient modeled concentrations in the Duck Creek Cooling Pond (DCCP) surface water and sediment based on available groundwater data. First, we estimated the flow rate of constituents of interest (COIs) potentially discharged to the DCCP *via* groundwater. Then, we adapted United States Environmental Protection Agency's (US EPA's) indirect exposure assessment methodology (US EPA, 1998) in order to model surface water and sediment water concentrations in the DCCP.

Model Overview

The groundwater flow into the DCCP is represented by a one-dimensional steady-state model. In this model, the groundwater migrates horizontally in the uppermost aquifer in the direction of the DCCP. For the Bottom Ash Basin (BAB), the groundwater flow entering the DCCP is the flow going through a cross-sectional area that has a length equal to the length of the DCCP adjacent to the BAB with potential coal combustion residual (CCR)-related impacts and a height equal to the saturated thickness of the permeable sand unit within the uppermost aquifer (Table 3.3). For the Gypsum Management Facility (GMF), the groundwater flow entering the DCCP is the flow going through a cross-sectional area that has a length equal to the length of the DCCP adjacent to the GMF with potential CCR-related impacts and a height equal to the saturated thickness of the "Shallow Sand Unit" of the uppermost aquifer (Table 3.5). It was assumed that all the groundwater flowing through the uppermost aquifer discharges to the DCCP.

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

Groundwater Discharge Rate

Gradient used conservative assumptions to evaluate the potential groundwater discharge rate of the COIs. We conservatively assumed that the groundwater concentrations were uniformly equal to the maximum detected concentration for each individual COI. We ignored adsorption by subsurface soil and assumed that all the groundwater flowing through the uppermost aquifer was discharged into the DCCP.

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

$$Q = KiA$$

where:

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

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

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

where:

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

The values of the aquifer parameters used for these calculations are provided in Table A.1 for the BAB and Table A.2 for the GMF. The calculated mass discharge rates were then used as inputs for the surface water and sediment partitioning model.

Surface Water and Sediment Concentration

Groundwater discharged into the DCCP gets diluted in the surface water. Constituents transported by groundwater into the surface water migrate into the water column and the bed sediments. The surface water model we used to estimate the surface water and sediment concentrations is a steady-state model described in US EPA's indirect exposure assessment methodology (US EPA, 1998) and also used in US EPA's "Human and Ecological Risk Assessment of Coal Combustion Residuals" (US EPA, 2014). This model describes the partitioning of constituents between surface water, suspended sediments, and benthic sediments based on equilibrium partition coefficients. It estimates the concentrations of constituents in surface water, suspended sediments, and benthic sediments at steady-state equilibrium at a theoretical location downstream of the discharge point after complete mixing of the water column. In our analysis, we used the partitioning coefficients given in Table J-1 of the US EPA CCR Risk Assessment for all COIs (US EPA, 2014) except radium (Sheppard, 2009). These coefficients are presented in Table A.3.

To be conservative, we assume that the constituents are not affected by dissipation or degradation once they enter the water body. The total water body concentration of the COI is calculated using the following equation from US EPA (1998):

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

where:

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

For the DCCP flow rate, we used a discharge rate of about 18 million gallons per day (MGD), based on the estimated DCCP surface water discharge rates to Duck Creek *via* outfall 001 (0.038 MGD) and outfall 002 (18 MGD), as indicated in National Pollutant Discharge Elimination System (NPDES) Permit No. IL0055620 (IEPA, 2013b).

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

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

where:

f_{water}	=	fraction of COI in the water column
K_{dsw}	=	Suspended sediment-water partition coefficient (mL/g)
K_{dbs}	=	Sediment-water partition coefficient (mL/g)
TSS	=	Total suspended solids in the surface water body (mg/L), set equal to the representative average concentration of 6 mg/L (Hanson Professional Services Inc., 2019)
0.000001	=	Units conversion factor
d_w	=	Depth of the water column (m)
d_b	=	Depth of the upper benthic layer (m), set equal to 0.03 m (US EPA, 2014)
$d_z = d_w + d_b$	=	Depth of the water body (m)
bsp	=	Bed sediment porosity (unitless), set equal to 0.6 (US EPA, 2014)
bsc	=	Bed sediment particle concentration (g/cm^3), set equal to 1.0 g/cm^3 (US EPA, 2014)

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

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

The values of the fraction of COIs in the water column and other calculated parameters are presented in Table A.4 for the BAB and in Table A.5 for the GMF. Other water body parameters are presented in Table A.6, which apply to both the BAB and GMF.

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

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

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

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

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

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

where:

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

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

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

where:

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

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

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

where:

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

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

The concentration sorbed to benthic sediments is calculated using the following equation from US EPA (1998):

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

where:

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

For each COI, the modeled total water column concentration, the modeled dry weight sediment concentration, and the modeled concentration sorbed to sediment are presented in Table A.7 for the BAB and in Table A.8 for the GMF.

References

Hanson Professional Services Inc. 2019. "Antidegradation Assessment for Management of Waters from Closure and Post-Closure Care of Ash Ponds, Vermilion Site, Dynegy Midwest Generation, LLC, NPDES Permit No. IL0004057." Report to Dynegy Midwest Generation, LLC, Collinsville, IL. June 1.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Bottom Ash Basin, Duck Creek Power Plant, Canton, Illinois." Report to Illinois Power Resources Generating, LLC.

Sheppard, S; Long, J; Sanipelli, B; Sohlenius, G. 2009. "Solid/liquid partition coefficients (Kd) for selected soils and sediments at Forsmark and Laxemar-Simpevarp." Report to Swedish Nuclear Fuel and Waste Management Co. SKB Rapport R-09-27, March.

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

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

Tables

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

GW Unit	Parameter	Full Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	260	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.01	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.00063	cm/s

Notes:
BAB = Bottom Ash Basin; GW = Groundwater.
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).

Table A.2 Parameters Used to Estimate Groundwater Discharge to Surface Water - GMF

GW Unit	Parameter	Full Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	2,488	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.02	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.00036	cm/s

Notes:
GMF = Gypsum Management Facility; GW = Groundwater.
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).

Table A.3 Partition Coefficients

Constituent	Sediment-Water, Mean, K_{dbs}		Suspended Sediment-Water, Mean, K_{dsw}	
	Value (log_{10}) (mL/g)	Value (mL/g)	Value (log_{10}) (mL/g)	Value (mL/g)
Antimony	3.6	3.98E+03	4.8	6.31E+04
Arsenic	2.4	2.51E+02	3.9	7.94E+03
Beryllium	2.8	6.31E+02	4.2	1.58E+04
Boron	0.8	6.31E+00	3.9	7.94E+03
Cadmium	3.3	2.00E+03	4.9	7.94E+04
Cobalt	3.1	1.26E+03	4.8	6.31E+04
Lead	4.6	3.98E+04	5.7	5.01E+05
Mercury	4.9	7.94E+04	5.3	2.00E+05
Radium-226 + 228	3.9	7.40E+03	3.9	7.40E+03
Selenium	0.6	3.98E+00	3.8	6.31E+03
Thallium	1.3	2.00E+01	4.1	1.26E+04

Notes:
Lithium was not modeled because it lacks a Kd value in US EPA (2014).
Sources: US EPA (2014); Sheppard (2009).

Table A.4 Calculated Parameters for the BAB

Constituent	Fraction of Constituent in the Water Column f_{water}	Fraction of Constituent in the Benthic Sediments $f_{benthic}$	Fraction of Constituent Dissolved in the Water Column $f_{dissolved}$
Arsenic	0.1741	0.8259	0.9545
Beryllium	0.0808	0.9192	0.9132
Boron	0.8848	0.1152	0.9545
Cobalt	0.0525	0.9475	0.7254
Lead	0.0051	0.9949	0.2496
Mercury	0.0014	0.9986	0.4551
Radium 226 + 228	0.0071	0.9929	0.9575

Note:
BAB = Bottom Ash Basin.

Table A.5 Calculated Parameters for the GMF

Constituent	Fraction of Constituent in the Water Column f_{water}	Fraction of Constituent in the Benthic Sediments $f_{benthic}$	Fraction of Constituent Dissolved in the Water Column $f_{dissolved}$
Antimony	0.0172	0.9828	0.7254
Arsenic	0.1741	0.8259	0.9545
Boron	0.8848	0.1152	0.9545
Cadmium	0.0361	0.9639	0.6772
Cobalt	0.0525	0.9475	0.7254
Lead	0.0051	0.9949	0.2496
Selenium (IV)	0.9199	0.0801	0.9635
Thallium	0.7261	0.2739	0.9298

Note:
GMF = Gypsum Management Facility.

Table A.6 Surface Water Parameters

Parameter	Full Name	Value	Unit
TSS	Total Suspended Solids	6	mg/L
V_{fx}	Surface Water Flow Rate	2.5E+10	L/yr
db	Depth of Upper Benthic Layer (default: 0.03)	0.03	m
dw	Depth of Water Column	1.52	m
dz	Depth of Water Body	1.55	m
bsc	Bed Sediment Bulk Density (default: 1.0)	1	g/cm^3
bsp	Bed Sediment Porosity (default: 0.6)	0.6	-
M_{TSS}	TSS Mass per Unit Area	0.009	kg/m^2
M_S	Sediment Mass per Unit Area	30	kg/m^2

Note:
Sources of default values: US EPA (1998, 2014).

Table A.7 Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations for the BAB

Constituent	Groundwater Concentration (mg/L)	Mass Discharge Rate to Surface Water (mg/year)	Total Water Column Concentration (mg/L)	Concentration Sorbed to Bottom Sediments (mg/kg)
Arsenic	2.40E-02	1.25E+04	5.10E-07	1.22E-04
Beryllium	6.80E-03	3.53E+03	1.44E-07	8.32E-05
Boron	7.80E+00	4.05E+06	1.66E-04	9.98E-04
Chloride	7.00E+02	3.64E+08	1.49E-02	Not Applicable
Cobalt	3.70E-02	1.92E+04	7.86E-07	7.18E-04
Lead	4.20E-02	2.18E+04	8.92E-07	8.86E-03
Lithium	6.80E-02	3.53E+04	1.44E-06	Not Applicable
Mercury	1.20E-03	6.23E+02	2.55E-08	9.22E-04
Constituent	**Groundwater Concentration (pCi/L)**	**Mass Discharge Rate to Surface Water (pCi/year)**	**Total Water Column Concentration (pCi/L)**	**Concentration Sorbed to Bottom Sediments (pCi/kg)**
Radium-226 + 228	9.64E+00	5.01E+06	2.05E-04	1.45E+00

Notes:
BAB = Bottom Ash Basin; K_d = Equilibrium Partitioning Coefficient.
Chloride and lithium were not modeled due to lack of K_d value in US EPA (2014).

Table A.8 Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations for the GMF

Constituent	Groundwater Concentration (mg/L)	Mass Discharge Rate to Surface Water (mg/year)	Total Water Column Concentration (mg/L)	Concentration Sorbed to Bottom Sediments (mg/kg)
Antimony	1.20E-02	6.75E+04	2.76E-06	7.97E-03
Arsenic	5.10E-02	2.87E+05	1.17E-05	2.81E-03
Boron	3.00E+00	1.69E+07	6.90E-04	4.15E-03
Cadmium	8.50E-03	4.78E+04	1.95E-06	2.64E-03
Cobalt	2.80E-02	1.57E+05	6.44E-06	5.88E-03
Lead	1.90E-01	1.07E+06	4.37E-05	4.34E-01
Selenium (VI)	2.50E-01	1.41E+06	5.75E-05	2.20E-04
Thallium	3.30E-03	1.86E+04	7.59E-07	1.41E-05

Notes:
GMF = Gypsum Management Facility.
Source: US EPA (2014).

Appendix B

Supporting Information

Supporting Information for Closure Alternatives Analysis – Gypsum Management Facility at Duck Creek Power Plant

GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE January 25, 2022 **Reference No.** 21454861-13-R-1

TO Illinois Power Resources Generating, LLC

FROM Golder Associates USA Inc.

SUPPORTING INFORMATION FOR CLOSURE ALTERNATIVES ANALYSIS – GYPSUM MANAGEMENT FACILITY POND AT DUCK CREEK POWER PLANT

Golder Associates USA Inc. (Golder), a Member of WSP, has prepared this technical memorandum for Illinois Power Resources Generating, LLC (IPRG) to support the Closure Alternatives Analysis for the Gypsum Management Facility (GMF) Pond at Duck Creek Power Plant (DCPP). The GMF Pond was used for containment of gypsum produced at DCPP and has not received gypsum since the power plant was retired in 2019. The Closure Alternatives Analysis is being completed in accordance with Illinois Administrative Code Title 35, Part 845, Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (Part 845), by Gradient. With this technical memorandum, Golder summarizes the design basis and references used in developing the closure concepts evaluated by the Closure Alternatives Analysis.

1.0 GMF POND HISTORY

1.1 Existing Liner System Information

Golder reviewed several documents related to the design, construction, and operation of the GMF Pond. Notable documents included the History of Construction (AECOM 2016), the Gypsum Stack Acceptance Report (Hanson 2009a), and the Initial Facility Report Volumes 1–4 (Hanson 2009b). Based on review of these documents, a dual composite liner system with a leak detection layer was installed for the GMF Pond consisting of (from top to bottom):

- primary composite liner
  - Solmax 460T-1000 60-mil textured high-density polyethylene (HDPE) geomembrane
  - 1-foot cushion dirt layer (2 feet in select areas on the sideslopes)
- leak detection layer
  - SKAPS GT-142 4-oz/yd^2 geotextile separator
  - 1-foot granular drainage layer
  - SKAPS GE-110 10-oz/yd^2 geotextile cushion
- secondary composite liner
  - Solmax 460T-4013 60-mil textured HDPE geomembrane

- CETCO Bentomat SDN reinforced geosynthetic clay liner (GCL)
- 3-foot compacted clay layer placed in 8-inch lifts, compacted to at least 95% of the standard Proctor maximum dry density at a moisture content between the standard Proctor optimum moisture content (OMC) and 5% wet of the OMC

According to the Acceptance Report (Hanson 2009a), the liner system was subjected to a rigorous construction quality assurance (CQA) program.

The GMF Pond was constructed by excavating the natural ground a minimum of 5.4 feet to reach foundation grades. During preparation of the foundation grades, unsuitable sand materials were removed from several areas and stockpiled separately. These areas were then backfilled with suitable material previously stockpiled or locally available. Backfilled areas were compacted to at least 95% of the standard Proctor maximum dry density at a moisture content within 2% of the OMC. Eight Shelby tube samples collected from the foundation grade berms were used for hydraulic conductivity testing, with results ranging from 2.2×10^{-8} centimeters per second (cm/s) to 1.0×10^{-7} cm/s.

After certification of the foundation grades, the 3-foot compacted clay layer was constructed in 8-inch lifts. Eighteen Shelby tube samples were collected during construction. Hydraulic conductivity results from tests on the Shelby tube samples ranged from 8.6×10^{-9} cm/s to 9.8×10^{-7} cm/s, significantly less than the construction specification of 1.0×10^{-4} cm/s. The compacted clay layer was proof rolled prior to installation of the overlying GCL.

After placement of the compacted clay layer, geosynthetic components of the secondary liner system were installed. Certified properties for the geosynthetic materials are provided in the Geosynthetics Quality Assurance Report (Feezor 2009).

A leak detection layer with leachate collection and recovery system (LD/LCRS) was installed above the lower geomembrane. The LD/LCRS included a 10-oz/yd^2 geotextile overlain by a 1-foot granular drainage layer with 6-inch- and 12-inch-diameter HDPE piping embedded. Laboratory hydraulic conductivity test results for the granular drainage layer soil ranged from 1.5×10^{-2} to 5.7×10^{-2} cm/s. Test reports from hydraulic conductivity and particle-size distribution testing are provided in the Acceptance Report (Hanson 2009a). The piping within the LD/LCRS directs leachate to two sumps at the toe of the south berm of the GMF Pond, with risers to facilitate removal of leachate. A 4-oz/yd^2 geotextile was installed above the 1-foot granular drainage layer. Certified properties for the geosynthetic materials are provided in the Geosynthetics Quality Assurance Report (Feezor 2009).

A 1-foot cushion soil layer compacted to at least 90% of the standard Proctor maximum dry density was placed above the 4-oz/yd^2 geotextile. According to the Acceptance Report (Hanson 2009a), the layer was constructed of general fill transported from a stockpile or borrow to the work area by truck and graded with a dozer to a depth of approximately 1 foot. The local stockpiles generally consisted of fine-grained soils, predominantly low-plasticity silts and clays (classified as CL and ML under the United Soil Classification System [USCS]). The cushion layer was then overlain by a 60-mil HDPE geomembrane constructed with the same installation specifications as the lower geomembrane. Certified properties for the upper geomembrane are provided in the Geosynthetics Quality Assurance Report (Feezor 2009).

In addition to the dual composite liner system, the GMF Pond has a ring drain system above the primary liner system that was used to recover and recycle water used for hydraulic conveyance of gypsum to the GMF Pond. The ring drain system consists of a rectangular array of 6-inch-diameter perforated HDPE pipe installed above the upper geomembrane around the perimeter of the GMF Pond floor. The pipe is surrounded by coarse aggregate and wrapped in a geotextile. The ring drain pipe network directs water to five sumps (one each along the toes of the north, east, and west embankments and two along the toe of the south embankment).

1.2 Operational History

The GMF Pond was constructed between 2007 and 2009 and was put into operation in 2009. The GMF Pond was used to store gypsum and to clarify gypsum transport water for reuse in the wet scrubber system until DCPP was retired in December 2019. Gypsum was hydraulically conveyed to the GMF Pond at approximately 20% solids (Hanson 2009b). It was deposited from the north end of the GMF Pond and in the northwest corner, which formed a delta or beach of built-up gypsum in these locations during the operational life. The gypsum would build up to the water level and then expand laterally (rather than vertically) due to the relatively weak nature of the subaqueous gypsum. During the operational life, the beach expanded so that roughly one-third of the GMF Pond footprint had gypsum built up to the typical water level. The water level was (and still is) controlled by an overflow channel at the southeast corner of the GMF Pond. The overflow elevation was adjustable and could be as low as El. 614 feet or as high as approximately El. 616 feet. Water decanted (or was siphoned early in the life of the GMF Pond) from the GMF Pond into the Recycle Pond, which is located immediately south of the GMF Pond. A set of pumps situated on the west side of the Recycle Pond was used to transfer the decanted water back to the wet scrubber system for reuse. The Operation and Maintenance Manual for the GMF Pond provides additional information and is included in the History of Construction (AECOM 2016).

It is Golder's understanding that the pumps for the LD/LCRS are controlled by the hydraulic head in the 1-foot granular drainage layer (i.e., they only operate when there has been enough infiltration into the LD/LCRS to build up the hydraulic head to a trigger level) and that the pumps have rarely needed to operate. This anecdotal information suggests that the primary composite liner is intact and provides an effective barrier to infiltration from the GMF Pond and that the secondary composite liner is intact and provides an effective barrier to lateral infiltration.

1.3 Type and Volume of Materials

Based on Golder's comparison (using Autodesk Civil 3D) of the existing conditions (December 2020 survey by IngenAE) and the approximate top-of-liner-system grades developed from the as-built top of cushion layer (Hanson 2009a), approximately 400,000 cubic yards (cy) of gypsum are present in the GMF Pond. The GMF Pond footprint is approximately 31 acres, with approximately 60,800 cy of cushion dirt, 55,500 cy of granular drainage material, and 166,500 cy of compacted clay used in construction of the GMF Pond.

The wet scrubber system used for flue gas desulfurization at DCPP produced synthetic gypsum (calcium sulfate). The synthetic gypsum is generally of the same chemical structure as natural gypsum. Because the material was sluiced, the particle-size distribution of the gypsum in the GMF Pond is expected to be variable, becoming finer with increased distance from the deposition locations. Based on geotechnical testing Golder conducted on a composite of three samples of gypsum collected near the north end of the GMF Pond, the material is non-plastic with more than 97% by weight passing the No. 200 sieve (ML under the USCS) and a specific gravity of 2.66. Slurry consolidation testing conducted by Golder on a reconstituted sample of gypsum from the GMF Pond indicated a range of hydraulic conductivities from 6×10^{-5} cm/s to 1×10^{-4} cm/s under typical confining stresses in the GMF Pond.

1.4 Water Levels

At the time of the December 2020 survey by IngenAE, the water level in the GMF Pond was at El. 613.9 (North American Vertical Datum of 1988). Although the water level would be expected to respond to wet or dry climate conditions, this water level is likely typical for the GMF Pond. Based on this water level, approximately 95% of the gypsum in the GMF Pond is below the water level. Based on Golder's site observations, gypsum below the water level can be considered saturated. The gypsum above the water level forms a plateau at the north end of the GMF Pond with the highest point at approximately El. 616 feet. Based on Golder's site observations, gypsum above the water level is moist, but not saturated, and is capable of supporting foot traffic, but likely not equipment traffic without dewatering.

2.0 CLOSURE CONCEPT INFORMATION

To provide necessary information for the Closure Alternatives Analysis, Golder developed a closure concept that would involve closure with CCR remaining in place and a closure concept that would involve closure by removal of CCR. These closure concepts are described in this section.

2.1 Closure in Place

2.1.1 Final Cover System Materials

For closure with CCR in place, Part 845 requires installation of a final cover system over the CCR. Based on a demonstration to be submitted to the Illinois Environmental Protection Agency for approval pursuant to Section 845.750(c)(2), an alternative final cover system is incorporated into the closure-in-place concept. The final cover system consists of (from top to bottom):

- 2-foot final protective layer—locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density for establishment of vegetation and protection of the underlying geomembrane. Material is likely to be primarily low-plasticity silt or clay based on review of site geotechnical information (e.g., Hanson 2009b).
- Geocomposite.
- 40-mil LLDPE geomembrane.

To the extent possible, the gypsum would be graded to achieve final cover subgrade, and the final cover system would be constructed directly on the gypsum surface in most areas. Compacted fill, composed of locally available soils, would be placed only as needed to achieve final cover subgrade. The compacted fill is anticipated to be compacted to a minimum of 95% of the standard Proctor maximum dry density to provide a firm subgrade.

2.1.2 Closure Construction Plan

Conceptual final cover system grades and details are shown in Exhibit 1. The closure-in-place concept was developed to reduce the waste footprint at closure, while also recognizing the complications associated with handling and stacking wet gypsum materials. The proposed closure-in-place option would have final cover slopes of 4% to accommodate moderate settlement, with a berm constructed at the south end of the consolidated footprint to enhance stability. The location of the berm has been selected to accommodate the estimated volume of gypsum to be contained within the consolidated footprint based on the grading plan presented. The general sequencing plan for the closure-in-place option is as follows:

- Pump out ponded water from the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400,000 cy of gypsum. Pumping out the ponded water will enable gravity drainage of the gypsum to begin, but there will be a significant amount of saturated material that will need to be relocated.
- Once the ponded water has been removed from the GMF Pond, shallow gypsum zones in the consolidated footprint will be dewatered as needed to enable equipment trafficking. Gypsum south of the consolidated footprint will be dewatered as needed to enable relocation. Free liquids in the gypsum will be eliminated by removing liquid wastes or solidifying gypsum remaining in place.
- Gypsum will be removed from the berm footprint and relocated into the consolidated footprint. The berm will be constructed in an east-west orientation at the south end of the consolidated footprint. The upstream face of the berm will be lined with a composite liner system consisting of a 60-mil HDPE geomembrane overlying a compacted clay layer, which will tie into the existing dual composite liner system.
- The remaining gypsum south of the berm will be collected and deposited north of the berm.
- Geosynthetic components of the existing dual composite liner system south of the berm will be removed and hauled away for disposal. Soil materials that must be removed to expose the geosynthetic layers will be stockpiled on site.

Ponded water removal from the GMF Pond will be a significant effort. Removal of the ponded water at the GMF Pond may take three to six months, depending on pumping rates, operating hours, and weather conditions. Once the ponded water is removed, Golder anticipates that the removal of liquid waste will take 12 to 18 months. The final cover system could be installed during the following construction season.

2.1.3 Stormwater Management

Stormwater runoff from the GMF Pond closure area will be managed by sheet flow off the cover system. Runoff will be routed into existing drainage channels northeast and southeast of the GMF Pond. A new channel will be excavated along the northern perimeter of the consolidated footprint to route water into the existing drainage channel northeast of the GMF Pond. To prevent impoundment of water in the south end of the current GMF Pond footprint, existing earthen embankments will be removed in the southeast corner of the GMF Pond and in the Recycle Pond to allow stormwater to passively flow into the existing drainage southeast of the GMF Pond. No new stormwater management ponds or other features would be needed for closure.

2.2 Closure by Removal

Under the closure-by-removal option, the gypsum in the GMF Pond will be dewatered and all gypsum will be hauled by truck from the GMF Pond to the existing permitted on-site landfill located approximately 1 mile north of the GMF Pond. Alternatively, the gypsum may be disposed of at an off-site landfill approximately 33 miles away. Additionally, the dual composite liner system described in Section 1.1 will be removed as required under 845.740(a) and disposed. Subsoil beneath the liner system will be excavated to a depth of up to 1 foot and disposed. Additional details on the closure-by-removal option are shown in Exhibit 2.

2.2.1 Material Removal Phasing

To completely remove the gypsum material from the GMF Pond, the gypsum will need to be dewatered. As described in Section 2.1.2, removal of ponded water from the GMF Pond is expected to take several months. After removal of the ponded water, the gypsum will still be unsuitable for supporting heavy construction traffic over much of the footprint. Careful planning will be required to safely remove the wet gypsum from the GMF Pond. The gypsum removal will likely be accomplished in phases, relying on a series of trenches to facilitate dewatering of the material. The trenches will shorten drainage routes to facilitate gravity dewatering of gypsum in the vicinity of each trench and will direct the water to sumps from which the water can be pumped. Exact dewatering means and methods would be determined by the gypsum removal contractor. The dewatering and closure-by-removal concept evaluated in the Closure Alternatives Analysis follows:

- Pump out ponded water from the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400,000 cy of gypsum. Pumping out the ponded water will enable gravity drainage of the gypsum to begin, but there will be a significant amount of saturated material that will need to be relocated.
- Excavate a series of trenches from north to south in the gypsum. Conceptually, the trenches may be on the order of 5 feet deep at regular spacing (potentially every 50 feet) and graded to allow water to drain to the south. Sumps in the trenches along the south end of the gypsum deposit will be used to collect water, which will be pumped from the GMF Pond to the Recycle Pond. The trenches will remain open until the top layer of gypsum across the GMF Pond is sufficiently dewatered to enable removal and transport without producing free water when disturbed. This process will repeat until all gypsum has been removed from the GMF Pond. Each layer may take several weeks or months to dewater and remove. Active dewatering or multiple handling of the gypsum may be an option to expedite the closure construction. The ring drain system may also be used to facilitate dewatering of the gypsum.
- Once all gypsum has been removed from the GMF Pond, the existing dual composite liner system described in Section 1.1 will be removed as required under 845.740(a). The earthen and geosynthetic materials will be disposed in a permitted landfill.
- A tentative schedule for the closure-by-removal process is:
  - three to six months to pump ponded water out of the GMF Pond
  - between one and two construction seasons to dewater and remove saturated gypsum
  - one or two construction seasons to remove the existing liner system and establish final reclamation grades, depending on on-site or off-site disposal

2.2.2 Surface Reconstruction

Once the GMF Pond is completely dewatered and all gypsum has been removed, the site will be reconfigured to allow passive surface water flow. Earthen embankments in the southeast corner of the GMF Pond and in the Recycle Pond will be removed to allow surface water to flow into an existing drainage channel southeast of the GMF Pond.

2.2.3 Stormwater Management

Surface water will shed to the south across the footprint and will be directed to an existing drainage southeast of the GMF Pond. To prevent impoundment of water in the south end of the footprint, existing earthen embankments will be removed in the southeast corner of the GMF Pond and in the Recycle Pond to allow stormwater to passively flow into the existing drainage southeast of the GMF Pond. No new stormwater management ponds or other features would be needed for closure.

3.0 ADDITIONAL INFORMATION

Gradient provided a request for additional information to support the Closure Alternatives Analysis. The additional information compiled by Golder in response to the request is provided in Tables 1 through 4. Table 1 provides narrative responses for information requests based largely on Part 845 requirements for the Closure Alternatives Analysis. Table 2 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-in-place approach. Table 3 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in a permitted on-site landfill, which would require an approximate 2-acre expansion to the existing on-site landfill. Table 4 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in an off-site landfill.

In accordance with Part 845, the cost estimates meet the criteria for a Class 4 estimate under the AACE classification standard (feasibility-level, -30% to +50% expected accuracy range). Cost estimates are presented in 2022 United States dollars. cost estimates for many of the cost components, whereby a labor and heavy equipment spread was assigned to the activity. That is, the number and classification (e.g., operator, laborer) of personnel carrying out the activity and the number and type of heavy equipment pieces (e.g., dozer, loader, haul truck) was estimated based on our experience with similar construction operations. This information, combined with an estimate of production rate (e.g., number of cubic yards placed per day), yields a unit cost for the operation (e.g., cost per cubic yard placed). Golder developed production rates based on equipment capabilities (e.g., haul truck capacity, estimated load and unload times, estimates of average speed) and checked them against experience from similar projects. The hourly heavy equipment rates used in the cost estimates were from an internal database of heavy equipment ownership and operating costs by type and size (capacity) of equipment. The internal database reflects the estimated cost associated with owned heavy equipment in the central United States. The hourly labor rates used in the cost estimates were from an internal database of typical labor rates from similar projects in the north-central United States. Unit prices for some cost components (e.g., furnishing and installation of geosynthetics, seeding and mulching) were estimated based on typical unit prices from similar recent projects. Material quantities correspond with the closure approaches shown in Exhibits 1 and 2 and were developed primarily in Autodesk Civil3D. At a conceptual level of cost estimating, project costs other than direct construction costs (e.g., mobilization and demobilization, miscellaneous construction items not captured elsewhere) were estimated as a proportion of the direct construction cost. Experience on similar projects was used as the basis for the proportions applied.

4.0 REFERENCES

AECOM. 2016. History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Duck Creek Power Station. October. Available online: https://www.luminant.com/ccr/?wpdf_download_file=L25hcy9jb250ZW50L2xpdmUvbHVtaW5hbnQzL2RvY3VtZW50cy9jY3IvSWxsaW5vaXMvRHVjay1DcmVlay8yMDE2L0hpc3Rvcnkgb2YgQ29uc3RydWN0aW9uLnBkZg%3D%3D).

Feezor (Feezor Engineering, Inc.). 2009. Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station. July.

Hanson (Hanson Professional Services Inc.). 2009a. Acceptance Report, Gypsum Stack, Gypsum Management Facility, AERG Duck Creek Power Generating Station. December.

Hanson. 2009b. Initial Facility Report, Gypsum Stack, Gypsum Management Facility, Duck Creek Generating Station. February.

Exhibits: Tables
- Table 1: Information Summary
- Table 2: Closure Estimates – Closure in Place
- Table 3: Closure Estimates – Closure by Removal with On-Site Disposal
- Table 4: Closure Estimates – Closure by Removal with Off-Site Disposal

Exhibits 1 and 2
- Exhibit 1: Closure-in-Place Figures
- Exhibit 2: Closure-by-Removal Figures

https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/13-r-closure_plan_gypsum_mgmt_facility_pond/13-r-1/att1/app b/caa_supporting_info-gmf_pond.docx

Tables

Table 1: Information Summary

Background/Current Site Conditions	
Surface area of impoundment	30.8 acres
Volume of CCR in impoundment	400,000 cy
Published or draft engineering evaluations undertaken at the site to date	
Conceptual site models	Refer to the Groundwater Modeling Report.
Regional well (receptor) survey information	Refer to the Groundwater Modeling Report.
History of construction report	See [1].
Dike stability report	Observations and stability factors of safety described by AECOM [2] and [3] were adequate.
Hydraulic evaluation of basins (evaluation of possibility of overtopping and/or emergency spillway releases during flood conditions)	Hydraulic and hydrologic analyses performed by AECOM [4] found that the geomembrane-lined spillway can adequately manage flow during peak discharge from the 1,000-year storm event without overtopping of the embankments. This also means that the spillway is adequate to carry sustained flows.
Surface impoundment hazard assessment/hazard category determination	A hazard potential classification assessment performed by Stantec [5] found the GMF Pond to have significant hazard potential. 40 CFR 257.53 defines a significant hazard potential CCR surface impoundment as a diked surface impoundment for which failure or misoperation would result in no probable loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, and/or impact other concerns.
Habitat survey	During site development, it was confirmed that the site did not contain wild or scenic rivers (per the National Park Service), the facility did not restrict the flow of a 100-year flood, the site did not qualify for listing on the National Register of Historic Places (per the Illinois Historic Preservation Agency), the site did not pose a threat to a dedicated nature preserve persuant to the Illinois Natural Areas Preservation Act (per the Illinois Nature Preserves Commission), and there were no records of the presence of endangered/threatened species or natural areas in the vicinity of the facility [6].
Wetlands survey	In March and May of 2007, field surveys were conducted to determine and delineate the existence of any potential wetland areas in accordance with the 1987 Corps of Engineers Wetland Delineation Manual. It was determined that six unnamed tributaries, a linear ditch wetland, and two headwater drainages were within the facility boundary. No defined hydrologic connection to Duck Creek was identified, so these were determined to be isolated waters and wetlands and not regulated under the Clean Water Act [6].

Table 1: Information Summary

Closure Design and Implementation	
Copy of draft of closure report, if available	Provided.
Engineering spreadsheet containing breakdown of labor, equipment/vehicle, and material requirements for each closure alternative, if available (expected on-site and off-site vehicle and equipment mileages, labor hours, etc.)	See Tables 2 through 4.

Overview of planned activities under each closure alternative	Closure in place: Under this scenario, gypsum will be contained in the northern portion of the GMF Pond, which will necessitate relocation of gypsum currently in the southern portion of the GMF Pond to this final containment area, followed by final cover installation. The general sequence is:
	-Ponded water will be pumped out of the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400000 cy of gypsum. Pumping out the ponded water will allow gravity drainage of the gypsum to begin.
	-Gypsum within the final containment area will be dewatered using trenches and sumps and possibly the existing ring drain system.
	-Once the ponded water has been removed from the GMF Pond, a berm will be constructed across the GMF Pond in an east-west orientation at the south end of the final containment area. Gypsum in the berm footprint will need to be removed before the berm is constructed. The upstream face of the berm will be lined with a composite liner system, which will tie into the existing dual liner system.
	-The remaining gypsum south of the berm will be collected and deposited north of the berm.
	-Geosynthetic components of the existing dual composite liner system south of the berm will be removed and disposed in the closure footprint. Soil materials between these components will be removed and stockpiled south of the GMF Pond.
	-Compacted fill will be used as needed to achieve subgrade and a final cover system consisting of the following components (from top to bottom) will be constructed over the final containment area:
	    -2-foot-thick final protective layer composed of locally available soils
	    -Geocomposite
	    -40-mil LLDPE geomembrane
	-A channel will be excavated, including removal of sections of the perimeter embankment around the Recycle Pond, to allow surface water flow into an existing drainage channel southeast of the GMF Pond.

Table 1: Information Summary

Closure Design and Implementation	
Overview of planned activities under each closure alternative	Closure by removal: Under this scenario, the gypsum in the GMF Pond will be dewatered and hauled by truck from the GMF Pond to the existing permitted on-site landfill, which will require a 2-acre expansion, or to a permitted off-site landfill. Additionally, the existing dual composite liner system will be removed as required under Part 845.740(a). The general sequence is: -Ponded water will be pumped out of the GMF Pond. Approximately 112 million gallons of water was contained in the GMF Pond as of the December 2020 survey by IngenAE, not including the pore water within the roughly 400000 cy of gypsum. Pumping out the ponded water will allow gravity drainage of the gypsum to begin. -A series of trenches will be excavated from north to south in the gypsum. The trenches will likely be on the order of 5 feet deep at regular spacing (such as every 50 feet) and graded to allow water to drain to the south. Sumps will be excavated in the trenches along the south end of the gypsum deposit to collect water, which will be pumped from the GMF Pond to the Recycle Pond. The trenches will remain open until the surrounding gypsum is sufficiently dewatered to enable removal and transport without producing free water. This process will repeat until all gypsum has been removed from the GMF Pond. Each layer may take several weeks or months to dewater and remove. The ring drain system may also be used to facilitate dewatering of the gypsum. -Once all gypsum has been removed from the GMF Pond, the existing dual composite liner system will be removed and the subsoil will be overexcavated up to an additional 1 foot. The geosynthetic materials and soils will be disposed in the on-site landfill or in an off-site landfill. -A channel will be excavated, including removal of sections of the perimeter embankment around the Recycle Pond, to allow surface water flow into an existing drainage channel southeast of the GMF Pond.
Expected duration of major construction activities under each closure activity	Closure in place: Approximately three years. Removal of ponded water from the GMF Pond may take 3 to 6 months, depending on pumping rates, operating hours, and weather conditions. Once the ponded water is removed, it is anticipated that the removal of liquid waste will take 12 to 18 months. It is anticipated that final cover construction and establishment of final grades efforts could be completed during the following construction season.
	Closure by removal: Approximately three years for on-site disposal and four years for off-site disposal. Removal of ponded water from the GMF Pond may take 3 to 6 months, depending on pumping rates, operating hours, and weather conditions. Expansion of the existing landfill can take place during this time. It is anticipated that dewatering and removal of the gypsum will take one or two construction seasons for on-site disposal or two full years for off-site disposal. It is anticipated that removal of the dual composite liner system and establishment of final grades will require an additional construction season for on-site disposal or 18 months for off-site disposal.

Table 1: Information Summary

Closure Design and Implementation	
If an on-site landfill will be constructed on the site under a given closure alternative, please include the years required to construct and later close the on-site landfill	Closure in place: Not applicable. The existing permitted on-site landfill has sufficient capacity to accept waste generated from closure in place without expansion of the existing landfill or construction of a new on-site landfill.
	Closure by removal: If disposal will be on site, the landfill expansion could be completed in a single construction season. Landfill closure could be completed in a single construction season following closure of the GMF Pond.
If an on-Site landfill must first be constructed on the Site, please estimate the anticipated delay in the commencement of excavation activities while the landfill is being sited, designed, and constructed. Will dewatering/unwatering of the ponds begin immediately, or after the landfill is constructed?	Closure in place: Not applicable.
	Closure by removal: The landfill has already been sited and permitted, including the expansion area. Final design and construction of the expansion could be completed while removal of ponded water and gypsum dewatering are occurring at the GMF Pond.
Proposed location of the on-site landfill if on-site disposal is being considered for CBR scenario	The existing on-site landfill is approximately 1 mile north of the GMF Pond via site roads.
Surface area of the on-site landfill, if a new landfill must be constructed at the site	If a landfill expansion is required (on-site disposal), the additional surface area is estimated as 2 acres.
Name and location of proposed off-site landfill	If an off-site landfill were to be used, the Peoria City-County Landfill is the nearest suitable facility (33 miles away). An alternate off-site landfill is the Envirofill of IL Landfill.
Location of borrow area, if a borrow area will be established (for either the impoundment or construction/closure of an on-Site landfill). If location is unknown, please estimate a likely distance to the borrow area.	The anticipated on-site borrow source location is approximately 0.4 miles north of the GMF via site roads and approximately 0.7 miles south of the on-site landfill by site roads.
Estimated volume of soil to be hauled from the borrow area under each closure alternative	Closure in place: The amount of borrow material required is estimated as 73,800 cubic yards.
	Closure by removal: If a landfill expansion is not required, no borrow material will be needed. If a landfill expansion is required (on-site disposal), the maximum amount of borrow material required is estimated as 18,000 cubic yards.
Difficulty associated with implementation of each closure alternative (e.g., do any alternatives pose particular engineering/implementation challenges?)	Closure in place: Dewatering and relocation of gypsum will require considerable effort and time. Establishing the surface water drainage channel through the Gypsum Recycle Pond perimeter berm will be challenging because of the excavation depths involved.
	Closure by removal: Dewatering of the gypsum prior to removal will require considerable effort and time. Establishing the surface water drainage channel through the Gypsum Recycle Pond perimeter berm will be challenging because of the excavation depths involved.
Availability of necessary equipment and specialists for each closure alternative	Good availability of equipment and services is anticipated for all closure alternatives.
Available capacity and location of needed treatment, storage, and disposal services for each closure alternative	The distance to the nearest off-site landfill (approximately 33 miles) presents a significant challenge for the option that involves off-site disposal.
Estimated cost of each closure alternative	Closure in place: $6.2 million.
	Closure by removal: $8.9 million (on-site disposal); $82.4 million (off-site disposal).

