Luminant

Dynegy Midwest Generation, 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: Hennepin Power Plant East Ash Pond; IEPA ID W1550100002-05

Dear Mr. LeCrone:

In accordance with 35 I.A.C. § 845.200, Dynegy Midwest Generation, LLC (DMG) is submitting a construction permit application for the Hennepin Power Plant East Ash Pond (IEPA ID W1550100002-05). 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 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:
W1550100002-05

CCR Permit Number:
Initial Permit

Facility Name:
Hennepin 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

Hennepin 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
13498 East 800th Street

County name Putnam	County code (if known)	
City or town Hennepin	State Illinois	Zip Code 61327

1.6 Name of Owner/Operator

Dynegy Midwest Generation, 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.		
		W1550100002-05 (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:
W1550100002 - 05

CCR Permit Number:
Initial Permit

Facility Name:
Hennepin 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.	East Ash Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).	W1550100002-05
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 C.
1.5	How long has the CCR surface impoundment been in operation?	See Attachment C.
1.6	List the types of CCR that have been placed in the CCR surface impoundment.	See Attachment D.

Design and Construction Plans (Continued)

1.7	List the name of the watershed within which the CCR surface impoundment is located.	
	See Attachment C.	
1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
	See Attachment C.	
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 D.

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 Section 2.2 of the construction permit application.

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.

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

CONSTRUCTION PERMIT APPLICATION

HENNEPIN POWER PLANT
EAST ASH POND
(IEPA ID W1550100002-05)
Hennepin, Illinois

Prepared by

Geosyntec
consultants
engineers | scientists | innovators

1 McBride and Son Center Drive, Suite 202
Chesterfield, Missouri 63005

Project Number GLP8026

Revision 0

January 28, 2022

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ATTACHMENTS

1. INTRODUCTION

Dynegy Midwest Generation, LLC (Dynegy) is the owner of the coal-fired Hennepin Power Plant (HPP), also referred to as Hennepin Power Station, in Hennepin, Illinois. The HPP was active until December of 2019, after which electricity production and coal combustion residual (CCR) production ceased and the HPP became inactive. According to the Illinois Environmental Protection Agency (IEPA), this power station had five CCR surface impoundments, as listed in **Table 1**. This construction permit application is for the East Ash Pond (EAP). The remaining four CCR surface impoundments at HPP were closed in 2020, prior to promulgation of Part 845.

Table 1 – CCR Surface Impoundments at Hennepin Power Plant

Impoundment Name	Status	Acronym	IEPA ID Number	Dynegy CCR Unit ID	National Inventory of Dams Number
East Ash Pond	**Active**	**EAP**	**W1550100005-05**	**803**	**IL50363**
Old West Ash Pond (Pond No. 1 and Pond No. 3)	Closed [1]	OWAP	W1550100002-01	804	IL50698
Old West Polishing Pond	Closed [2]		W1550100002-03		
Ash Pond No. 2	Closed [1]	AP2	W1550100002-04	802	IL50363
Ash Pond No. 4	Closed	AP4	W1550100002-07	508	None

This construction permit application was developed in accordance with 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845).

1.1. Legal Description

Section 845.210(c): *All permit applications must contain a legal description of the facility boundary and a description of the boundaries of all units included in the facility.*

Legal description of the facility is provided in **Attachment A**.

1.2. Previous Assessments

Section 845.210(d): *Previous Assessments, Investigations Plans, and Programs*

Although the HPP is currently inactive, it was operating as of October 19, 2015 and the EAP was actively receiving CCR at that time. The EAP was therefore initially regulated by 40 C.F.R. Part 257, herein referred to as the CCR Rule [3] and subsequently regulated by Part 845. Multiple previous initial and periodic assessments, investigation plans, and programs were completed for the EAP to satisfy the requirements of both the CCR Rule and Part 845; some of which are referred to within this report.

<u>Section 845.210(d)(1):</u> *The Agency may approve the use of any hydrogeologic site investigation or characterization, groundwater monitoring well or system, or groundwater monitoring plan, bearing the seal and signature of an Illinois Licensed Professional Geologist or Licensed Professional Engineer, completed before April 21, 2021 to satisfy the requirements of this Part.*

The hydrogeologic site investigation and characterization, groundwater monitoring well system, and groundwater monitoring plan are provided for the EAP in **Attachment B**.

<u>Section 845.210(d)(4):</u> *For inactive closed CCR surface impoundments, the owner or operator of the CCR surface impoundment may use a post-closure care plan previously approved by the Agency.*

No post-closure care plan for the EAP was previously approved by the Agency.

2. CONSTRUCTION PERMIT

2.1. History of Construction

Section 845.220(a)(1): Design and Construction Plans (Construction History)

The History of Construction report for the EAP and subsequent update letter is provided in **Attachment C**.

2.2. Narrative Description of Facility

Section 845.220(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:

The Facility Narrative Description details are described in the following sections.

Section 845.220(a)(2)(A): The types of CCR expected in the CCR surface impoundment, including a chemical analysis of each type of expected CCR;

The types of CCR expected in EAP and analysis of the chemical constituents found within the CCR in the EAP is provided in **Attachment D.**

Section 845.220(a)(2)(B): An estimate of the maximum capacity of each surface impoundment in gallons or cubic yards;

The EAP currently contains approximately 680,000 cubic yards (CY) of CCR. No additional CCR will be generated at the HPP. Approximately 7,000 CY (9,500 tons) of additional bottom ash that is currently existing at and was previously generated by the HPP will be placed in the EAP during closure (see **Section 2.4**), resulting in a maximum CCR capacity of approximately 687,000 CY.

Section 845.220(a)(2)(C): The rate at which CCR and non-CCR waste streams currently enter the CCR surface impoundment in gallons per day and dry tons;

There are no CCR waste streams currently entering the EAP as the HPP is inactive and other non-CCR waste streams were subsequently discontinued after retirement of the HPP.

<u>Section 845.220(a)(2)(D):</u> *The estimated length of time the CCR surface impoundment will receive CCR and non-CCR waste streams; and*

There are no CCR waste streams currently entering the EAP as the HPP is inactive and other non-CCR waste streams have subsequently been discontinued. Therefore, there is no additional length of time over which the EAP will receive CCR and non-CCR waste streams.

<u>Section 845.220(a)(2)(E):</u> *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.*

The EAP is currently not receiving CCR as the HPP is inactive, therefore there is no active on-site transportation for CCR materials being actively generated at the HPP. However, site access roads will be used, as necessary to support closure construction for the EAP. An On-Site Transportation Plan was developed as required by Section 845.220(a)(2)(E) and is provided for the EAP in **Attachment F** that includes all on-site access roads and the surrounding roadways.

2.3. Site Maps

<u>Section 845.220(a)(3):</u> *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 another map whose scale clearly shows the following information:*

A. The facility boundaries and all adjacent property, extending at least 1000 meters (3280 feet) beyond the boundary of the facility;
B. All surface waters;
C. The prevailing wind direction;
D. The limits of all 100-year floodplains;
E. All-natural areas designated as a Dedicated Illinois Nature Preserve under the Illinois Natural Areas Preservation Act [525 ILCS 30];
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
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].

A Site Location Map showing the information required in Section 845.220(a)(3) is provided for the EAP in **Attachment F**. The Site Location Map consists of the most recent USGS topographic map (2013) which contains the facility and at least 1,000 metres of the surrounding area. Information included on the site location map meets the requirements for a Flood Hazard Map, Topographic Vicinity Map, Designated Nature Map, Designated Historic and Archeological Site Map, and Identified Critical Habitat Map.

The data in the Site Location Map was collected by performing a comprehensive search of the Illinois Department of Natural Resources (IDNR) natural heritage database [4] for natural and protected areas within 1,000 meters of the EAP. Within Putnam and adjacent Bureau County, a total of 11 of these sites were identified from the Illinois Natural Areas Inventory and 5 were identified from the Illinois Nature Preserves list. None of the natural areas of preserves fall within 1,000 meters of the EAP.

The IDNR natural heritage database also includes a list of Endangered Species by County [5] and notes that a total of 34 threatened and endangered species as located within Putnam County and adjacent Bureau County, including 20 endangered and 14 threatened species. A review of the U.S. Fish and Wildlife Service (USFWS) Threatened & Endangered Species Active Critical Habitat Report [6] identified critical habitat for the endangered Indiana Bat located in adjacent Bureau County, on the opposite bank of the Illinois River from the Site and located within 1,000 meters of the EAP.

A search of the IDNR Historic and Architectural Resources Geographic Information System (HARGIS database [7] for historical sites within the 1,000 meters of the Site located no results.

The 100-year flood plain limits were obtained from the Federal Emergency Management Area (FEMA) Flood Map Service Center [8]. Portions of the HPP site is within the 100-year flood plain of the Illinois River, although the EAP is outside of the 100-year floodplain limits.

<u>Section 845.220(a)(4):</u> *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:*

A. *The entire facility, including any proposed and all existing CCR surface impoundment locations;*
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;*
C. *All existing and proposed groundwater monitoring wells; and*
D. *All main service corridors, transportation routes, and access roads to the facility.*

The Site Plan Map showing the information required in Section 845.220(a)(4) is provided for the EAP in **Attachment F**.

2.4. Narrative Description of Proposed Construction

<u>*Section 845.220(a)(5):*</u> *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.*

The proposed modification to the EAP will include closing the EAP by leaving CCR in-place and covering it with a final cover system. The EAP is a lined CCR surface impoundment. The bottom liner includes a 4-ft thick compacted clay liner with a design permeability of 1×10^{-7} cm/sec overlying a 1-ft thick layer of sand. The side slope liner consists of two layers of 45-mil reinforced polypropylene geomembrane overlying 1-ft of compacted clay [9]. Therefore, closing the EAP with a final cover system will result in the CCR retained within the EAP being encapsulated within a continuous liner system on the sides, bottom, and top of the CCR.

Closure with a final cover system will include unwatering the EAP by removing impounded water, abandoning and grouting the existing outfall structures, regrading existing CCR within the EAP, and constructing a final cover system including a geomembrane, geotextile, cover soil, topsoil, and vegetation. A post-closure stormwater management system including channels and riprap-lined downchutes will direct non-contact stormwater to the adjacent polishing pond.

A CCR volume increase of approximately 7,000 cubic yards (CY) will occur as part of closure. This will include excavating the estimated 7,000 CY of beneficially-placed bottom ash ballast material placed over the primary liner system in the adjacent Hennepin Landfill and placing it in the EAP as compacted subgrade fill. The bottom ash ballast material is the only CCR that has been placed in the Hennepin Landfill, and was utilized to provide freeze protection for the underlying liner system. Production CCR was never placed in the Hennepin Landfill.

No changes in waste streams are expected to occur, outside of using CCR from the bottom ash as compacted subgrade fill, as the EAP does not currently receive CCR or non-CCR waste streams.

All areas affected by releases of CCR from the CCR surface impoundment will be decontaminated in accordance with 845.740(a). All structures and conveyances used to manage CCR will be placed beneath the final cover system of the EAP, decontaminated, or removed and sent to a licensed landfill.

Additional information on the proposed construction and modification to the EAP is included within the Closure Plan provided in **Attachment G**.

2.5. Plans and Specifications

<u>Section 845.220(a)(6):</u> Plans and specifications fully describing the design, nature, function and interrelationship of each individual component of the facility.