Table 1: Information Summary

Post-Closure Plan/Long-Term Management Plan	
Planned duration of post-closure care activities	Closure in place: The owner or operator of the CCR surface impoundment must conduct post-closure care for 30 years. The owner or operator must continue to conduct post-closure care beyond the 30-year post-closure care period until groundwater monitoring data shows the concentrations are (a) below groundwater protection standards given in Section 845.600 of Part 845 or (b) not increasing for those constiuents over background using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
	Closure by removal: An owner or operator of a CCR surface impoundment that elects to close a CCR surface impoundment by removing CCR as provided in Section 845.740 must continue groundwater monitoring for three years after the completion of closure or until concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
Expected frequency of groundwater and surface water monitoring during post-closure period	Closure in place: Quarterly for 5 years and semi-annually thereafter.
	Closure by removal: Quarterly.
Expected frequency of inspections post closure	Monthly for the first year and annually thereafter [6].
Summary of planned maintenance activities post-closure	Closure in place: Groundwater monitoring will be conducted. Site inspections will be conducted on a quarterly basis for a minimum of 5 years after closure. An annual site inspection will be performed until settlement has ceased and there are no eroded or scoured areas or until the end of the 30-year post-closure care period. Over these 30 years, repair and maintenance, including soil filling and reseeding, will be performed if ponding is observed, cracks greater than 1 inch wide or gullies 6 inches or deeper have formed, vegetative or vector problems arise, or leachate seeps are present. Areas susceptible to erosion will be recontoured and reseeded. Eroded and scoured drainage channels will be repaired and the liner material replaced if necessary. Vegetation will be mowed annually. Areas of failed or eroded vegetation in excess of 100 square feet will be revegetated. Minor repairs to ensure the integrity and proper function of fencing, surface water drainage features, monitoring points, and groundwater monitoring wells may be required. Leachate will be pumped from the leachate collection sumps into storage tanks or tanker trucks and transported to a wastewater treatment plant for treatment and disposal [6].
	Closure by removal: Groundwater monitoring will be conducted.
Summary of planned post-closure care activities at the on-site landfill, if a new on-site landfill is going to be constructed	Not applicable.

Table 1: Information Summary

Corrective Measures Assessment	
Corrective measures being considered post-closure	None anticipated.
Overview of planned activities for each corrective measure	None anticipated.

References

1) AECOM. (2016). History of Construction, USEPA Final CCR Rule, 40 CFR 257.73(c), Duck Creek Power Station, Canton, Illinois. Available online: https://www.luminant.com/ccr.

2) AECOM (2016). CCR Rule Report: Initial Structural Stability Assessment for GMF Pond at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

3) AECOM (2016). CCR Rule Report: Initial Safety Factor Assessment for GMF Pond at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

4) AECOM (2016). CCR Rule Report: Initial Inflow Design Flood Control System Plan for GMF Pond at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

5) Stantec. (2016). Initial Hazard Potential Classification Assessment, EPA Final CCR Rule, GMF Pond, Duck Creek Power Station, Fulton County, Illinois. Available online: https://www.luminant.com/ccr.

6) Hanson (Hanson Professional Services, Inc.) 2009. Geosynthetics Quality Assurance Report, Gypsum Stack, AERG (Ameren) Duck Creek Power Station.

Table 2: Closure Estimates - Closure In Place

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 488,170	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 75,000	$ 75,000	1 surveyor	Pickup truck	
Borrow Area Preparation and Reclamation	LS	1	$ 50,000	$ 50,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Ponded Water Removal	LS	1	$ 128,000	$ 128,000	1 superintendent (part-time), 1 laborer (part-time)	Pickup truck (part-time), diesel pump, generator	
Pipe Removal/Abandonment	LS	1	$ 15,000	$ 15,000	2 equipment operators, 2 laborers	Excavator, haul truck	
Embankment Fill/Compacted Clay - Berm	CY	25,700	$ 4.50	$ 115,650	7 equipment operators	Excavator, dozer, compactor, water truck, 3 haul trucks	889 (0.4 miles one way)
Geomembrane - Berm	SF	58,600	$ 0.85	$ 49,810	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance technician	Pickup truck, telehandler	
Gypsum Dewatering	LS	1	$ 1,700,000	$ 1,700,000	1 superintendent, 1 laborer, 1 operator (part-time)	Excavator, diesel pumps	
Gypsum Relocation	CY	85,000	$ 8.20	$ 697,000	9 equipment operators	2 excavators, dozer, 2 loaders, 4 haul trucks, diesel pump	2,778 (0.2 miles one way)
Geosynthetics Removal and Disposal	AC	17	$ 4,000	$ 68,000	4 equipment operators, 2 laborers	Loader, 3 haul trucks	100 (0.2 miles one way)
Cushion Soil Removal and Stockpiling	CY	29,100	$ 2.90	$ 84,390	5 equipment operators	Excavator, dozer, 3 haul trucks, diesel pump	1,007 (0.2 miles one way)
Drainage Soil Removal and Stockpiling	CY	26,600	$ 2.90	$ 77,140	5 equipment operators	Excavator, dozer, 3 haul trucks, diesel pump	920 (0.2 miles one way)
Geomembrane - Final Cover	SF	679,600	$ 0.75	$ 509,700	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance	Pickup truck, telehandler	
Geocomposite- Final Cover	SF	679,600	$ 0.75	$ 509,700			
Protective Soil Layer	CY	50,400	$ 3.90	$ 196,560	8 equipment operators	2 excavators, dozer, water truck, 4 haul trucks	1,744 (0.4 miles one way)
Fertilize, Seed, and Mulch	AC	35	$ 5,000	$ 175,000	2 equipment operators	Seed drill or hydroseeder	
Stormwater Channel Excavation	CY	81,000	$ 4.70	$ 380,700	3 equipment operators	Excavator, 2 haul trucks, diesel pump	2,803 (0.4 miles one way)
Erosion Controls	LS	1	$ 50,000	$ 50,000	2 laborers		
Construction Quality Assurance	LS	1	$ 300,000	$ 300,000	1 to 2 technicians	1 to 2 pickup trucks	
Miscellaneous Construction	LS	1	10%	$ 536,980	Miscellaneous	Miscellaneous	
			Total	$ 6,206,800			

Notes:
Miscellaneous Construction includes other work not captured in the items shown.
Soil components were assumed to be taken from the stockpile north of the GMF (0.4-mile haul).
Disposal was assumed to occur in the on-site landfill (1.2-mile haul).
Stockpiling was assumed to occur south of the closure footprint (0.2-mile haul).
Soil excavated for the stormwater channel was assumed to be stockpiled 0.4 miles from the excavation.

Table 3: Closure Estimates - Closure by Removal with On-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 727,240	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 50,000	$ 50,000	1 surveyor	Pickup truck	
Ponded Water Removal	LS	1	$ 128,000	$ 128,000	1 superintendent (part-time), 1 laborer (part-time)	Pickup truck (part-time), diesel pump	
Pipe Removal/Abandonment	LS	1	$ 25,000	$ 25,000	2 equipment operators, 2 laborers	Excavator, haul truck	
Gypsum Dewatering	LS	1	$ 1,700,000	$ 1,700,000	1 superintendent, 1 laborer, 1 operator (part-time)	Excavator, diesel pumps	
Gypsum Loading and Disposal	CY	400,000	$ 7.00	$ 2,800,000	11 equipment operators	2 excavators, dozer, 2 loaders, 6 haul trucks, diesel pump	13,072 (1.2 miles one way)
Geosynthetics Removal and Disposal	AC	31	$ 8,000	$ 248,000	4 equipment operators, 2 laborers	Loader, 3 haul trucks	119 (1.2 miles one way)
Cushion Soil Removal and Disposal	CY	60,800	$ 4.00	$ 243,200	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	2,104 (1.2 miles one way)
Drainage Soil Removal and Disposal	CY	55,500	$ 4.00	$ 222,000	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	1,920 (1.2 miles one way)
Compacted Clay Removal and Disposal	CY	166,500	$ 4.00	$ 666,000	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	5,761 (1.2 miles one way)
Subsoil Overexcavation and Disposal	CY	50,000	$ 4.00	$ 200,000	6 equipment operators	Excavator, dozer, 4 haul trucks, diesel pump	1,731 (1.2 miles one way)
Fertilize, Seed, & Mulch	AC	36	$ 5,000	$ 180,000	2 equipment operators	Seed drill or hydroseeder	
Stormwater Channel Excavation	CY	86,000	$ 4.70	$ 404,200	3 equipment operators	Excavator, 2 haul trucks, diesel pump	2,976 (0.4 miles one way)
Erosion Controls	LS	1	$ 75,000	$ 75,000	2 laborers		
Subgrade Preparation - Landfill Expansion	AC	2	$ 10,000	$ 20,000	2 equipment operators, laborer	Dozer, loader	
Compacted Clay - Landfill Expansion	CY	9,700	$ 4.50	$ 43,650	7 equipment operators	Excavator, dozer, compactor, water truck, 3 haul trucks	336 (0.7 miles one way)
Geomembrane - Landfill Expansion	SF	87,100	$ 0.85	$ 74,035	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance technician	Pickup truck, telehandler	
Geosynthetic Clay Liner - Landfill Expansion	SF	87,100	$ 0.95	$ 82,745		Pickup truck, telehandler	
Geotextile - Landfill Expansion	SF	174,200	$ 0.15	$ 26,130		Pickup truck, telehandler	
Drainage Soil - Landfill Expansion	CY	3,200	$ 17.00	$ 54,400	2 equipment operators	Dozer, loader	
Leachate Collection System - Landfill Expansion	LS	1	$ 30,000	$ 30,000	5 laborers		
Construction Quality Assurance	LS	1	$ 75,000	$ 75,000	1 to 2 technicians	1 to 2 pickup trucks	
Miscellaneous Construction	LS	1	10%	$ 799,960	Miscellaneous	Miscellaneous	
			Total	**$ 8,874,560**			

Notes:

Miscellaneous Construction includes other work not captured in the items shown.

Disposal was assumed to occur in the on-site landfill (1.2-mile haul).

Soil excavated for the stormwater channel was assumed to be stockpiled 0.4 miles from the excavation.

Soil components for landfill expansion except drainage soil (imported) were assumed to be taken from the stockpile north of the GMF (0.7-mile haul).

Table 4: Closure Estimates - Closure by Removal with Off-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 6,806,150	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 25,000	$ 25,000	1 surveyor	Pickup truck	
Ponded Water Removal	LS	1	$ 128,000	$ 128,000	1 superintendent (part-time), 1 laborer (part-time)	Pickup truck (part-time), diesel pump	
Pipe Removal/Abandonment	LS	1	$ 25,000	$ 25,000	2 equipment operators, 2 laborers	Excavator, haul truck	
Gypsum Dewatering	LS	1	$ 1,700,000	$ 1,700,000	1 superintendent, 1 laborer, 1 operator (part-time)	Excavator, diesel pumps	
Gypsum Removal	CY	400,000	$ 3.40	$ 1,360,000	5 equipment operators	2 excavators, dozer, 2 loaders, diesel pump	
Gypsum Disposal	CY	400,000	$ 79	$31,600,000	8 equipment operators	8 on-highway trucks	26,846 (32.6 miles one way)
Geosynthetics Removal	AC	31	$ 6,000	$ 186,000	Equipment operator, 2 laborers	Loader	
Geosynthetics Hauling and Disposal	AC	31	$ 5,000	$ 155,000	3 equipment operators	3 on-highway trucks	245 (32.6 miles one way)
Cushion Soil Removal	CY	60,800	$ 2.90	$ 176,320	2 equipment operators	2 excavators, diesel pump	
Cushion Soil Hauling and Disposal	CY	60,800	$ 94	$ 5,715,200	8 equipment operators	8 on-highway trucks	4,343 (32.6 miles one way)
Drainage Soil Removal	CY	55,500	$ 2.90	$ 160,950	2 equipment operators	2 excavators, diesel pump	
Drainage Soil Hauling and Disposal	CY	55,500	$ 94	$ 5,217,000	8 equipment operators	8 on-highway trucks	3,964 (32.6 miles one way)
Compacted Clay Removal	CY	166,500	$ 2.90	$ 482,850	2 equipment operators	2 excavators, diesel pump	
Compacted Clay Hauling and Disposal	CY	166,500	$ 94	$15,651,000	8 equipment operators	8 on-highway trucks	11,893 (32.6 miles one way)
Subsoil Overexcavation	CY	50,000	$ 2.90	$ 145,000	2 equipment operators	2 excavators, diesel pump	
Subsoil Hauling and Disposal	CY	50,000	$ 94	$ 4,700,000	8 equipment operators	8 on-highway trucks	3,571 (32.6 miles one way)
Fertilize, Seed, & Mulch	AC	36	$ 5,000	$ 180,000	2 equipment operators	Seed drill or hydroseeder	
Stormwater Channel Excavation	CY	86,000	$ 4.70	$ 404,200	3 equipment operators	Excavator, 2 haul trucks, diesel pump	2,976 (0.4 miles one way)
Erosion Controls	LS	1	$ 50,000	$ 50,000	2 laborers		
Miscellaneous Construction	LS	1	10%	$ 7,486,770	Miscellaneous	Miscellaneous	
			Total	**$ 82,354,440**			

Notes:

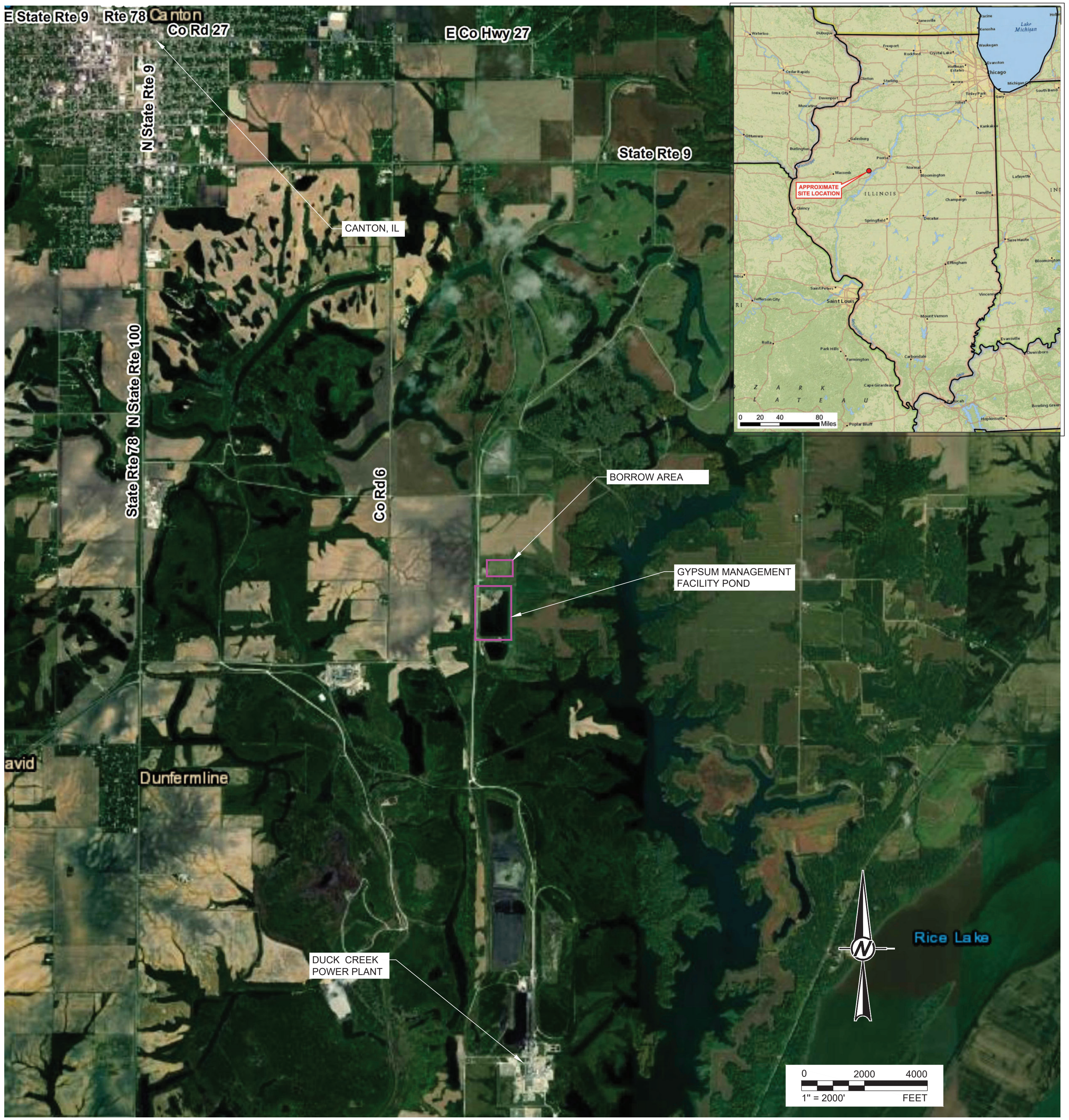
Miscellaneous Construction includes other work not captured in the items shown.

Disposal was assumed to occur in an off-site landfill (32.6-mile haul).

Soil excavated for the stormwater channel was assumed to be stockpiled 0.4 miles from the excavation.

EXHIBIT 1

Closure-in-Place Figures



ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI USA 63021

PERMIT APPLICATION DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	GYPSUM REGRADING AND CONTAINMENT PLAN	A
4	FINAL COVER AND STORMWATER PLAN	A
5	SECTIONS	A
6	DETAILS (1 OF 2)	A
7	DETAILS (2 OF 2)	A

NOTE(S)

1. AERIAL IMAGERY FROM ESRI-PROVIDED BASEMAP SERVICE. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.
2. INSET MAP BOUNDARIES FROM ESRI-PROVIDED FEATURE SERVICE. USA STATE BOUNDARIES. 2021
3. INSET MAP BACKGROUND FROM ESRI-PROVIDED BASEMAP SERVICE. NATIONAL GEOGRAPHIC BASEMAP. 2021.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT

GOLDER MEMBER OF WSP
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
TITLE SHEET

PROJECT NO. 21454861 | REV. A | 1 of 7 | DRAWING 1

LEGEND

- 600 — EXISTING GROUND ELEVATION CONTOURS (NOTE 1)
- EXISTING ROAD
- LIMIT OF GMF POND LINER SYSTEM (NOTE 2)
- WATER LEVEL LINE (NOTE 3)
- EXISTING PIPING (NOTE 3)

NOTES

1. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
2. LIMIT OF LINER SYSTEM ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009.
3. WATER LEVEL LINE AND EXISTING PIPING FROM INGENAE SURVEY RECORD DRAWING DATED 3/19/2021.
4. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

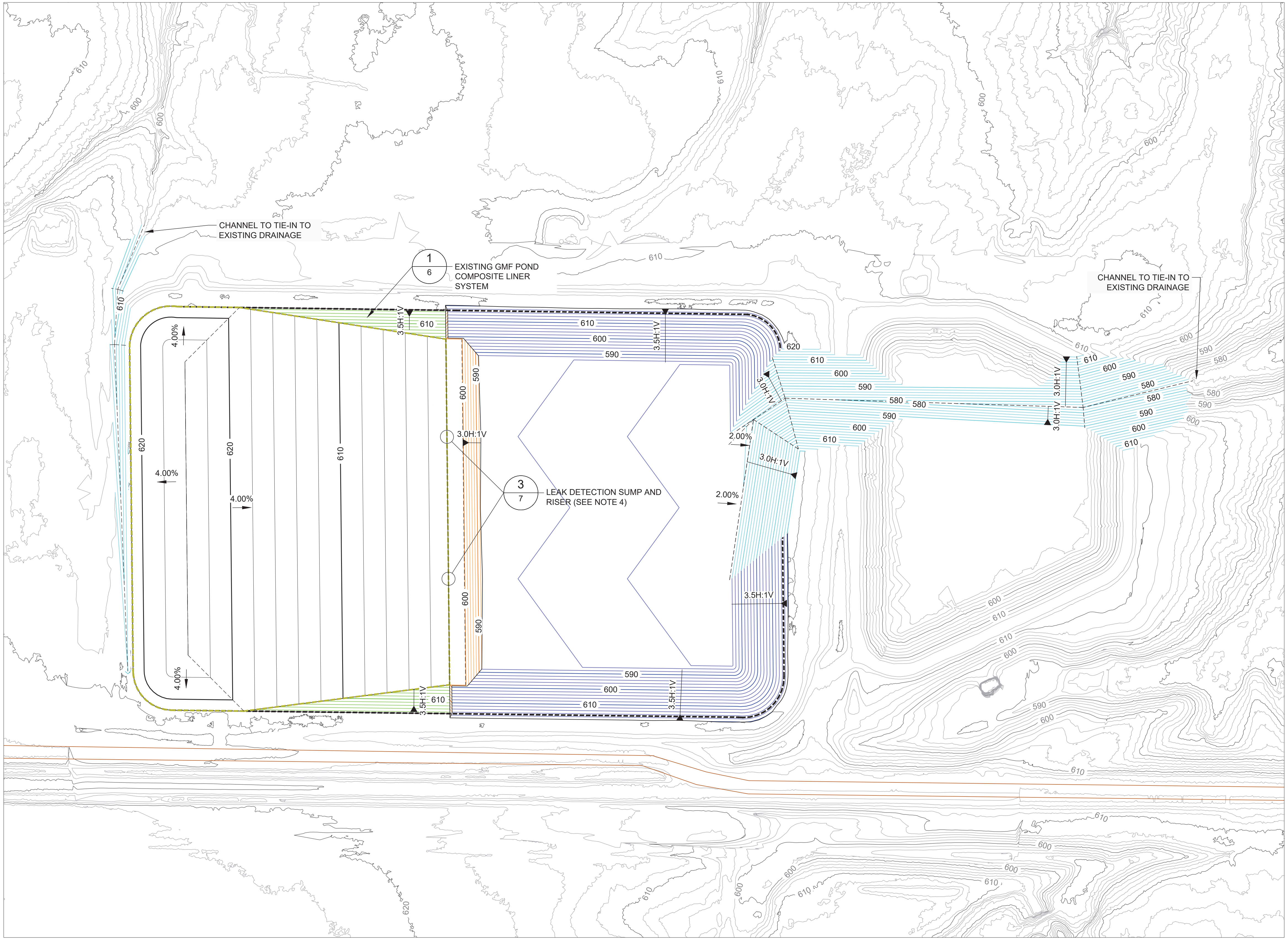
CONSULTANT

GOLDER
MEMBER OF WSP
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
EXISTING CONDITIONS

PROJECT NO. 21454861 | REV. A | 2 of 7 | DRAWING 2



LEGEND

600	TOP OF RELOCATED GYPSUM
600	TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
600	TOP OF EXISTING CLAY LINER (SEE NOTE 1)
600	DRAINAGE CHANNEL GRADES
600	EARTHEN BERM GRADES
600	EXISTING GROUND CONTOURS (SEE NOTE 2)
	EXISTING ROAD
	LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)
	LIMIT OF WASTE

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.
4. THE EXISTING LEAK DETECTION SYSTEM WILL BE ADAPTED TO THE CLOSURE FOOTPRINT. EXISTING LEACHATE COLLECTION PIPING WILL BE TERMINATED IN NEW SUMPS (TWO LOCATIONS WITH NEW RISERS FOR CONTINUED LEAK DETECTION CAPABILITY.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

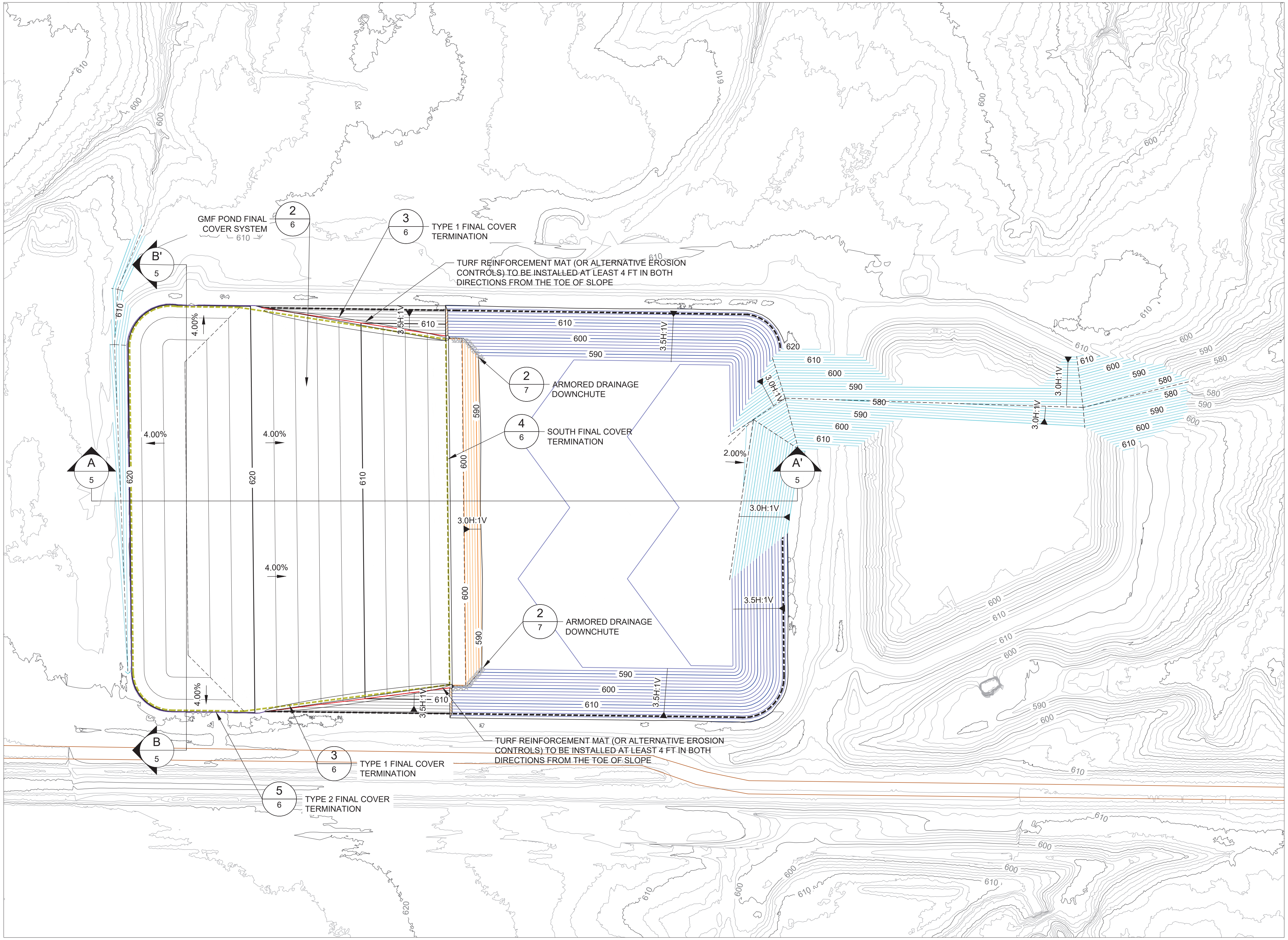
CONSULTANT
GOLDER MEMBER OF WSP
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
GYPSUM REGRADING AND CONTAINMENT PLAN

PROJECT NO. 21454861 | REV. A | 3 of 7 | DRAWING 3

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



LEGEND

600	TOP OF FINAL COVER SYSTEM
600	TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
600	TOP OF EXISTING CLAY LINER (SEE NOTE 1)
600	EARTHEN BERM GRADES
600	EXISTING GROUND CONTOURS (SEE NOTE 2)
	EXISTING ROAD
	LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)
	LIMIT OF WASTE AT CLOSURE
	TYPE 1 FINAL COVER TERMINATION
	TYPE 2 FINAL COVER TERMINATION

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.

0 120 240
1" = 120' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

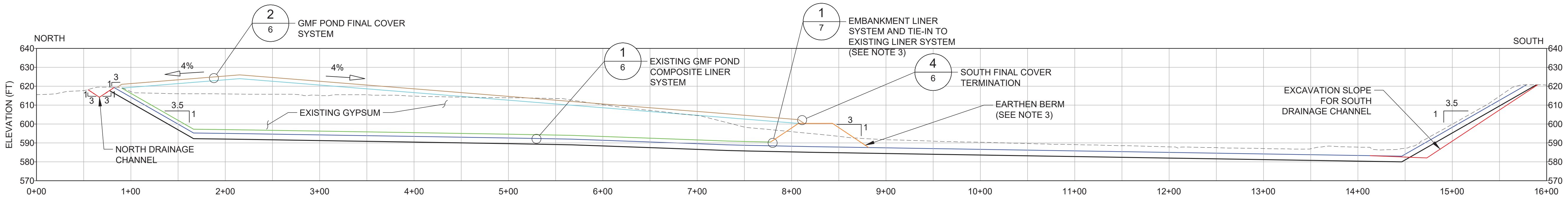
CONSULTANT
GOLDER
MEMBER OF WSP
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
FINAL COVER AND STORMWATER PLAN

PROJECT NO. 21454861 | REV. A | 4 of 7 | DRAWING 4

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

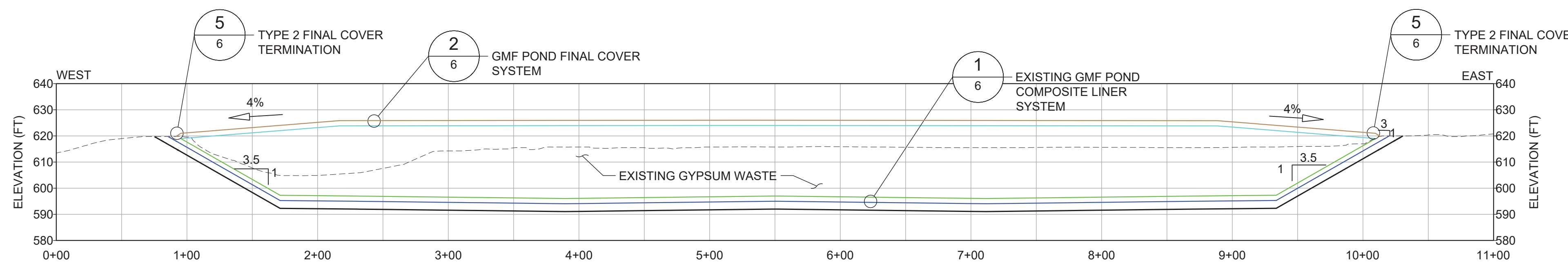


SCALE 1"=60'
VERT. SCALE X2

A
5

SECTION A-A'

0 60 120
1" = 60' FEET



SCALE 1" = 60'
VERT. SCALE X2

B
5

SECTION B-B'

0 60 120
1" = 60' FEET

LEGEND

- TOP OF FINAL COVER SYSTEM
- TOP OF RELOCATED GYPSUM
- TOP OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- TOP OF EXISTING CLAY LINER (SEE NOTE 1)
- BOTTOM OF EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- EXISTING GROUND CONTOURS (SEE NOTE 2)
- EARTHEN BERM (SEE NOTE 3)
- DRAINAGE CHANNEL GRADING

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.

2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.

3. CLOSURE WILL INVOLVE REMOVAL OF PONDED WATER AND LIQUID WASTE, CONSTRUCTION OF AN EARTHEN BERM WITH A LINER SYSTEM ON THE UPSTREAM SLOPE, REMOVAL AND RELOCATION OF GYPSUM SOUTH OF THE BERM TO WITHIN THE CLOSURE FOOTPRINT, AND FINAL COVER SYSTEM CONSTRUCTION.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

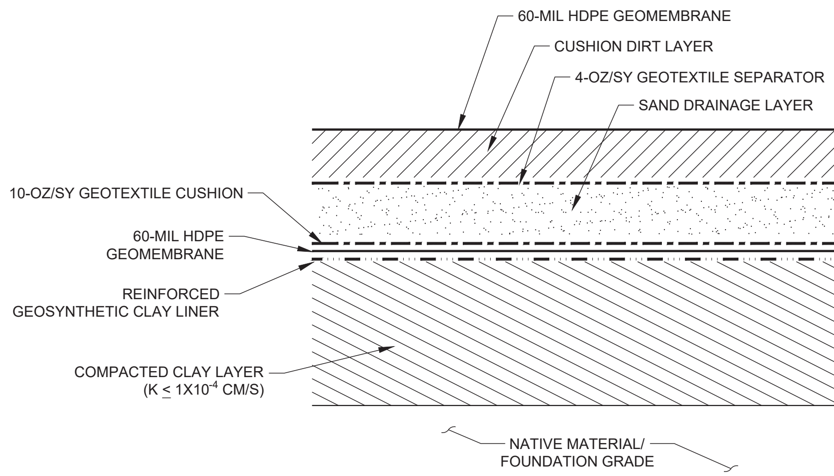
CONSULTANT
GOLDER
MEMBER OF WSP

13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

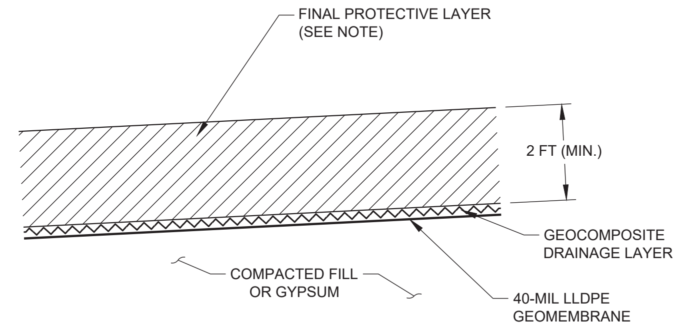
PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
SECTIONS

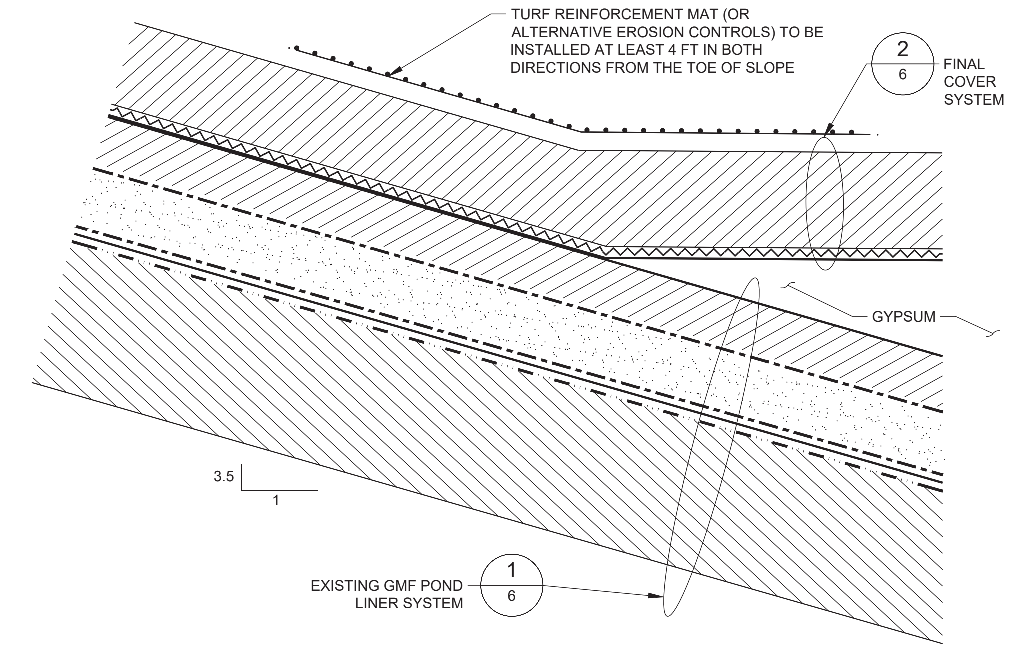
PROJECT NO. 21454861 | REV. A | 5 of 7 | DRAWING 5



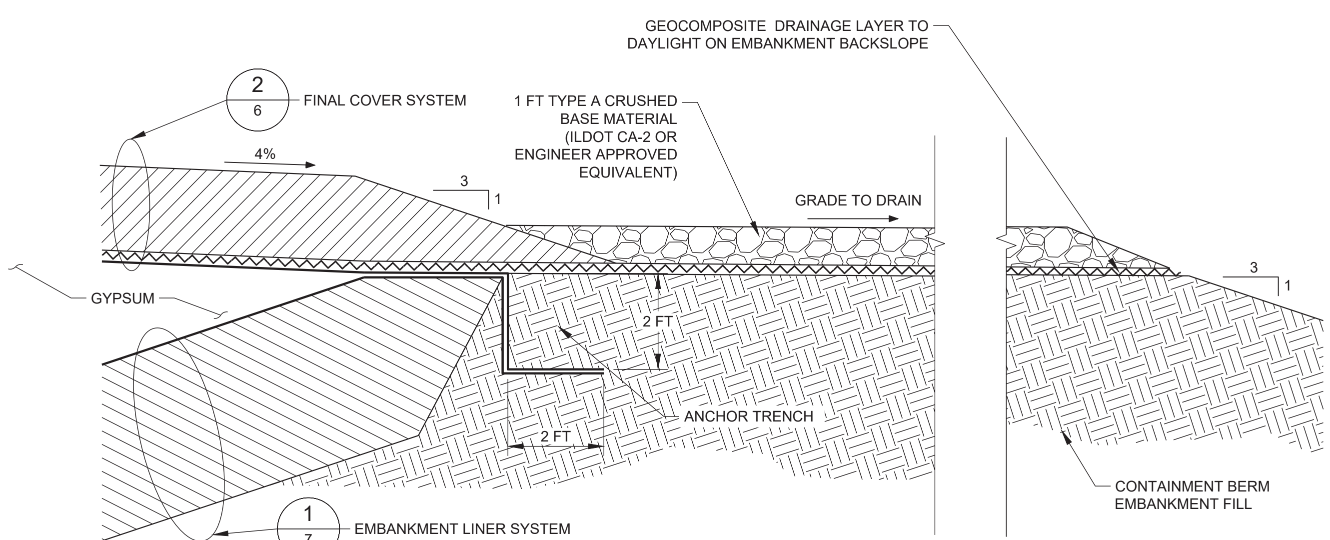
SCALE N.T.S. 1/6 EXISTING GMF POND COMPOSITE LINER SYSTEM



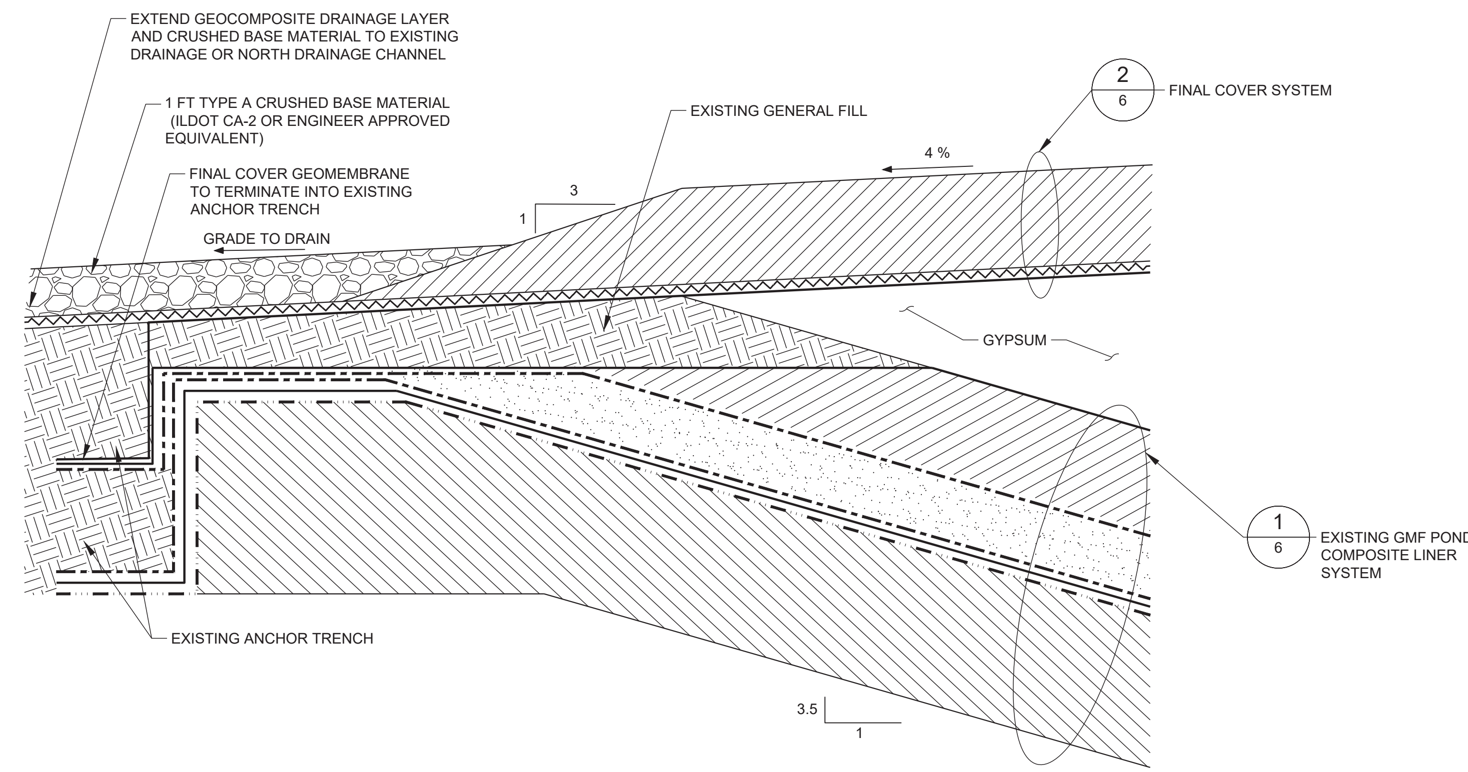
SCALE N.T.S. 2/6 FINAL COVER SYSTEM



SCALE N.T.S. 3/6 TYPE 1 FINAL COVER TERMINATION



SCALE N.T.S. 4/6 SOUTH FINAL COVER TERMINATION



SCALE N.T.S. 5/6 TYPE 2 COVER TERMINATION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