Permit-level design plans are included within the Closure Plan provided for the EAP in **Attachment G** and were prepared in accordance with Section 845.220(a)(6). The permit-level design plans are consistent with the narrative description provided in Section 845.220(A)(5).

2.6. Groundwater Monitoring Program

<u>Section 845.220(a)(7):</u> A new groundwater monitoring program or any modification to an existing groundwater monitoring program that includes but is not limited to the following information:

The Groundwater Monitoring Program details are described within this section and the referenced attachments.

<u>Section 845.220(a)(7)(A):</u> A hydrogeologic site investigation meeting the requirements of Section 845.620, if applicable;

Hydrogeologic site investigations for EAP are provided in **Attachment B**.

<u>Section 845.220(a)(7)(B):</u> Design and construction plans of a groundwater monitoring system meeting the requirements of Section 845.630; and

Design and construction plans of a groundwater monitoring system as required by Section 845.630 are provided in **Attachment B**.

<u>Section 845.220(a)(7)(C):</u> A proposed groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data (see Sections 845.640 and 845.650).

A groundwater sampling and analysis program that meets the requirements of Section 845.640 and 845.650 is provided in **Attachment B**.

2.7. Certification

Section 845.220(a)(8): *The signature and seal of a qualified professional engineer.*

I, Lucas P. Carr, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this construction permit application has been prepared in accordance with the accepted practice of engineering.

Lucas P. Carr
Printed Name

1/28/2022
Signature Date

062066694 IL 4/30/2023
Registration Number State Expiration Date

LUCAS PHILIP
CARR
062066694

Affix Seal

2.8. Public Meeting Information

<u>Section 845.220(a)(9):</u> *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.*

Certification that the public notification and public meetings have been completed as required by Section 845.6240 is provided as **Attachment H**.

2.9. Corrective Action Construction

<u>Section 845.220(c):</u> *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:*

Groundwater protection standards are currently being met for the EAP and closure of the EAP will further mitigate future groundwater impacts by acting as source control, based on the Groundwater Model Report prepared by Ramboll and included in **Attachment B**. Therefore, corrective action construction is not required and will not be performed as part of closure of the EAP.

2.10. Closure Construction

<u>Section 845.220(d):</u> *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:*

The Closure Construction details are described in the following sections.

<u>Section 845.220(d)(1):</u> *Closure prioritization category, if applicable (see Section 845.700(g));*

A CCR Surface Impoundment Category Designation and Justification letter was submitted to IEPA on May 19, 2021. The EAP was designated as Category 3 CCR surface impoundment located in an area of environmental justice concern. This letter is provided in **Attachment I**.

<u>Section 845.220(d)(2):</u> *Final closure plan (see Section 845.720(b)), including the closure alternatives analysis required by Section 845.710;*

The Final Closure Plan as required by Section 845.720(b) and the Alternatives Analysis as required by Section 845.210 are provided in **Attachment G**.

<u>*Section 845.220(d)(3):*</u> *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;*
- 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.*

Groundwater modeling as required by Section 845.220(d)(3) is provided in **Attachment B**.

<u>*Section 845.220(d)(4):*</u> *Proposed schedule to complete closure; and*

The proposed schedule to completed closure is included within the Final Closure Plan, provided in **Attachment G.**

<u>*Section 845.220(d)(5):*</u> *Post-closure care plan specified in Section 845.780(d), if applicable.*

The Post Closure Care Plan required by Section 845.220(d)(5) is provided in **Attachment J**.

3. ADDITIONAL INFORMATION

Certification that Dynegy will utilize contractors, subcontractors, and installers who are participants in an approved training program, in accordance with 415 Illinois Complied Statutes (ILCS) 5/22.59(b)(4), is provided in **Attachment K**.

4. REFERENCES

[1] D. Tickner, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notification of Completion of Closure," Luminant, Collinsville, Illinois, December 17, 2020.

[2] D. Tickner, "Hennepin Power Station; Old West Polishing Pond, Notificaiton of Completion of Closure," Luminant, December 17, 2020.

[3] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[4] Illinois Department of Natural Resrouces, "IDNR Natural Heritage Database," [Online]. Available: https://www2.illinois.gov/sites/naturalheritage/DataResearch/Pages/Access-Our-Data.aspx. [Accessed 5 October 2021].

[5] Illinois Department of Natural Resources, "Illinois Threatened and Endangered Species by County," September 2021. [Online]. Available: https://www2.illinois.gov/sites/naturalheritage/DataResearch/Documents/ETCountyList_sept2021.pdf. [Accessed 5 October 2021].

[6] U.S. Fish & Wildlife Service, "USFWS Threatened & Endangered Species Active Critical Habitat Report," [Online]. Available: https://ecos.fws.gov/ecp/report/table/critical-habitat.html. [Accessed 2021 6 October].

[7] Illinois Department of Natural Resources, "IDNR Historic Preservation Devision HARGIS," [Online]. Available: https://www2.illinois.gov/dnrhistoric/Preserve/Pages/HARGIS.aspx. [Accessed 5 October 2021].

[8] Federal Emergency Management Agency, "FEMA Flood Map Service Center: Welcome!," [Online]. Available: https://msc.fema.gov/portal/home. [Accessed 6 October 2021].

[9] AECOM, "CCR Certification Report: Liner Design Criteria Evaluation for East Ash Pond at Hennepin Power Station," St. Louis, MO, October 2016.

ATTACHMENT A

Legal Description

845.210(c)

CONTROL MONUMENTATION TABLE				
POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
2007	1688860.60	2534632.47	526.23	FOUND MAG NAIL
2026	1687419.25	2526768.08	448.87	BRASS PLUG IN PVC CONCRETE MONUMENT
4204	1688760.04	2526732.99	443.25	FOUND IRON PIN

CCR FACILITY BOUNDARY CORNERS				
Point #	Northing	Easting	Elevation	Description
1013	1689896.08	2533261.65	497.75	SET I.P.
1014	1689723.50	2532799.73	495.69	SET I.P.
1015	1689102.71	2533256.07	499.11	SET I.P.
1017	1688845.48	2533445.15	0.00	
1018	1688966.30	2533356.34	0.00	
1019	1690108.87	2533782.87	0.00	
1020	1690050.50	2533941.18	0.00	
1021	1689488.89	2534231.22	0.00	
1022	1689385.42	2534193.84	0.00	
1023	1689087.06	2533489.66	0.00	

DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER PLANT

LEGEND

—·-·—	SECTION LINE
▭	RESTRICTED USE BOUNDARY
——	FACILITY BOUNDARY
●	FOUND SURVEY MARKER AS NOTED

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN FEBRUARY 12 THROUGH JULY 21, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983.

N

0' 100' 200'

Land Description of the Hennepin Power Plant
East New Primary Ash Pond Facility Boundary
21.08 Acres

Part of the North Half of Section 26 Township 33 North, Range 2 West of the Third Principal Meridian, Putnam County, Illinois being more particularly described as follows:

Commencing at the found Magnetic Nail at the East Quarter Corner of Section 26, from which bears an Iron Pin at the Center of Section 27, South 89 degrees 16 minutes 15 seconds West a distance of 7900.12 feet; thence from said commencement point at the East Quarter Corner of Section 26, South 89 degrees 16 minutes 15 seconds West a distance of 1187.42 feet; thence North 36 degrees 19 minutes 09 seconds West a distance of 149.95 feet to the Point of Beginning of the Tract described herein; thence continuing North 36 degrees 19 minutes 09 seconds West a distance of 939.76 feet; thence North 69 degrees 30 minutes 49 seconds East a distance of 493.10 feet; thence North 67 degrees 47 minutes 30 seconds East a distance of 562.99 feet; thence along a curve to the right having a radius of 125.00, feet a curve length of 185.21 feet, a chord bearing South 69 degrees 45 minutes 39 seconds East a chord distance of 168.73 feet; thence South 27 degrees 18 minutes 48 seconds East a distance of 632.08 feet; thence along a curve to the right having a radius of 75.00 feet, a curve length of 123.51 feet, a chord bearing South 19 degrees 51 minutes 44 seconds West a chord distance of 110.02 feet; thence South 67 degrees 02 minutes 16 seconds West a distance of 764.78 feet; thence South 47 degrees 49 minutes 49 seconds West a distance of 179.89 feet to the Point of Beginning and containing 21.08 Acres.

SURVEYOR CERTIFICATE:
THIS IS TO CERTIFY THAT WE, INGENAE, LLC, HAVE AT THE REQUEST OF AND FOR THE EXCLUSIVE USE OF THE OWNERS, PERFORMED A SURVEY OF THE TRACT AS SHOWN HEREON AND THAT THIS IS A TRUE REPRESENTATION OF THAT SURVEY. THIS PLAT AND THE SURVEY FROM WHICH IT IS BASED WERE DONE IN ACCORDANCE WITH THE "MINIMUM STANDARDS OF PRACTICE" FOR LAND SURVEYING IN THE STATE OF ILLINOIS.

INGENAE, LLC
PROFESSIONAL DESIGN FIRM
LICENSE NO. 184.007588-0010

MICHAEL J. GRAMINSKI
035-2901
Sept 20, 2021

MICHAEL J. GRAMINSKI — DATE
I.P.L.S. NO. 035.002901
EXPIRES: 11/30/2022

IngenAE
502 Earth City Plaza, Suite 120
Earth City, MO 63045
www.ingenae.com

Submissions / Revisions:	Date:
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13	

Project Name & Location:

HENNEPIN
POWER PLANT
13498 EAST 800TH STREET
HENNEPIN, IL
61327

DO NOT SCALE PLANS
Copying, Printing, Software and other processes required to produce these prints can stretch or shrink the actual paper or layout. Therefore, scaling of this drawing may be inaccurate. Contact IngenAE with any need for additional dimensions or clarifications.

Drawing Name:

CCR FACILITY
BOUNDARY
EXHIBIT

Date: 9/21/2021
Project No.
Type: SITE
Drawing No. 1
Drawn By: CB
Approved By: MG
Scale: AS NOTED