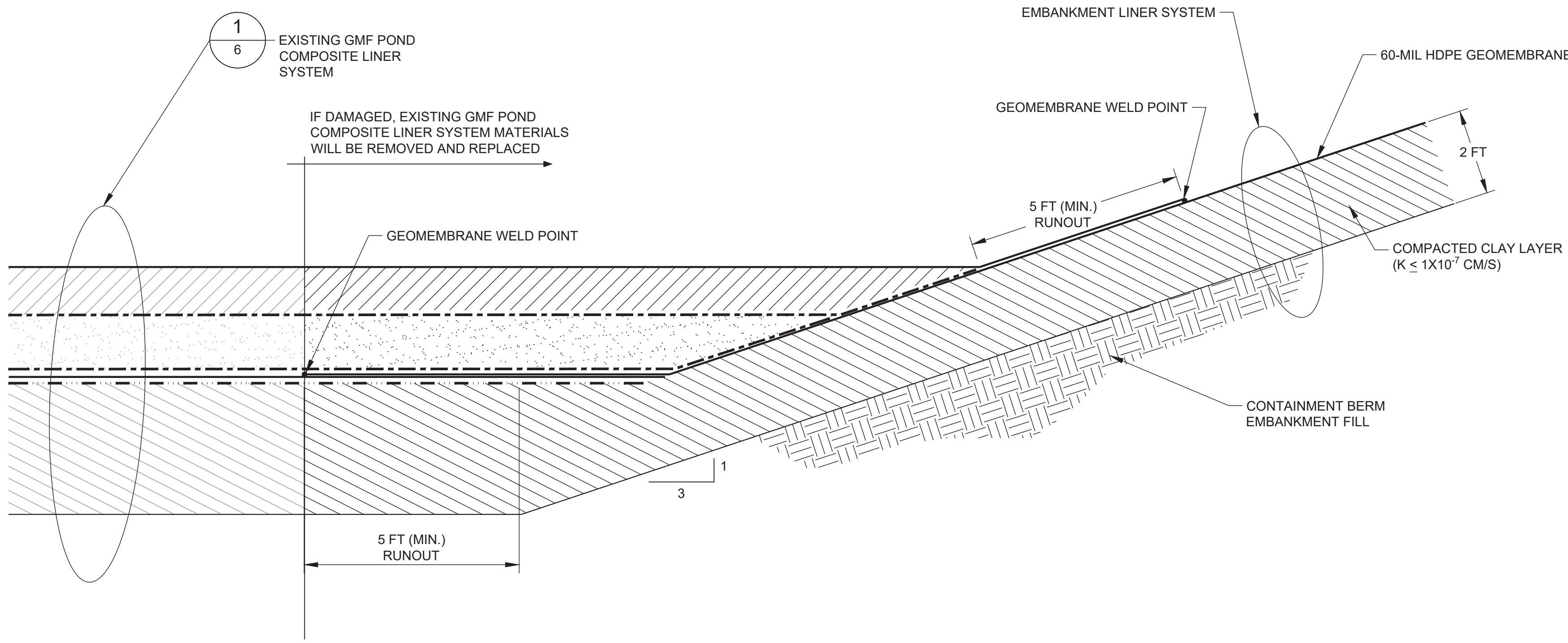
CONSULTANT
GOLDER
MEMBER OF WSP
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

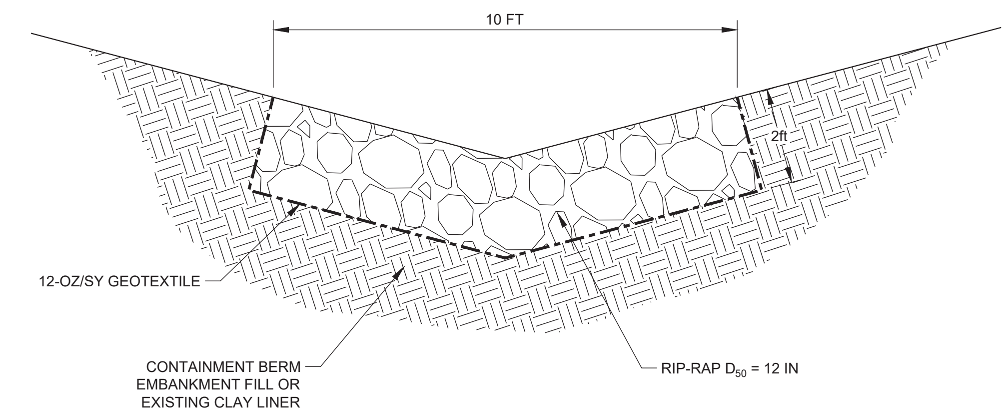
TITLE
DETAILS (1 OF 2)

PROJECT NO. 21454861 | REV. A | 6 of 7 | DRAWING 6

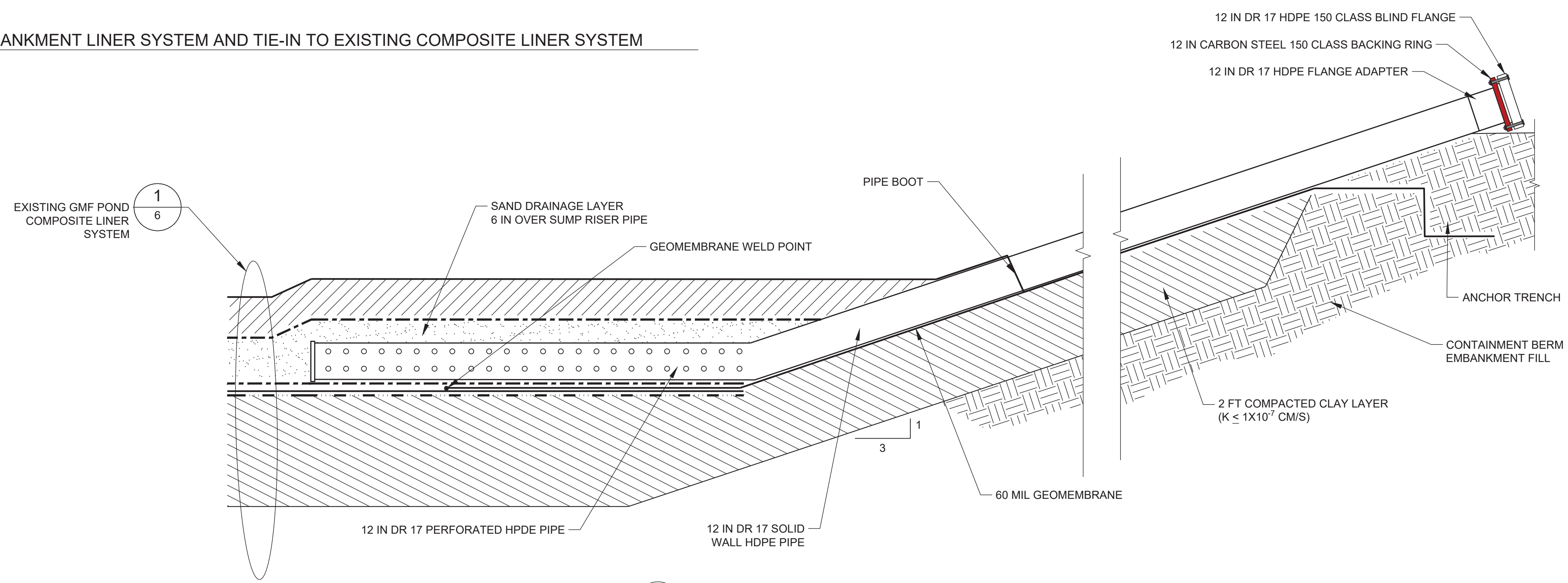
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE N.T.S. 1/7 EMBANKMENT LINER SYSTEM AND TIE-IN TO EXISTING COMPOSITE LINER SYSTEM



SCALE N.T.S. 2/7 ARMORED DRAINAGE DOWNCHUTE



SCALE N.T.S. 3/7 LEAK DETECTION SYSTEM SUMP AND RISER

NOTE

EXISTING 6 INCH LEACHATE COLLECTION PIPE NOT SHOWN IN DETAIL. LEACHATE COLLECTION PIPE WILL TERMINATE AND BE CAPPED AT THE TOE OF THE CONTAINMENT BERM

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT

GOLDER MEMBER OF WSP

13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MO 63021
UNITED STATES
(313) 984 8770
www.golder.com

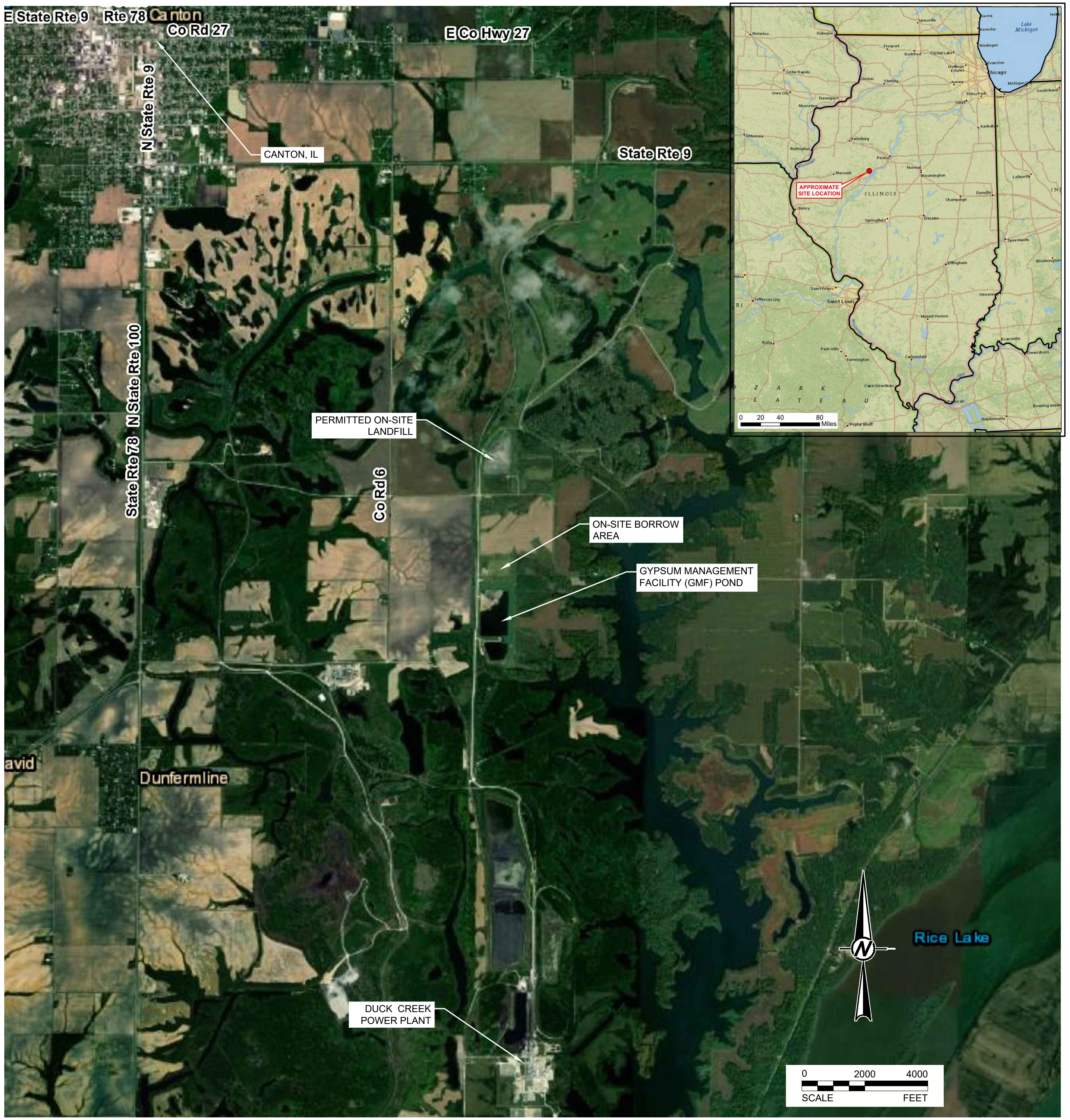
PROJECT
GYPSUM MANAGEMENT FACILITY POND
CONSTRUCTION PERMIT APPLICATION

TITLE
DETAILS (2 OF 2)

PROJECT NO. 21454861 REV. A 7 of 7 DRAWING 7

EXHIBIT 2

Closure-by-Removal Figures



ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
GYPSUM MANAGEMENT FACILITY POND
CLOSURE-BY-REMOVAL

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI USA 63021

DRAWING LIST

NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	EXCAVATION PLAN	A
4	SECTIONS	A
5	DETAILS	A

NOTE(S)

1. AERIAL IMAGERY FROM ESRI-PROVIDED BASEMAP SERVICE. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.
2. INSET MAP BOUNDARIES FROM ESRI-PROVIDED FEATURE SERVICE. USA STATE BOUNDARIES. 2021

   INSET MAP BACKGROUND FROM ESRI-PROVIDED BASEMAP SERVICE. NATIONAL GEOGRAPHIC BASEMAP. 2021.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

PROJECT
GYPSUM MANAGEMENT FACILITY POND

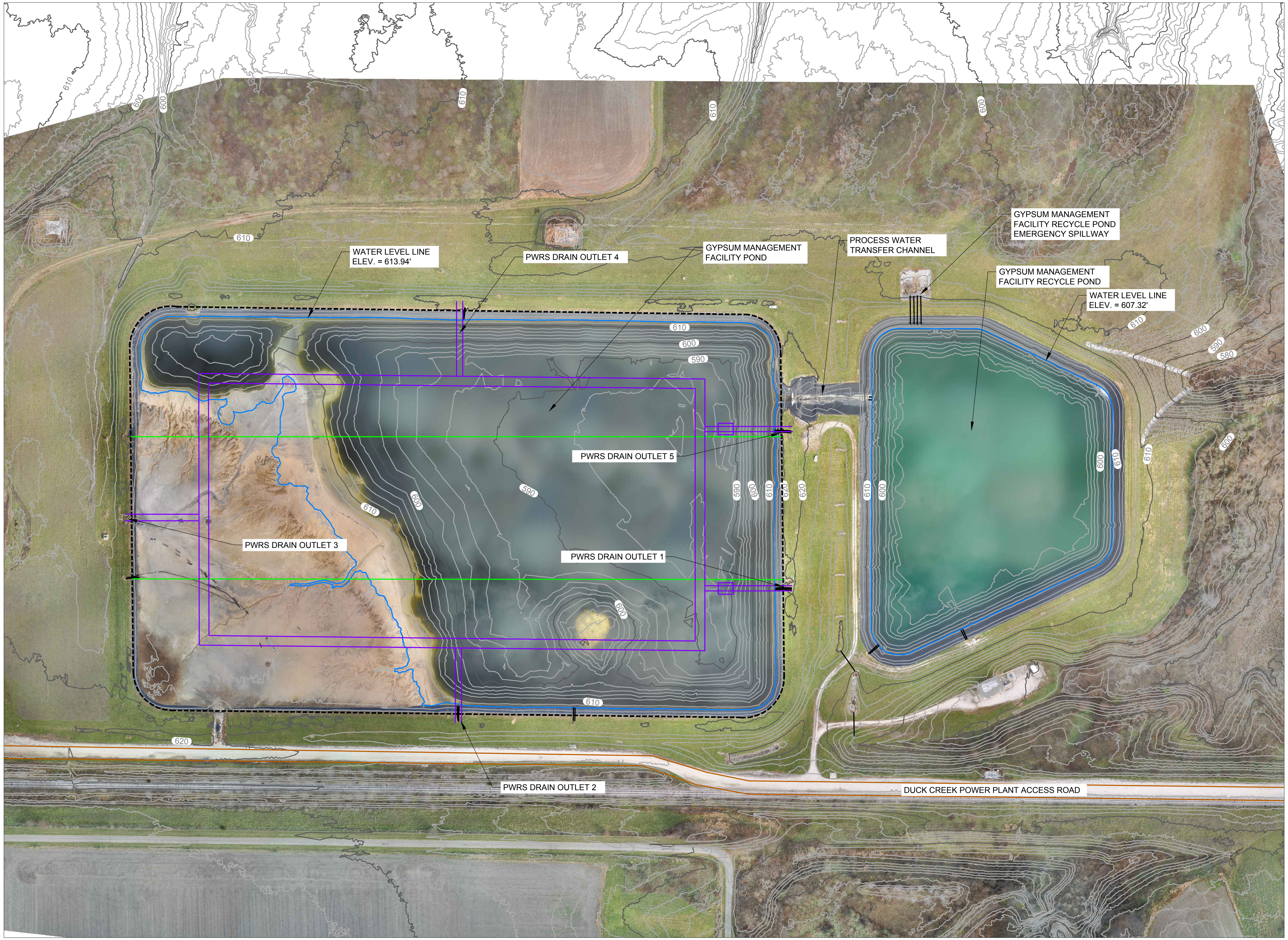
CONSULTANT
GOLDER
MEMBER OF WSP

PROJECT OFFICE
13515 BARRET PARKWAY, SUITE 260
BALLWIN, MISSOURI 63021
UNITED STATES
(313) 984 8770
www.golder.com

TITLE
TITLE SHEET

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 1 in



LEGEND

600	EXISTING GROUND ELEVATION CONTOURS (NOTE 1)
	EXISTING ROAD
	LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 2)
	WATER LEVEL LINE (NOTE 3)
	EXISTING PIPING (NOTE 3)
	EXISTING LCRS PIPING (SEE NOTE 4)
	EXISTING PWRS RING DRAIN SYSTEM (NOTE 4)

NOTES

1. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
2. LIMIT OF LINER SYSTEM ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009.
3. WATER LEVEL LINE AND EXISTING PIPING FROM INGENAE SURVEY RECORD DRAWING DATED 3/19/2021.
4. LEACHATE COLLECTION AND REMOVAL SYSTEM (LCRS) PIPING AND PROCESS WATER RECOVERY SYSTEM (PWRS) RING DRAIN INFRASTRUCTURE LOCATIONS ARE ESTIMATED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES, DATED 03/05/2009. LCRS PIPING AND PWRS RING DRAIN MATERIALS WILL BE REMOVED AND DISPOSED.
5. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020.

0 120 240
SCALE FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

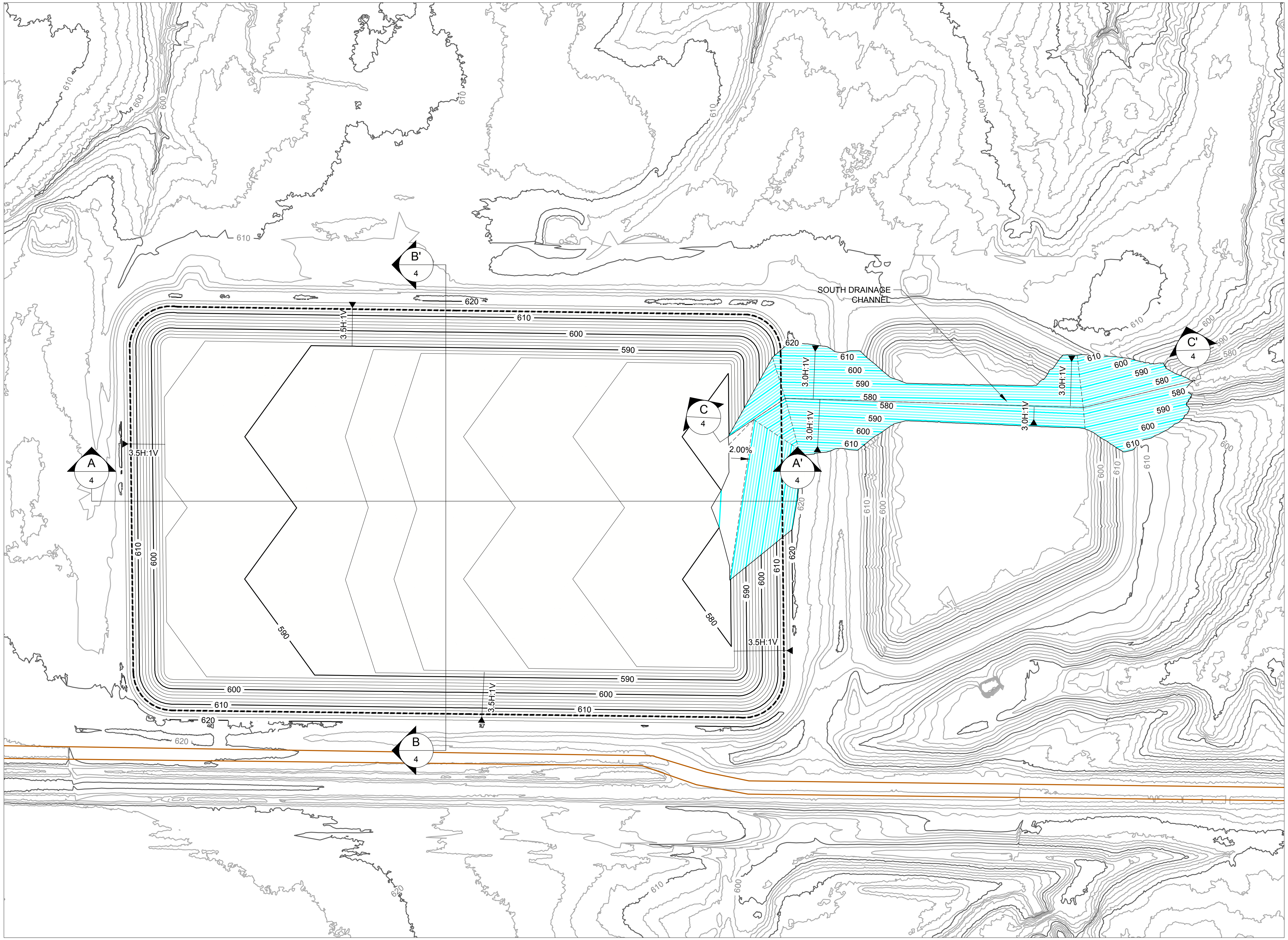
PROJECT OFFICE
13515 BARRET PARKWAY, SUITE 260
BALLWIN, MISSOURI 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND

TITLE
EXISTING CONDITIONS

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		2

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



LEGEND

600 — BOTTOM OF EXISTING GMF POND COMPOSITE LINER SYSTEM (NOTE 1)

600 — EXISTING GROUND ELEVATION CONTOURS (NOTE 2)

600 — DRAINAGE CHANNEL GRADES

EXISTING ROAD

LIMIT OF EXISTING GMF POND LINER SYSTEM (NOTE 1)

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES AND LIMIT OF LINER SYSTEM SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES. SOUTH DRAINAGE CHANNEL DESIGNED BY GOLDER.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE BY REMOVAL INCLUDES REMOVAL OF PONDED WATER, REMOVAL OF GYPSUM, AND REMOVAL OF THE EXISTING GMF POND LINER SYSTEM. GYPSUM REMOVED FROM THE GMF POND WILL BE DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.

0 120 240
SCALE FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT

GOLDER
MEMBER OF WSP

PROJECT OFFICE
13515 BARRET PARKWAY, SUITE 260
BALLWIN, MISSOURI 63021
UNITED STATES
(313) 984 8770
www.golder.com

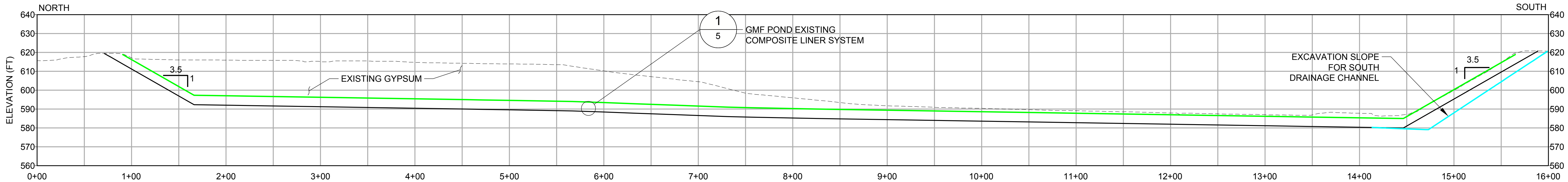
PROJECT
GYPSUM MANAGEMENT FACILITY POND

TITLE
EXCAVATION PLAN

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		3

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

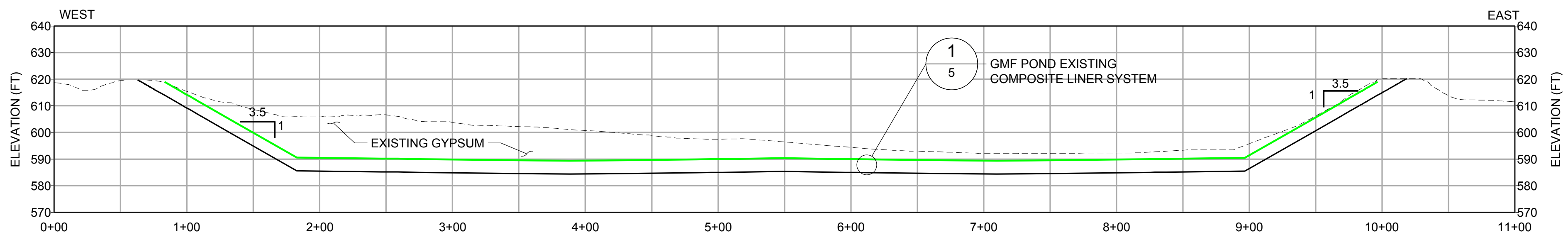
0 1 in



SCALE AS SHOWN
VERT. SCALE X2

A / 4 SECTION A-A'

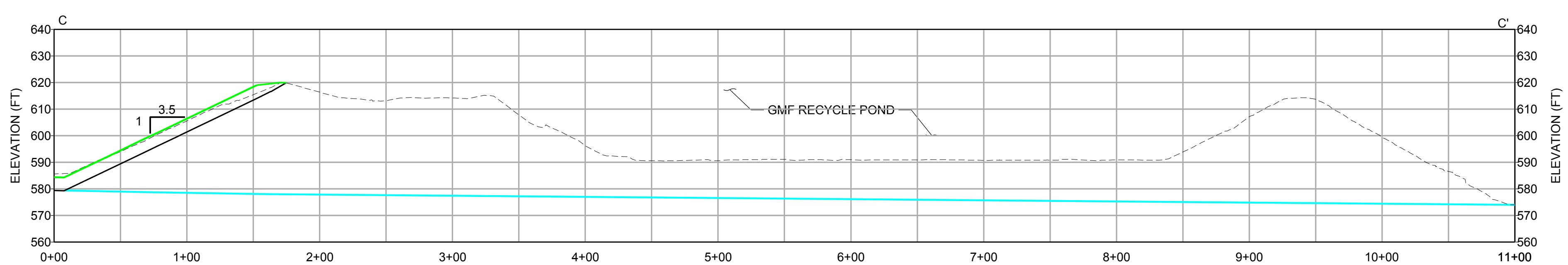
0 60 120
SCALE FEET



SCALE AS SHOWN
VERT. SCALE X2

B / 4 SECTION B-B'

0 60 120
SCALE FEET



SCALE AS SHOWN
VERT. SCALE X2

C / 4 SECTION C-C'

0 60 120
SCALE FEET

LEGEND

- TOP OF EXISTING GMF POND COMPOSITE LINER SYSTEM (SEE NOTE 1)
- BOTTOM OF GMF POND EXISTING COMPOSITE LINER SYSTEM (SEE NOTE 1)
- DRAINAGE CHANNEL GRADING
- EXISTING GROUND CONTOURS (SEE NOTE 2)

NOTES

1. GYPSUM MANAGEMENT FACILITY (GMF) POND BASE GRADES SHOWN WERE DEVELOPED FROM CONSTRUCTION RECORD DRAWINGS PREPARED BY HANSON PROFESSIONAL SERVICES.
2. EXISTING CONTOURS ARE A COMPOSITE OF AN AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020, AND U.S. GEOLOGICAL SURVEY LIDAR POINT CLOUD DATA DATED 2/12/2018.
3. CLOSURE BY REMOVAL INCLUDES REMOVAL OF PONDED WATER, REMOVAL OF GYPSUM, AND REMOVAL OF THE EXISTING GMF POND LINER SYSTEM. GYPSUM REMOVED FROM THE GMF POND WILL BE DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT

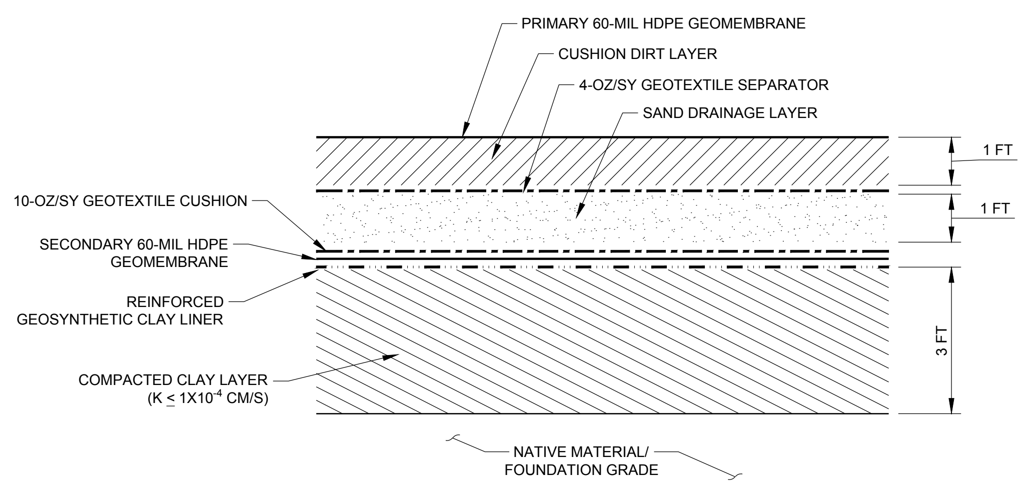
GOLDER
MEMBER OF WSP

PROJECT OFFICE
13515 BARRET PARKWAY, SUITE 260
BALLWIN, MISSOURI 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND

TITLE
SECTIONS

PROJECT NO.	CONTROL	REV.	of	DRAWING
21454861		A		4



SCALE N.T.S. 1/5 **GMF POND EXISTING COMPOSITE LINER SYSTEM**

NOTE: ALL COMPONENTS OF THE EXISTING LINER SYSTEM WILL BE REMOVED AND DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL. UP TO AN ADDITIONAL 12 INCHES OF SOIL MAY BE EXCAVATED FROM BENEATH THE EXISTING LINER SYSTEM AND DISPOSED.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	DVS	DVS	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

PROJECT OFFICE
13515 BARRET PARKWAY, SUITE 260
BALLWIN, MISSOURI 63021
UNITED STATES
(313) 984 8770
www.golder.com

PROJECT
GYPSUM MANAGEMENT FACILITY POND

TITLE
DETAILS

PROJECT NO. 21454861 CONTROL REV. A of DRAWING 5

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

Supporting Information for Closure Alternatives Analysis – Bottom Ash Basin at Duck Creek Power Plant

TECHNICAL MEMORANDUM

DATE January 25, 2022 **Reference No.** 21454861-12-R-0

TO Illinois Power Resources Generating, LLC

FROM Golder Associates USA Inc.

SUPPORTING INFORMATION FOR CLOSURE ALTERNATIVES ANALYSIS – BOTTOM ASH BASIN AT DUCK CREEK POWER PLANT

Golder Associates USA Inc. (Golder), a Member of WSP, has prepared this technical memorandum for Illinois Power Resources Generating, LLC (IPRG) to support the Closure Alternatives Analysis for the Bottom Ash Basin at Duck Creek Power Plant (DCPP). The Bottom Ash Basin was used to temporarily store and dewater sluiced bottom ash produced at DCPP and has not received bottom ash since the power plant was retired in 2019. The Closure Alternatives Analysis is being completed in accordance with Illinois Administrative Code Title 35, Part 845, Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (Part 845) by Gradient. With this technical memorandum, Golder summarizes the design basis and references used in developing the closure concepts evaluated by the Closure Alternatives Analysis.

1.0 BOTTOM ASH BASIN HISTORY

1.1 Existing Liner System Information

Based on construction drawings by Sargent & Lundy (2007a), the existing liner system for the facility consists of (from top to bottom):

- 8 inches of reinforced concrete
- 1 foot of compacted clay, placed in 6-inch-thick lifts to at least 95% of the standard Proctor maximum dry density
- 60-mil HDPE geomembrane
- minimum 6 inches of prepared subgrade (presumably native soils) compacted to at least 95% of the standard Proctor maximum dry density

According to the Bottom Ash and Low Volume Sump Water Basin and Piping General Work Contract Specifications (Sargent & Lundy 2007b), the liner system was subjected to a rigorous construction quality assurance (CQA) program.

According to the technical specifications for the reinforced concrete layer from Sargent & Lundy (2007b), the concrete appears to have used a conventional mix design (28-day compressive strength of 4,000 pounds per square inch, water-to-cement ratio of 0.5 or less).

The technical specifications for composite-lined ponds from Sargent & Lundy (2007b) required a hydraulic conductivity of 1×10^{-6} centimeters per second (cm/s) or less for the compacted clay.

According to the technical specifications for geomembrane liner from Sargent & Lundy (2007b), the geomembrane was specified to conform to GRI GM 13, which is a common HDPE geomembrane product for waste containment. According to the technical specifications (Sargent & Lundy 2007b), the CQA program for the liner system included destructive and non-destructive testing of geomembrane seams.

Based on borehole logs from the area of the Bottom Ash Basin (Hanson 2006), native soils at the subgrade elevations (roughly El. 568 to 580 feet) generally consist of clayey silt with trace sand (ML under the Unified Soil Classification System). The hydraulic conductivity of these soils at the degree of compaction required by the technical specifications ranged from 6.0×10^{-7} to 2.4×10^{-5} cm/s, with a geometric mean of 6.1×10^{-6} cm/s, in permeability testing reported by Hanson (2006).

1.2 Operational History

The Bottom Ash Basin is an incised CCR surface impoundment with reinforced concrete slopes and floor. It was used to manage sluiced bottom ash at DCPP from the time construction of the Bottom Ash Basin was completed in 2009 until the power plant was retired in December 2019. During operation, bottom ash was hydraulically conveyed (sluiced) from the power plant in 10-inch-diameter basalt-lined piping and deposited at the Bottom Ash Basin in one of the two western cells, known as Primary Pond 1 and Primary Pond 2. Coarse bottom ash particles settled by gravity in the cell where they were deposited, and the sluice water was decanted via 12-inch-diameter corrugated high-density polyethylene (HDPE) piping into the eastern cell, known as the Secondary Pond. Further gravity settling occurred in the Secondary Pond before the clarified water was decanted via 12-inch-diameter corrugated HDPE piping into the Discharge Canal, which flows into Duck Creek Reservoir, with discharge at a permitted outfall in accordance with the site's National Pollutant Elimination System (NPDES) permit. Bottom ash particles accumulated in Primary Pond 1 and Primary Pond 2, requiring periodic cleanout events. During cleanout events, mobile equipment was used to excavate bottom ash out of the cell, stage it on the concrete apron for dewatering as needed, and load it into trucks for beneficial reuse or permanent disposal at the on-site landfill. Primary Pond 1 and Primary Pond 2 could operate alternately, so that bottom ash could be deposited into one cell while the other cell was being cleaned out. When DCPP was retired, nearly all of the remaining bottom ash was removed and disposed, with no appreciable bottom ash remaining at the Bottom Ash Basin.

1.3 Type and Volume of Materials

The Bottom Ash Basin does not contain appreciable amounts of CCR. Precipitation is stored in the Bottom Ash Basin when it occurs.

2.0 CLOSURE CONCEPT INFORMATION

Although appreciable amounts of CCR are not present in the Bottom Ash Basin, two concepts have been developed regarding closure of the facility. The first option for closure of the Bottom Ash Basin is to leave the existing concrete structure and underlying liner system intact, place fill to establish positive surface water drainage, and construct a final cover system compliant with Part 845 (i.e., closure in place). The second option for the closure of the Bottom Ash Basin is to remove and dispose the existing liner system components and place fill to promote positive surface water drainage (i.e., closure by removal). Additional discussion of these concepts is presented in the following sections.

2.1 Closure in Place

Under this scenario, the liner system for the Bottom Ash Basin described in Section 1.1 is to remain in place. Because 845.740(a) requires removal of the liner system for closure by removal, Golder interprets that this concept would be subject to the requirements for closure in place (845.750), including installation of a final cover system, even though no CCR would remain in place. Fill will be brought in to reach subgrade elevations designed to promote positive drainage. The facility will then be closed as described in the following section.

2.1.1 Final Cover System Materials

For closure with CCR in place, Part 845 requires installation of a final cover system over the CCR. Based on a demonstration to be submitted to the Illinois Environmental Protection Agency for approval pursuant to Section 845.750(c)(2), an alternative final cover system is incorporated into the closure-in-place concept. The final cover system consists of (from top to bottom):

- 2-foot final protective layer—locally available soils compacted to between 80% and 95% of the standard Proctor maximum dry density for establishment of vegetation and protection of the geomembrane. Material is likely to be primarily low-plasticity silt based on review of site geotechnical information (Hanson 2006).
- Geocomposite.
- 40-mil linear low-density polyethylene (LLDPE) geomembrane.

Compacted fill, composed of locally available soils, would be placed as needed to achieve final cover subgrade. The compacted fill is anticipated to be compacted to a minimum of 95% of the standard Proctor maximum dry density to provide a firm subgrade.

2.1.2 Cover System Grades

The closure design consists of the final cover system covering the concrete-lined areas. The final cover system is sloped at a 2% grade, and then terminates at the edge of concrete. A 4H:1V slope composed of compacted fill ties the final cover system at the edge of concrete into existing ground. Cover system grades and details are provided in Figures 1 and 2.

2.1.3 Closure Construction Timeline

The closure construction will require approximately 10,750 cubic yards (cy) of import fill to reach subgrade, followed by installation of 87,500 square feet (sf) of geomembrane and geocomposite. Approximately 6,500 cy of soil fill will be installed for the final protective layer. The area is not currently ponding water, and significant dewatering is not anticipated prior to beginning closure construction. Based on these construction quantities, closure is anticipated to be completed in a single construction season, and a phased construction plan is unnecessary.

2.1.4 Stormwater Management

Stormwater runoff from the Bottom Ash Basin closure area will be managed by sheet flow off the cover system into an existing stormwater channel (Sargent & Lundy 2007a). Stormwater in this channel is routed into the existing Discharge Canal south of the Bottom Ash Basin. No new stormwater management ponds or features are planned for closure.

2.2 Closure by Removal

Under this scenario, the concrete, compacted clay, and geomembrane components of the liner system for the Bottom Ash Basin, as described in Section 1.1, will be removed as required under 845.740(a) and disposed of in the existing permitted on-site landfill located approximately 3.7 miles north of the Bottom Ash Basin. Alternatively, the materials may be disposed of at an off-site landfill approximately 33 miles away. Subsoil beneath the liner system will be excavated to a depth of up to 1 foot and disposed. Fill will be brought in to reach subgrade elevations designed to promote positive surface water drainage. The facility will then be closed as described in the following section.

2.2.1 Closure Materials

Because no appreciable amounts of bottom ash remain in the Bottom Ash Basin, once the concrete, compacted clay, geomembrane, and subsoil are removed, closure will consist of grading of the area to promote positive drainage and prevent significant ponding. The closed area will be seeded and mulched to promote long-term vegetation.

Based on a review of the soil materials available on site, the fill to reach closure grades is anticipated to consist of low-plasticity silts (Hanson 2006). To limit the potential for excessive settlement, the fill will be compacted to a minimum of 95% of the standard Proctor maximum dry density.

2.2.2 Closure Grades

Because no engineered final cover is necessary for this concept, the closure grades for the closure by removal option are lower in elevation compared to those shown for the closure in place concept. The final grades are still sloped at a 2% grade, and then terminate at the edge of concrete. A 4H:1V slope composed of compacted fill will be used to tie the final surface at the edge of concrete into existing ground. The plan grades and details for this concept are provided in Figures 3 and 4.