Luminant

DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER PLANT

CONTROL MONUMENTATION TABLE				
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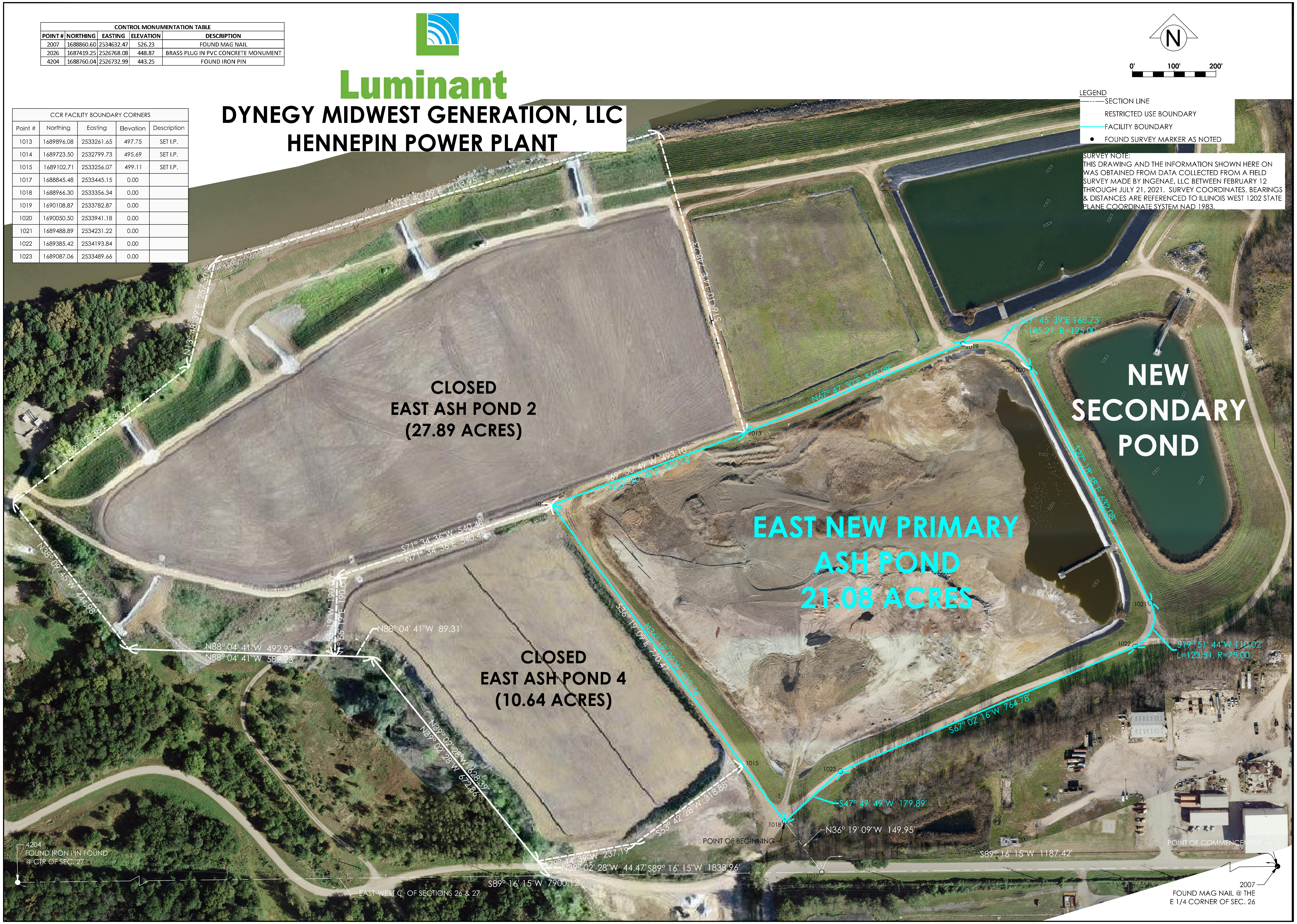
1021	1689488.89	2534231.22	0.00	
1022	1689385.42	2534193.84	0.00	
1023	1689087.06	2533489.66	0.00	



LEGEND

—·-·—	SECTION LINE
—	RESTRICTED USE BOUNDARY
—	FACILITY BOUNDARY
●	FOUND SURVEY MARKER AS NOTED

SURVEY NOTE:
THIS DRAWING AND THE INFORMATION SHOWN HERE ON WAS OBTAINED FROM DATA COLLECTED FROM A FIELD SURVEY MADE BY INGENAE, LLC BETWEEN FEBRUARY 12 THROUGH JULY 21, 2021. SURVEY COORDINATES, BEARINGS & DISTANCES ARE REFERENCED TO ILLINOIS WEST 1202 STATE PLANE COORDINATE SYSTEM NAD 1983.

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Submissions / Revisions:	Date:
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Luminant

Project Name & Location:

HENNEPIN
POWER PLANT
13498 EAST 800TH STREET
HENNEPIN, IL
61327

Drawing Name:

CCR FACILITY
BOUNDARY
EXHIBIT

Date: 9/21/2021
Project No.
Type: SITE
Drawn By: CB
Approved By: MG
Scale: AS NOTED
Drawing No. 2

ATTACHMENT B

Groundwater Information

845.210(d)(1), 845.220(a)(7)(A-C), 845.220(c)(2), and 845.220(d)(3)

Intended for
Dynegy Midwest Generation, LLC

Date
January 28, 2022

Project No.
1940101010-004

GROUNDWATER MODEL REPORT

EAST ASH POND

HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

RAMBOLL Bright ideas. Sustainable change.

GROUNDWATER MODEL REPORT
HENNEPIN POWER PLANT EAST ASH POND

Project name	**Hennepin Power Plant East Ash Pond**
Project no.	**1940101010-004**
Recipient	**Dynegy Midwest Generation, LLC**
Document type	**Groundwater Model Report**
Revision	**Final**
Date	**January 28, 2022**

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Senior Hydrogeologist

Brian G. Hennings, PG
Senior Managing Hydrogeologist

CONTENTS

TABLES (IN TEXT)

TABLES (ATTACHED)

FIGURES (ATTACHED)