2.2.3 Closure Construction Timeline

The closure construction will require removal of approximately 1,950 cy of concrete, 1,600 cy of compacted clay, 3,200 cy of subsoil, and 1 acre of geomembrane. Approximately 17,500 cy of fill will be required to reach closure grades. No final cover system is needed for this closure scenario. The area is not currently ponding water, and significant dewatering is not anticipated prior to beginning closure construction. Based on these construction quantities, the closure is anticipated to be completed in a single construction season, and a phased construction plan was deemed unnecessary.

2.2.4 Stormwater Management

Stormwater runoff from the Bottom Ash Basin closure area will be managed by sheet flow off the final surface into an existing stormwater channel (Sargent & Lundy 2007a). Stormwater in this channel is routed into the existing Discharge Canal south of the Bottom Ash Basin. No new stormwater management ponds or features are planned for closure.

3.0 ADDITIONAL INFORMATION

Gradient provided a request for additional information to support the Closure Alternatives Analysis. The additional information compiled by Golder in response to the request is provided in Tables 1 through 4. Table 1 provides narrative responses for information requests based largely on Part 845 requirements for the Closure Alternatives Analysis. Table 2 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-in-place approach. Table 3 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in the existing permitted on-site landfill, which has ample remaining capacity to accept these materials. Table 4 summarizes conceptual-level estimates of material quantities, costs, equipment and vehicle usage, labor resources, and haul truck trips for the closure-by-removal approach with disposal in an off-site landfill.

In accordance with Part 845, the cost estimates meet the criteria for a Class 4 estimate under the AACE classification standard (feasibility-level, -30% to +50% expected accuracy range). Cost estimates are presented in 2022 United States dollars. cost estimates for many of the cost components, whereby a labor and heavy equipment spread was assigned to the activity. That is, the number and classification (e.g., operator, laborer) of personnel carrying out the activity and the number and type of heavy equipment pieces (e.g., dozer, loader, haul truck) was estimated based on our experience with similar construction operations. This information, combined with an estimate of production rate (e.g., number of cubic yards placed per day), yields a unit cost for the operation (e.g., cost per cubic yard placed). Golder developed production rates based on equipment capabilities (e.g., haul truck capacity, estimated load and unload times, estimates of average speed) and checked them against experience from similar projects. The hourly heavy equipment rates used in the cost estimates were from an internal database of heavy equipment ownership and operating costs by type and size (capacity) of equipment. The internal database reflects the estimated cost associated with owned heavy equipment in the central United States. The hourly labor rates used in the cost estimates were from an internal database of typical labor rates from similar projects in the north-central United States. Unit prices for some cost components (e.g., furnishing and installation of geosynthetics, seeding, and mulching) were estimated based on typical unit prices from similar recent projects. Material quantities correspond with the closure approaches shown in Exhibits 1 and 2 and were developed primarily in Autodesk Civil3D. At a conceptual level of cost estimating, project costs other than direct construction costs (e.g., mobilization and demobilization, miscellaneous construction items not captured elsewhere) were estimated as a proportion of the direct construction cost. Experience on similar projects was used as the basis for the proportions applied.

4.0 REFERENCES

Hanson (Hanson Professional Services Inc.). 2006. Geotechnical Investigation Results. Bottom Ash Basin. Duck Creek Power Station. February.

Sargent & Lundy. 2007a. Bottom Ash and Low Volume Sump Water Basin and Piping Drawings, Issued for Construction. Duck Creek Power Station. September.

Sargent & Lundy. 2007b. Bottom Ash and Low Volume Sump Water Basin and Piping Construction Specifications. Duck Creek Power Station. September.

Attachments: Attachment 1: Exhibits 1 and 2
Exhibit 1: Closure-in-Place Figures
Exhibit 2: Closure-by-Removal Figures
Attachment 2: Tables
Table 1: Information Summary
Table 2: Closure Estimates – Closure in Place
Table 3: Closure Estimates – Closure by Removal with On-Site Disposal
Table 4: Closure Estimates – Closure by Removal with Off-Site Disposal

https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/12-r-closure_plan_bottom_ash_basin/12-r-0/att 1 caa/app b supporting info/caa_supporting_info-bottom_ash_basin.docx

Tables

Table 1: Information Summary

Background/Current Site Conditions	
Surface area of impoundment	2.2 acres total (includes all three cells and the concrete area around the cells). 0.9 acres maximum wetted area.
Volume of CCR in impoundment	No appreciable amount (CCR has already been removed and disposed).
Published or draft engineering evaluations undertaken at the site to date	
Conceptual site models	None.
Regional well (receptor) survey information	None.
History of construction report	See [1]
Dike stability report	Stability analysis was not completed for the CCR Rule (volume is less than 20 acre-feet and height is less than 20 feet), according to AECOM [2]. Based on site observations, there is no risk associated with dike stability.
Hydraulic evaluation of basins (evaluation of possibility of overtopping and/or emergency spillway releases during flood conditions)	Hydraulic and hydrologic analyses performed by AECOM [3] found that the Bottom Ash Basin adequately manages outflow during the 25-year IDF, as overtopping of the BAB is not expected.
Surface impoundment hazard assessment/hazard category determination	Hazard category determination not completed for the CCR Rule (not required for incised CCR surface impoundments).
Habitat survey	Not available.
Wetlands survey	Not available. Based on visual observation, wetlands do not appear to be present in the area to be disturbed for closure construction.

Table 1: Information Summary

Closure Design and Implementation	
Copy of draft of closure report, if available	Provided.
Engineering spreadsheet containing breakdown of labor, equipment/vehicle, and material requirements for each closure alternative, if available (expected on-site and off-site vehicle and equipment mileages, labor hours, etc.)	See Tables 2 through 4.
Overview of planned activities under each closure alternative	Closure by removal: Under this scenario, approximately 1950 cy of concrete, 1600 cy of compacted clay, and 1 acre of geomembrane that make up the BAB liner system, along with 3200 cy of overexcavated subsoil, will be removed and disposed in the on-site landfill or in an off-site landfill. Approximately 17500 cy of low-plasticity silts available on site will be used as fill to reach reclamation grades, and it will be compacted to at least 95% of the standard Proctor maximum dry density to prevent excessive settlement. The site will be graded to promote positive drainage and prevent significant ponding (2% grade to the edge of concrete, 4H:1V from edge of concrete to existing ground), and it will be seeded to promote long-term vegetation.
	Closure in place: Under this scenario, the concrete, compacted clay, and geomembrane that make up the BAB liner system will remain in place. Approximately 10750 cy of low-plasticity silt available on site will be used as fill to reach reclamation grades, and it will be compacted to at least 95% of the standard Proctor maximum dry density to prevent excessive settlement. The final cover system will be composed of (from top to bottom): 2 feet of locally available low-plasticity silt, compacted to between 80% and 95% of the standard Proctor maximum dry density; a drainage layer of approximately 87500 sq ft of geocomposite; and approximately 87500 sq ft of 40-mil LLDPE geomembrane. To promote drainage and prevent excessive ponding, the cover system will be sloped at a 2% grade to the edge of concrete, and compacted fill with a 4H:1V slope will extend from the edge of concrete to the existing grades. It will be seeded to promote long-term vegetation.
Expected duration of major construction activities under each closure activity	Closure by removal: 12 weeks.
	Closure in place: 6 weeks.
If an on-site landfill will be constructed on the site under a given closure alternative, please include the years required to construct and later close the on-site landfill	Not applicable. The existing permitted on-site landfill has sufficient capacity to accept waste generated from closure by removal without expansion of the existing landfill or construction of a new on-site landfill.
If an on-site landfill must first be constructed on the site, please estimate the anticipated delay in the commencement of excavation activities while the landfill is being sited, designed, and constructed; indicate whether dewatering/unwatering of the ponds will begin immediately, or after the landfill is constructed	Not applicable.
Proposed location of the on-site landfill if on-site disposal is being considered for CBR scenario	The existing on-site landfill is approximately 3.7 miles north of the Bottom Ash Basin via site roads.

Table 1: Information Summary

Closure Design and Implementation	
Surface area of the on-site landfill, if a new landfill must be constructed at the site	Not applicable.
Name and location of proposed off-site landfill	If an off-site landfill were to be used, the Peoria City-County Landfill is the nearest suitable facility (33 miles away). An alternate off-site landfill is the Envirofill of IL Landfill.
Location of borrow area, if a borrow area will be established (for either the impoundment or construction/closure of an on-site landfill); if location is unknown, please estimate a likely distance to the borrow area	The anticipated on-site borrow source location is approximately 3.4 miles north of the Bottom Ash Basin via site roads.
Estimated volume of soil to be hauled from the borrow area under each closure alternative	Closure by removal: 18,000 cy.
	Closure in place: 17,000 cy.
Difficulty associated with implementation of each closure alternative (e.g., do any alternatives pose particular engineering/implementation challenges?)	No major challenges are anticipated for any closure alternative.
Availability of necessary equipment and specialists for each closure alternative	Good availability of equipment and services is anticipated for all closure alternatives.
Available capacity and location of needed treatment, storage, and disposal services for each closure alternative	The distance to the nearest off-site landfill (approximately 33 miles) presents a significant challenge for the option that involves off-site disposal.
Estimated cost of each closure alternative	Closure by removal: $480,000 (on-site disposal); $1,360,000 (off-site disposal).
	Closure in place: $500,000.

Table 1: Information Summary

Post-Closure Plan/Long-Term Management Plan	
Planned duration of post-closure care activities	Closure by removal: An owner or operator of a CCR surface impoundment that elects to close a CCR surface impoundment by removing CCR as provided in Section 845.740 must continue groundwater monitoring for three years after the completion of closure or until concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
	Closure in place: The owner or operator of the CCR surface impoundment must conduct post-closure care for 30 years. The owner or operator must continue to conduct post-closure care beyond the 30-year post-closure care period until groundwater monitoring data shows the concentrations are (a) below groundwater protection standards given in Section 845.600 of Part 845 or (b) not increasing for those constiuents over background using the statistical procedures and performance standards in Section 845.640(f) and (g), provided that concentrations have been reduced to the maximum extent feasible and they are protective of human health and the environment.
Expected frequency of groundwater and surface water monitoring during post-closure period	Closure by removal: Quarterly.
	Closure in place: Quarterly for 5 years and semi-annually thereafter.
Summary of planned maintenance activities post-closure	Closure by removal: Groundwater monitoring will be conducted.
	Closure in place: Groundwater monitoring will be conducted. Site inspections will be conducted on a quarterly basis for a minimum of 5 years after closure. An annual site inspection will be performed until settlement has ceased and there are no eroded or scoured areas or until the end of the 30-year post-closure care period. Over these 30 years, repair and maintenance, including soil filling and reseeding, will be performed if ponding is observed, cracks greater than 1 inch wide or gullies 6 inches or deeper have formed, vegetative or vector problems arise, or leachate seeps are present. Areas susceptible to erosion will be recontoured and reseeded. Eroded and scoured drainage channels will be repaired and the liner material replaced if necessary. Vegetation will be mowed annually. Areas of failed or eroded vegetation in excess of 100 square feet will be revegetated. Minor repairs to ensure the integrity and proper function of fencing, surface water drainage features, monitoring points, and groundwater monitoring wells may be required.
Summary of planned post-closure care activities at the on-site landfill, if a new on-site landfill is going to be constructed	Not applicable.

Corrective Measures Assessment	
Corrective measures being considered post-closure	None anticipated.
Overview of planned activities for each corrective measure	None anticipated.

References

1) Golder (2021). History of Construction for the Bottom Ash Basin, Duck Creek Power Plant.

2) AECOM (2016). CCR Rule Report: Initial Structural Stability Assessment for Bottom Ash Basin at Duck Creek Power Station. Available online: https://www.luminant.com/ccr.

3) AECOM (2016). CCR Rule Report: Initial Inflow Design Flood Control System Plan for Bottom Ash Basin at Duck Creek Power Station. Available online:

Table 2: Closure Estimates - Closure in Place

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 34,950	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 20,000	$ 20,000	1 surveyor		
Borrow Area Preparation and Reclamation	LS	1	$ 15,000	$ 15,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Pipe Removal/Abandonment	LS	1	$ 10,000	$ 10,000	1 equipment operator, 4 laborers	Excavator	
Embankment Fill	CY	10,750	$ 9.30	$ 99,975	8 equipment operators	Excavator, dozer, compactor, water truck, 4 haul trucks	372 (3.4 miles one way)
Geomembrane	SF	87,500	$ 0.75	$ 65,625	5 laborers, 1 equipment operator, 1 superintendent, 1 quality assurance technician	Telehandler	
Geocomposite	SF	87,500	$ 0.75	$ 65,625			
Final Protective Soil Layer	CY	6,500	$ 8.20	$ 53,300	7 equipment operators	Excavator, dozer, water truck, 4 haul trucks	225 (3.4 miles one way)
Fertilize, Seed, and Mulch	AC	3	$ 5,000	$ 15,000	2 equipment operators	Seed drill or hydroseeder	
Erosion Control	LS	1	$ 5,000	$ 5,000	1 equipment operator, 2 laborers	Excavator	
Construction Quality Assurance	LS	1	$ 75,000	$ 75,000	1 technician		
Miscellaneous Construction	LS	1	10%	$ 38,450	Miscellaneous	Miscellaneous	
			Total	**$ 497,925**			

Notes:

Miscellaneous Costruction includes other work not captured in the items shown.

Soil components were assumed to be taken from the stockpile north of the GMF (3.4-mile haul).

Table 3: Closure Estimates - Closure by Removal with On-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 37,530	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 10,000	$ 10,000	1 surveyor		
Borrow Area Preparation and Reclamation	LS	1	$ 15,000	$ 15,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Pipe Removal/Abandonment	LS	1	$ 10,000	$ 10,000	1 equipment operator, 4 laborers	Excavator	
Concrete Demolition and Disposal	CY	1,950	$ 57	$ 111,150	5 equipment operators, 4 laborers	2 breakers, dozer, loader, haul truck	67 (3.7 miles one way)
Geomembrane Removal and Disposal	AC	1	$ 8,000	$ 8,000	3 equipment operators, 4 laborers	Dozer, loader, haul truck	4 (3.7 miles one way)
Liner Soil Removal and Disposal	CY	1,600	$ 8.00	$ 12,800	6 equipment operators	Excavator, dozer, 4 haul trucks	55 (3.7 miles one way)
Subsoil Overexcavation and Disposal	CY	3,200	$ 8.00	$ 25,600	6 equipment operators	Excavator, dozer, 4 haul trucks	111 (3.7 miles one way)
Embankment Fill	CY	17,500	$ 9.30	$ 162,750	8 equipment operators	Excavator, dozer, compactor, water truck, 4 haul trucks	606 (3.4 miles one way)
Fertilize, Seed, and Mulch	AC	3	$ 5,000	$ 15,000	2 equipment operators	Seed drill or hydroseeder	
Erosion Control	LS	1	$ 5,000	$ 5,000	1 equipment operator, 2 laborers	Excavator	
Construction Quality Assurance	LS	1	$ 25,000	$ 25,000	1 technician		
Miscellaneous Construction	LS	1	10%	$ 41,280	Miscellaneous	Miscellaneous	
			Total	**$ 479,110**			

Notes:
Miscellaneous Construction includes other work not captured in the items shown.
Soil components were assumed to be taken from the stockpile north of the GMF (3.4-mile haul).
Disposal was assumed to occur in the on-site landfill (3.7-mile haul).

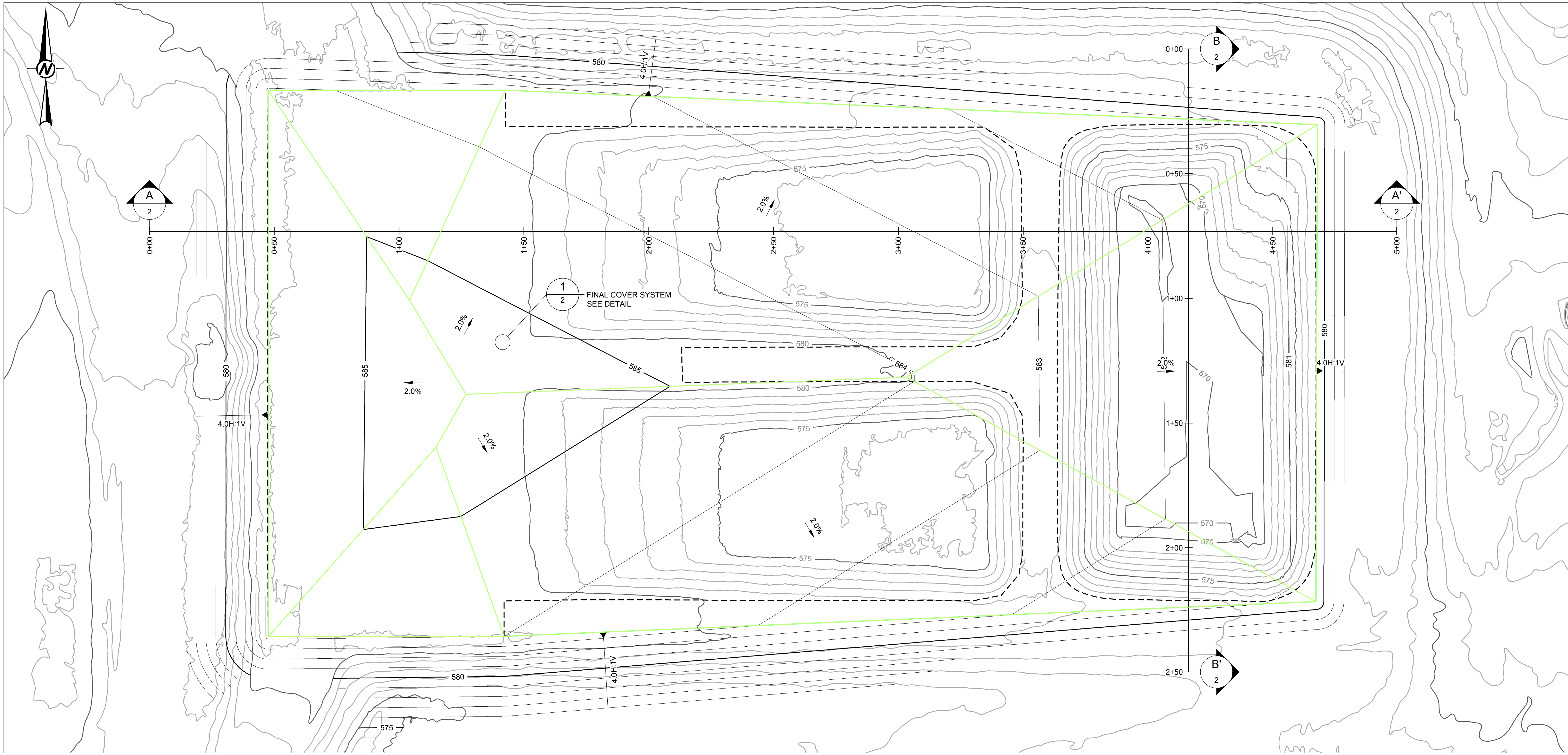
Table 4: Closure Estimates - Closure by Removal with Off-Site Disposal

Description	Unit	Quantity	Unit Price	Total	Labor	Equipment	Truck Trips
Mobilization/Demobilization	LS	1	10%	$ 110,440	1 superintendent	Pickup truck, flatbed truck	
Survey	LS	1	$ 10,000	$ 10,000	1 surveyor		
Borrow Area Preparation and Reclamation	LS	1	$ 15,000	$ 15,000	2 equipment operators	Dozer, seed drill or hydroseeder	
Pipe Removal/Abandonment	LS	1	$ 10,000	$ 10,000	1 equipment operator, 4 laborers	Excavator	
On-Site Concrete Demolition	CY	1,950	$ 182	$ 354,900	4 equipment operators, 4 laborers	2 breakers, dozer, loader	
Off-Site Concrete Hauling and Disposal					Equipment operator	On-highway truck	140 (32.6 miles one way)
On-Site Geomembrane Removal	AC	1	$ 8,500	$ 8,500	2 equipment operators, 4 laborers	Dozer, loader	
Off-Site Geomembrane Hauling and Disposal					Equipment operator	On-highway truck	6 (32.6 miles one way)
On-Site Liner Soil Removal	CY	1,600	$ 109	$ 174,400	2 equipment operators	Excavator, dozer	
Off-Site Liner Soil Hauling and Disposal					4 equipment operators	4 on-highway trucks	114 (32.6 miles one way)
On-Site Subsoil Overexcavation	CY	3,200	$ 109	$ 348,800	2 equipment operators	Excavator, dozer	
Off-Site Subsoil Hauling and Disposal					4 equipment operators	4 on-highway trucks	229 (32.6 miles one way)
Embankment Fill	CY	17,500	$ 9.30	$ 162,750	8 equipment operators	Excavator, dozer, compactor, water truck, 4 haul trucks	606 (3.4 miles one way)
Fertilize, Seed, and Mulch	AC	3	$ 5,000	$ 15,000	2 equipment operators	Seed drill or hydroseeder	
Erosion Control	LS	1	$ 5,000	$ 5,000	1 equipment operator, 2 laborers	Excavator	
Construction Quality Assurance	LS	1	$ 25,000	$ 25,000	1 technician		
Miscellaneous Construction	LS	1	10%	$ 121,480	Miscellaneous	Miscellaneous	
			Total	**$ 1,361,270**			

Notes:
Miscellaneous Construction includes other work not captured in the items shown.
Soil components were assumed to be taken from the stockpile north of the GMF (3.4-mile haul).
Disposal was assumed to occur in an off-site landfill (32.6-mile haul).

EXHIBIT 1

Closure-in-Place Figures



LEGEND

600	PROPOSED CLOSURE GRADES
600	EXISTING GROUND CONTOURS (SEE NOTE 1)
- - - -	EDGE OF CONCRETE (SEE NOTE 3)
——	GRADING BREAKLINE

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020 AND TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE LOCATED DURING THIS SURVEY.
2. ELEVATIONS ARE IN NAVD 88.
3. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.

0 20 40
SCALE FEET

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

PROJECT
BOTTOM ASH BASIN
CLOSURE ALTERNATIVES ANALYSIS

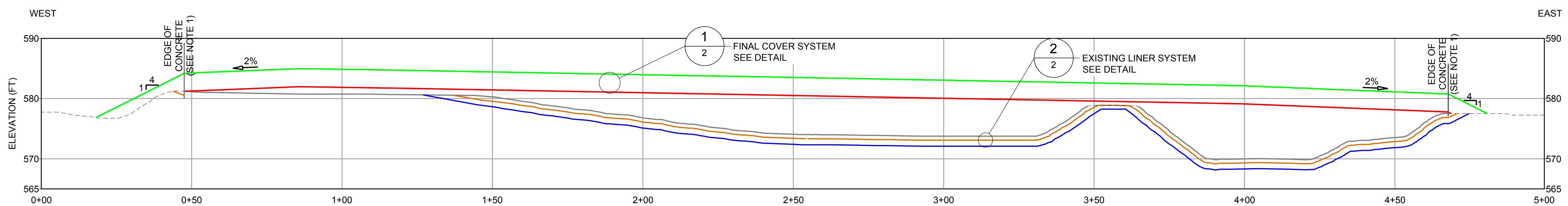
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-05
DESIGNED	JEO
PREPARED	KAC
REVIEWED	JJS
APPROVED	JEO

TITLE
CLOSURE IN PLACE
CONCEPTUAL DESIGN PLAN

PROJECT NO.	REV.	FIGURE
21454861	A	1

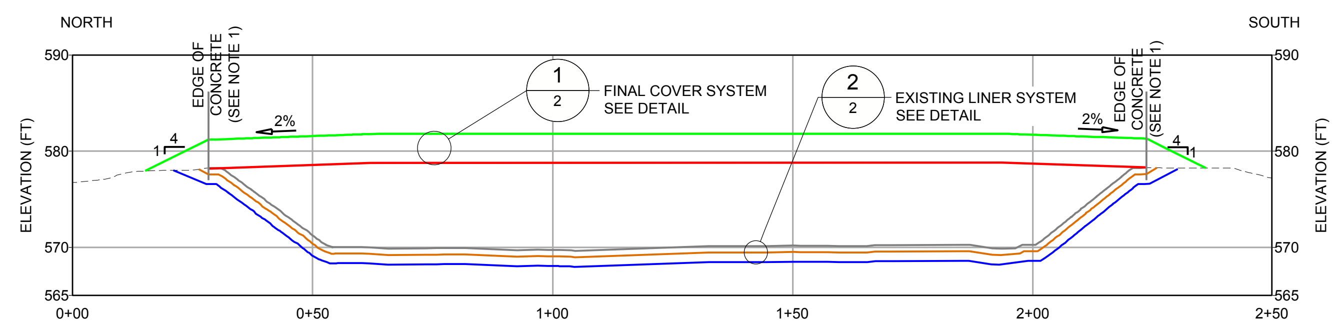
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE AS SHOWN
VERT. SCALE = 2X

A/2 CROSS SECTION A

0 20 40
SCALE FEET



SCALE AS SHOWN
VERT. SCALE = 2X

B/2 CROSS SECTION B

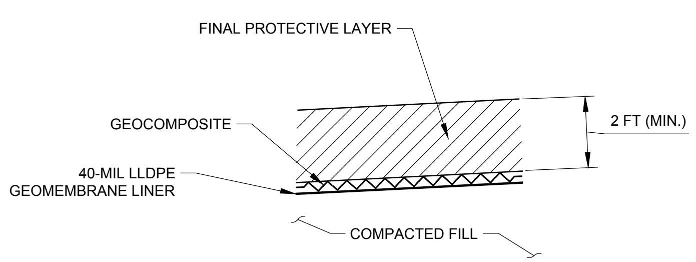
0 20 40
SCALE FEET

CROSS SECTION LEGEND

- PROPOSED TOP OF FINAL COVER SYSTEM
- PROPOSED TOP OF COMPACTED FILL
- EXISTING GROUND
- EXISTING LINER SYSTEM - TOP OF CONCRETE
- EXISTING LINER SYSTEM - TOP OF COMPACTED CLAY
- EXISTING LINER SYSTEM - GEOMEMBRANE

NOTE(S)

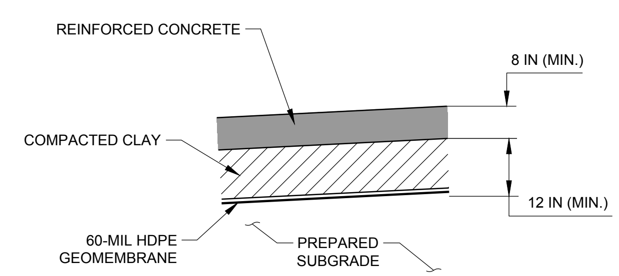
1. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.



SCALE N.T.S. 1/2 FINAL COVER SYSTEM

NOTE(S)

FINAL PROTECTIVE LAYER WILL BE COMPOSED OF LOCALLY AVAILABLE SOILS COMPACTED TO BETWEEN 80% AND 95% OF THE STANDARD PROCTOR MAXIMUM DRY DENSITY FOR ESTABLISHMENT OF VEGETATION AND PROTECTION OF THE GEOMEMBRANE.

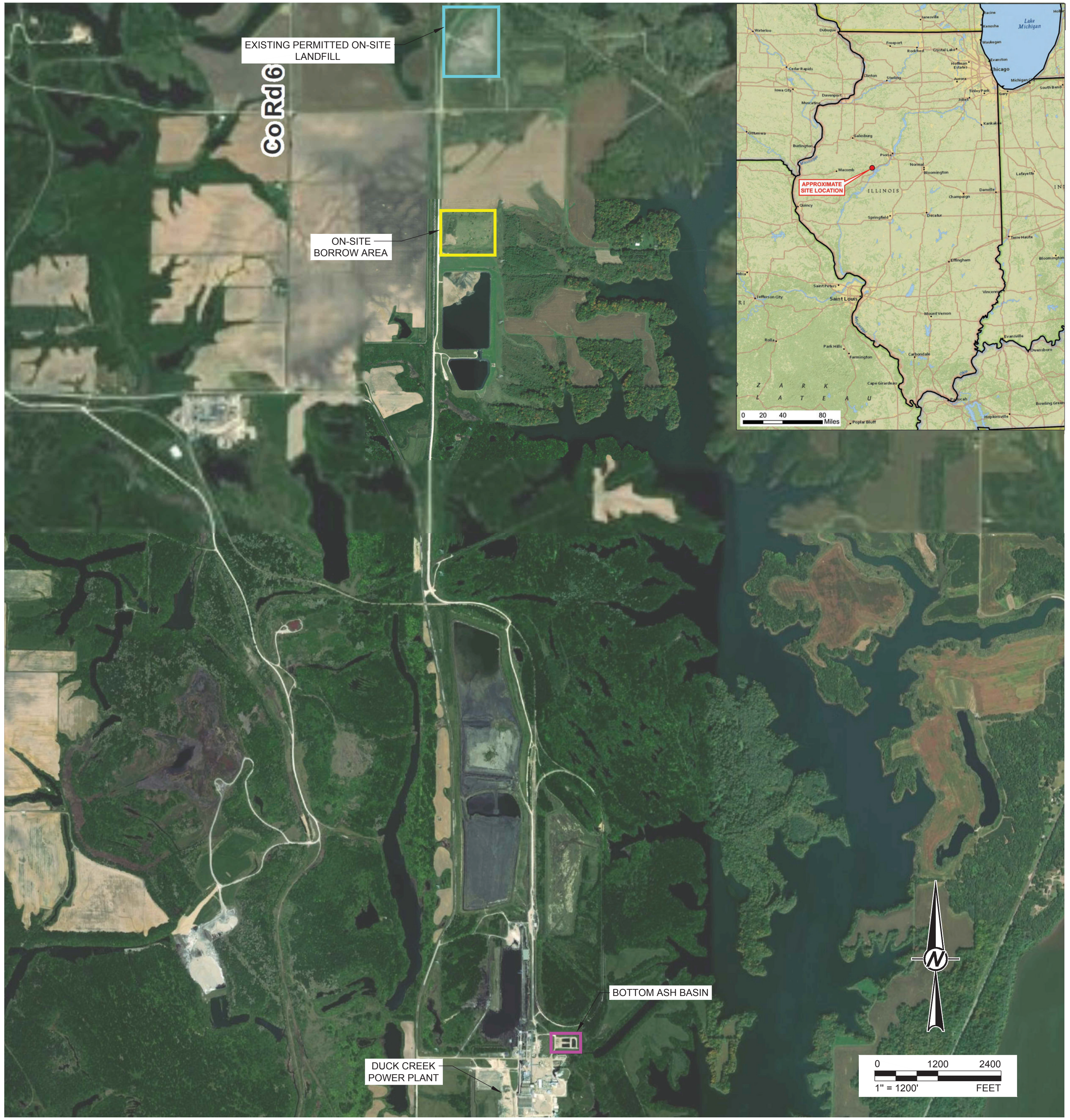


SCALE N.T.S. 2/2 EXISTING LINER SYSTEM

CLIENT ILLINOIS POWER RESOURCES GENERATING, LLC DUCK CREEK POWER PLANT		PROJECT BOTTOM ASH BASIN CLOSURE ALTERNATIVES ANALYSIS	
CONSULTANT	YYYY-MM-DD: 2021-11-05	TITLE **CLOSURE IN PLACE** **SECTIONS AND DETAILS**	
GOLDER MEMBER OF WSP	DESIGNED: JEO		
	PREPARED: KAC		
	REVIEWED: JJS	PROJECT NO. 21454861	REV. A — FIGURE 2
	APPROVED: JEO		

EXHIBIT 2

Closure-by-Removal Figures



ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021

PERMIT APPLICATION DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	EXCAVATION GRADES	A
4	FINAL GRADES	A
5	SECTIONS AND DETAILS	A

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM ESRI PROVIDED BASEMAP SURVEY. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

CONSULTANT
GOLDER MEMBER OF WSP
GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

TITLE
TITLE SHEET

PROJECT NO. 21454861 | REV. A | DRAWING 1

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

LEGEND

- 580 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- EDGE OF EXISTING CONCRETE (SEE NOTE 3)
- LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER
- EXISTING STORMWATER CHANNEL (SEE NOTE 4)
- EXISTING CULVERT (SEE NOTE 4)

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.
4. LOCATIONS OF STORMWATER CHANNELS AND LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
5. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, IN COMBINATION WITH TOPOGRAPHIC SURVEY (NOTE 1).

N

0 30 60
1" = 30' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

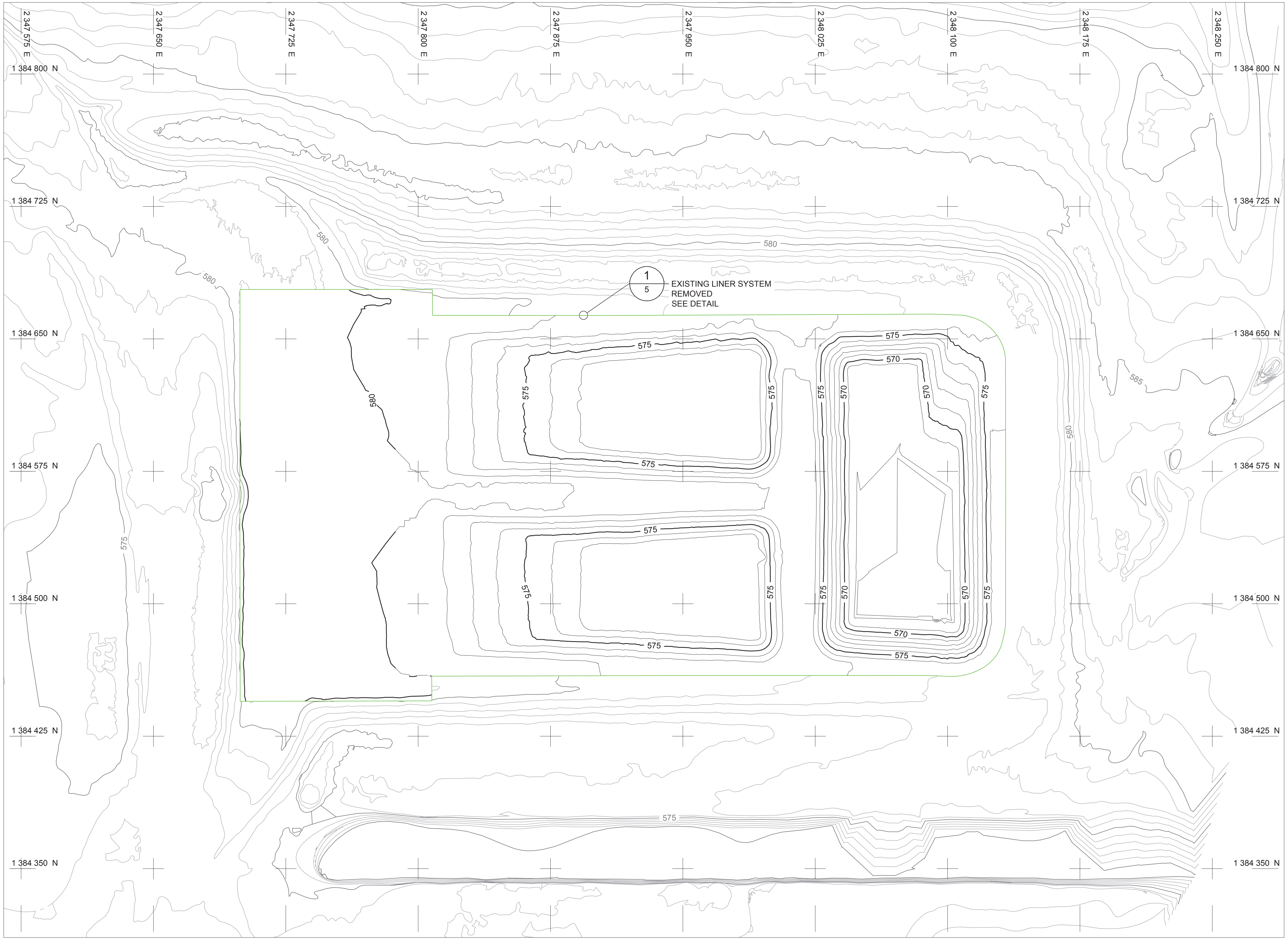
GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
EXISTING CONDITIONS

PROJECT NO. 21454861 | REV. A | DRAWING 2

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

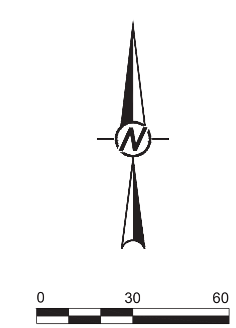


LEGEND

580	EXISTING GROUND CONTOURS (SEE NOTE 1)
575	EXCAVATION CONTOURS (SEE NOTE 3)
	EXTENTS OF EXCAVATION

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. EXCAVATION GRADES ARE SHOWN AS A 20-INCH OFFSET BELOW THE EXISTING GRADES TO ACCOUNT FOR THE REMOVAL OF THE LINER SYSTEM.



REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

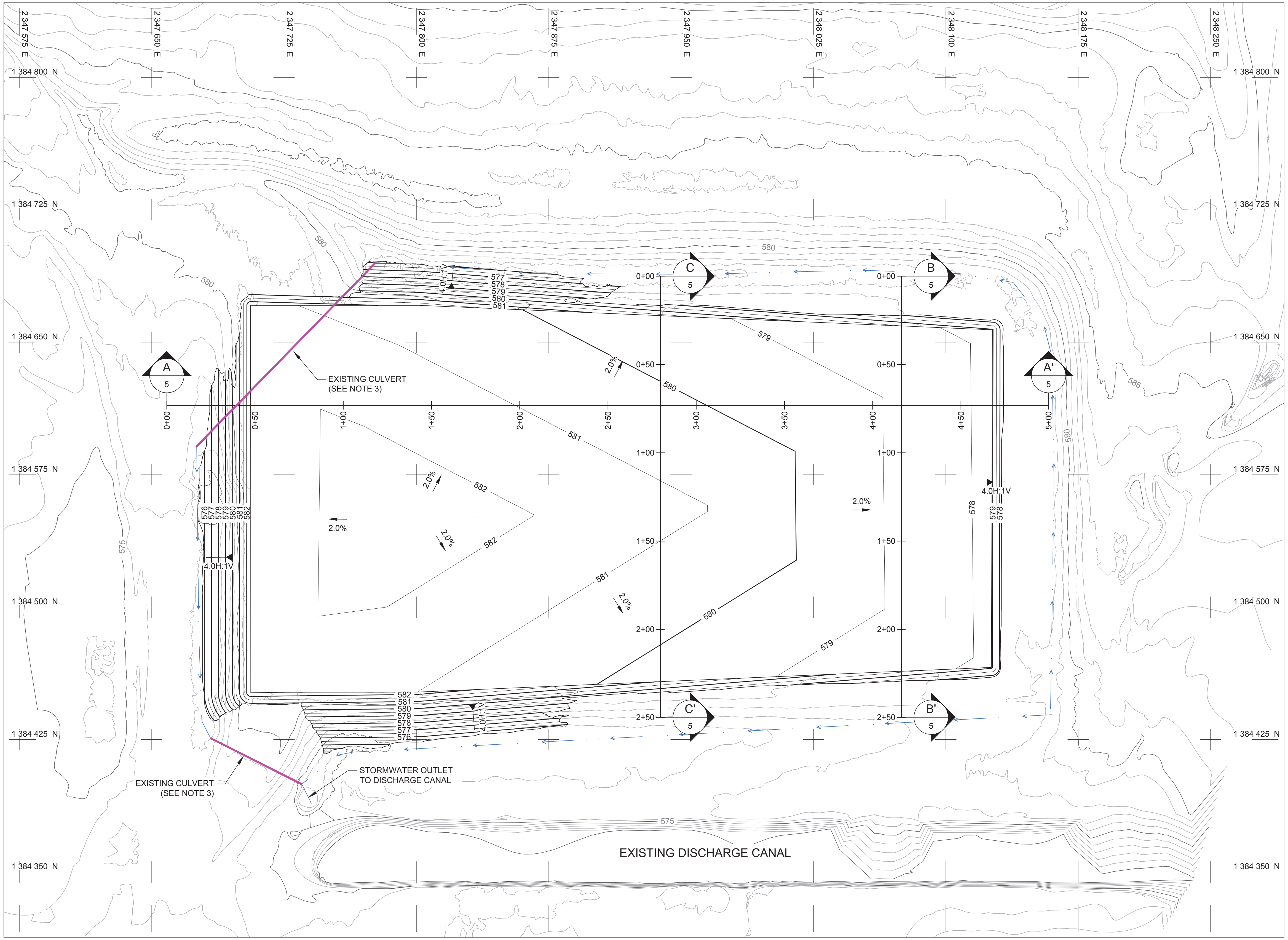
CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
EXCAVATION GRADES

PROJECT NO.	REV.	of	DRAWING
21454861	A		3



LEGEND

- 580 — PROPOSED TOP OF COMPACTED FILL ELEVATION CONTOURS
- 580 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- EXISTING STORMWATER CHANNEL (SEE NOTE 3)
- EXISTING CULVERT (SEE NOTE 3)

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. LOCATIONS OF STORMWATER CHANNELS BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
4. COMPACTED FILL TO BE PLACED TO A MINIMUM OF 95 PERCENT OF STANDARD PROCTOR MAXIMUM DRY DENSITY TO LIMIT POTENTIAL FOR EXCESSIVE SETTLEMENT.
5. UPON COMPLETION OF COMPACTED FILL CONSTRUCTION, DISTURBED AREAS SHALL BE SEEDED AND MULCHED TO PROMOTE VEGETATIVE GROWTH AND LIMIT POTENTIAL FOR FUTURE EROSION.

N

0 30 60
1" = 30' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT

GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

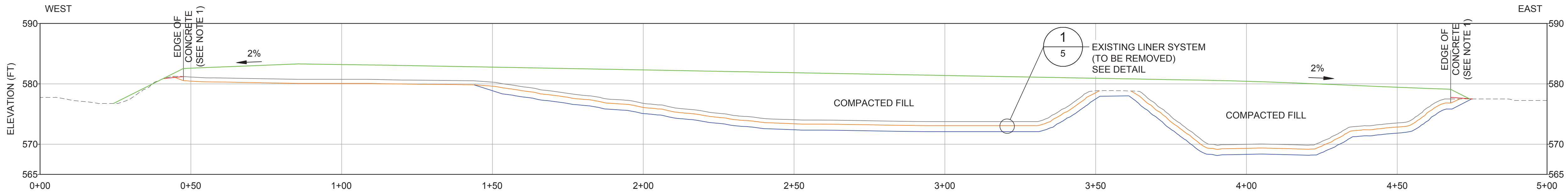
PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
FINAL GRADES

PROJECT NO. 21454861
REV. A
DRAWING 4

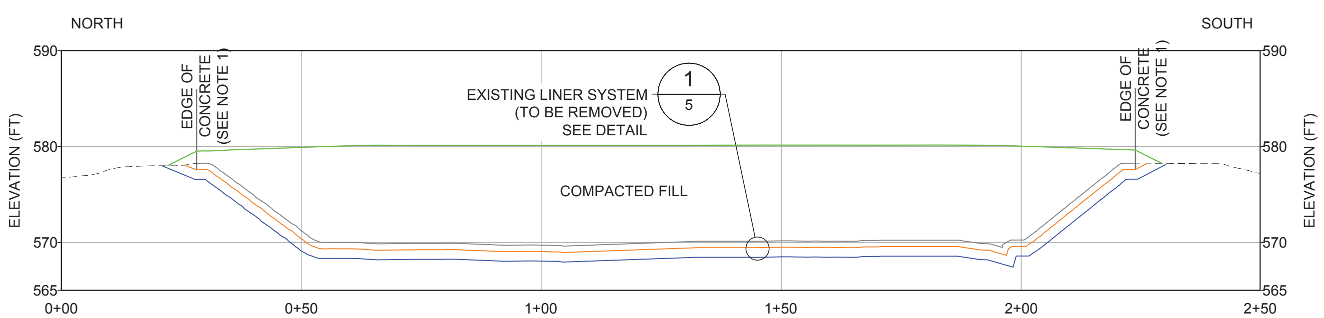
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\complexdata\office\Denver\acad\VISTRA\Duck Creek\99_PROJECTS\21454861\Bottom Ash\02_PRODUCTION\DWG\ | File Name: 4-FINAL GRADES.dwg | Last Edited By: adarr Date: 2021-10-18 Time:6:18:00 PM | Printed By: JObermeyer Date: 2022-01-25 Time:4:28:22 PM



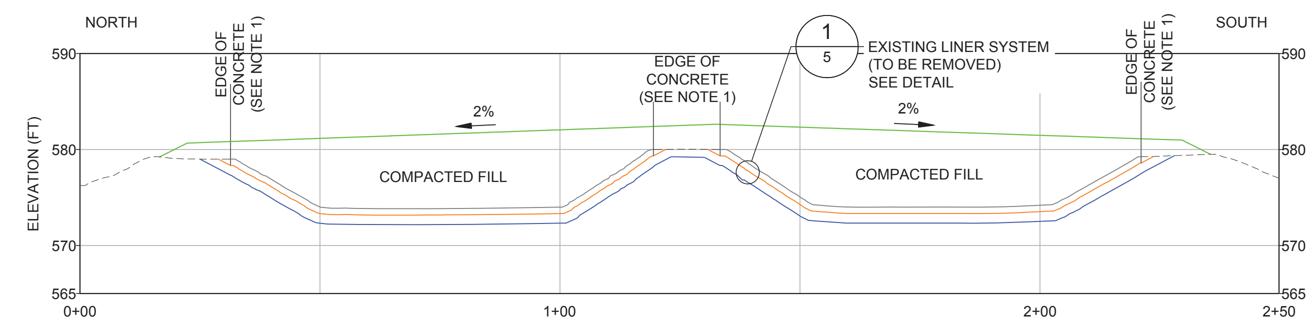
SCALE 1" = 20'
VERT. SCALE = 2X
A / 4 CROSS SECTION A

0 20 40
1" = 20' FEET



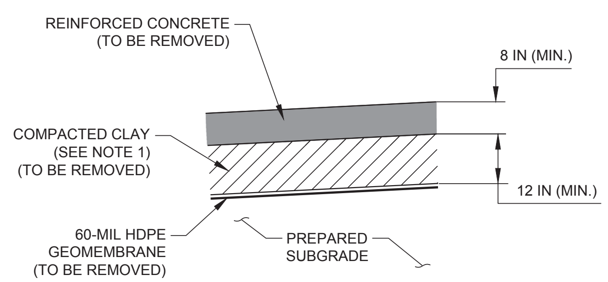
SCALE 1" = 20'
VERT. SCALE = 2X
B / 4 CROSS SECTION B

0 20 40
1" = 20' FEET



SCALE 1" = 20'
VERT. SCALE = 2X
C / 4 CROSS SECTION C

0 20 40
1" = 20' FEET



SCALE N.T.S.
1 / 5 EXISTING LINER SYSTEM

CROSS SECTION LEGEND

- PROPOSED TOP OF COMPACTED FILL
- EXISTING GROUND
- EXISTING LINER SYSTEM - TOP OF CONCRETE (SEE NOTES 1 AND 2)
- EXISTING LINER SYSTEM - TOP OF COMPACTED CLAY (SEE NOTES 1 AND 2)
- EXISTING LINER SYSTEM - GEOMEMBRANE (SEE NOTES 1 AND 2)

NOTE(S)

1. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021. LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
2. CONCRETE, COMPACTED CLAY, AND GEOMEMBRANE COMPONENTS OF THE BOTTOM ASH BASIN LINER SYSTEM TO BE REMOVED AND DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.
3. UP TO AN ADDITIONAL 12 INCHES OF SOIL MAY BE EXCAVATED FROM BENEATH THE LINER SYSTEM AND REPLACED WITH COMPACTED FILL.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

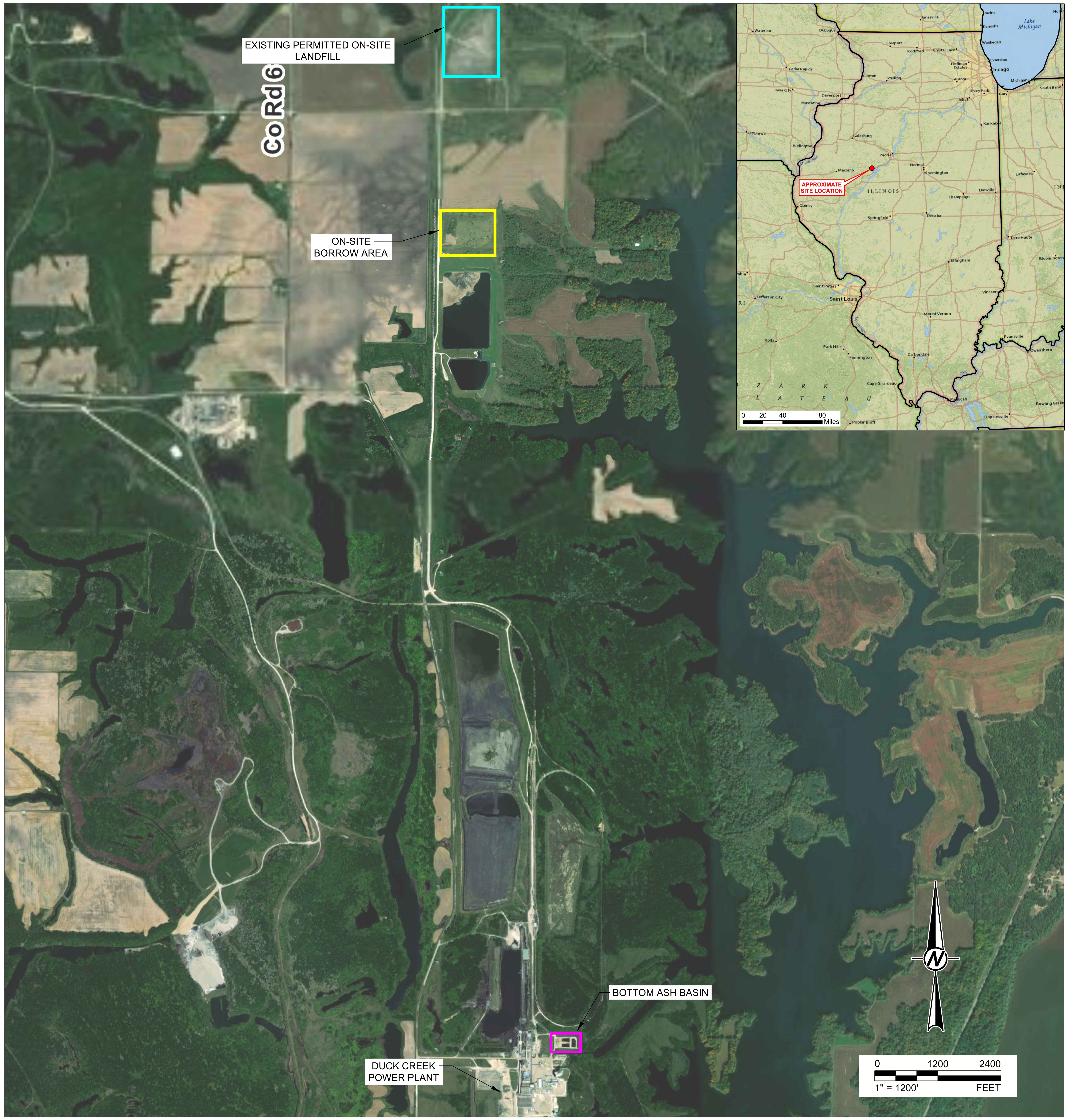
PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
SECTIONS AND DETAILS

PROJECT NO. 21454861
REV. A
DRAWING 5

ATTACHMENT 2

Drawings



ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

PREPARED BY:

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021

PERMIT APPLICATION DRAWING LIST		
NUMBER	TITLE	REVISION
1	TITLE SHEET	A
2	EXISTING CONDITIONS	A
3	EXCAVATION GRADES	A
4	FINAL GRADES	A
5	SECTIONS AND DETAILS	A

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM ESRI PROVIDED BASEMAP SURVEY. IMAGERY COLLECTED 5/14/2017, 10/21/2017, 8/22/2018, AND 4/1/2019.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

TITLE
TITLE SHEET

PROJECT NO. 21454861
REV. A
DRAWING 1

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

LEGEND

- 580 — EXISTING GROUND CONTOURS (SEE NOTE 1)
- EDGE OF EXISTING CONCRETE (SEE NOTE 3)
- LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER
- EXISTING STORMWATER CHANNEL (SEE NOTE 4)
- EXISTING CULVERT (SEE NOTE 4)

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021.
4. LOCATIONS OF STORMWATER CHANNELS AND LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
5. AERIAL IMAGERY FROM DRAGONFLY AEROSOLUTIONS DATED 11/17/2020, IN COMBINATION WITH TOPOGRAPHIC SURVEY (NOTE 1).

N

0 30 60

1" = 30' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

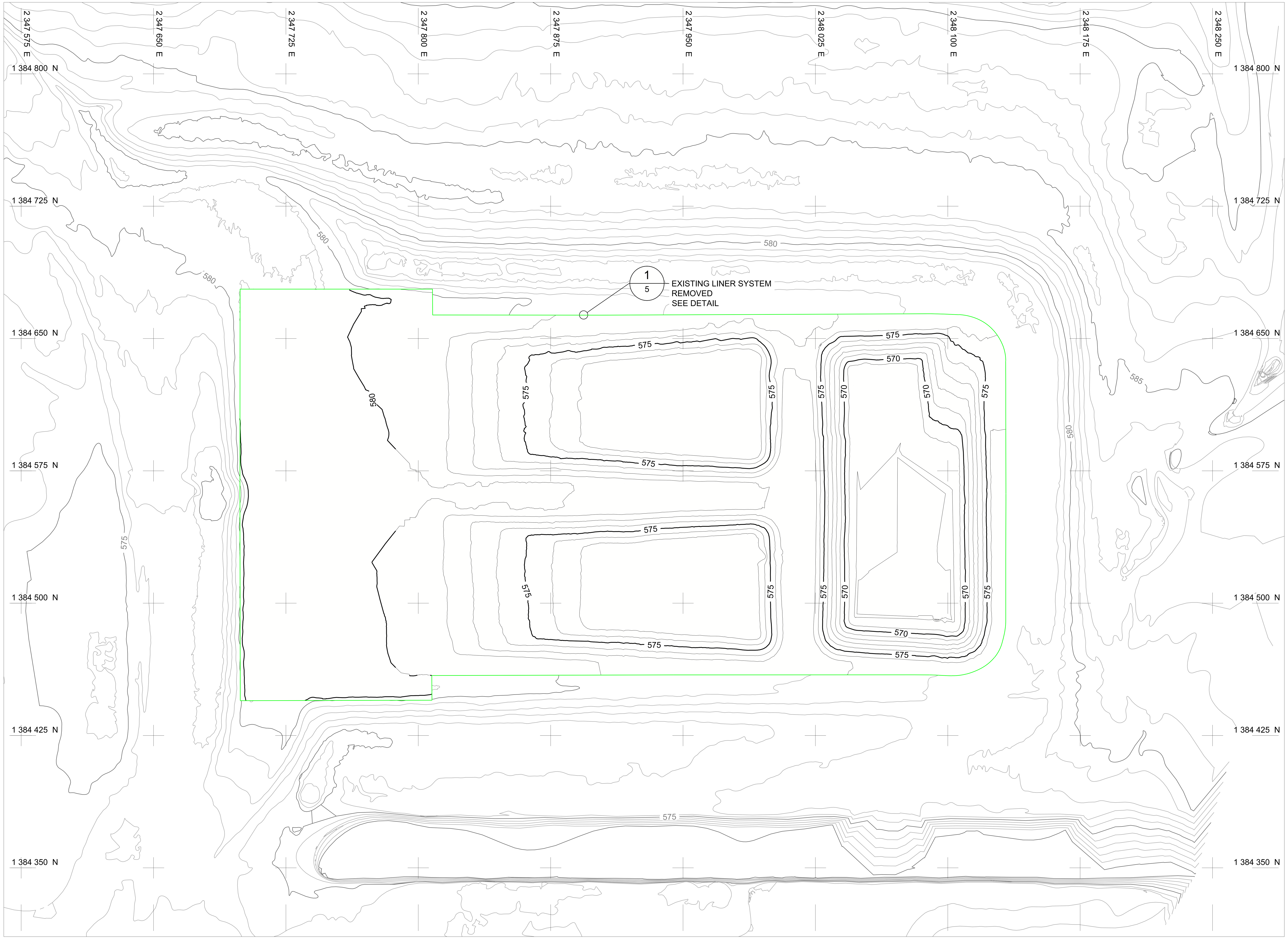
CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
EXISTING CONDITIONS

PROJECT NO. 21454861
REV. A
DRAWING 2



LEGEND

580	EXISTING GROUND CONTOURS (SEE NOTE 1)
575	EXCAVATION CONTOURS (SEE NOTE 3)
	EXTENTS OF EXCAVATION

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. EXCAVATION GRADES ARE SHOWN AS A 20-INCH OFFSET BELOW THE EXISTING GRADES TO ACCOUNT FOR THE REMOVAL OF THE LINER SYSTEM.

N

0 30 60
1" = 30' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

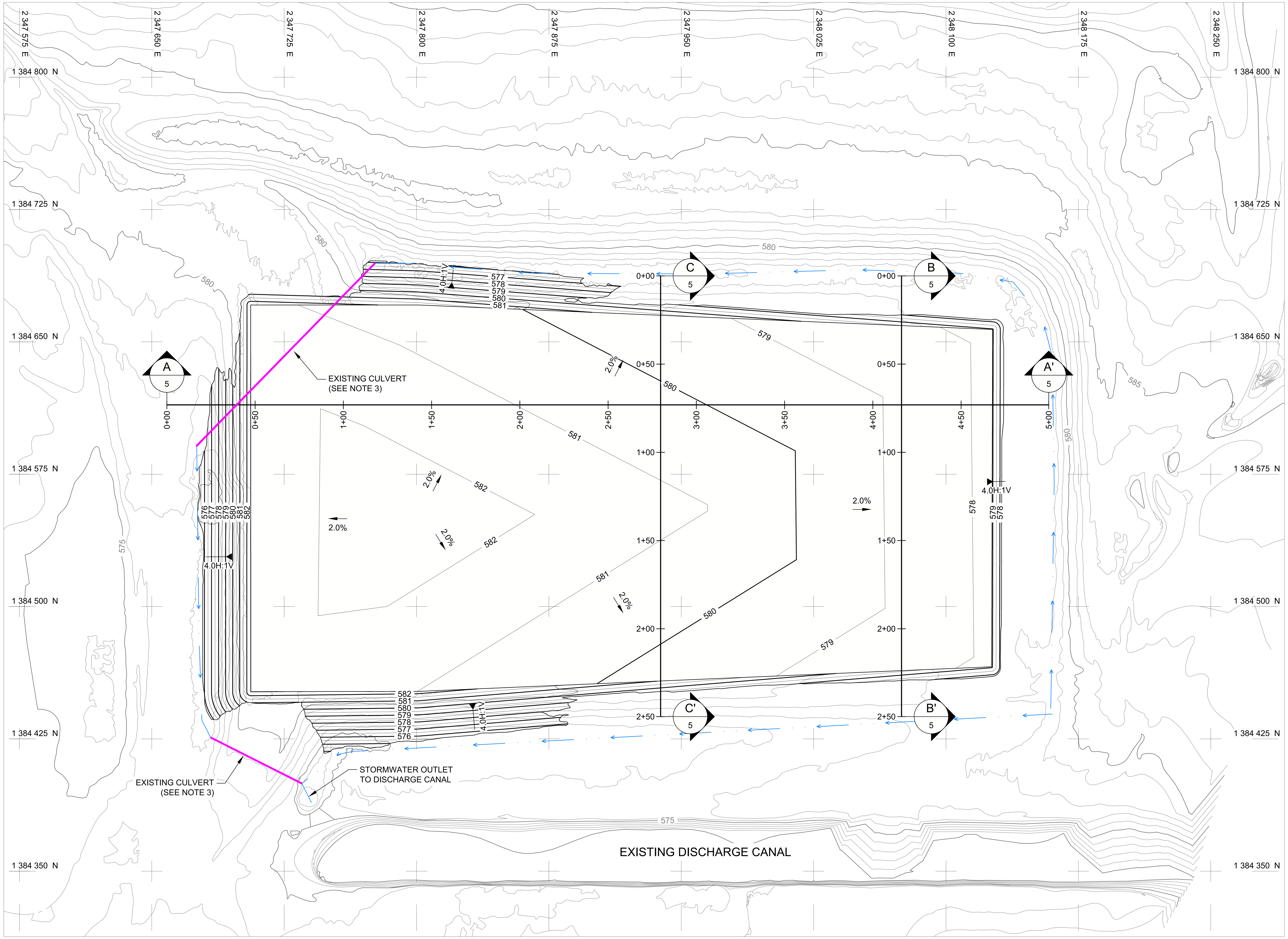
CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
EXCAVATION GRADES

PROJECT NO.	REV.	of	DRAWING
21454861	A		3



LEGEND

580 — PROPOSED TOP OF COMPACTED FILL ELEVATION CONTOURS

580 — EXISTING GROUND CONTOURS (SEE NOTE 1)

EXISTING STORMWATER CHANNEL (SEE NOTE 3)

EXISTING CULVERT (SEE NOTE 3)

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM TOPOGRAPHIC SURVEY COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020. NO UNDERGROUND OR OVERHEAD UTILITIES WERE SURVEYED.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NORTH AMERICAN DATUM OF 1983. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3. LOCATIONS OF STORMWATER CHANNELS BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
4. COMPACTED FILL TO BE PLACED TO A MINIMUM OF 95 PERCENT OF STANDARD PROCTOR MAXIMUM DRY DENSITY TO LIMIT POTENTIAL FOR EXCESSIVE SETTLEMENT.
5. UPON COMPLETION OF COMPACTED FILL CONSTRUCTION, DISTURBED AREAS SHALL BE SEEDED AND MULCHED TO PROMOTE VEGETATIVE GROWTH AND LIMIT POTENTIAL FOR FUTURE EROSION.

0 30 60

1" = 30' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT

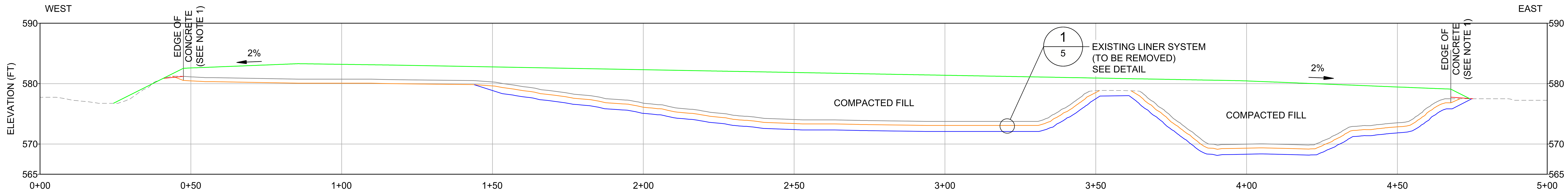
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

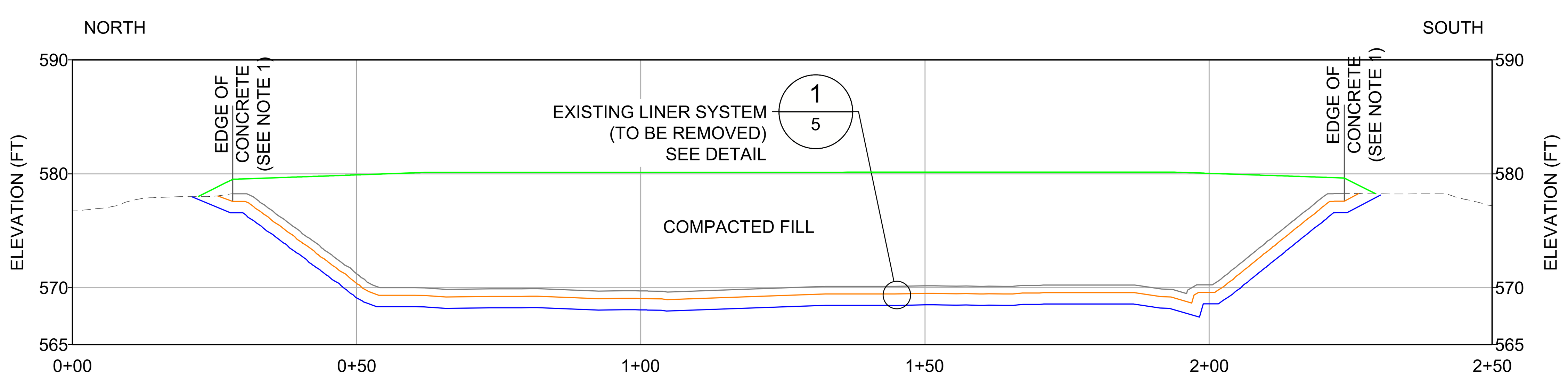
TITLE
FINAL GRADES

PROJECT NO. 21454861 | REV. A | DRAWING 4



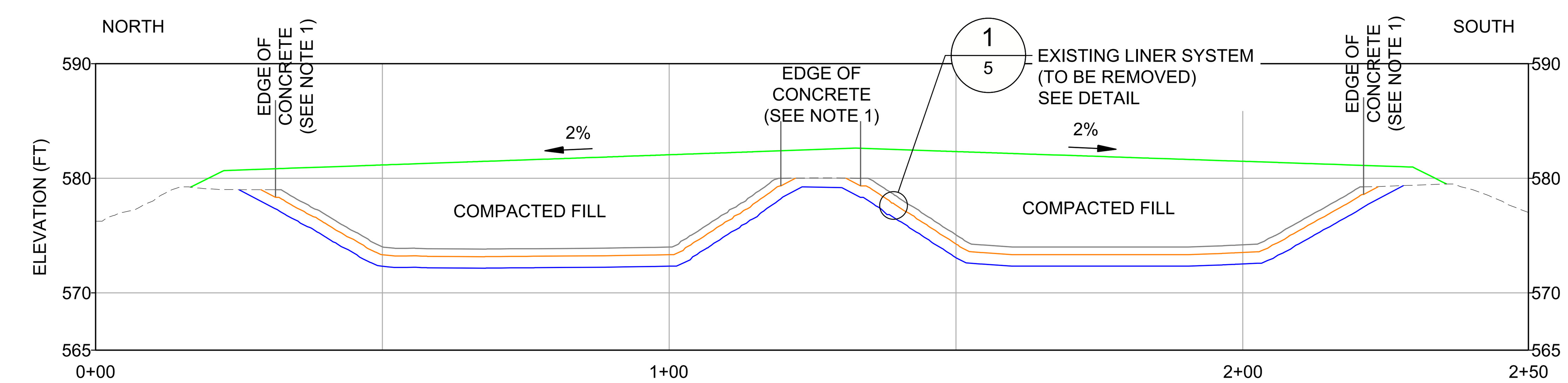
SCALE 1" = 20'
VERT. SCALE = 2X
A / 4 CROSS SECTION A

0 20 40
1" = 20' FEET



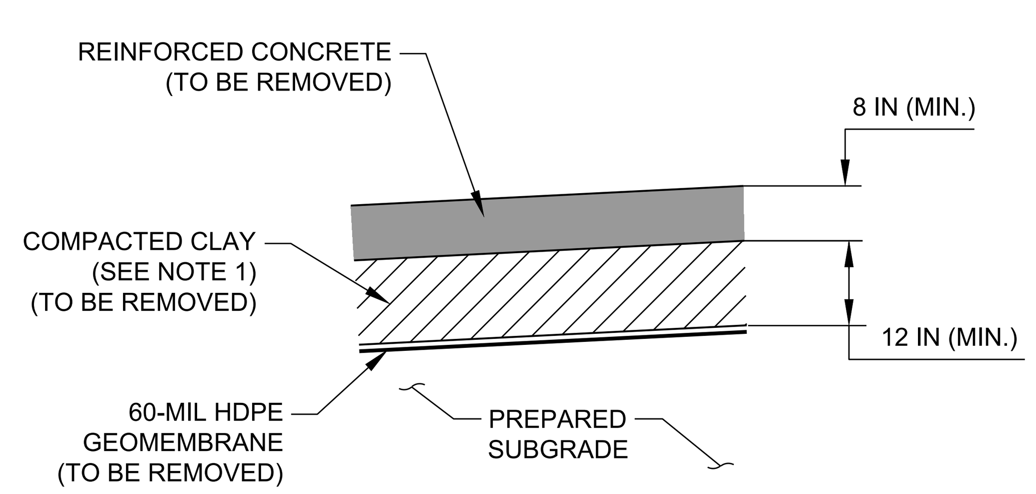
SCALE 1" = 20'
VERT. SCALE = 2X
B / 4 CROSS SECTION B

0 20 40
1" = 20' FEET



SCALE 1" = 20'
VERT. SCALE = 2X
C / 4 CROSS SECTION C

0 20 40
1" = 20' FEET



SCALE N.T.S.
1 / 5 EXISTING LINER SYSTEM

CROSS SECTION LEGEND

- PROPOSED TOP OF COMPACTED FILL
- EXISTING GROUND
- EXISTING LINER SYSTEM - TOP OF CONCRETE (SEE NOTES 1 AND 2)
- EXISTING LINER SYSTEM - TOP OF COMPACTED CLAY (SEE NOTES 1 AND 2)
- EXISTING LINER SYSTEM - GEOMEMBRANE (SEE NOTES 1 AND 2)

NOTE(S)

1. EDGE OF CONCRETE PROVIDED IN INGENAE SURVEY RECORD DRAWING DATED 2/9/2021. LIMITS OF EXISTING GEOMEMBRANE AND COMPACTED CLAY LAYER BASED ON SEPTEMBER 2007 ISSUED FOR CONSTRUCTION DRAWINGS PREPARED BY SARGENT & LUNDY, LLC.
2. CONCRETE, COMPACTED CLAY, AND GEOMEMBRANE COMPONENTS OF THE BOTTOM ASH BASIN LINER SYSTEM TO BE REMOVED AND DISPOSED IN THE EXISTING PERMITTED ON-SITE LANDFILL OR TRANSPORTED FOR OFF-SITE DISPOSAL.
3. UP TO AN ADDITIONAL 12 INCHES OF SOIL MAY BE EXCAVATED FROM BENEATH THE LINER SYSTEM AND REPLACED WITH COMPACTED FILL.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-25	ISSUED FOR PERMIT APPLICATION	AGD	BCB	JJS	JEO

SEAL

CLIENT
ILLINOIS POWER RESOURCES GENERATING, LLC
DUCK CREEK POWER PLANT

CONSULTANT
GOLDER
MEMBER OF WSP

GOLDER ASSOCIATES INC.
13515 BARRETT PARKWAY DRIVE, SUITE 260
BALLWIN, MISSOURI 63021
USA
[+1] (314) 984 8800
www.golder.com

PROJECT
BOTTOM ASH BASIN
CONSTRUCTION PERMIT APPLICATION

TITLE
SECTIONS AND DETAILS

PROJECT NO.	REV.	DRAWING
21454861	A	5

ATTACHMENT 3

Hydrologic Calculations

GOLDER
MEMBER OF WSP

CALCULATION

DATE	January 25, 2022	**Reference No.** 21454861-12-R-0
PREPARED BY:	Micah Richey	
CHECKED BY:	Brendan Purcell	
REVIEWED BY:	Jason Obermeyer	**CLIENT NAME: Illinois Power Resources Generating, LLC**

HYDROLOGY CALCULATIONS FOR CLOSURE OF THE BOTTOM ASH BASIN AT THE DUCK CREEK POWER PLANT

1.0 OBJECTIVE

Evaluate the hydrology (routing of stormwater runoff) after closure of the Duck Creek Bottom Ash Basin (BAB). These calculations were done to support the closure plan by checking the adequacy of the existing stormwater channels to route peak design flows after closure.

2.0 METHODOLOGY

The areas contributing to the BAB drainage were delineated in AutoCAD using existing topography from IngenAE's survey completed on November 4–5, 2020, and the United States Geological Survey and the closure grading plan, as shown in Figure 1. The ground conditions were used to estimate a lag time using NRCS methodology (NRCS 1986). The calculations for the hydrologic parameters are included in Tables 1 and 2. The hydrologic parameters were used to model the stormwater runoff reporting to the existing perimeter channels and culverts around the closed BAB during the 25-year, 24-hour design storm event using HEC-HMS software (USACE 2021). The channels were analyzed using Manning's equation to evaluate the steady-state hydraulics. The existing opening in the sheet pile wall was modeled as an orifice using Flowmaster software (Bentley 2020).

3.0 INPUTS AND ASSUMPTIONS

Information and assumptions regarding input parameters used in the analyses include the following:

- A curve number of 58 was used to be consistent with the closed condition of Meadow and hydrologic soil group B (NRCS 1986) based on a review of the Web Soil Survey in the vicinity of the BAB (NRCS 2021).
- The design storm (25-year, 24-hour) depth from NOAA Atlas 14 (NOAA 2006) is 5.25 inches.
- Lag time was estimated using NRCS TR-55 methodology.
- Manning's number used for channel design was 0.030 for capacity and 0.035 for depth assuming a grass-lined channel.
- The culverts are 24-inch-diameter corrugated metal pipes, as indicated in the issued-for-construction design drawings by Sargent & Lundy, LLC.
- Perimeter channel slopes of 0.005 ft/ft were assumed based on existing topography.

- The minimum depth for the perimeter channels is assumed to be 1 foot based on the topography.
- The opening in the sheet pile for the site drainage channel is approximately 18 inches x 18 inches, and surface water can temporarily pond to approximately 2.5 feet above the opening, based on site observations.

4.0 RESULTS AND CONCLUSIONS

The HEC-HMS model results provide the estimated peak flow rates from the 25-year, 24-hour design storm to discharge points of interest:

- The peak flow rate for the north perimeter channel is estimated as 8.8 cubic feet per second (cfs).
- The peak flow rate for the south perimeter channel is estimated as 1.4 cfs.
- The combined, routed peak flow at the discharge point through the sheet pile wall is 10 cfs.

The output from the HEC-HMS model is shown in Table 3.

The culverts were analyzed with the dimensions provided in the issued-for-construction design drawings by Sargent & Lundy, LLC using HY8 software (FHWA 2016). As shown in Exhibit 1, the culverts will pass the peak flow from the design storm event with no surcharging of the road crossings.

The channels were analyzed based on dimensions provided in the design drawings. The maximum normal flow depth was calculated as indicated in Table 4. The channels have adequate capacity to convey the design storm.

The perimeter channels meet at the southwest corner of the BAB and report through an opening in the sheet pile wall into the existing Discharge Canal. The orifice calculations for this opening are provided in Exhibit 2. The estimated maximum depth of water at this location to pass the peak flow rate through the orifice during the design storm event is 1.6 feet, which is contained by the surrounding topography. Thus, the capacity of the opening in the sheet pile wall is sufficient to convey the peak flows from the design storm. The calculations indicate that the existing channels, culverts, and opening have sufficient capacity to convey the design storm for the proposed grading plan.

5.0 REFERENCES

Bentley Systems, Inc. 2020. Bentley FlowMaster Connect.

NOAA (National Oceanic and Atmospheric Administration). 2006. Precipitation-Frequency Atlas of the United States, Volume 2 Version 3.0.

NRCS (Natural Resources Conservation Service). 1986. Urban Hydrology for Small Watersheds. 2nd edition Technical Release 55). June

NRCS. 2021. Web Soil Survey. [Accessed January 25, 2022.] http://websoilsurvey.sc.egov.usda.gov/.

USACE (United States Army Corps of Engineers). 2021. Hydrologic Modeling System (HEC-HMS), Version 4.8.0. Release date: April 8, 2021.

FHWA (United States Federal Highway Administration). 2016. HY8 – Culverts, Version 7.50, FHWA Culvert Analysis.

USGS (United States Geological Survey). 2021. Lidar Point Cloud - USGS National Map 3DEP Downloadable Data Collection: U.S. Geological Survey. Point clouds used: USGS_LPC_IL_District4_Fulton_2014_2346_1382_LAS_2018, USGS_LPC_IL_District4_Fulton_2014_2346_1384_LAS_2018, USGS_LPC_IL_District4_Fulton_2014_2346_1386_LAS_2018, USGS_LPC_IL_District4_Fulton_2014_2348_1382_LAS_2018, USGS_LPC_IL_District4_Fulton_2014_2348_1384_LAS_2018, and USGS_LPC_IL_District4_Fulton_2014_2348_1386_LAS_2018.

Golder Associates USA Inc.

https://golderassociates.sharepoint.com/sites/141778/project files/6 deliverables/reports/12-r-closure_plan_bottom_ash_basin/12-r-0/att 3 sw calcs/att3_duck_creek_bab_hydrology_calculations.docx

Tables

TABLE 1
SUBBASIN SUMMARY TABLE

Illinois Power Resources Generating, LLC
Bottom Ash Basin
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

Design Storm 25 -Year Recurrence Interval

Storm Duration (hours)	2-Year Depth (inches)	25 -Year Depth (inches)	Storm Distribution
24	3.01	5.25	II

Subbasin ID	Subbasin Area (ft^2)	Subbasin Area (acres)	Subbasin Area (sq mile)	CN = 58 Meadow HSG B (acres)	CN = 99 Open Water or Impervious (acres)	Composite SCS Curve No.	$S = \frac{1000}{CN} - 10$	Unit Runoff Q (in)	Runoff Volume (ac-ft)	Runoff Volume (ft^3)
CAB N	266,446	6.12	0.0096	6.12		CN = 58	7.24	1.31	0.67	29,060
CAB S	53,874	1.24	0.0019	1.24		CN = 58	7.24	1.31	0.13	5,876

GOLDER
MEMBER OF WSP

TABLE 2
BASIN TIME OF CONCENTRATION CALCULATIONS

Illinois Power Resources Generating, LLC
Bottom Ash Basin
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

					Flow Segment 1							Flow Segment 2							Flow Segment 3						
Subbasin ID	Subbasin Area (sq mile)	Composite Curve Number	Total Lag (0.6*Tc) (min)	Total Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)
CAB N	0.0096	58	10.7	17.8	Sheet	100	0.150	G	Bermuda Grass		10.1	Shallow	140	0.021	U	Unpaved		1.0	Channel	760	0.0050	G	Grass-lined	0.50	6.7
CAB S	0.0019	58	15.9	26.4	Sheet	100	0.020	G	Bermuda Grass		22.6	Shallow	40	0.075	U	Unpaved		0.2	Channel	250	0.0050	G	Grass-lined	0.23	3.7

TABLE 3
FLOW RESULTS FROM HEC-HMS

Illinois Power Resources Generating, LLC
Bottom Ash Basin
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	JEO

HEC-HMS Basin Model:	BAB
HEC-HMS Met. Model:	25-yr, 24-hr
HEC-HMS Control Specs:	48-hr, 1-min

Hydrologic Element	Drainage Area (sq mile)	Peak Discharge (cfs)	Time of Peak	Total Volume (ac-ft)
CAB N	0.010	8.8	02Jun2525, 01:05	1.31
CAB S	0.002	1.4	02Jun2525, 01:10	1.31
J-S	0.012	10	02Jun2525, 01:06	1.31
Sink-S	0.012	10	02Jun2525, 01:06	1.31

TABLE 4
CHANNEL HYDRAULIC CALCULATIONS

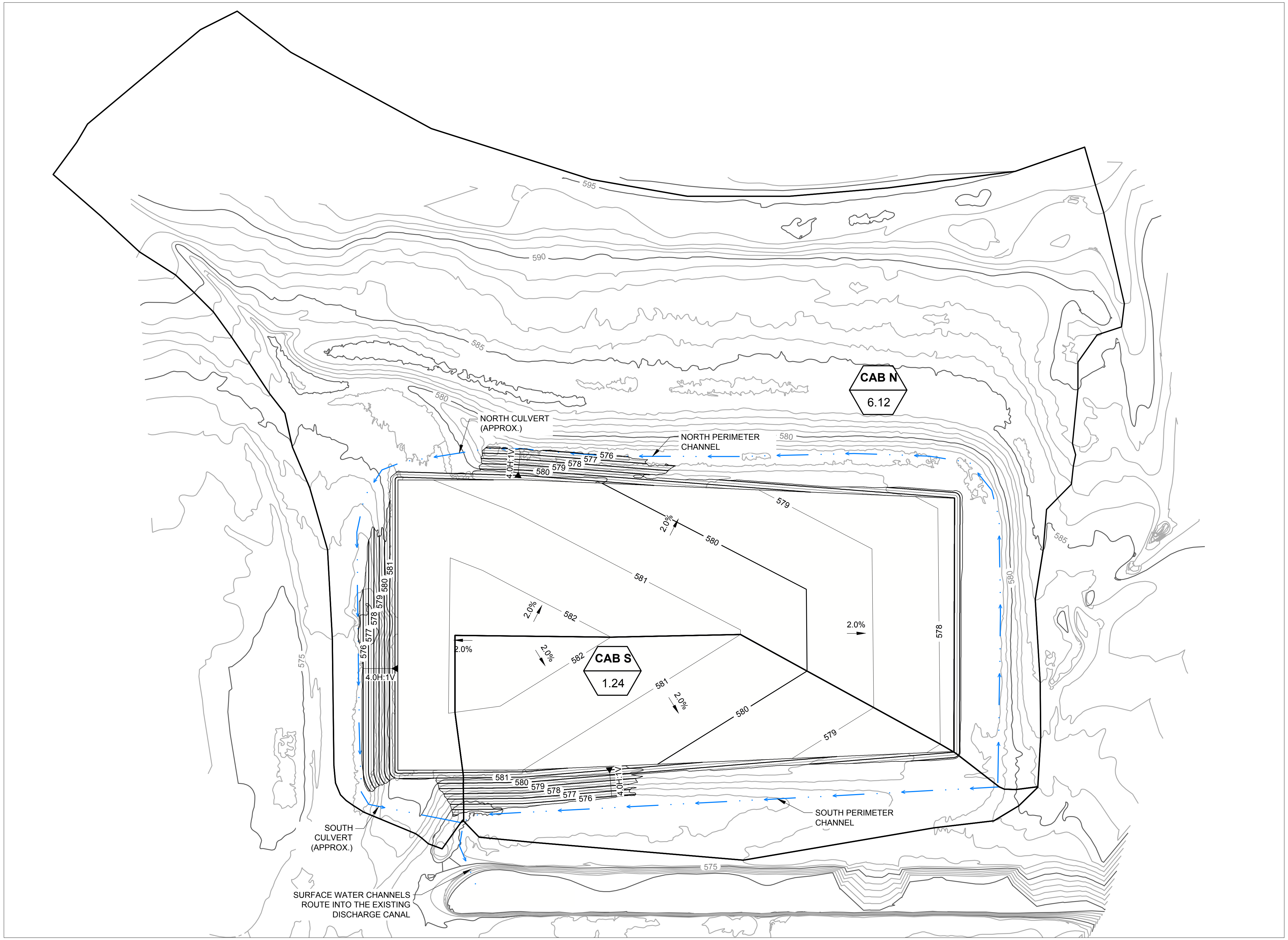
Illinois Power Resources Generating, LLC
Bottom Ash Basin
Project Number: 21454861

Date:	1/25/22
By:	MBR
Chkd:	BJP
Apprvd:	BJP

			Channel Design Geometry						Channel Roughness Parameters				Hydraulic Calculations							Channel Evaluations	
Reach Designation	Q25 from HEC-HMS (cfs)	HEC HMS Element ID for Q	Approximate Channel Length (ft)	Bed Slope (ft/ft)	Left Side Slope (H:1V)	Right Side Slope (H:1V)	Bottom Width (ft)	Minimum Channel Depth (ft)	Design Channel Lining		Mannings 'n' for Capacity (Depth Calculation)	Mannings 'n' for Stability (Velocity Calculation)	Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)	Froude Number	Normal Depth Shear Stress (lb/ft^2)	Stream Power (W/m^2)	Top Width of Flow (ft)	Top Width of Channel (ft)	Available Freeboard (ft)	
CAB N	8.8	CAB N	760	0.0050	4.0	10.0	3	1.25	G	Grass-lined	0.035	0.030	1.9	0.68	0.53	0.21	5.77	12.5	20.5	0.6	Suitable
CAB S	1.4	CAB S	250	0.0050	10.0	4.0	3	1.25	G	Grass-lined	0.035	0.030	1.1	0.28	0.47	0.09	1.43	6.9	20.5	1.0	Suitable

GOLDER
MEMBER OF WSP

Figures



LEGEND

580 PROPOSED TOP OF COMPACTED FILL CONTOURS

580 EXISTING GROUND CONTOURS (SEE NOTE 1)

BASIN DELINEATION

EXISTING STORMWATER ROUTING (SEE NOTE 3)

BASIN
ACRES

NOTE(S)

1. EXISTING CONTOURS SHOWN ARE FROM AERIAL SURVEY COMPLETED BY DRAGONFLY AEROSOLUTIONS DATED 11/17/2020 AND TOPOGRAPHIC/BATHYMETRIC SURVEYS COMPLETED BY INGENAE DATED 11/4/2020 & 11/5/2020.
2. COORDINATE SYSTEM USED IS ILLINOIS STATE PLANE ZONE-WEST NAD 1983. ELEVATIONS ARE IN NAVD 88.
3. STORMWATER WILL SHEET FLOW INTO THE EXISTING STORM WATER CHANNEL SYSTEM AND BE CONVEYED TO THE EXISTING DISCHARGE CANAL SOUTH OF THE FACILITY. LOCATIONS OF STORMWATER CHANNELS AND CULVERTS ARE APPROXIMATE.