APPENDICES

ACRONYMS AND ABBREVIATIONS

§	Section
35 I.A.C.	Title 35 of the Illinois Administrative Code
amsl	above mean sea level
AP2	Ash Pond No. 2
AP4	Ash Pond No. 4
CCWL	Coal Combustion Waste Landfill
CBR	closure-by-removal
CCR	coal combustion residual
CIP	closure-in-place
cm/s	centimeter per second
DMG	Dynegy Midwest Generation, LLC
EAP	East Ash Pond
EAPS	East Ash Pond System
ft/d	feet per day
Geosyntec	Geosyntec Consultants, Inc.
GWPS	groundwater protection standards
HCR	Hydrogeologic Site Characterization Report
HELP	Hydrologic Evaluation of Landfill Performance
HDPE	high density polyethylene
HPP	Hennepin Power Plant
ID	identification
IEPA	Illinois Environmental Protection Agency
in/yr	inches per year
LLDPE	linear low density polyethylene
mg/L	milligrams per liter
mil	One thousandth of an inch
NAVD88	North American Vertical Datum of 1988
NID	National Inventory of Dams
No.	number
NPDES	National Pollutant Discharge Elimination System
Part 845	35 I.A.C. § 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments
Ramboll	Ramboll Americas Engineering Solutions, Inc.
SI	surface impoundment
SP	stress period
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Groundwater Model Report on behalf of Hennepin Power Plant (HPP), operated by Dynegy Midwest Generation, LLC (DMG), in accordance with requirements of Title 35 of the Illinois Administrative Code (35 I.A.C.) Section (§) 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) (Illinois Environmental Protection Agency [IEPA], April 15, 2021). This document presents the results of predictive groundwater modeling simulations for proposed closure scenarios for the East Ash Pond (EAP; Vistra identification [ID] number [No.] 803, IEPA ID No. W1550100002-05, and National Inventory of Dams [NID] No. IL50363) at HPP in Hennepin, Illinois.

The EAP is one of three coal combustion residuals (CCR) surface impoundments (SI), and two non-CCR units (Leachate Pond and the Polishing Pond) that are collectively known as the East Ash Pond System (EAPS). The Coal Combustion Waste Landfill (CCWL; Vistra ID No. 801) is located adjacent to and north of the EAP. Ash Pond No. 2 (AP2; Vistra ID No. 802) and Ash Pond No. 4 (AP4; Vistra ID No. 804) are located adjacent to each other and to the north and west of the EAP, respectively. Both AP2 and AP4 were closed in-place in 2020, in accordance with closure and post-closure care plans approved by IEPA (Civil & Environmental Consultants, Inc., 2017). The HPP property is bordered to the north by the Illinois River, to the south and east by industrial property, and to the west by agricultural land and the Donnelly WMA. The EAP is a lined unit constructed in 1995 to 1996.

Groundwater at the EAPS is encountered in unconsolidated alluvial and glacial outwash materials which overlie a shale bedrock. CCR material at the EAP and CCWL are located above the water table and described in the *Hydrologic Site Characterization Report* for the EAP (Ramboll, 2021a). The *History of Potential Exceedances* (Ramboll, 2021b) indicated that there are no potential groundwater exceedances of applicable groundwater standards attributable to the EAP.

Groundwater flow and transport at the EAP was simulated using site-specific MODFLOW and MT3DMS models, which were modified from pre-existing models developed to simulate unit closure at AP2 and AP4 in 2017. Modifications to the 2017 models generally consisted of the following:

- Changes to the recharge distributions for the EAP and the polishing ponds for the years 1996-present
- Incorporation of changes in recharge for AP2 and AP4 to reflect closure of those units (completed in November 2020)
- Alterations to the time discretization to extend the second stress period from 2017 to November 2020
- Addition of a third stress period to represent conditions following closure of AP2 and AP4 up to the present.

A qualitative calibration was performed to compare simulated concentrations following closure of AP2 and AP4 to observed boron concentrations from 2020 and 2021. Results of the qualitative calibration indicated the modified MODFLOW and MT3DMS models were appropriate for simulation of proposed closure scenarios at the EAP.

Predictive simulations were performed to evaluate the effects of the proposed capping system on surrounding groundwater quality. Three predictive source control scenarios were evaluated for the EAP:

- No-action.
- Closure-in-place (CIP).
- Closure-by-removal (CBR).

Infiltration rates for each predictive scenario were calculated using the Hydrologic Evaluation of Landfill Performance software (HELP), according to proposed design parameters and specifications. Predictive simulations of EAP closure scenarios indicated boron concentrations at monitoring network wells will remain below 2 milligrams per liter (mg/L) (maintaining compliance with the groundwater protection standards [GWPS]) for no action, CIP, and CBR remedial actions. Both closure scenarios (CIP and CBR) demonstrate maintained compliance with the GWPS beyond the post-closure care period of 30 years.

1. BACKGROUND

1.1 Overview

In accordance with Part 845 (IEPA, 2021), Ramboll has prepared this Groundwater Model Report on behalf of HPP, operated by DMG. This document was prepared to present the results of predictive groundwater modeling simulations for proposed closure scenarios for the EAP at the HPP in Hennepin, Illinois.

Site hydrogeology, and groundwater quality are summarized in **Section 1**, and described in detail in the Hydrogeologic Site Characterization Report (HCR; Ramboll, 2021a). The HCR was completed and submitted with the Initial Operating Permit for the EAP as required by 35 I.A.C. § 845.230(d)(2)(I)(i).

Previously-developed site-specific MODFLOW and MT3D flow and transport models were modified and used to assess the effects of the proposed capping system on surrounding groundwater quality, documented in **Section 2**. The details of model calibration and prediction results are presented in **Sections 3 and 4**, respectively. **Section 5** presents a summary of the report with an emphasis on results of predictive modeling of closure scenarios for the EAP.

1.2 Site Description and Hydrogeology

1.2.1 Site Description

The HPP is located in northcentral Illinois in Putnam County, approximately four miles northeast of the Village of Hennepin. The EAP is located in the northeast quarter of Section 26, Township 33 North, Range 2 West, Putnam County, Illinois. The EAP is located south of the Illinois River and approximately one mile east of the Big Bend, where the river shifts course from predominantly west to predominantly south. Existing CCR impoundments and other site structures border the EAP to the north, west, and east. Surrounding areas include industrial properties to the east and south of the EAPS, agricultural land to the southwest, and the retired HPP to the west.