N

0 40 80
SCALE FEET

GOLDER
MEMBER OF WSP

BOTTOM ASH BASIN
SURFACE WATER DRAINAGE BASINS

FIGURE 1

Exhibits

HY-8 Culvert Analysis Report

Project Notes

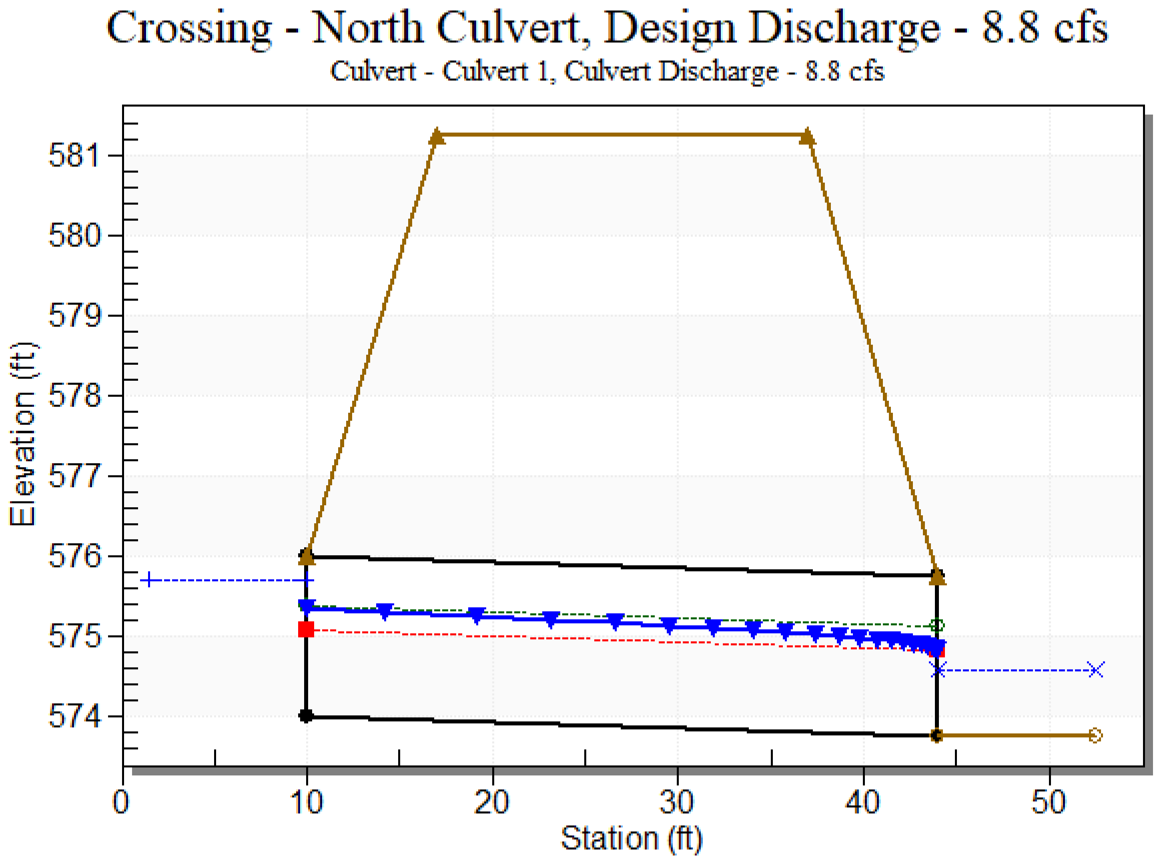
Project Title:

Designer:

Project Date:Sunday, October 17, 2021

Notes:

Water Surface Profile Plot for Culvert: Culvert 1



Worksheet for Rectangular Orifice

Project Description	
Solve For	Headwater Elevation

Input Data	
Discharge	10.00 cfs
Centroid Elevation	0.75 ft
Tailwater Elevation	0.00 ft
Discharge Coefficient	0.620
Opening Width	1.50 ft
Opening Height	1.5 ft

Results	
Headwater Elevation	1.55 ft
Headwater Height Above Centroid	0.80 ft
Tailwater Height Above Centroid	-0.75 ft
Flow Area	2.3 ft^2
Velocity	4.44 ft/s

GOLDER

MEMBER OF WSP

golder.com

APPENDIX G

Groundwater Monitoring Plan

Intended for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

GROUNDWATER MONITORING PLAN

BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

Bright ideas. Sustainable change.

GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT BOTTOM ASH BASIN

Project Name	**Duck Creek Power Plant Bottom Ash Basin**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Groundwater Monitoring Plan**
Revision	**FINAL**
Date	**October 25, 2021**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Brian G. Hennings, PG
Senior Managing Hydrogeologist

Eric J. Tlachac, PE
Senior Managing Engineer

Nathaniel R. Keller
Senior Hydrogeologist

Chase J. Christenson, PG
Hydrogeologist

LICENSED PROFESSIONAL CERTIFICATIONS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Duck Creek Power Plant Bottom Ash Basin), has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).

Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

LICENSED PROFESSIONAL ENGINEER
ERIC J. TLACHAC
062-063091
STATE OF ILLINOIS

35 I.A.C. § 845.630 Groundwater Monitoring Systems (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the groundwater monitoring system described in this document (Groundwater Monitoring Plan, Duck Creek Power Plant Bottom Ash Basin), has been designed and constructed to meet the requirements of 35 I.A.C. § 845.630. The monitoring system was developed based on information included in the Hydrogeologic Site Characterization Report (Ramboll 2021; included in the Operating Permit to which this Groundwater Monitoring Plan is attached).

Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

LICENSED PROFESSIONAL GEOLOGIST
BRIAN G. HENNINGS
196.001482
ILLINOIS

CONTENTS

Licensed Professional Certifications		**2**
1.	**Introduction**	**6**
1.1	Overview	6
1.2	Site Location and Background	6
1.3	Conceptual Model	7
2.	**Groundwater Monitoring Systems**	**9**
2.1	Existing Monitoring Well Network and Analysis	9
2.1.1	40 C.F.R. § 257 Monitoring Program	9
2.1.2	Part 845 Well Installation and Monitoring	9
2.2	Proposed Part 845 Monitoring Well Network	10
2.3	Well Abandonment	11
3.	**Applicable Groundwater Quality Standards**	**12**
3.1	Groundwater Classification	12
3.2	Statistical Evaluation of Background Groundwater Data	12
3.3	Applicable Groundwater Protection Standards	12
4.	**Groundwater Monitoring Plan**	**14**
4.1	Monitoring Networks and Parameters	14
4.1.1	40 C.F.R. § 257 Groundwater Monitoring	14
4.1.2	Part 845 Groundwater Monitoring	14
4.2	Sampling Schedule	15
4.3	Groundwater Sample Collection	15
4.4	Laboratory Analysis	15
4.5	Quality Assurance Program	16
4.6	Groundwater Monitoring System Maintenance Plan	16
4.7	Statistical Analysis	17
4.8	Data Reporting	17
4.9	Compliance with Applicable On-site Groundwater Protection Standards	17
4.10	Alternate Source Demonstrations	18
4.11	Assessment of Corrective Measures and Corrective Action	18
5.	**References**	**19**

TABLES (IN TEXT)

Table A	40 C.F.R. § 257 Groundwater Monitoring Program Parameters
Table B	Part 845 Groundwater Monitoring Program Parameters
Table C	Proposed Part 845 Monitoring Well Network
Table D	Part 845 Groundwater Monitoring Program Parameters
Table E	Part 845 Sampling Schedule

TABLES (ATTACHED)

Table 1-1	Part 845 Requirements Checklist
Table 2-1	Monitoring Well Locations and Construction Details
Table 3-1	Background Groundwater Quality and Standards
Table 4-1	Sampling and Analysis Summary
Table 4-2	Detection and Reporting Limits for Part 845 Parameters

FIGURES (ATTACHED)

Figure 1-1	Site Location Map
Figure 1-2	Site Map
Figure 1-3	Uppermost Aquifer Groundwater Elevation Contours, April 28, 2021
Figure 2-1	Proposed Part 845 Groundwater Monitoring Well Network

APPENDICES

Appendix A	Statistical Analysis Plan

ACRONYMS AND ABBREVIATIONS

35 I.A.C.	Title 35 of the Illinois Administrative Code
40 C.F.R.	Title 40 of the Code of Federal Regulations
ASD	Alternate Source Demonstration
BAB	Bottom Ash Basin
bgs	below ground surface
CCR	coal combustion residuals
cm/s	centimeters per second
CSM	conceptual site model
DCPP	Duck Creek Power Plant
GMF	Gypsum Management Facility
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standard
HCR	Hydrogeologic Site Characterization Report
HDPE	high-density polyethylene
ID	identification
IEPA	Illinois Environmental Protection Agency
IPRG	Illinois Power Resources Generating, LLC
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NRT/OBG	Natural Resource Technology, an OBG Company
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
PMP	potential migration pathway
QA/QC	quality assurance/quality control
Ramboll	Ramboll Americas Engineering Solutions, Inc.
RL	reporting limit
SI	surface impoundment
TDS	total dissolved solids
UA	uppermost aquifer
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

1.1 Overview

In accordance with requirements of the Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (SIs): Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15, 2021), Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Monitoring Plan (GMP) on behalf of Duck Creek Power Plant (DCPP), operated by Illinois Power Resources Generating, LLC (IPRG). This report will apply specifically to the CCR Unit referred to as the Bottom Ash Basin (BAB) (Vistra identification [ID] number [No.] 205, IEPA ID No. W0578010001-03, and National Inventory of Dams [NID] No. IL50716). This GMP includes Part 845 content requirements specific to 35 I.A.C. § 845.630 (Groundwater Monitoring System), 35 I.A.C. § 845.640 (Groundwater Sampling and Analysis), and 35 I.A.C. § 845.650 (Groundwater Monitoring Program) for the BAB at the DCPP.

A checklist which identifies the specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650 is included in **Table 1-1**. The table provides references to sections, tables, and figures included in this document to locate the information that meets specific requirements of 35 I.A.C. § 845.630, 35 I.A.C. § 845.640, and 35 I.A.C. § 845.650.

1.2 Site Location and Background

The DCPP is located in Fulton County, Illinois, approximately six miles southeast of the town of Canton, Illinois. The BAB is located north of the DCPP within Section 30, Township 6 North, Range 5 East (**Figure 1-1**). Prior to construction of the DCPP and associated facilities, strip mining of coal took place within the current property boundary. Land use adjacent to the DCPP is primarily agriculture, pasture, and forested land with minimal development.

The Duck Creek BAB is an inactive 2.2-acre lined CCR SI formerly used to manage CCR and non-CCR waste streams at DCPP (**Figure 1-2**). The BAB consists of three cells; the bottom and side slopes of all three cells are concrete lined. Gravel surfaced roads surround the basin cells. A sluice pipe delivered CCR material to the pond. An outlet structure for water is located in the southeast corner of the south cell. The western two cells are designed with a gently sloping ramp so that front-end loaders can remove bottom ash. The east cell flows toward a discharge structure that drains accumulated water. All bottom ash (*i.e.,* CCR) was removed from the BAB when the plant was retired in 2019; the basin currently contains no impounded water or CCR materials. During operation, CCR (bottom ash) was sluiced to the western cells of the pond. Particles settled within the cell and decant water was piped to the eastern cell. The western cells required frequent clean out events using heavy equipment (likely a front-end loader) to remove bottom ash from the cell for permanent disposal at the on-site landfill.

Construction of the BAB took place sometime in late 2007 or early 2008. In 2016, a History of Construction was provided by AECOM for the DCPP, but the BAB was small enough in volume (less than 20-acre feet) to be exempt from this history by Title 40 of the Code of Federal Regulations (40 C.F.R.) § 257.73(b) A liner design criteria evaluation was performed by AECOM in 2016 and states that the BAB was constructed with a lower and upper liner; the lower consists of a one foot thick layer of compacted clay overlain by a 60-millimeter high-density polyethylene (HDPE) membrane, and the upper consists of eight inches of reinforced concrete (AECOM, 2016).

Permeability and hydraulic conductivity could not be determined from the records available; therefore, the BAB does not meet the 40 C.F.R. § 257.71(a)(1) criteria for a lined impoundment. The BAB is estimated to enable storage of approximately 25,000 cubic yards of CCR material (IPRG, 2016).

Several other CCR units are located on the DCPP property, including the closed units, Duck Creek Ash Pond No. 1 and Ash Pond No. 2 located north of the BAB; the Gypsum Management Facility (GMF) Pond and GMF Recycle Pond located north of the closed ponds; and the Landfill located north of the GMF Pond.

1.3 Conceptual Model

Significant site investigation has been completed at the DCPP to characterize the geology, hydrogeology, and groundwater quality. Based on extensive investigation and monitoring, the BAB has been well characterized and detailed in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021]; included in the Operating Permit to which this Plan is attached). A conceptual site model (CSM) has been developed and is discussed below.

The three distinct hydrostratigraphic units summarized below have been identified at the BAB based on stratigraphic relationships and common hydrogeologic characteristics:

- **Fill Unit**: This unit includes shallow groundwater present in fill material and coal mine spoils.
- **Uppermost Aquifer:** The uppermost aquifer in the area of the BAB includes the Peoria/Roxanna Loess and the sand and silt zones within the Radnor Till. Within the till sequences at the BAB, a continuous intercalated sand exists below the basin between approximately 18 to 40 feet below ground surface (bgs). The sand zone is typically very dense, very fine- to coarse-grained, with few silt and trace small gravel. This sand unit is the primary horizontal migration pathway and generally ranges in thickness from about 2 to 7 feet. The base of the uppermost aquifer is the bedrock. The Peoria/Roxanna Loess within the uppermost aquifer has also been identified as a potential migration pathway (PMP). While the primary horizontal migration pathway consists of the sand zones of the uppermost aquifer, impacts have the potential to migrate within groundwater in the overlying Peoria/Roxanna Loess.
- **Bedrock Confining Unit**: This unit includes the Pennsylvanian shaley siltstone and silty shale bedrock. The shale bedrock unit underlying the Springfield Coal Member has been demonstrated by packer testing to be an aquitard.

Groundwater migrates downward through the loess and upper Radnor Till into the shallow sands of the uppermost aquifer. Groundwater flow across the BAB within the uppermost aquifer is consistently southward toward a channel located approximately 50 feet to the south that leads to the Cooling Pond. Groundwater elevations of the uppermost aquifer across the BAB typically range from approximately 570 to 580 feet North American Vertical Datum of 1988 (NAVD88). Groundwater elevations may fluctuate seasonally, but the groundwater flow direction remains consistent in a south-southeast direction toward the Cooling Pond.

The BAB is lined, has been drained, and bottom ash is no longer present in the settling basins. There is a minimal amount of water in the BAB, predominately due to precipitation. Groundwater elevation contours of surrounding monitoring wells indicate groundwater generally flows to the south, with no indication of radial flow (**Figure 1-3**). The minimal amount of water present in the

BAB, in addition to no observations of radial flow, provide evidence that the BAB does not impact groundwater flow directions.

Part 845 parameters were monitored in the uppermost aquifer and PMP monitoring wells at the BAB as part of the 40 C.F.R. § 257 monitoring program beginning in 2015. These data were supplemented with sampling of additional locations in 2021. The results indicate that the following parameters were detected at concentrations greater than the applicable 35 I.A.C. § 845.600 groundwater protection standards (GWPSs) and are considered potential exceedances:

- Total arsenic, beryllium, boron, cobalt, lead, and pH were detected at least once at concentrations greater than the GWPS in downgradient uppermost aquifer wells (including PMP wells). All of these parameters, with the exception of pH were also detected in one or both background wells at least once at concentrations greater than the GWPS. Total chloride, lithium, radium 226 and 228 combined, sulfate, and total dissolved solids (TDS) were also detected at least once at concentrations greater than the GWPS in one or both background wells.

Concentration results for the above parameters were compared directly to 35 I.A.C. § 845.600 GWPS, without an evaluation of background concentrations. Evaluation of background groundwater quality has been completed as part of this GMP, and compliance with Part 845 will be determined following the first round of groundwater sampling. The first round of groundwater sampling for compliance will be completed the quarter following issuance of the Operating Permit and in accordance with this GMP.

2. GROUNDWATER MONITORING SYSTEMS

2.1 Existing Monitoring Well Network and Analysis

This GMP is being provided to propose a groundwater monitoring network and monitoring program specific to the BAB that will comply with Part 845. Monitoring networks and programs that apply to other units are not discussed in this GMP. Those programs will continue to be performed as specified in IEPA approvals. Any future modifications will be proposed and submitted to IEPA for approval in a separate document. The remaining discussion in this document will include only these networks and monitoring programs that are applicable and specific to the BAB, specifically the 40 C.F.R. § 257 monitoring program and the proposed Part 845 monitoring network.

2.1.1 40 C.F.R. § 257 Monitoring Program

The 40 C.F.R. § 257 well network for the BAB consists of six monitoring wells installed nearby or adjacent to the BAB in the uppermost aquifer. The BAB 40 C.F.R. § 257 well network consists of two background monitoring wells (BA05 and BA06) and four compliance monitoring wells (BA01, BA02, BA03, and BA04). The boring logs, well construction forms, and other related monitoring well forms are available in the Operating Records as required by 40 C.F.R. § 257.91 for each monitored CCR Unit or CCR Multi-Unit, and are included in Appendix B of the HCR (included in the Operating Permit to which this Plan is attached).

Groundwater is being monitored at the BAB in accordance with the Detection Monitoring Program requirements specified in 40 C.F.R. § 257.94. Details on the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the Sampling and Analysis Plan for the BAB (Natural Resource Technology, an OBG Company [NRT/OBG], 2017).

Groundwater samples are collected semiannually and analyzed for the laboratory and field parameters from Appendix III of 40 C.F.R. § 257, summarized in **Table A** below.

Table A. 40 C.F.R. § 257 Groundwater Monitoring Program Parameters

Field Parameters[1]		
Groundwater Elevation	pH	
Appendix III Parameters (Total, except TDS)		
Boron	Chloride	Sulfate
Calcium	Fluoride	TDS
Beryllium	Lead	

[1]Dissolved oxygen, temperature, specific conductance, oxidation/reduction potential, and turbidity are recorded during sample collection.

Results and analysis of groundwater sampling are reported annually by January 31 of the following year and made available on the CCR public website as required by 40 C.F.R. § 257.

2.1.2 Part 845 Well Installation and Monitoring

In 2021, four additional monitoring wells (BA01L, BA01C, BA02L, and BA03L) were installed at the BAB to assess the vertical and horizontal lithology, stratigraphy, chemical properties, and physical properties of geologic layers to a minimum of 100 feet bgs as specified in 35 I.A.C. § 845.620(b).

Prospective Part 845 monitoring wells were sampled for eight rounds between April and August 2021 and the results were assessed for selection of the BAB Part 845 monitoring well network. Groundwater samples were collected and analyzed for 35 I.A.C. § 845.600 parameters as summarized in **Table B** below.

Table B. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total, except TDS)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential were recorded during sample collection.

Data and results from the Part 845 background monitoring were included in the water quality discussion included in the HCR (included in the Operating Permit to which this Plan is attached). The data collected from background locations during the Part 845 monitoring were used to evaluate and calculate background concentrations for the BAB. The evaluation and discussion are included in **Section 3.2** of this report.

Data collected from the 40 C.F.R. § 257 monitoring network from 2015 to 2021, and from the Part 845 background monitoring, were used for selection of the Part 845 monitoring well network proposed in **Section 2.2**.

2.2 Proposed Part 845 Monitoring Well Network

The groundwater monitoring network proposed in this plan will include six wells screened in the uppermost aquifer (BA01, BA02, BA03, BA04, BA05, and BA06) and two wells screened in the PMP (BA02L and BA03L). The proposed network is summarized in **Table C** below and displayed on **Figure 2-1**. Eight wells (two background and six compliance) will be used to monitor groundwater concentrations within the hydrostratigraphic units.

The groundwater samples collected from the eight wells will be used to monitor and evaluate groundwater quality and demonstrate compliance with the groundwater quality standards listed in 35 I.A.C. § 845.600(a). The proposed monitoring wells will yield groundwater samples that represent the quality of downgradient groundwater at the CCR boundary (as required in 35 I.A.C. § 845.630(a)(2)). Monitoring well depths and construction details are listed in **Table 2-1** and summarized in **Table C** below.

Table C. Proposed Part 845 Monitoring Well Network

Well ID	Monitored Unit	Well Screen Interval (feet bgs)	Well Type[1]
BA01	UA	33.1 – 37.7	Compliance
BA02	UA	23.6 – 28.4	Compliance
BA02L	PMP	7.0 – 11.7	Compliance
BA03	UA	16.1 – 25.6	Compliance
BA03L	PMP	5.3 – 9.9	Compliance
BA04	UA	24.6 – 29.4	Compliance
BA05	UA	36.5 – 46.1	Background
BA06	UA	32.3 – 41.9	Background

[1]Well type refers to the role of the well in the monitoring network.
UA = uppermost aquifer
PMP = potential migration pathway

2.3 Well Abandonment

No wells are currently proposed for abandonment.

3. APPLICABLE GROUNDWATER QUALITY STANDARDS

3.1 Groundwater Classification

Groundwater at the BAB meets the definition of Class I – Potable Resource Groundwater (35 I.A.C. § 620.210), based on the following criteria:

- Groundwater in the uppermost aquifer extends ten feet or more below the land surface.
- Field hydraulic conductivity tests performed in the unlithified geologic materials that include loess, shallow sand, and intermediate sand at the BAB resulted in an overall (geometric mean) horizontal hydraulic conductivity exceeding the 1 x 10^{-4} centimeters per second (cm/s) criterion.

However, background (upgradient) groundwater originates from areas north and west of the BAB that have been surface mined and present a significant alternative source for groundwater impacts.

3.2 Statistical Evaluation of Background Groundwater Data

A Statistical Analysis Plan (**Appendix A**) has been developed to describe procedures that will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring.

In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality was either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). A comparison of the statistical background concentrations and groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) and the resulting GWPSs are summarized in **Table 3-1**.

3.3 Applicable Groundwater Protection Standards

The applicable GWPSs will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The results of the statistical analysis of background groundwater data (**Table 3-1**) indicate that many background concentrations in the uppermost aquifer are below the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1). Therefore, for these parameters, the groundwater quality standards listed in 35 I.A.C. § 845.600(a)(1) will be applied to the results from the proposed groundwater monitoring network. The exceptions include arsenic, boron, chloride, cobalt, lead, lithium, mercury, pH (lower limit), radium 226 and 228 combined, sulfate, and TDS, where the background concentration is greater (or less for pH lower limit) than the 35 I.A.C. § 845.600(a)(1) standard. In these instances, the GWPS will be the background concentration.

Under most circumstances, the GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Exceptions are when there are high percentages (greater than 50 percent) of non-detects in compliance well data, for which a future mean (for 50 to 70 percent non-detects) or median (for greater than 70 percent non-detects) will be compared to the GWPS. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Evaluation of the applicable standards will occur in conjunction with the analysis of groundwater quality results. Background calculations and the resulting concentrations may be updated as appropriate, in accordance with the Statistical Analysis Plan included in **Appendix A**.

4. GROUNDWATER MONITORING PLAN

The groundwater monitoring plan will monitor and evaluate groundwater quality to demonstrate compliance with the groundwater quality standards included in 40 C.F.R. § 257.94(e), 40 C.F.R. § 257.95(h), and 35 I.A.C. § 845.600(a). The groundwater monitoring program will include sampling and analysis procedures that are consistent and that provide an accurate representation of groundwater quality at the background and compliance wells as required by 35 I.A.C. § 845.630. As discussed in **Section 2**, two monitoring programs specific to the BAB exist: the 40 C.F.R. § 257 monitoring program and the proposed Part 845 monitoring program. These programs will continue to be monitored until USEPA approves Part 845. It is expected that upon USEPA approval of Part 845, the 40 C.F.R. § 257 monitoring program and reporting will be eliminated, and the proposed Part 845 monitoring and reporting included in this Plan will continue until the requirements of Part 845 have been achieved.

4.1 Monitoring Networks and Parameters

4.1.1 40 C.F.R. § 257 Groundwater Monitoring

The existing 40 C.F.R. § 257 monitoring program was discussed in detail in **Section 2.1.1**. Six wells (two background and four compliance) are sampled for Appendix III parameters on a semi-annual frequency. No changes are proposed to this monitoring network. Well locations and parameters will continue to be monitored and reported as required by 40 C.F.R. § 257 until USEPA approves Part 845.

4.1.2 Part 845 Groundwater Monitoring

The proposed Part 845 monitoring network will consist of two background monitoring wells (BA05 and BA06) and six compliance monitoring wells (BA01, BA02, BA02L, BA03, BA03L, and BA04) to monitor potential impacts from the BAB (**Figure 2-1**). The monitoring wells are screened within the uppermost aquifer (BA01, BA02, BA03, BA04, BA05, and BA06) and PMP (BA02L and BA03L) along the perimeter of the BAB. Groundwater samples will be collected and analyzed for the laboratory and field parameters in **Table D** below.

Table D. Part 845 Groundwater Monitoring Program Parameters

Field Parameters[1]			
Groundwater Elevation	pH	Turbidity	
Metals (Total)			
Antimony	Boron	Cobalt	Molybdenum
Arsenic	Cadmium	Lead	Selenium
Barium	Calcium	Lithium	Thallium
Beryllium	Chromium	Mercury	
Inorganics (Total, except TDS)			
Fluoride	Sulfate	Chloride	TDS
Other (Total)			
Radium 226 and 228 combined			

[1] Dissolved oxygen, temperature, specific conductance, and oxidation/reduction potential will be recorded during sample collection.

All parameters listed above were sampled a minimum of eight times by October 18, 2021 to establish background groundwater quality in accordance with 35 I.A.C. § 845.650 (b)(1)(A). Discussion of background groundwater quality is included in **Section 3.2**.

4.2 Sampling Schedule

Groundwater sampling for the Part 845 monitoring well network will initially be performed quarterly according to the following schedule:

Table E. Part 845 Sampling Schedule

Frequency	Duration
Monthly (groundwater elevations only)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).
Quarterly (groundwater quality)	Begins: the quarter following approval of this plan and issuance of the Operating Permit.
	Ends: Following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii), or upon IEPA approval of an alternate schedule as allowed by 35 I.A.C. § 845.650(b)(4).
Semi-annual (groundwater quality)	Begins: Following 5 years of quarterly groundwater monitoring and IEPA approval of a demonstration that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and not exhibiting statistically-significant increasing trends, monitoring effectiveness is not compromised by a semi-annual schedule, and sufficient data has been collected to characterize groundwater.
	Ends: Following detection of a statistically-significant increasing trend in groundwater concentrations or an exceedance of the standards in 35 I.A.C. § 845.600 (quarterly monitoring shall be resumed in these circumstances), or following the 30-year post closure care period and following IEPA approval of documentation that groundwater concentrations are below standards in 35 I.A.C. § 845.600 and concentrations exceeding background are not increasing and meet requirements in 35 I.A.C. § 845.780 (c)(2)(B)(i) and (ii).

4.3 Groundwater Sample Collection

Groundwater sampling procedures have been developed and the collection of groundwater samples is being implemented to meet the requirements of 35 I.A.C. § 845.640. In addition to groundwater well samples, quality assurance samples will be collected as described in **Section 4.5** (**Table 4-1**).

4.4 Laboratory Analysis

Laboratory analysis will be performed consistent with the requirements of 35 I.A.C. § 845.640(j) by a state-certified laboratory using methods approved by IEPA and USEPA. Laboratory methods may be modified based on laboratory equipment availability or procedures, but the Reporting Limit (RL) for all parameters analyzed, regardless of method, will be lower than the applicable groundwater quality standard. RLs for the applicable parameters are summarized in **Table 4-2**. Concentrations lower than the RL will be reported as less than the RL.

4.5 Quality Assurance Program

Consistent with the requirements of 35 I.A.C. § 845.640(a)(5), the sampling and analysis program includes procedures and techniques for quality assurance/quality control (QA/QC). Additional quality assurance samples to be collected will include the following:

- Field duplicates will be collected at a frequency of one per group of ten or fewer investigative water samples.
- One equipment blank sample will be collected and analyzed for each day of sampling. If dedicated sampling equipment is used, then equipment blank samples will not be collected.
- The duplicate and equipment blank quality assurance samples will be supplemented by the laboratory QA/QC program, which typically includes:
  - Regular generation of instrument calibration curves to assure instrument reliability
  - Laboratory control samples and/or quality control check standards that have been spiked, and analyses to monitor the performance of the analytical method
  - Matrix spike/matrix spike duplicate analyses to determine percent recoveries and relative percent differences for each of the parameters detected
  - Analysis of replicate samples to check the precision of the instrumentation and/or methodology employed for all analytical methods
  - Analysis of method blanks to assure that the system is free of contamination

Water quality meters used to measure pH and turbidity will be calibrated according to manufacturer’s specifications. At a minimum, it is recommended that calibration of pH occur daily prior to sampling and checked for accuracy at the end of each day. Unusual or suspect pH measurements during sampling events will be flagged, evaluated, and additional calibration may be performed throughout the sampling events. Turbidity meters will be checked daily, prior to and following sampling. Unusual measurements or erratic meter performance will be flagged and evaluated for overall effects on the data prior to reporting.

4.6 Groundwater Monitoring System Maintenance Plan

Consistent with the requirements of 35 I.A.C. § 845.630(e)(2), maintenance will be performed as needed to assure that the monitoring wells provide representative groundwater samples. Monitoring wells will be inspected during each groundwater sampling event; inspections will consist of the following:

- Visual inspection, clearing of vegetation, replacement of markers, and painting of protective casings as needed to assure that monitoring wells are clearly marked and accessible
- Visual inspection and repair or replacement of well aprons as needed to assure that they are intact, drain water away from the well, and have not heaved
- Visual inspection and repair or replacement of protective casings as needed to assure that they are undamaged, and that locks are present and functional
- Checks to assure that well caps are intact and vented, unless in flood-prone areas in which case caps will not be vented

- Annual measurement of monitoring well depths to determine the degree of siltation within the wells. Wells will be redeveloped as needed to remove siltation from the screened interval if it impedes flow of water into the well
- Checks to assure that wells are clear of internal obstructions, and flow freely

If maintenance of a monitoring well cannot address an identified deficiency, a replacement well will be installed.

4.7 Statistical Analysis

Statistical analysis will be consistent with procedures listed in 35 I.A.C. § 845.640(f). A Statistical Analysis Plan, provided in **Appendix A**, has been developed to summarize the statistical procedures that will be used to evaluate the groundwater results.

4.8 Data Reporting

Data reporting for the 40 C.F.R. § 257 monitoring program will be consistent with recordkeeping, notification, and internet posting requirements described in 40 C.F.R. § 257.105 through 257.107.

Groundwater monitoring and analysis completed in accordance with the Part 845 monitoring under an approved monitoring program will be reported to IEPA within 60 days after completion of sampling and the data placed in the facility's operating record as required by 35 I.A.C. § 845.610(b)(3)(D). Within 14 days of posting to the operating record, information will be posted to the publicly accessible internet site "Illinois CCR Rule Compliance Data and Information" as required by 35 I.A.C. § 845.810(d). Information will also be submitted to IEPA annually by January 31 as required by 35 I.A.C. § 845.550, for data collected the preceding year. The report will include the status of the groundwater monitoring and any required corrective action plan for the BAB in addition to other requirements detailed in 35 I.A.C. § 845.610(e).

4.9 Compliance with Applicable On-site Groundwater Protection Standards

In accordance with 35 I.A.C. § 845.600(a)(1), the groundwater protection standard at the waste boundary will be the higher of either the 35 I.A.C. § 845.600 standard or the concentration determined by background groundwater monitoring.

As provided in 35 I.A.C. § 845.780(c)(2), at the end of the 30-year post-closure care period, groundwater monitoring will continue to be conducted in post-closure care until the groundwater results show the concentrations are:

- Below the GWPS in 35 I.A.C. § 845.600; and
- Not increasing for those constituents over background, using the statistical procedures and performance standards in 35 I.A.C. § 845.640(f) and (g), provided that:
  - Concentrations have been reduced to the maximum extent feasible; and
  - Concentrations are protective of human health and the environment.

Following detection of an exceedance of the GWPS, an Alternate Source Demonstration (ASD) will be evaluated as described in **Section 4.10**.

4.10 Alternate Source Demonstrations

As allowed in 35 I.A.C. § 845.650(e), following detection of an exceedance of the GWPS, an ASD will be evaluated and, if completed, submitted to IEPA within 60 days. The ASD will provide lines of evidence that a source other than the BAB caused the contamination and the BAB did not contribute to the contamination, or that the exceedance of the GWPS resulted from error in sampling, analysis, statistical evaluation, natural variation in groundwater quality, or a change in the potentiometric surface and groundwater flow direction.

The ASD will include information and analysis that supports the conclusions and a certification of accuracy by a qualified professional engineer. Once the ASD is approved by IEPA, the Part 845 groundwater monitoring will continue as defined in **Section 4.1.2**.

If an ASD is not completed and submitted, or IEPA does not approve the ASD, a notification of the exceedance will be provided to IEPA and placed in the operating record. Additional actions will also be completed as required by 35 I.A.C § 845.650(d)(1) through (3), including initiation of an assessment of corrective measures under 35 I.A.C § 845.660. As allowed in 35 I.A.C § 845.650(e)(7) a petition for review of IEPA's non-concurrence under 35 I.A.C. § 105 may also be filed.

4.11 Assessment of Corrective Measures and Corrective Action

As described in 35 I.A.C. § 845.660, if the ASD summarized in **Section 4.10** has not been approved by IEPA, an assessment of corrective measures will be initiated within 90 days of the detection of a result exceeding 35 I.A.C. § 845.600 standards (*i.e.,* receipt of laboratory data). The assessment of corrective measures will include at least the following (35 I.A.C. § 845.660 (c)):

- 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 corrective action plan; and
- The institutional requirements, such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the corrective action plan.

Within one year of completing the assessment of corrective measures, a corrective action plan will be developed to identify the selected remedy in accordance with 35 I.A.C. § 845.670. If closure of the CCR Unit is required, a closure alternatives analysis will be completed as specified in 35 I.A.C. § 845.710. The analysis and selected alternative will be submitted to IEPA in a Closure Plan as specified by 35 I.A.C. § 845.720. Groundwater monitoring proposed in this Addendum will continue as specified until the post closure care period has expired and IEPA has approved termination of post-closure care.

5. REFERENCES

AECOM, 2016. *CCR Certification Report: Liner Design Criteria Evaluation for Bottom Ash Basin at Duck Creek Power Station.* October 2016.

Illinois Environmental Protection Agency, 2021. *Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845.* April 15, 2021.

Illinois Power Resources Generating, LLC (IPRG), 2016. *Closure Plan for Existing CCR Surface Impoundment*. October 2016.

Natural Resource Technology, an OBG Company (NRT/OBG), 2017. *Sampling and Analysis Plan, Final, Duck Creek Bottom Ash Basin, Duck Creek Power Station, Canton, Illinois, Project No. 2285, Revision 0.* October 17, 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021. *Hydrogeologic Site Characterization Report. Bottom Ash Basin. Duck Creek Power Plant*. Canton, Illinois.

United States Environmental Protection Agency (USEPA), March 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*. Office of Resource Conservation and Recovery, Program Implementation and Information Division, United States Environmental Protection Agency, Washington D.C. EPA/530/R-09/007.