The HPP had two coal-fired units constructed in 1953 and 1959 with capacities of 70 and 210 megawatts, respectively. The plant initially burned high-sulfur Illinois coal and switched to sub-bituminous Powder River Basin coal in 1999.The plant ceased operations in November of 2019 when the plant was retired.

The CCR Units located adjacent to each other in the eastern portion of the HPP are AP2, AP4, and the EAP (referred to as the Primary East Ash Pond in previous documents), and non-CCR units including the Leachate Pond (formerly Pond 2E) and the Polishing Pond (formerly Secondary Pond); all of which comprise the East Ash Pond System (EAPS) (**Figure 1**). The CCWL was constructed on a portion of AP2 and is included in the extent of the EAPS. The CCR Units associated with the EAPS are situated south and adjacent to the Illinois River. The area is also bounded to the east and south by industrial properties owned by Tri-Con Materials and Washington Mills, respectively. The HPP provides the western boundary for the CCR Units with agricultural land to the southwest. Additionally, a 9-acre parcel between the HPP property and Washington Mills (south of the CCR Units) was previously occupied by Advanced Asphalt but operations are no longer active, and the property contains several buildings. The current owner of this parcel is listed as Tri-Con Materials.

Figure 1 depicts the location of the CCR Units and non-CCR Units within the EAPS. The four Hennepin EAPS CCR units consist of the following: one existing landfill (CCWL), one existing SI (EAP), and two IEPA-approved, closed SIs (AP2 and AP4). A detailed history of the EAPS is presented in the HCR (Ramboll, 2021a). Operational changes and relevant site activities are described below:

- The EAP was completed in 1996, and used to store bottom ash, fly ash, and other non-CCR waste. Discharge from the EAP was routed to the adjacent non-CCR Leachate Pond and Polishing Pond prior to its discharge to the Illinois River in accordance with the plant's National Pollutant Discharge Elimination System (NPDES) permit. The pond is approximately 21 acres in size, and was constructed with a 4-foot thick clay liner at the base; containment dikes surrounding the unit were raised in 2003. Disposal of CCR waste in the EAP stopped in 2019 when the power plant was retired from service.
- AP4 is a former unlined impoundment. This unit was closed in place with final cover completed in November 2020.
- The Polishing Pond was constructed in 1995 with a 48-inch thick compacted clay liner having a vertical hydraulic conductivity of 1 x 10^{-7} centimeters per second (cm/s).
- AP2 is a former unlined impoundment constructed in 1958 and used to store fly ash, bottom ash, and other non-CCR waste streams (*e.g.,* coal pile runoff). The pond was removed from service in 1996. Groundwater modeling of this unit was conducted in 2017 and 2020 in support of unit closure, and this unit was closed-in-place in November 2020.
- The easternmost portion of AP2 was removed from service in 2010 to facilitate construction of the Leachate Pond. The Leachate Pond is lined with 60-millimeter high density polyethylene (HDPE) overlying three feet of compacted clay with a vertical hydraulic conductivity of 1 x 10^{-7} cm/s.
- Between the Leachate Pond and closed AP2 is the CCWL (Phase I), an overfill with geomembrane liner and leachate collection system that was completed in 2010. The CCWL (**Figure 1**) was completed in February 2011 but never used to store CCR actively generated at HPP. Approximately 7,000 cubic yards of bottom ash was placed over the liner system to provide ballast and freeze-thaw protection for the liner, but no other material has been placed in the CCWL since that time. Although additional landfill cells (*i.e.,* Phases II, III, IV) and a future bottom ash pond were planned in 2009, it was subsequently decided that no further construction of lined ash disposal units (landfill or bottom ash pond) would be undertaken because of decreased ash disposal due to beneficial reuse of CCR.

1.2.2 Site Hydrogeology

The hydrogeology of the EAP is described in detail in the Hydrologic Site Characterization Report (Ramboll, 2021a). A short summary is provided below.

The principal stratigraphic layers (from top to bottom) encountered at the EAP and adjacent areas are:

- Fill comprised of CCR, fly ash, bottom ash, and other non-CCR waste streams, including coal pile runoff
- Alluvial fine-grained silts and clays, classified as Cahokia Alluvium

- Sand and gravel with boulders, deposited by glacial meltwaters and classified as Henry Formation
- Shale Bedrock

The river is immediately adjacent to the lower terrace, east of the EAPS, and there is minimal alluvium between the pond system and the river. The highly permeable Henry Formation sands and gravels make up the upper and lower terraces, and fill the valley beneath the alluvium. The sand and gravels of the two terraces are indistinguishable, consisting of a heterogeneous mixture of silty-sandy gravel, with cobble zones and with boulders up to several feet in diameter. The Henry Formation is more than 100 feet thick in the river valley and at least 130 feet thick on the upper terrace.

The Henry Formation and alluvium comprise the uppermost aquifer at the EAPS and extend from the water table to the bedrock. This uppermost aquifer extends about 7,000 feet upgradient from the pond system to the south where clay-rich glacial till is encountered. Clay-rich glacial tills typically yield little water, especially compared with the high permeability Henry Formation.

The Henry Formation deposits are underlain by shale bedrock. The Pennsylvanian-age bedrock consists of interbedded layers of shale with thin limestone, sandstone, and coal beds. The shale bedrock unit has low hydraulic conductivity and defines the lower boundary of the uppermost aquifer.

Regional groundwater flow in the unlithified deposits above the shale bedrock discharges into the Illinois River. The primary flow direction of groundwater flow beneath the EAP is north (Ramboll, 2021a). Depth to the water table is typically greater than 20 feet below ground surface around the EAPS. The water table elevation can vary due to changes in river stage. During flood stages, exfiltration from the river may temporarily recharge groundwater close to the river, increasing the elevation of the water table beneath the EAPS and adjacent areas of the floodplain. Generally, groundwater elevations vary with river stage.