TABLES

TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.630	**Groundwater Monitoring Systems**	
845.630(a)(2)	Potential contaminant pathways must be monitored.	Sections 2.1.2, 2.2, & 4.1.2 Table 2-1 Figure 2-1
845.630(a) 845.630(b) 845.630(c)	At least two upgradient wells and four downgradient wells (min. 1 and 3, but requires additional documentation)	Sections 2.1.2, 2.2, & 4.1.2 Table 2-1 Figure 2-1
845.630(a) 845.630(b) 845.630(c)	Downgradient Well Density	Figure 2-1
845.630(a)(2)	Downgradient wells at waste boundary	Figure 2-1
845.640	**Groundwater Sampling and Analysis Requirements**	
845.640(a)	Consistent sampling and analysis procedures	Section 4 Tables 4-1 & 4-2
845.640(b)	Methods are appropriate	Section 4 Tables 4-1 & 4-2
845.640(c)	Groundwater elevations must be measured in each well prior to purging, each time groundwater is sampled.	Section 4.3
845.640 (d)(e)(f)(g)(h)	Establishment of background and application of statistical methods	Sections 3 & 4.7 Appendix A
845.640(i)	Analyze total recoverable metals	Section 4.1.2
845.640(j)	Analyze groundwater samples using a certified laboratory	Section 4.4

TABLE 1-1. PART 845 REQUIREMENTS CHECKLIST
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Part 845 Reference	Part 845 Components	Location of Information in GMP
845.650	**Groundwater Monitoring Program**	
845.650(a)	Must include monitoring for all constituents with a groundwater protection standard in Section 845.600(a), calcium, and turbidity	Section 4.1.2
845.650(b)(c)	Groundwater Monitoring Frequency	Sections 4.1.2 & 4.2
845.650(d)(e)	Exceedances of the groundwater protection standard	Sections 4.9, 4.10, & 4.11
845.650(b)(2) and (3)	Staff gauge/ piezometer to monitor head in impoundment	NA
NA	Staff gauge/ piezometer to monitor head of neighboring surface water body	NA

[O: CJC 09/22/21; C: LDC 09/22/21]

Notes:
GMP = Groundwater Monitoring Plan
NA = Not Applicable

TABLE 2-1. MONITORING WELL LOCATIONS AND CONSTRUCTION DETAILS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Well Number	Type	HSU	Date Constructed	Top of PVC Elevation (ft)	Measuring Point Elevation (ft)	Measuring Point Description	Ground Elevation (ft)	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Well Depth (ft BGS)	Bottom of Boring Elevation (ft)	Screen Length (ft)	Screen Diameter (inches)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
BA01	C	UA	12/16/2015	--	587.09	Top of Disk	584.44	33.06	37.73	551.49	546.82	38.20	544.10	4.7	2	40.468895	-89.982141
BA02	C	UA	12/30/2015	--	579.92	Top of Disk	577.18	23.63	28.43	553.65	548.85	28.80	547.90	4.8	2	40.468427	-89.981325
BA02L	C	PMP	02/04/2021	579.91	579.91	Top of PVC	577.17	6.98	11.66	570.19	565.51	12.09	565.08	9.52	2	40.468439	-89.981326
BA03	C	UA	12/29/2015	--	578.34	Top of Disk	575.73	16.11	25.57	559.75	550.29	26.20	548.40	9.5	2	40.468091	-89.982136
BA03L	C	PMP	02/02/2021	577.75	577.75	Top of PVC	575.13	5.25	9.94	569.88	565.19	10.29	564.84	4.69	2	40.468077	-89.982135
BA04	C	UA	12/29/2015	--	578.19	Top of Disk	575.55	24.58	29.38	551.07	546.27	29.80	545.70	4.8	2	40.468382	-89.982991
BA05	B	UA	07/28/2016	--	595.72	Top of Disk	593.23	36.48	46.08	556.39	546.79	46.60	546.30	9.6	2	40.469355	-89.983075
BA06	B	UA	08/03/2016	--	595.63	Top of Disk	593.12	32.32	41.93	560.58	550.97	42.40	548.90	9.6	2	40.469324	-89.980961

Notes:
All elevation data are presented relative to the North American Vertical Datum 1988 (NAVD88), GEOID 12A
Type refers to the role of the well in the monitoring network: background (B), compliance (C), or water level measurements only (WLO)
WLO wells are temporary pending implementation of impoundment closure per an approved Construction Permit application
-- = data not available
BGS = below ground surface
ft = foot or feet
HSU = Hydrostratigraphic Unit
PMP = potential migration pathway
PVC = polyvinyl chloride
UA = uppermost aquifer

generated 10/05/2021, 3:13:02 PM CDT

TABLE 3-1. BACKGROUND GROUNDWATER QUALITY AND STANDARDS
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Parameter	Background Concentration	845 Limit	Groundwater Protection Standard	Unit
Antimony, total	0.003	0.006	0.006	mg/L
Arsenic, total	0.024	0.010	0.024	mg/L
Barium, total	0.48	2.0	2.0	mg/L
Beryllium, total	0.0021	0.004	0.004	mg/L
Boron, total	7.9	2	7.9	mg/L
Cadmium, total	0.001	0.005	0.005	mg/L
Chloride, total	700	200	700	mg/L
Chromium, total	0.073	0.1	0.1	mg/L
Cobalt, total	0.03	0.006	0.03	mg/L
Fluoride, total	0.461	4.0	4.0	mg/L
Lead, total	0.042	0.0075	0.042	mg/L
Lithium, total	0.068	0.04	0.068	mg/L
Mercury, total	0.004	0.002	0.004	mg/L
Molybdenum, total	0.0055	0.1	0.1	mg/L
pH (field)	7.5 / 6.4	9.0 / 6.5	9.0 / 6.4	SU
Radium 226 and 228 combined	7.27	5	7.27	pCi/L
Selenium, total	0.0023	0.05	0.05	mg/L
Sulfate, total	890	400	890	mg/L
Thallium, total	0.001	0.002	0.002	mg/L
Total Dissolved Solids	2590	1200	2590	mg/L

Notes:
For pH, the values presented are the upper / lower limits
Groundwater protection standards for calcium and turbidity do not apply per 35 I.A.C. § 845.600(b)
mg/L = milligrams per liter
SU = standard units
pCi/L = picocuries per liter

generated 10/07/2021, 6:48:16 AM CDT

RAMBOLL

TABLE 4-1. SAMPLING AND ANALYSIS SUMMARY
GROUNDWATER MONITORING PLAN
DUCK CREEK POWER PLANT
BOTTOM ASH BASIN
CANTON, ILLINOIS

Parameter	Analytical Method [1]	Number of Samples	Field Duplicates [2]	Field Blanks [3]	Equipment Blanks [3]	MS/MSD [4]	Total	Container Type	Minimum Volume [5]	Preservation (Cool to 4 °C for all samples)	Sample Hold Time from Collection Date
Metals											
Metals [6]	6020, Li - EPA 200.7	8	1	0	0	1	10	plastic	600 mL	HNO_3 to pH<2	6 months
Mercury	7470A or 6020	8	1	0	0	1	10	plastic	400 mL	HNO_3 to pH<2	28 days
Inorganic Parameters											
Fluoride	9214 or EPA 300	8	1	0	0	1	10	plastic	300 mL	Cool to 4 °C	28 days
Chloride	9251 or EPA 300	8	1	0	0	1	10	plastic	100 mL	Cool to 4 °C	28 days
Sulfate	9036 or EPA 300	8	1	0	0	1	10	plastic	50 mL	Cool to 4 °C	28 days
Total Dissolved Solids	SM 2540 C	8	1	0	0	1	10	plastic	200 mL	Cool to 4 °C	7 days
Radium											
Radium 226	9315 or EPA 903	8	0	0	0	0	8	plastic	1000 mL	HNO_3 to pH<2	6 months
Radium 228	9320 or EPA 904	8	0	0	0	0	8	plastic	1000 mL	HNO_3 to pH<2	6 months
Field Parameters											
pH	SM 4500-H+ B	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Dissolved Oxygen [8]	SM 4500-O/405.1	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Temperature [8]	SM 2550	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Oxidation/Reduction Potential [8]	SM 2580 B	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Specific Conductance [8]	SM 2510 B	8	NA	NA	NA	NA	8	flow-through cell	NA	none	immediately
Turbidity [7]	SM 2130 B	8	NA	NA	NA	NA	8	flow-through cell or hand-held turbidity meter	NA	none	immediately

[O: CJC 09/22/21; C: LDC 09/22/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Analytical methods may be updated with more recent versions as appropriate.
[2] Field duplicates will be collected at a frequency of one per group of 10 or fewer investigative water samples. Field duplicates will not be collected for radium analysis.
[3] Field blanks will be collected at the discretion of the project manager; Equipment blanks will be collected at a rate of 1 per sampling event if non-dedicated equipment is used.
[4] Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of one per group of 20 or fewer investigative water samples per CCR unit/multi-unit. Additional volume to be determined by laboratory.
[5] Sample volume is estimated and will be determined by the laboratory.
[6] Metals = antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, lead, lithium, molybdenum, selenium, thallium. Metals may be analyzed via ICP/ ICP-MS USEPA methods 6010 or 6020 depending on laboratory instrument availability
[7] If turbidity exceeds 10 NTUs, a duplicate sample filtered through a .45 micron filter may be collected for metals analysis in addition to the unfiltered sample. Both samples would be submitted for analysis.
[8] Parameter collected for quality assurance and quality control for field sampling purposes only; not required to be collected or reported under Part 845; collection of parameter may be discontinued without notification.

< = less than
°C = degrees Celsius
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
NTU = nephelometric turbidity unit

TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Metals							
Antimony	7440-36-0	mg/L	6020	0.006	0.006	0.003	0.00036
Arsenic	7440-38-2	mg/L	6020	0.01	0.01	0.001	0.00013
Barium	7440-39-3	mg/L	6020	2	2	0.001	0.00028
Beryllium	7440-41-7	mg/L	6020	0.004	0.004	0.001	0.000017
Boron	7440-42-8	mg/L	6020	NS	2	0.01	0.0023
Cadmium	7440-43-9	mg/L	6020	0.005	0.005	0.001	0.000042
Calcium	7440-70-2	mg/L	6020	NS	NS	0.15	0.15
Chromium	7440-47-3	mg/L	6020	0.1	0.1	0.004	0.00027
Cobalt	7440-48-4	mg/L	6020	0.006	0.006	0.002	0.000017
Lead	7439-92-1	mg/L	6020	0.015	0.0075	0.001	0.000025
Lithium	7439-93-2	mg/L	6020 or EPA 200.7	0.04	0.04	0.02	0.0001
Mercury	7439-97-6	mg/L	6020 or 7470A	0.002	0.002	0.0002	0.000078
Molybdenum	7439-98-7	mg/L	6020	0.1	0.1	0.001	0.000063
Selenium	7782-49-2	mg/L	6020	0.05	0.05	0.001	0.00032
Thallium	7440-28-0	mg/L	6020	0.002	0.002	0.001	0.000062
Inorganics							
Fluoride	7681	mg/L	9214 or EPA 300	4	4	0.25	0.065
Chloride	16887-00-6	mg/L	9251 or EPA 300	250 [3]	200	1	0.15
Sulfate	18785-72-3	mg/L	9036 or EPA 300	250 [3]	400	1	0.24
Total Dissolved Solids	10052	mg/L	SM 2540C	500 [3]	1200	17	--
Other							
Radium 226 and 228 combined	7440-14-4	pCi/L	9315/9320 or EPA 903/904	5	5	-- [6]	-- [7]
Field							
pH	NA	SU	SM 4500-H+ B	NS	6.5-9.0	NA	NA
Oxidation/Reduction Potential	NA	mV	SM 2580 B	NS	NS	NA	NA
Dissolved Oxygen	NA	mg/L	SM 4500-O/405.1	NS	NS	NA	NA
Temperature	NA	°C	SM 2550	NS	NS	NA	NA
Specific Conductivity	NA	µS/cm	SM 2510 B	NS	NS	NA	NA

TABLE 4-2. DETECTION AND REPORTING LIMITS FOR PART 845 PARAMETERS

GROUNDWATER MONITORING PLAN

DUCK CREEK POWER PLANT

BOTTOM ASH BASIN

CANTON, ILLINOIS

Constituent	CAS	Unit	Analytical Methods [1]	USEPA MCL [2]	35 I.A.C. § 845.600	RL [4, 5]	MDL [5]
Turbidity	NA	NTU	SM 2130 B	NS	NS	NA	NA

[O: CJC 09/22/21; C: LDC 09/22/21]

Notes:

[1] Analytical method numbers are from SW-846 unless otherwise indicated. Metals will be analyzed via Method 6020 or 6010 depending on laboratory equipment availability. Selected method will ensure reporting limits (RL) are below Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845.600 groundwater protection standards.

[2] USEPA MCL = United States Environmental Protection Agency Maximum Contaminant Level.

[3] USEPA SMCL = United States Environmental Protection Agency Secondary Maximum Contaminant Level.

[4] RLs will be less than the 35 I.A.C. § 845.600 groundwater protection standards.

[5] RLs and method detection limits (MDL) will vary depending on the laboratory performing the work.

[6] All radium results will be reported (values may be positive or negative) and will include uncertainty and the calculated MDC.

[7] Laboratories calculate a minimum detectable concentration (MDC) based on the sample.

°C = degrees Celsius

µS/cm = microSiemens per centimeter

CAS = Chemical Abstract Number

MDL = Method detection limit as established by the laboratory

mg/L = milligrams per liter

mV = millivolts

NS = No standard

NTU = nephelometric turbidity unit

pCi/L = picoCuries per liter

RL = Reporting limit as established by the laboratory

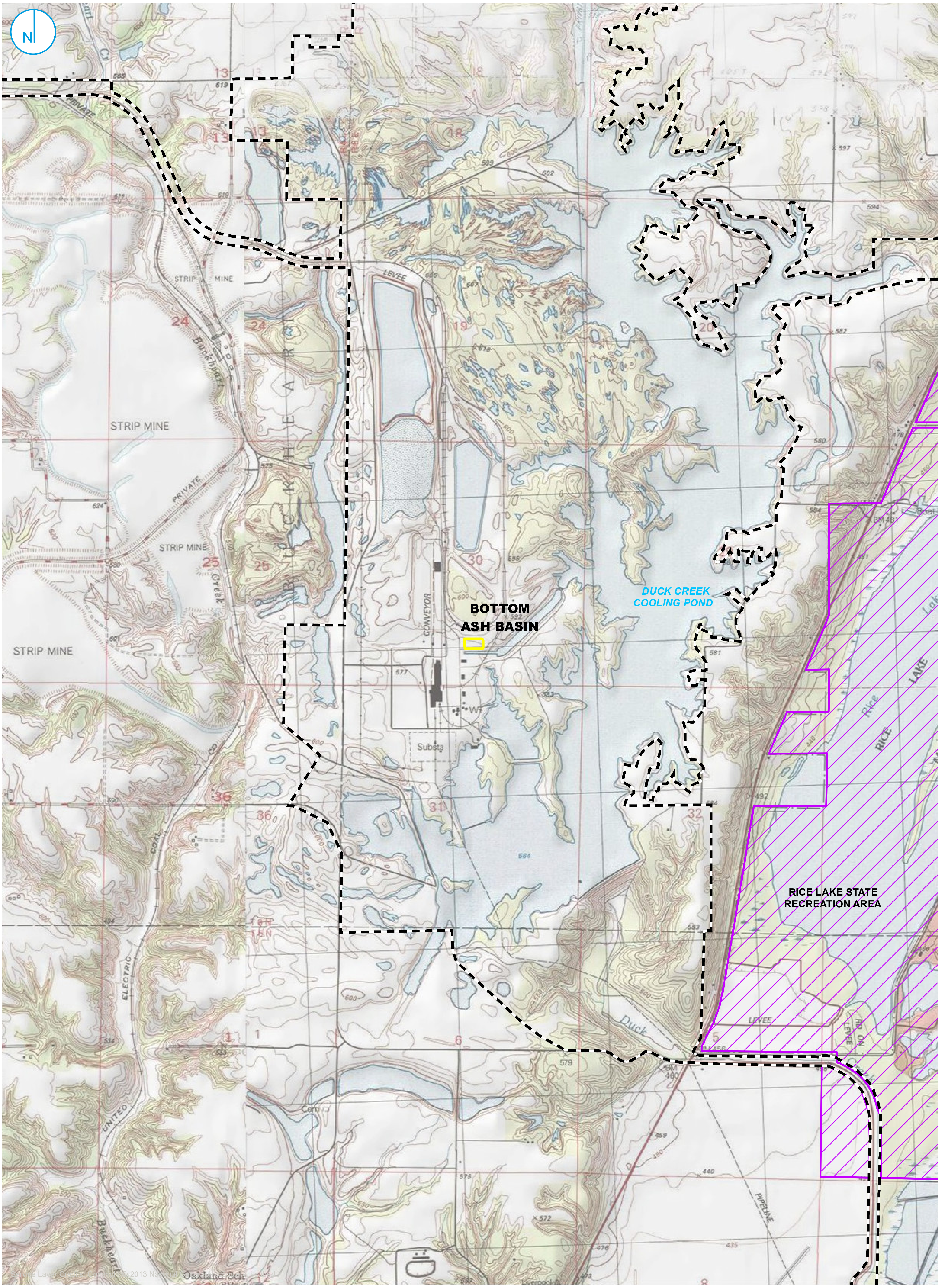
SM = Standard Methods for the Examination of Water and Wastewater

SU = standard units

FIGURES

PROJECT: 169000XXXX | DATED: 10/20/2021 | DESIGNER: STOLZSD

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\GMP\Figure 1-1_Site Location Map.mxd



PART 845 REGULATED UNIT (SUBJECT UNIT)

PROPERTY BOUNDARY

COFFEEN LAKE STATE FISH AND WILDLIFE AREA

0 1,000 2,000 Feet

SITE LOCATION MAP

FIGURE 1-1

GROUNDWATER MONITORING PLAN
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\GMP\Figure 1-2_Site Map.mxd

PROJECT: 169000XXXX | DATED: 10/14/2021 | DESIGNER: HOTCALD

PART 845 REGULATED UNIT (SUBJECT UNIT)

SURFACE COAL MINE

0 150 300 Feet

SITE MAP

FIGURE 1-2

GROUNDWATER MONITORING PLAN
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\GMP\Figure 1-3_GWE Contours 20210428.mxd

PROJECT: 169000XXXX | DATED: 9/24/2021 | DESIGNER: STOLZSD

BACKGROUND WELL

MONITORING WELL

GROUNDWATER ELEVATION CONTOUR (2-FT CONTOUR INTERVAL, NAVD88)

PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

NOTE

PARENTHESIS INDICATES WELL NOT USED FOR CONTOURING

UPPERMOST AQUIFER GROUNDWATER ELEVATION CONTOURS
APRIL 28, 2021

GROUNDWATER MONITORING PLAN

BOTTOM ASH BASIN

DUCK CREEK POWER PLANT

CANTON, ILLINOIS

FIGURE 1-3

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL

Y:\Mapping\Projects\22\2285\MXD\845_Operating_Permit\Duck_Creek\BAB\GMP\Figure 2-1_Proposed 845 GW Monitoring Well Network.mxd

PROJECT: 169000XXXX | DATED: 9/24/2021 | DESIGNER: STOLZSD

BACKGROUND WELL

COMPLIANCE WELL

PART 845 REGULATED UNIT (SUBJECT UNIT)

0 50 100 Feet

PROPOSED PART 845 GROUNDWATER MONITORING WELL NETWORK

FIGURE 2-1

GROUNDWATER MONITORING PLAN
BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

APPENDIX A
STATISTICAL ANALYSIS PLAN

Prepared for
Illinois Power Resources Generating, LLC

Date
October 25, 2021

Project No.
1940100806-003

STATISTICAL ANALYSIS PLAN

BOTTOM ASH BASIN
DUCK CREEK POWER PLANT
CANTON, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

STATISTICAL ANALYSIS PLAN
DUCK CREEK POWER PLANT BOTTOM ASH BASIN

Project Name	**Duck Creek Power Plant Bottom Ash Basin**
Project No.	**1940100806-003**
Recipient	**Illinois Power Resources Generating, LLC**
Document Type	**Statistical Analysis Plan**
Version	**FINAL**
Date	**October 25, 2021**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

Brian G. Hennings, PG
Senior Managing Hydrogeologist

Eric J. Tlachac, PE
Senior Managing Engineer

Rachel A. Banoff, EIT
Project Statistician

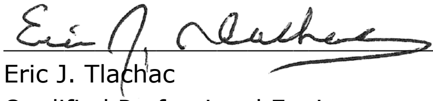
LICENSED PROFESSIONAL CERTIFICATIONS

This certification is based on the description of the statistical methods selected to evaluate groundwater as presented in the following Statistical Analysis Plan; Duck Creek Power Plant Bottom Ash Basin. The procedures described in the plan will be used to establish background conditions and implement compliance monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. The Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in the United States Environmental Protection Agency (USEPA)'s *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance,* March 2009), and is intended to provide a logical process and framework for conducting the statistical analysis of the data obtained during groundwater monitoring. In accordance with 35 I.A.C. § 845.640(f)(1), the statistical method chosen for analysis of background groundwater quality will be either the tolerance interval or the prediction interval procedure for each constituent listed in 35 I.A.C. § 845.600(a)(1) at this CCR unit per 35 I.A.C. § 845.640(f)(1)(C). Groundwater Protection Standards (GWPS) will be established in accordance with 35 I.A.C. § 845.600(a) (greater of the background concentration or numerical limit specified in 35 I.A.C. § 845.600(a)(1)). The GWPS will be compared to the lower confidence limit for the observed concentrations for each constituent in each compliance well. Consistent with the *Unified Guidance*, the same general statistical method of confidence interval testing against a fixed GWPS is recommended in compliance and corrective action programs. Confidence intervals provide a flexible and statistically accurate method to test how a parameter estimated from a single sample compares to a fixed numerical limit. Confidence intervals explicitly account for variation and uncertainty in the sample data used to construct them.

Description of the statistical methods chosen for analysis of groundwater monitoring data and application of these methods for determining exceedances of the GWPS identified in 35 I.A.C. § 845.600(a) is provided in this Statistical Analysis Plan.

35 I.A.C. § 845.640 Statistical Analysis (PE)

I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the statistical methods summarized above and described in this document (Statistical Analysis Plan; Duck Creek Power Plant Bottom Ash Basin) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § 845.640.



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
Date: October 25, 2021

35 I.A.C. § 845.640 Statistical Analysis (PG)

I, Brian G. Hennings, a qualified professional geologist in good standing in the State of Illinois, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Bottom Ash Basin) are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § *845.640.*

____
Brian G. Hennings
Professional Geologist
196.001482
Illinois
Date: October 25, 2021

35 I.A.C. § 845.640 Statistical Analysis

I, Rachel A. Banoff, a qualified professional, certify that the statistical methods described in this document (Statistical Analysis Plan; Duck Creek Power Plant Bottom Ash Basin), are appropriate for evaluating the groundwater monitoring data collected as described in the attached document and are in substantial compliance with 35 I.A.C. § *845.640.*

____
Rachel A. Banoff, EIT
Project Statistician
Date: October 25, 2021

CONTENTS

Licensed Professional Certifications		**2**
1.	**Introduction**	**6**
1.1	Statistical Analysis Objectives	6
1.2	Statistical Analysis Plan Approach	6
2.	**Background Monitoring and Data Preparation**	**8**
2.1	Sample Independence	8
2.2	Non-Detect Data Processing	9
2.3	Testing for Normality	9
2.4	Testing for Outliers	9
2.5	Trend Analysis	10
2.6	Spatial Variation	10
2.7	Temporal Variation	10
2.8	Updating Background	11
3.	**Compliance Monitoring**	**13**
3.1	GWPS Establishment and Exceedance Determination	13
3.1.1	The Upper Tolerance Limit	14
3.1.2	Parametric Confidence Intervals around a Mean	16
3.1.3	Non-Parametric Confidence Intervals around a Median	16
3.1.4	The Upper Prediction Limit for a Future Mean	17
3.1.5	The Non-Parametric Upper Prediction Limit for a Future Median	17
3.1.6	Parametric Linear Regression and Confidence Band	18
3.1.7	Non-Parametric Thiel-Sen Trend Line and Confidence Band	20
3.2	Determination of Statistically Significant Increases over Background	21
4.	**References**	**22**

TABLES (IN TEXT)

Table A Statistical Calculations Used in Compliance Monitoring Procedures

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
ANOVA	analysis of variance
CCR	coal combustion residuals
COC	constituents of concern
GWPS	groundwater protection standard
IEPA	Illinois Environmental Protection Agency
LCL	lower confidence limit
LTL	lower tolerance limit
MSE	mean squared error
P	probability
Part 845	Residuals in Surface Impoundments: Title 35 of the Illinois Administrative Code § 845
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SI	surface impoundment
SSI	statistically significant increase
SWFPR	site-wide false positive rate
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

In April 2021, the Illinois Environmental Protection Agency (IEPA) issued a final rule for the regulation and management of Coal Combustion Residuals (CCR) in surface impoundments (SIs) under the Standards for the Disposal of CCR in Surface Impoundments: Title 35 of the Illinois Administrative Code (35 I.A.C.) § 845 (Part 845). Facilities regulated under Part 845 are required to develop and sample a groundwater monitoring well network to evaluate whether impounded CCR materials are impacting downgradient groundwater quality. The groundwater quality evaluation must include selection and certification by a qualified professional engineer of the statistical procedures to be used. The procedures described in the evaluation will be used to establish background conditions and implement compliance and corrective action monitoring as necessary and required by 35 I.A.C. § 845.640 and 35 I.A.C. § 845.650. This Statistical Analysis Plan was prepared in accordance with the requirements of 35 I.A.C. § 845.640(f), with reference to the acceptable statistical procedures provided in United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (*Unified Guidance*) (March 2009).

This Statistical Analysis Plan does not include procedures for groundwater sample collection and analysis, as these activities are conducted in accordance with the Sampling and Analysis Plan prepared for each CCR unit in accordance with 35 I.A.C. § 845.640. This Statistical Analysis Plan will be used as the primary reference for evaluating groundwater quality during operation and post-closure care.

1.1 Statistical Analysis Objectives

This Statistical Analysis Plan is intended to provide a logical process and framework for conducting the statistical analyses of data obtained during groundwater monitoring conducted in accordance with the Sampling and Analysis Plan for each CCR unit. The Statistical Analysis Plan will enable a qualified professional engineer to certify that the selected statistical methods are appropriate for evaluating the groundwater monitoring data for the applicable CCR unit(s).

1.2 Statistical Analysis Plan Approach

The main sections of this Statistical Analysis Plan should be viewed as a "generic" outline of statistical methods utilized for each CCR unit and constituent required to be monitored. The statistical analysis of the groundwater monitoring data, however, will be conducted on an individual-constituent or well basis, and may involve the use of appropriate statistical procedures depending on multiple factors such as detection frequency and normality distributions.

The CCR Rule outlines two phases of groundwater monitoring:

- Background Monitoring in accordance with 35 I.A.C. § 845.650(b)(1)
- Compliance Monitoring in accordance with 35 I.A.C. § 845.650

Each phase of the groundwater monitoring program requires specific statistical procedures to accomplish the intended purpose. During the background monitoring phase, background groundwater quality will be established utilizing upgradient and background wells and downgradient groundwater quality data will be collected to facilitate statistics in subsequent phases. Compliance Monitoring is then initiated through the evaluation of the downgradient groundwater monitoring data for exceedances of the groundwater protection standard (GWPS) established by Part 845 (concentration specified in 35 I.A.C. § 845.600 or an IEPA-approved background concentration). The developed statistical analysis plan will be implemented for each monitoring phase and in accordance with the statistical procedures.

2. BACKGROUND MONITORING AND DATA PREPARATION

The background and compliance monitoring wells were sampled and analyzed for constituents, as listed in Part 845 (antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, pH, radium 226 and 228 combined, selenium, sulfate, thallium, total dissolved solids, and turbidity), during the baseline phase of the groundwater monitoring program.

The background monitoring well(s) were placed upgradient of the CCR unit, or at an alternative background location, where they are not affected by potential leakage from the CCR unit. Compliance monitoring wells were placed at the waste boundary of the CCR unit, along the same groundwater flow path. As 35 I.A.C. § 845.630(a) specifies, the location of these wells ensures that background accurately represents the quality of unaffected groundwater, while compliance wells accurately represent groundwater quality at the waste boundary and monitor all potential contaminant pathways.

As required by 35 I.A.C. § 845.650(a)(1), eight sampling events were completed within 180 days of April 21, 2021. As outlined, groundwater sampling procedures included sampling of the background and compliance wells using low-flow sampling methods, collection of one field quality control sample per event, and groundwater samples were not field filtered before laboratory analysis of total recoverable metals.

Following completion of the eight sampling events, background groundwater quality was established for Part 845 constituents. Groundwater monitoring will be conducted quarterly for at least the first five years. In accordance with 35 I.A.C. § 845.650(b)(4), after the first five years, a request to reduce the monitoring frequency to semiannual may be submitted to IEPA if all of the following can be demonstrated:

- Groundwater monitoring effectiveness will not be compromised by the reduced frequency
- Sufficient data has been collected to characterize groundwater
- Monitoring to date does not show any statistically significant increasing trends
- The concentrations of monitored constituents at the compliance monitoring wells are below the applicable GWPSs established in 35 I.A.C. § 845.600

The following subsections outline the statistical tests and procedures (methods) that will be utilized to evaluate data collected for each constituent in both background and compliance wells for Background and Compliance Monitoring. When necessary and contingent upon equivalent statistical power, an alternative test not included in this Statistical Analysis Plan may be chosen due to site-specific data requirements.

2.1 Sample Independence

Independence of sample results is a major assumption for most statistical analyses. To ensure physical independence of groundwater sampling results, the minimum time between sampling events must be longer than the time required for groundwater to move through the monitoring well. The sampling schedules for both the baseline and compliance monitoring periods are specified in 35 I.A.C. § 845.650(b) and may conflict with the statistical assumption of independence of sample results.

2.2 Non-Detect Data Processing

The reporting limit (RL) will be used as the lower level for the reporting of non-detected groundwater quality data. For all summary statistics (box plots, timeseries, etc.), the RL will be substituted for concentrations reported below the RL, including non-detects. With professional judgement, analytical results between the RL and the method detection limit, *i.e.,* estimated values, typically identified with a "J" flag, may be utilized if provided by the laboratory.

For all statistical test procedures:

- If the frequency of non-detect data are less than or equal to 15 percent, half of the RL will be substituted for these data
- If the non-detect frequency is between 15 percent and 50 percent, either the Kaplan-Meier or robust regression on order statistics (ROS) will be used to estimate the mean and standard deviation adjusted for the presence of left-censored values
- If the non-detect frequency is greater than 50 percent, a non-parametric test will be used
- If only one background result is detected that value will be used as the non-parametric upper prediction limit (UPL)

2.3 Testing for Normality

Many statistical analyses assume that sample data are normally distributed (parametric). However, environmental data are frequently not normally distributed (nonparametric). 35 I.A.C. § 845.640(g) requires the knowledge of the background data distribution for comparison to compliance results. The *Unified Guidance* document recommends the Shapiro-Wilk normality test for sample sizes of 50 or less, and the Shapiro-Francia normality test for sample sizes greater than 50.

When possible, transformation of datasets to achieve normal distributions is preferred.

2.4 Testing for Outliers

Part 845 constituents will be screened for the existence of outliers using a method described by the *Unified Guidance*. Outliers are extreme data points that may represent an anomaly or erroneous data point. To test for outliers, one or more of the following outlier tests will be utilized:

- Dixon's test, for well-constituent pairs with less than 25 samples, assumes normally distributed data.
- Rosner's test, for well-constituent pairs with more than 20 samples, assumes normally distributed data.
- Grubb's test for well-constituent pairs with seven or more samples, assumes normally distributed data.
- Time series, box-whisker plots, and probability plots provide visual tools to identify potential outliers, and evaluation of seasonal, spatial, or temporal variability for both normally and non-normally distributed data.

Data quality control, groundwater geochemistry, and sampling procedures will be evaluated as potential sources of error leading to an outlier result. The outlier tests cannot be used alone to determine whether a value is a true outlier that should be excluded from future statistical analysis. Corroborating evidence needed to exclude values includes a discrete data reporting or analytical error, or potential laboratory bias. Absent corroborating evidence, the flagged values are considered true, but extreme, values in the data set. Professional judgement will be used to exclude extreme outliers from further statistical analyses. Outliers will be retained in the database.

With professional judgement, a confirmatory sample may be collected to allow for the distinction between an outlier and a true representation of groundwater quality at the monitoring point. If re-sampling is conducted, this sample will be collected within 90 days following outlier identification. If the confirmatory sample indicates the original result as an outlier, it will be reported as such.

2.5 Trend Analysis

Statistical analyses supporting the lack of trend are a fundamental step to confirm the assumption that groundwater quality values are stationary or constant over time at a CCR unit. These analyses allow for evaluation of variation in the background and compliance data for each constituent over time. A statistically significant increasing trend in background data could indicate an existing release from the CCR unit or alternate source, requiring further investigation. In addition, statistically significant trending background data can result in increased standard deviation and, therefore, greater prediction or control limits. Consequently, the increased prediction or control limit will have less power or ability to identify a release from the CCR unit.

A linear regression, coupled with a t-test for slope significance at a 95 percent confidence level (0.05 significance level), may be used on datasets for each constituent with few non-detects and a normally distributed variance of the mean to evaluate time trends. The Theil-Sen trend line, coupled with the Mann-Kendall test for slope significance at a 95 percent confidence level (0.05 significance level), will be used for datasets with frequent non-detects or non-normal variance. Similarly, trend analyses could also be used on compliance data to evaluate a possible release from the CCR unit.

2.6 Spatial Variation

Spatial trends and/or variation between background wells could indicate an existing release from a CCR unit. If the spatial variability is not due to an existing release, intrawell comparisons in compliance wells may be used to account for spatial variability and monitor for a future release. However, the CCR unit being monitored was placed into service prior to the start of groundwater monitoring and it is unknown whether a previous release has occurred. Accordingly, intrawell comparisons in compliance wells cannot be used to determine the occurrence of a future release. Interwell comparisons between compliance wells and background wells will be used.

2.7 Temporal Variation

Time series plots can be used to identify temporal dependence. Potentially significant temporal components of variability can be identified by graphing single constituent data from multiple wells together on a time series plot. With temporal dependence, the time series plot as a pattern of parallel traces, in which the individual wells will tend to rise and fall together across the sequence of sampling dates. Time series plots can be helpful by plotting multiple constituents over time for the same well, or averaging values for each constituent across wells on each sampling event and then plotting the averages over time. In either case, the plots can signify whether the general concentration pattern over time is simultaneously observed for different constituents. If so, it may indicate that a group of constituents is highly correlated in groundwater or that the same artifacts of sampling and/or lab analysis impacted the results of several monitoring parameters.

Hydrologic factors such as drought, recharge patterns or regular (*e.g.,* seasonal) water table fluctuations may be responsible for the temporal variation. In these cases, it may be useful to test for the presence of a significant temporal effect by first constructing a parallel time series plot and then running a formal one-way analysis of variance (ANOVA) ($\alpha = 0.05$) for temporal effects. A one-way ANOVA for temporal effects considers multiple well data sets for individual sampling events or seasons as the relevant statistical factor. If event-specific analytical differences or seasonality appear to be an important temporal factor, the one-way ANOVA for temporal effects can be used to formally identify seasonality, parallel trends, or changes in lab performance that affect other temporal effects. The one-way ANOVA for temporal effects assumes that the data groups are normally distributed with constant variance. It is also assumed that for each of a series of background wells, measurements are collected at each well on sampling events or dates common to all the wells. Results of the ANOVA can also be used to create temporally stationary residuals, where the temporal effect has been 'subtracted from' the original measurements. These stationary residuals may be used to replace the original data in subsequent statistical testing.

If the data cannot be normalized, a similar test for a temporal or seasonal effect can be performed using the Kruskal-Wallis test ($\alpha = 0.05$). Each sampling event should be treated as a separate 'well,' while each well is treated as a separate 'sampling event.' In this case, no residuals can be computed since the Kruskal-Wallis test employs ranks of the data rather than the measurements themselves.

Where both spatial and temporal variation occur, two-way ANOVA can be considered where both well location and sampling event/season are treated as statistical factors. This procedure is described in Davis (1994).

2.8 Updating Background

Updating the background dataset periodically by adding recent results to an existing background dataset can improve the statistical power and accuracy of the statistical analysis, especially for non-parametric prediction intervals. The *Unified Guidance* recommends updating statistical limits (background) when at least four to eight new measurements (every 1 to 2 years under a quarterly monitoring program), are available for comparison to historical data. Professional judgement will be used to evaluate whether any background data appear to be affected by a release and need to be excluded from a background update. A t-test for equal means (if normal data distribution) or appropriate non-parametric test (if non-normal data distribution) such as a Mann-Whitney (or Wilcoxon) rank-sum or box-whisker plots, will be conducted to evaluate whether the two groups of background sample populations are statistically different prior to updating any background datasets. A 0.05 significance level will be utilized when evaluating the two populations, with the null hypothesis that they are equivalent. In addition, time series graphs or other trend evaluation statistics will be conducted on the new background dataset to verify the absence of a release or changing groundwater quality. If the tests indicate that there are no statistical differences between the two background populations, the new data will be combined with the existing dataset. If the two populations are found to be different, the data will be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a release (if the new data are significantly higher, or lower for pH), then the previous background dataset may continue to be used. Furthermore, verified outliers will not be added to an existing background dataset. In accordance with the *Unified Guidance*, continual background updates will not be conducted due to the lack of sufficient samples for a statistical comparison.

3. COMPLIANCE MONITORING

Compliance monitoring is designed to monitor groundwater for evidence of a release by comparing Part 845 constituents in compliance wells to both background concentrations and the GWPS. Compliance Monitoring will begin the 1st quarter following approval of this Groundwater Monitoring Plan and issuance of the Operating Permit. The selected Compliance Monitoring statistical method used to compare compliance groundwater quality data for each constituent to the GWPS will provide for adequate statistical power, error levels and individual test false positive rates, and be appropriate for the distribution and detection frequency of the background dataset. Statistical power is the ability of a statistical test to detect a true exceedance.

In accordance with 35 I.A.C. § 845.610(b)(3)(D), compliance monitoring statistical analyses will be completed and submitted to IEPA within 60 days after completion of sampling.

3.1 GWPS Establishment and Exceedance Determination

In accordance with 35 I.A.C. § 845.600(a), the GWPS will be the constituent concentrations specified in 35 I.A.C. § 845.600(a)(1) except for when the background concentration is greater, or no concentration is specified (*i.e.,* for calcium and turbidity), in which case the GWPS will be the background concentration. The GWPS based on background concentration will be calculated using a parametric upper tolerance limit (UTL), a parametric UPL for a future mean, or a non-parametric UPL for a future median.

Statistical calculations that will be utilized in Compliance Monitoring procedures are summarized in **Table A** below and listed in **Sections 3.1.1** through **3.1.7**. Depending on the distribution of the data and the percentage of non-detects, it may be more appropriate to use a parametric model over a non-parametric model. As necessary, other techniques as mentioned in the *Unified Guidance* and/or new methods will be implemented.

Table A. Statistical Calculations Used in Compliance Monitoring Procedures

<table>
<tr><th colspan="7">Compliance Monitoring</th></tr>
<tr><th rowspan="2">Significant Trend?</th><th colspan="3">Background Data</th><th colspan="3">Compliance Data</th></tr>
<tr><th>Percent Non-Detects</th><th>Distribution</th><th>GWPS Determination</th><th>Percent Non-Detects</th><th>Distribution</th><th>Method to Determine Exceedance</th></tr>
<tr><td rowspan="7">No</td><td rowspan="4">0 ≤ 50</td><td rowspan="4">Normal</td><td rowspan="4">35 I.A.C § 845.600(a)(1) constituent concentration or The Upper Tolerance Limit</td><td>≤75</td><td>Normal</td><td>Parametric Lower Confidence Limit around a Normal Mean</td></tr>
<tr><td>≤75</td><td>Log-Normal</td><td>Parametric Lower Confidence Limit around a Lognormal Geometric Mean</td></tr>
<tr><td>NA</td><td>Non-Normal</td><td rowspan="2">Non-Parametric Lower Confidence Limit around a Median</td></tr>
<tr><td>>75</td><td>Unknown/ Cannot be determined</td></tr>
<tr><td>50 ≤ 70</td><td>Normal</td><td>The Upper Prediction Limit for a Future Mean</td><td>NA</td><td>NA</td><td>Future mean</td></tr>
<tr><td>>70</td><td>Non-Normal</td><td>Upper Prediction Limit for a Future Median</td><td>NA</td><td>NA</td><td>Future median</td></tr>
<tr><td>100</td><td>Non-Normal</td><td>Double Quantification Rule</td><td>NA</td><td>NA</td><td>Individual Retesting Values</td></tr>
<tr><td rowspan="2">Yes</td><td>0 ≤ 50</td><td>Normal</td><td>UCL of Confidence Band around Linear Regression</td><td>≤75</td><td>Residuals after subtracting trend are normal, equal variance</td><td>Lower Limit from Confidence Band around Linear Regression</td></tr>
<tr><td>50 ≤ 100</td><td>Non-Normal</td><td>UCL of Confidence Band around Thiel-Sen trend line</td><td>≤75</td><td>Residuals not normal</td><td>Lower Limit from Confidence Band around Thiel-Sen</td></tr>
</table>

3.1.1 The Upper Tolerance Limit

The UTL will be used to calculate the GWPS when pooled background data are normally distributed, with a non-detect frequency of 50 percent or less. When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects. The *Unified Guidance* recommends 95 percent confidence level and 95 percent coverage (95/95 tolerance interval).

- When non-detect frequency is 15 percent or less, half the RL will be substituted for non-detects (simple substitution), and the normal mean and standard deviation will be calculated.

- The Kaplan-Meier or the ROS method will be used when the detection frequency is between 15 percent and 50 percent. The Kaplan-Meier method assesses the linearity of a censored probability plot to determine whether the background sample can be approximately normalized. If so, then the Kaplan-Meier method will be used to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. The Kaplan-Meier or ROS estimate of the mean and standard deviation will be substituted for the sample mean and standard deviation.
- If background normality cannot be achieved, non-parametric UTLs will not be calculated until a minimum of 60 background samples have been collected (to achieve 95 percent coverage).

The parametric UTL on a future mean will be calculated from the background dataset as follows:

$$UTL = \overline{x} + \kappa\,(n, \gamma, \alpha - 1) \cdot s$$

$\overline{x}$ = background sample mean

s = background sample standard deviation

$\kappa\,(n, \gamma, \alpha - 1)$ = one-sided normal tolerance factor based on the chosen coverage (γ) and confidence level (α -1) and the size of the background dataset (n). Values are tabulated in Table 17-3 in Appendix D of the *Unified Guidance*. If exact values are not provided, then κ values can be estimated by linear interpolation.

If the UTL is constructed on the logarithms of original observations to achieve normality, where $\overline{y}$ and s_y are the log-mean and log-standard deviation, the limit will be exponentiated for back-transformation to the concentration scale as follows:

$$UTL = \exp\left[\overline{y} + \kappa\,(n, \gamma, \alpha - 1) \cdot s_y\right]$$

$\overline{y}$ = background sample log-mean

s_y = background sample log-standard deviation

When the GWPS is based on the 35 I.A.C. § 845.600(a)(1) constituent concentrations or a UTL derived from the background dataset, an exceedance in compliance wells relative to the GWPS will be evaluated using confidence intervals. A confidence interval defines the upper and lower bound of the true mean of a constituent concentration in groundwater within a specified confidence range.

- Non-detects in compliance data will be handled similarly to upgradient analyses, with half the RL substituted for non-detects when the frequency is 15 percent or less.
- The Kaplan-Meier, or the ROS method, will be used when the detection frequency is between 15 percent and 50 percent to compute estimates of the mean and standard deviation adjusted for the presence of left-censored values. These estimates will then be substituted for the sample mean and standard deviation.

Once the GWPS is established for background data using the UTL, either parametric or non-parametric confidence intervals will be computed for each constituent in compliance wells to identify GWPS exceedances.

3.1.2 Parametric Confidence Intervals around a Mean

If compliance data are approximately normal, one-sided parametric confidence intervals around a sample mean will be constructed for each constituent and well pair. The lower confidence limit (LCL) will be calculated as:

$$LCL_{1-\alpha} = \overline{x} - t_{1-\alpha,n-1} \cdot \frac{s}{\sqrt{n}}$$

$\overline{x}$ = compliance sample mean

s = compliance sample standard deviation

n = compliance sample size

$t_{1-\alpha,n-1}$ = obtained from a Student's t-table with (n–1) degrees of freedom (Table 16-1 in Appendix D of the *Unified Guidance*)

The chosen t value will aim to achieve both a low false-positive rate, and high statistical power. Minimum α values are tabulated in Table 22-2 of Appendix D of the *Unified Guidance*. The selected minimum α value, from which the t value will be derived, will have at least 80 percent power ($1-\beta = 0.8$) when the underlying mean concentration is twice the GWPS.

If compliance data are distributed lognormally, the LCL will be computed around the lognormal geometric mean as:

$$LCL_{1-\alpha} = \exp\left(\overline{y} - t_{1-\alpha,n-1} \cdot \frac{s_y}{\sqrt{n}}\right)$$

$\overline{y}$ = compliance sample log-mean

s_y = compliance sample log-standard deviation

3.1.3 Non-Parametric Confidence Intervals around a Median

Non-parametric confidence intervals around the median will be computed if the compliance data contain greater than 50 percent non-detects or are not normally distributed. The mathematical algorithm used to construct non-parametric confidence intervals is based on the probability (*P*) that any randomly selected measurement in a sample of n concentration measurements will be less than an unknown *P* x 100th percentile of interest (where *P* is between 0 and 1). Then the probability that the measurement will exceed the *P* x 100^{th} percentile is (1–*P*). The number of sample values falling below the *P* x 100^{th} percentile out of a set of n should follow a binomial distribution with parameters n and success probability *P*, where 'success' is defined as the event that a sample measurement is below the *P* x 100^{th} percentile. The probability that the interval formed by a given pair of order statistics will contain the percentile of interest will then be determined by a cumulative binomial distribution *Bin(x;n,p)*, representing the probability of *x* or fewer successes occurring in *n* trials with success probability p. *P* will be set to 0.50 for an interval around the median.

The sample size n will be ordered from least to greatest. Given *P* = 0.50, candidate interval endpoints will be chosen by ordered data values with ranks close to the product of (n+1) x 0.50. If the result of (n+1) x 0.50 is a fraction (for even-numbered sample sizes), the rank values immediately above and below will be selected as possible candidate endpoints. If the result of (n+1) x 0.50 is an integer (for odd-numbered sample sizes), one will be added to and subtracted from the result to get the upper and lower candidate endpoints. The ranks of the endpoints will be denoted L* and U*. For a one-sided LCL, the confidence level associated with endpoint L* will be computed as:

$$1 - \alpha = Bin(L^* - 1; n, 0.50) = \sum_{x=L^*}^{n} \binom{n}{x} \left(\frac{1}{2}\right)^n$$

If the candidate endpoint(s) do not achieve the desired confidence level, new candidate endpoints (L*−1) and (U*+1) and achieved confidence levels will be calculated. If one candidate endpoint equals the data minimum or maximum, only the rank of the other endpoint will be changed. Achievable confidence levels are tabulated using these equations in Table 21-11 in Appendix D of the *Unified Guidance*.

Both parametric and non-parametric confidence limits will then be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance monitoring wells. A GWPS exceedance is determined if the LCL exceeds the GWPS.

3.1.4 The Upper Prediction Limit for a Future Mean

The parametric UPL for a future mean will be used to calculate the GWPS if the pooled background data contain 50 to 70 percent non-detects and normality can be achieved. The Kaplan-Meier or ROS methods will be used to estimate the mean and standard deviation. The non-parametric UPL for a future median will be calculated as the GWPS if background samples cannot be normalized or contain greater than 70 percent non-detects. The parametric UPL for a future mean will be calculated from the background dataset at follows:

$$UPL_{1-\alpha} = \overline{x} + \kappa s$$

$\overline{x}$ = background sample mean

s = background standard deviation

κ = multiplier based on the order (p) of the future mean to be predicted, the number of compliance wells to be tested (w), the background sample size (n) the number (c) of constituents of concern (COCs), the “1-of-m” retesting scheme, and the evaluation schedule (annual, semi-annual, quarterly). Values are tabulated in 19-5 to 19-9 in Appendix D of the *Unified Guidance*.

The mean of order p will be computed for each well and compared against the UPL. For any compliance point mean that exceeds the limit, p additional resamples may be collected at that well for a 1-of-2 retesting scheme. Resample means will then be compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when the initial mean and all resample means exceed the UPL.

3.1.5 The Non-Parametric Upper Prediction Limit for a Future Median

The non-parametric UPL for a future median will be used to calculate the GWPS if the pooled background data contain greater than 70 percent non-detects and normality cannot be achieved. Non-parametric methods assume that the data does not have an underlying distribution. To calculate the non-parametric UPL on a future value, the target per-constituent false positive rate (a_{const}) will be determined as follows:

$$\alpha_{const} = 1 - (1 - \alpha)^{1/c}$$

α = the site-wide false positive rate (SWFPR) of 0.10 recommended by the *Unified Guidance*

c = the number of monitoring constituents

The number of yearly statistical evaluation (nE) will be multiplied by the number of compliance wells (w) to determine the look-up table entry, w*. The background sample size (n) and w* will be used to select an achievable per-constituent false positive rate value in Table 19-24 of Appendix D in the *Unified Guidance*. The chosen achievable per-constituent false positive rate value will determine the type of non-parametric prediction limit (maximum or 2nd highest value in background) and a retesting scheme for a future median. The background data will be sorted in ascending order, and the upper prediction limit will be set to the appropriate order statistic previously determined by the achievable per-constituent false positive rate value in Table 19-24. If all constituent measurements in a background sample are non-detect, the Double Quantification rule will be used. The use of the Double Quantification rule in Compliance Monitoring will only be applicable if the RL is above the 35 I.A.C. § 845.600(a)(1) constituent concentration or a constituent concentration is not specified in § 845.600(a)(1). This scenario is highly unlikely. The constituent will also be removed from calculations identifying the target false positive rate.

Two initial measurements per compliance well will be collected. If both do not exceed the upper prediction limit, a third initial measurement will not be collected since the median of order 3 will also not exceed the limit. If both exceed the prediction limit, a third initial measurement will not be collected since the median will also exceed the limit. If one initial measurement is above and one below the limit, a third initial observation may be collected to determine the position of the median relative to the UPL. Up to three resamples will be collected in order to assess the resample median. In all cases, if two or more of the compliance point observations are non-detect, the median will be set equal to the RL. The median value for each compliance well will be compared to the UPL. For the 1-of-2 retesting scheme, if any compliance point median exceeds the limit, up to three additional resamples will may be collected from that well. The resample median will be computed and compared to the UPL. A GWPS exceedance has been deemed to occur at a compliance well when either the initial median, or both the initial median and resample median exceed the UPL.

If the concentrations of detected constituents are below the established GWPS, Compliance Monitoring will continue.

3.1.6 Parametric Linear Regression and Confidence Band

If the t-test detects a significant trend in the parametric linear regression line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. If this is not accounted for, a wider confidence interval will inevitably be calculated for a given confidence level and sample size (n). A wider confidence interval will result in less statistical power, or ability to demonstrate an exceedance or return to compliance. When a linear trend line has been estimated, a series of confidence intervals is estimated at each point along the trend. This creates a simultaneous confidence band that follows the trend line. As the underlying population mean increases or decreases, the confidence band does also to reflect this change at that point in time.

Linear regression will be used when background or compliance data are approximately normally distributed, with a constant sample variance around the mean, and the frequency of non-detects is low. The linear regression of concentration against sampling date (time) will be computed as follows:

$$\hat{b} = \sum_{i=1}^{n} (t_i - \bar{t}) \cdot x_i / (n-1) \cdot s_t^2$$

x_i = i^{th} concentration value and

t_i = i^{th} sampling date

$\bar{t}$ = sampling mean date

s_t^2 = variance of the sampling dates

This estimate leads to the following regression equation:

$$\hat{x} = \bar{x} + \hat{b} \cdot (\mathrm{t} - \bar{t})$$

$\bar{x}$ = mean concentration level

$\hat{x}$ = estimated mean concentration at time t

The regression residuals will also be computed at each sampling event to ensure uniformity and lack of significant skewness. Regression residuals will be computed at each sampling event as follows:

$$r_i = x_i - \hat{x}_i$$

The estimated variance around the regression line, or mean squared error (MSE) will be computed as follows:

$$s_e^2 = \frac{1}{n-2} \sum_{i=1}^{n} r_i^2$$

The confidence intervals around a linear regression trend line given confidence level (1-α) and a point in time (t_0), will be computed as follows:

$$LCL_{1-\alpha} = \hat{x}_0 - \sqrt{2s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-1} \cdot \left[\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$$UCL_{1-\alpha} = \hat{x}_0 - \sqrt{2s_e^2 \cdot F_{1-2\alpha,2,\mathrm{n}-2} \cdot \left[\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1) \cdot s_t^2}\right]}$$

$\hat{x}_0$ = estimated mean concentration from the regression equation at time t_0

$F_{1-2\alpha,2,\mathrm{n}-2}$ = upper $(1\text{-}2\alpha)^{\text{th}}$ percentage point from an F-distribution with 2 and (n-2) degrees of freedom

For background data, the UCL around the linear regression line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the linear regression line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is determined when the LCL based on the trend line first exceeds the GWPS.

3.1.7 Non-Parametric Thiel-Sen Trend Line and Confidence Band

If the Mann-Kendall test detects a significant trend in the non-parametric Thiel-Sen line using either background or compliance data for a particular constituent, confidence bands accounting for trends will be constructed to account for the trend-induced variation. The Thiel-Sen trend line will be used as a non-parametric alternative to linear regression when trend residuals cannot be normalized or if there are a higher percentage of non-detects in either background or compliance data. The Thiel-Sen trend line estimates the median concentration over time by combining the median pairwise slope with the median concentration value and the median sample date. To compute the Thiel-Sen line, the data will first be ordered by sampling event x1, x2, xn. All possible distinct pairs of measurements (x_i, x_j) for j > i will be considered and the simple pairwise slope estimate will be computed for each pair as follows:

$$m_{ij} = (x_j - x_i)/(j - i)$$

With a sample size of n, there will be a total of N = n(n-1)/2 pairwise estimates (m_{ij}). If a given observation is a non-detect, half the RL will be substituted. The N pairwise slope estimates (m_{ij}) will be ordered from least to greatest (renamed m(1), m(2),..m(N)). The Thiel-Sen estimate of slope (Q) will be calculated as the median value of the list depending on whether N is even or odd as follows:

$$Q = \begin{cases} m_{([N+1]/2)} \; if\; N\; is\; odd \\ (m_{(N/2)} + m_{([N+2]/2)})/2 \; if\; N\; is\; even \end{cases}$$

The sample concentration magnitude will be ordered from least to greatest, x(1), x(2), to x(n) and the median concentration will be calculated as follows:

$$\tilde{x} = \begin{cases} x_{([n+1]/2)} \; if\; n\; is\; odd \\ (x_{(n/2)} + x_{([n+2]/2)})/2 \; if\; n\; is\; even \end{cases}$$

The median sampling date ($\tilde{t}$) with ordered times (t(1), t(2), to t(n)) will also be determined in this way. The Thiel-Sen trend line will then be computed for an estimate at any time (t) of the expected median concentration (x) as follows:

$$x = \tilde{x} + Q \cdot (\mathrm{t} - \tilde{t}) = (\tilde{x} - Q \cdot \tilde{t}) + Q \cdot \mathrm{t}$$

To construct a confidence band around the Thiel-Sen line, sample pairs (ti, xi) will be formed with a sample date (ti) and the concentration measurement from that date (xi). Bootstrap samples (B) will be formed by repeatedly sampling n pairs at random with replacement from the original sample pairs. This will be repeated 500 times. For each bootstrap sample, a Thiel-Sen trend line will be constructed using the equation above. A series of equally spaced time points (tj) will be identified along the range of sampling dates represented in the original sample, j =1 to m. The Thiel-Sen trend line associated with each bootstrap replicate will be used to compute an estimated concentration ($\hat{x}_j^B$). An LCL will be constructed for the lower α^{th} percentile $\hat{x}_j^{[\alpha]}$ from the distribution of estimated concentrations at each time point (tj). For a UCL, compute the upper $(1-\alpha)^{th}$ percentile, $\hat{x}_j^{[1-\alpha]}$ at each time point (tj).

For background data, the UCL around the Thiel-Sen trend line will be used as the GWPS for the trending constituent. For compliance data, confidence bands around the Thiel-Sen trend line will be compared to the GWPS. The CCR unit is considered to be in compliance if the LCL is equal to or lower than the GWPS for all detected constituents at all compliance wells. A GWPS exceedance is confirmed when the LCL based on the trend line first exceeds the GWPS.

3.2 Determination of Statistically Significant Increases over Background

In accordance with 35 I.A.C. §§ 845.610(b)(3)(B) and 845.640(h), individual monitoring event concentrations for each constituent detected in the compliance monitoring wells during compliance monitoring sampling events will be compared to the background concentration as determined by the methods described above. An exceedance of the background concentration for any constituent measured at any compliance monitoring well, or constituent detection if not detected in the background samples, constitutes a Statistically Significant Increase (SSI). An exception to this method is pH, where two-sided (upper and lower) tolerance limits are established from the distribution of the background groundwater quality data. An exceedance of either the UTL or lower tolerance limit (LTL) would constitute an SSI for pH.

4. REFERENCES

Davis, C.B., 1994. *Environmental Regulatory Statistics.* In GP Patil & CR Rao (Eds.) *Handbook of Statistics, Volume 12: Environmental Statistics*, Chapter 26. New York: Elsevier Science B.V.

United States Environmental Protection Agency (USEPA), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA 530-R-09-007. March 2009.

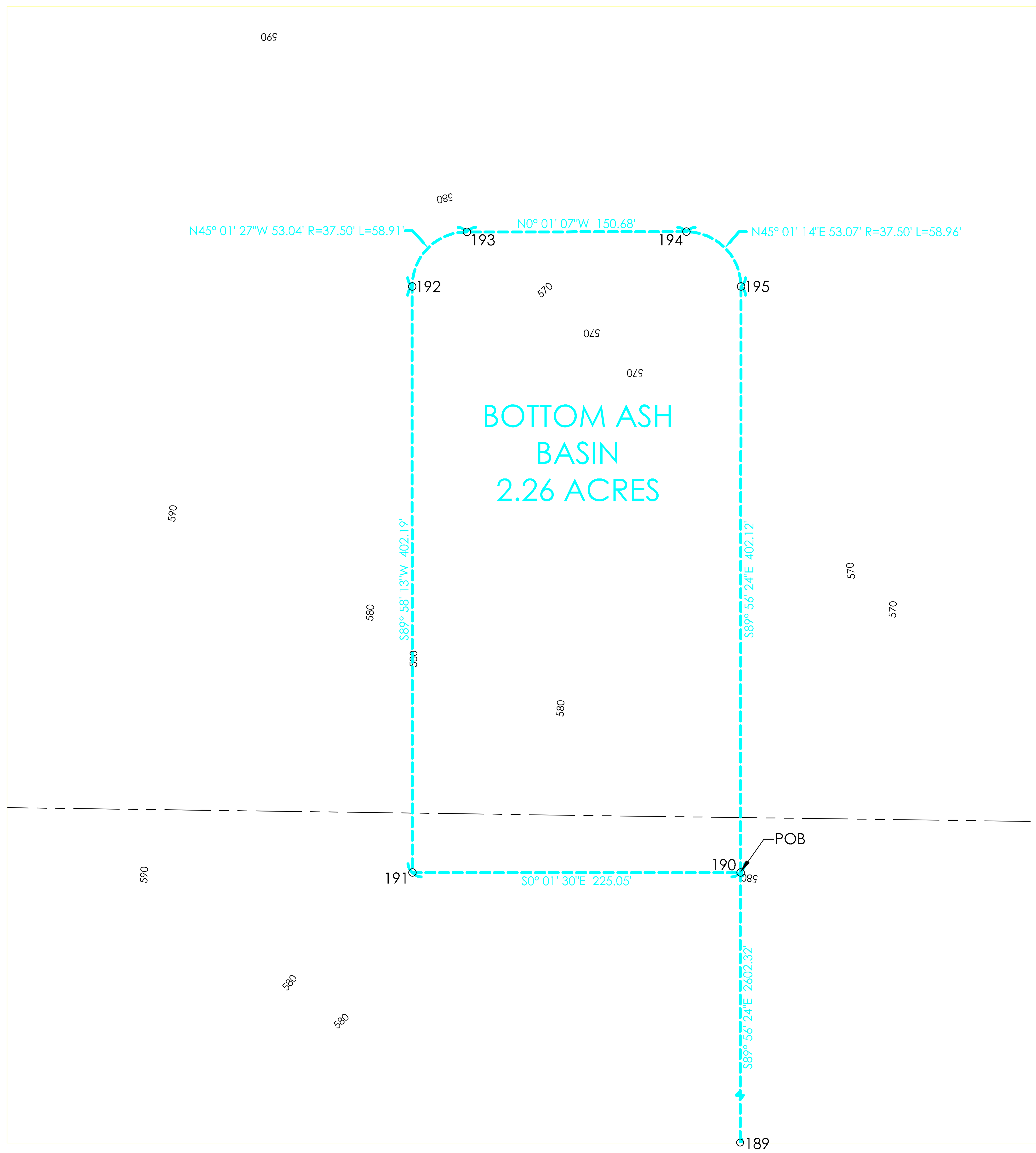
APPENDIX H

Legal Description

FACILITY CORNER COORDINATES		
Point #	Northing	Easting
189	1384451.47	2345101.36
190	1384448.75	2347703.68
191	1384673.80	2347703.58
192	1384674.01	2348105.77
193	1384636.52	2348143.29
194	1384485.84	2348143.34
195	1384448.33	2348105.80

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT



0' 50' 100'

LEGEND

- SECTION LINE
- RESTRICTED USE BOUNDARY
- APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE
- FACILITY BOUNDARY
- N0° 47' 10"E 3100.48' RECORD BOUNDARY DIMENSIONS
- ● FOUND SURVEY MARKER AS NOTED
- M DENOTES MEASURED DIMENSION

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN MARCH 16 THROUGH JUNE 29, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988.

Land Description of the Duck Creek Power Plant
Bottom Ash Basin Facility Boundary
2.26 Acres

Part of the South Half of Section 30, Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

Commencing at the Four Way Township Corner Being the same as the Southeast corner of Section 36 T. 6 N., R. 4 E., also being the same as the Southwest corner of Section 31 T. 6 N., R. 5 E. of the Fourth Principal Meridian; thence North 0 degrees 46 minutes 44 seconds East along the Township line dividing T. 6 N., R 4 E. and T. 6 N., R. 5 E. a distance of 6099.34 feet; thence South 89 degrees 56 minutes 24 seconds East a distance of 2602.32 feet to the Point of Beginning of the Tract described herein; thence continuing South 89 degrees 56 minutes 24 seconds East a distance of 402.12 feet; thence along a curve to the left having a radius of 37.50 feet, a curve length of 58.96 feet, a chord bearing North 45 degrees 01 minutes 14 seconds East, a chord distance of 53.07 feet; thence North 0 degrees 01 minutes 07 seconds West a distance of 150.68 feet; thence along a curve to the left having a radius of 37.50 feet a curve length of 58.91 feet, a chord bearing North 45 degrees 01 minutes 27 seconds West, a chord distance of 53.04 feet; thence South 89 degrees 58 minutes 13 seconds West a distance of 402.19 feet; thence South 0 degrees 01 minutes 30 seconds East a distance of 225.05 feet to the Point of Beginning and containing 2.26 Acres.

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:	Date:
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	

Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

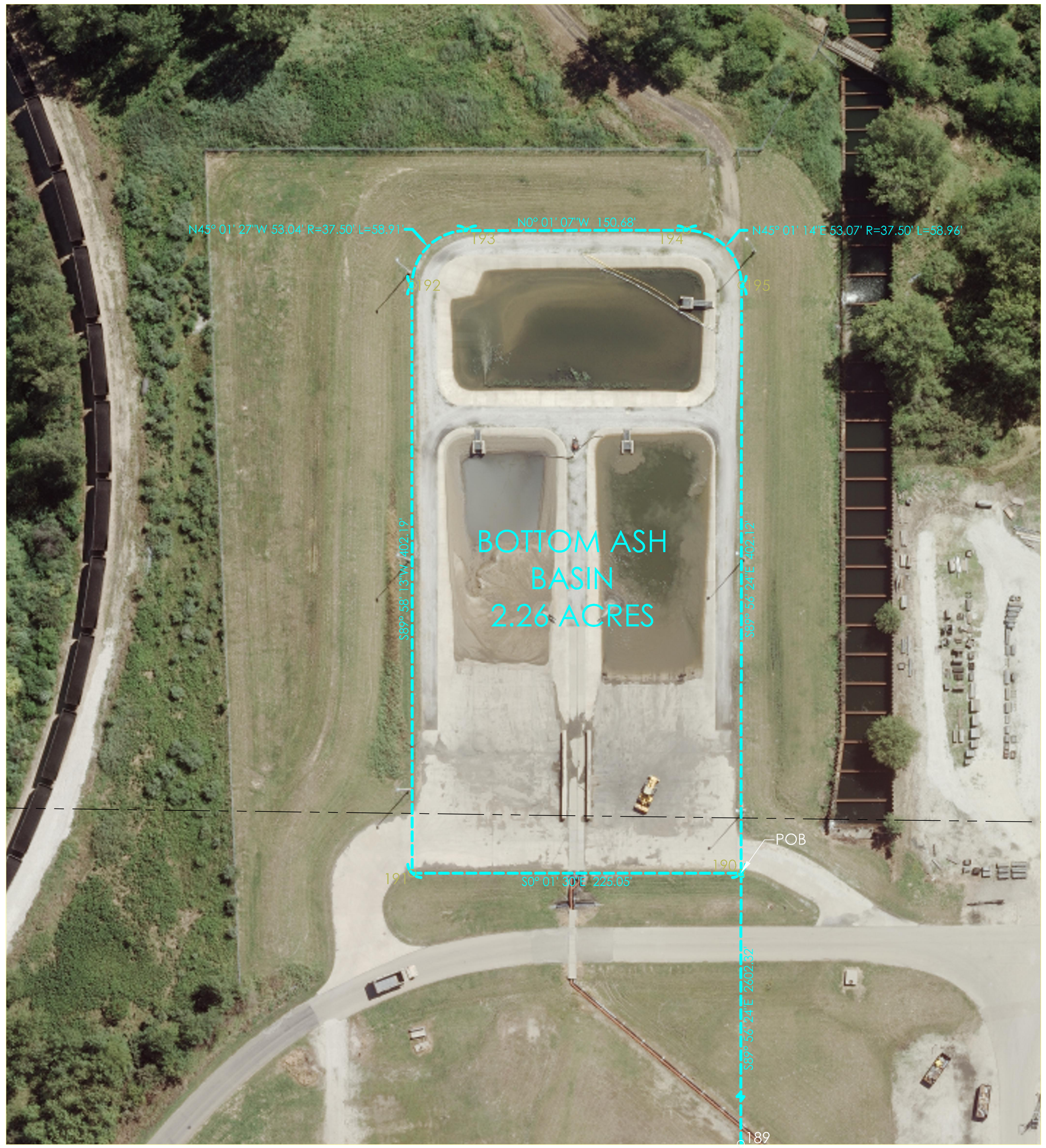
Drawing Name:
BOTTOM ASH BASIN BOUNDARY EXHIBIT

Date: 9/21/2021	Project No.
Type: SITE	Drawing No. 5
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

FACILITY CORNER COORDINATES		
Point #	Northing	Easting
189	1384451.47	2345101.36
190	1384448.75	2347703.68
191	1384673.80	2347703.58
192	1384674.01	2348105.77
193	1384636.52	2348143.29
194	1384485.84	2348143.34
195	1384448.33	2348105.80

Luminant

ILLINOIS POWER RESOURCES GENERATING L.L.C.
DUCK CREEK POWER PLANT



0' 50' 100'

LEGEND

- SECTION LINE
- RESTRICTED USE BOUNDARY
- APPROXIMATE DUCK CREEK POWER STATION PROPERTY BOUNDARY LINE
- FACILITY BOUNDARY
- N0° 47' 10"E 3100.48' RECORD BOUNDARY DIMENSIONS
- ● FOUND SURVEY MARKER AS NOTED
- M DENOTES MEASURED DIMENSION

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN MARCH 16 THROUGH JUNE 29, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS SHOWN HEREON ARE BASED ON NAVD 1988.

Land Description of the Duck Creek Power Plant
Bottom Ash Basin Facility Boundary
2.26 Acres

Part of the South Half of Section 30, Township 6 North, Range 5 East of the Fourth Principal Meridian, Fulton County, Illinois and being more particularly described as follows:

Commencing at the Four Way Township Corner Being the same as the Southeast corner of Section 36 T. 6 N., R. 4 E., also being the same as the Southwest corner of Section 31 T. 6 N., R. 5 E. of the Fourth Principal Meridian; thence North 0 degrees 46 minutes 44 seconds East along the Township line dividing T. 6 N., R 4 E. and T. 6 N., R. 5 E. a distance of 6099.34 feet; thence South 89 degrees 56 minutes 24 seconds East a distance of 2602.32 feet to the Point of Beginning of the Tract described herein; thence continuing South 89 degrees 56 minutes 24 seconds East a distance of 402.12 feet; thence along a curve to the left having a radius of 37.50 feet, a curve length of 58.96 feet, a chord bearing North 45 degrees 01 minutes 14 seconds East, a chord distance of 53.07 feet; thence North 0 degrees 01 minutes 07 seconds West a distance of 150.68 feet; thence along a curve to the left having a radius of 37.50 feet a curve length of 58.91 feet, a chord bearing North 45 degrees 01 minutes 27 seconds West, a chord distance of 53.04 feet; thence South 89 degrees 58 minutes 13 seconds West a distance of 402.19 feet; thence South 0 degrees 01 minutes 30 seconds East a distance of 225.05 feet to the Point of Beginning and containing 2.26 Acres.

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:	Date:
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	

Luminant

Project Name & Location:

DUCK CREEK
POWER PLANT
17751 N. CILCO RD.
CANTON, IL 61520

Drawing Name:

BOTTOM ASH BASIN BOUNDARY EXHIBIT

Date: 9/21/2021	Project No.
Type: SITE	Drawing No. 6
Drawn By: CB	
Approved By: MG	
Scale: AS NOTED	

APPENDIX I

Public Meetings Information

Dianna Tickner
Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

January 28, 2022

Illinois Environmental Protection Agency
DWPC – Permits MC # 15
ATTN: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: 35 IAC 845.220(a)(9) Certification Statement
Duck Creek Power Plant Bottom Ash Basin (IEPA ID # W0578010001-03)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundment and in accordance with 35 IAC 845.220(a)(9), Illinois Power Resources Generating, LLC certifies that the public notification and public meetings required under 35 IAC 845.240 were completed. Please find enclosed both the public meeting summary and listserv.

Sincerely,
Illinois Power Resources Generating, LLC

Dianna Tickner

Dianna Tickner
Director, Decommissioning & Demolition

Duck Creek Public Meeting Issues Summary, December 7, 2021

On Sunday, November 7, 2021, Illinois Power Resource Generating, LLC made available to the public its plans to close the GMF Pond and Bottom Ash Basin (BAB) CCR surface impoundments located at Duck Creek Power Plant. On Tuesday, December 7, 2021, Illinois Power Resource Generating, LLC held in-person and virtual public meetings at 3:00 pm and 5:30 pm to present its decision-making process, a comparison of projected groundwater impacts for the alternatives presented, and an objective comparison of the pros and cons of each alternative presented. During the question-and-answer portion of the meeting, the public asked questions related to the closure and, the company-provided answers.

As required by Section 845.240(g), Illinois Power Resource Generating, LLC distributed to those public meeting attendees who requested a copy a general summary of the issues raised by the public, a response to those issues or comments raised by the public, and a summary of any revisions, changes, and considerations made to the closure plans, on December 21, 2021.

Issue/Topic		**Summary of Response Provided at Meeting**	**Additional Written Response**
1.	Engineered Final Cover System at the GMF Pond	The final cover system includes a 60-mil high-density polyethylene (HDPE) geomembrane and 2 feet of soil on top of the geomembrane to protect the geomembrane from damage. Vegetative grass with a shallow root system will be planted on the final cover system. The geomembrane will be rolled out in panels. The panels will be heat sealed to each other. In combination with the existing liner system, the final cover system will provide complete encapsulation of the material within the GMF Pond. The final cover system will be monitored for 30 years. If preferential pathways for water infiltration through the final cover system were to form, they would be detected during the monitoring and inspections and would be corrected. Groundwater data will continue to be collected to monitor system performance. Groundwater data will be publicly available.	The issue of geomembrane service life was raised. A significant amount of research has been conducted to evaluate the expected service life of geomembranes under different field conditions. The Geosynthetics Research Institute developed the foremost technical paper on this topic entitled "Geomembrane Lifetime Predictions: Unexposed and Exposed Conditions" (Koerner et al., 2011) to summarize the findings from a 12-year study on this topic and to provide guidance on the expected service life for geomembranes. The expected service life of a geomembrane is dependent on whether it is exposed or unexposed to ultraviolet radiation and other environmental factors, as well as the in-service temperature of the geomembrane. The geomembrane in the final cover system over the GMF Pond will be covered with soil, so it will be unexposed. Considering the soil cover thickness and the climate at the site, the highest expected in-service temperature at the depth of the geomembrane is about 20˚C (68˚F). According to Koerner et al. (2011), the expected service life of an HDPE geomembrane under these conditions is nearly 450 years.

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			In accordance with Section 845.780(c), the monitoring and inspection period for the GMF Pond is at least 30 years.
2.	GMF Pond Liner System	The GMF Pond was built and lined in or around 2010. The liner system beneath the GMF Pond is a very robust, state-of-the-art system. No exceedances of Groundwater Protection Standards (GWPS) related to the GMF Pond have been detected.	Based on information reviewed after the public meeting, the GMF Pond was constructed in 2008 and 2009. The GMF Pond liner system was designed and constructed to meet or exceed the criteria specified in 35 IAC 811 and 40 CFR 257 (Hanson Professional Services Inc., 2016). It has an upper geomembrane and a lower geomembrane with a leak detection system between them. The leak detection system has not detected any leakage. The lower geomembrane has two additional soil barrier layers below it for enhanced containment/redundancy. The issue of geomembrane service life was raised. A significant amount of research has been conducted to evaluate the expected service life of geomembranes under different field conditions. The Geosynthetics Research Institute developed the foremost technical paper on this topic entitled "Geomembrane Lifetime Predictions: Unexposed and Exposed Conditions" (Koerner et al., 2011) to summarize the findings from a 12-year study on this topic and to provide guidance on the expected service life for geomembranes. The expected service life of a geomembrane is dependent on whether it is exposed or unexposed to ultraviolet radiation and other environmental factors, as well as the in-service temperature of the geomembrane. The geomembranes in the liner system beneath the GMF Pond will be unexposed at closure. Considering the depth to the liner system and the measured temperatures of groundwater in the vicinity of the GMF Pond, the highest expected in-service temperature at the depths of the geomembranes is about 20°C (68°F).

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			According to Koerner et al. (2011), the expected service life of an HDPE geomembrane under these conditions is nearly 450 years. As a result of the issue raised by the public, the closure plan for the GMF Pond will be revised slightly to indicate that all areas of the liner system will be covered with soil to prevent geomembrane exposure.
3.	Groundwater Monitoring	At the GMF Pond, there are approximately 52 groundwater monitoring wells. At the BAB, there are approximately 10 groundwater monitoring wells. Maps and tables showing well locations and depths have been provided in the on-line, publicly available materials. Quarterly groundwater monitoring is required for at least 30 years after closure of the GMF Pond (closure in place). Groundwater monitoring is required for at least 3 years after closure of the BAB (closure by removal). Follow-up actions are required if GWPS exceedances are detected, as prescribed in Part 845, but there is no expectation of future impacts associated with the GMF Pond or BAB.	Based on information reviewed after the public meeting, we have confirmed there are 10 monitoring wells around the BAB. There are 36 monitoring wells around the GMF Pond, and 16 monitoring wells located around the GMF Recycle Pond. The proposed Part 845 monitoring well network for the BAB consists of 8 monitoring wells. The proposed Part 845 monitoring well network for the GMF Pond will consist of 10 wells and 1 unit water monitoring location.
4.	Water Handling	Ponded water in the GMF Pond will be removed to facilitate closure; interstitial water (water within pore spaces) will remain. Water will be discharged through an existing NPDES outfall, consistent with permit requirements. Treatment may be required prior to discharge.	No additional response is necessary.

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
5.	Risk Assessment	We will provide a written response for this issue due to the level of technical detail involved.	The Duck Creek Power Plant Risk Assessment was conducted to identify potential hazards and evaluate potential risks to human and ecological receptors that may be exposed to CCR constituents in environmental media potentially impacted by the GMF Pond and BAB. The conceptual site model (CSM) provides a basis for understanding the site conditions and exposure pathways for receptors that may be exposed to site-related constituents. Exposure pathways refer to the way a person or animal could come in contact with a constituent. They are generally referred to as either complete or incomplete. The necessary components for a complete exposure pathway consist of: ▪ A source and mechanism of constituent release from the source; ▪ Retention or transport of the constituent through the environmental medium; ▪ A point of contact between the receptor and the environmental medium; and ▪ A route of exposure for the potential receptor at the contact point. Cancer risks are expressed as a unitless probability of an individual developing cancer over a lifetime, above background risk, as a result of site-related exposures. US EPA has established an acceptable target cancer risk range of 1×10^{-6} to 1×10^{-4} (US EPA, 1990, 1991). Non-cancer risks are expressed as a hazard index (HI) and US EPA has established an acceptable target HI of 1 (US EPA, 1997). An HI less than 1 suggests that exposures are not likely to cause an appreciable risk of non-cancer effects during a lifetime. Risks above these US EPA defined target levels are termed potentially "unacceptable risks".

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			For the Duck Creek Risk Assessment, we followed processes and protocols provided by US EPA comparing measured and modeled environmental concentrations to screening levels (*e.g.*, surface water quality standards) that have been determined by US EPA to be protective of human health and the environment. If the environmental concentrations were below the health protective screening levels, we concluded that there is no unacceptable risk. Based on the evaluation, no unacceptable risks to human and ecological receptors resulting from CCR exposures associated with either the GMF Pond or the BAB were identified.
6.	Closure Cost Estimation	For this current evaluation cost estimates were not considered. Cost estimates are being prepared and will be included in the construction permit application.	
7.	Financial Assurance/Future Assurances	Part 845 requires that the owner provide financial assurance instruments to cover the cost of closure and post-closure care in the event that the owner is unable to carry out these obligations.	Illinois Power Resources Generating, LLC (IPRG) has complied with the Part 845 financial assurance requirements for each of the CCR surface impoundments it is closing under Part 845. The financial assurance provisions in Part 845 are robust and were constructed based on other established financial assurance program regulations. Financial assurance has already been provided for closure activities, post-closure activities, and to address the need for potential remediation of releases and will be updated in the future as needed. The mechanisms for financial assurance provided for under Part 845 are all ones that have been successfully used in other regulatory contexts and that can be easily accessed by IEPA. For Duck Creek, IPRG is using surety bonds guaranteeing performance as its financial assurance mechanism. In the unlikely event of a default, this form of financial assurance allows the surety to step in to perform the closure, post-closure care, or corrective action or to pay a penal sum that will

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			be placed into the CCR Surface Impoundment Financial Assurance Fund within the State Treasury, assuring the work under Part 845 will be performed.
8.	Availability of Information Related to Public Meetings	Slides will not be posted on our publicly available website. Written responses will be provided to all issues raised in the public meetings.	
9.	On-Site Landfill	The landfill has been permitted with IEPA and permit conditions allow disposal of CCR. It has received CCR and will be closed in accordance with the permit after final receipt of waste.	The landfill remains open only for decommissioning activities. There is not capacity in the landfill for disposal of materials from the GMF Pond.
10.	GMF Recycle Pond	The GMF Recycle Pond is regulated under different regulatory provisions (*i.e.*, not Part 845) since it is not a CCR surface impoundment.	No further response is necessary since this question does not pertain to the GMF Pond or Bottom Ash Basin.
11.	Cooling Pond	The cooling pond is not subject to Part 845. Sampling is required for discharges from the cooling pond in accordance with the NPDES permit.	No further response is necessary since this question does not pertain to the GMF Pond or Bottom Ash Basin.
12.	NPDES Permitting	All surface water runoff from the closed GMF Pond and BAB will flow into the cooling pond. Discharges from the cooling pond are regulated by a NPDES permit. The NPDES permit is currently up for reauthorization. The NPDES permit reauthorization is a different issue from the CCR units and the Part 845 requirements.	The ammonia and other constituents are a byproduct of former used air pollution control devices.

In accordance with 845.240(f)(4), a list people who requested to be added to the IEPA Listserv for Duck Creek is as follows:

Duck Creek Listserv	
Name	email
Joseph Cooper	bgfarm47@gmail.com
Nancy Long	nclong405@yahoo.com
Joyce Blumanshire	joblumen@yahoo.com
Bob Jorgensen	jestpr@hotmail.com
Russell Shantz	icmfarm@yahoo.com
Bob Gilmore	robert.gilmore67@gmail.com
Andrew Rehn	arehn@prairierivers.org

APPENDIX J

Training Program Statement

Luminant

Dianna Tickner
Dynegy Midwest Generation, LLC
Illinois Power Resources Generating, LLC
1500 Eastport Plaza Drive
Collinsville, IL 62234

January 14, 2022

Illinois Environmental Protection Agency
DWPC – Permits MC # 15
ATTN: Part 845 Coal Combustion Residual Rule Submittal
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Re: 415 ILCS 5/22.59(b)(4) Certification Statement
Duck Power Plant GMF Pond (IEPA ID # W0578010001-04)
Duck Creek Power Plant Bottom Ash Basin (IEPA ID # W0578010001-03)
Hennepin Power Plant East Ash Pond (IEPA ID # W1550100002-05)
Vermilion Power Plant New East Ash Pond (IEPA ID # W1838000002-04)
Vermilion Power Plant North Ash Pond/Old East Ash Pond (IEPA ID # W1838000002- 01,03)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundments and in accordance with 415 ILCS 5/22.59(b)(4), Dynegy Midwest Generation, LLC and Illinois Power Resources Generating, LLC certify that all contractors, subcontractors, and installers utilized to construct, install, modify, or close a CCR surface impoundment will be participants in a training program that is approved by and registered with the US Department of Labor's Employment and Training Administration and that includes instruction in the following: erosion control, environmental remediation, operation of heavy equipment and excavation.

Sincerely,
Dynegy Midwest Generation, LLC
Illinois Power Resources Generating, LLC

Dianna Tickner

Dianna Tickner
Director, Decommissioning & Demolition

GOLDER
MEMBER OF WSP

golder.com