The lowest elevation of the ash within the lined EAP is 464 feet North American Vertical Datum of 1988 (NAVD88). Saturation of ash in the EAP due to flooding in the Illinois River is not expected to occur based upon historic observed river stage, the 100-year FEMA flood elevation of 462 ft amsl, and the presence of the liner system below the CCR material.

1.3 Groundwater Quality

There are no potential groundwater exceedances of applicable groundwater standards attributable to the EAP as described below.

Groundwater quality at the EAPS has been monitored since 1983. At this time, groundwater monitoring is being conducted to meet requirements of several overlapping programs for the IEPA and United States Environmental Protection Agency (USEPA). Generally, monitoring to identify groundwater impacts due to operation of the EAPS consists of chemical constituents related to CCR products and disposal, specifically for metals and general groundwater quality indicators (pH, sulfate, chloride, and total dissolved solids [TDS]). A full history and summary of groundwater monitoring at the EAPS is presented in the HCR (Ramboll, 2021a). Groundwater concentrations from 2015 to 2021 presented in HCR Table 4-1 and summarized in the History of Potential Exceedances (attached to the Operating Permit Application) are considered potential exceedances because the methodology used to determine them is proposed in the Statistical

Analysis Plan (Appendix A to Groundwater Monitoring Plan [GMP]) which has not been reviewed or approved by IEPA at the time of submittal of the Part 845 Operating Permit application.

Table 1 of the *History of Potential Exceedances* (Ramboll, 2021b) summarizes how potential exceedances were identified following the proposed Statistical Analysis Plan. No potential exceedances were identified for the EAP. This includes monitoring data for boron, which was selected as the constituent for transport modeling. The applicable GWPS for boron is 2 mg/L.

2. GROUNDWATER MODELING APPROACH

This section describes the approach to the modeling task documented in this report.

2.1 Modeling objectives

Under current conditions, the groundwater protection standards are being met for the EAP. Proposed plans for Closure-in-place (CIP) and Closure-by-removal (CBR) are effective source control measures that further mitigate future groundwater impacts by minimizing the hydraulic head on the CCR in the lined unit; or, through removal of the CCR. While no potential exceedances of GWPS have been identified in the monitoring well network for this unit (**Section 1.3**); and, source control will mitigate future groundwater impacts, groundwater modeling of closure alternatives was completed to demonstrate that closure will maintain compliance with applicable groundwater quality standards following construction.

Boron was selected for groundwater transport modeling. Boron is commonly used as an indicator parameter for contaminant transport modeling for CCR because: (i) it is commonly present in coal ash leachate; (ii) it is mobile and typically not very reactive but conservative (*i.e.*, low rates of sorption or degradation) in groundwater; and (iii) it is less likely than other constituents to be present in background groundwater from natural or other anthropogenic sources.

Previously, contaminant fate and transport modeling for boron was performed to support closure of AP2 and AP4 using MODFLOW and MT3D (O'Brien and Gere Engineers, Inc. [OBG], 2017). The EAP is present within the previous model domain and was simulated as part of AP2 and AP4 models. Groundwater elevation and concentration data from wells located between AP2 and the EAP are consistent with previously simulated values and have not consistently exceeded GWPS for boron.

2.2 Model Code Selection

This section describes the model codes used to provide site-specific prediction estimates for the EAP.

2.2.1 MODFLOW

For the construction and calibration of the numerical groundwater flow model for the site, Ramboll selected the model code MODFLOW, a publicly-available groundwater flow simulation program developed by the United States Geological Survey (USGS) (McDonald and Harbaugh, 1988). MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory and litigation proceedings. MODFLOW uses a finite difference approximation to solve a three-dimensional head distribution in a transient, multi-layer, heterogeneous, anisotropic, variable-gradient, variable-thickness, confined or unconfined flow system. User-supplied inputs are hydraulic conductivity, aquifer/layer thickness, recharge, wells, and boundary conditions. The program also calculates water balance at wells, rivers, and drains. Principal assumptions governing groundwater flow simulation include: 1) groundwater flow is governed by Darcy's law; 2) the formation behaves as a continuous porous medium; 3) flow is not affected by chemical, temperature, or density gradients; and 4) hydraulic properties are constant within a grid cell.

This groundwater flow modeling used MODFLOW-96 (Harbaugh and McDonald, 1996), with Groundwater Vistas 7 software for model pre- and post-processing tasks (Environmental Simulations, Inc, 2017).

2.2.2 MT3DMS

MT3DMS (Zheng and Wang, 1998) is an update of MT3D. It calculates concentration distribution for a single dissolved solute as a function of time and space. Concentration is distributed over a three-dimensional, non-uniform, transient flow field. Solute mass may be input at discrete points (wells, drains, river nodes, constant head cells), or distributed evenly or unevenly over the land surface (recharge).

MT3DMS accounts for advection, dispersion, diffusion, first-order decay and sorption. Sorption can be calculated using linear, Freundlich, or Langmuir isotherms. First-order decay terms may be differentiated for the adsorbed and dissolved phases.

The program uses the standard finite difference method, the particle-tracking-based Eulerian-Lagrangian methods, and the higher-order finite-volume total-variation-diminishing TVD method for the solution schemes. The finite difference solution can be prone to numerical dispersion for low-dispersivity transport scenarios, and the particle-tracking method has problems in conserving mass-balance. The TVD solution is not subject to numerical dispersion and conserves mass well, but is computationally intensive. For this modeling, the TVD solution was used.

Major assumptions include: (i) changes in the concentration field do not affect the flow field; (ii) changes in the concentration of one solute do not affect the concentration of another solute; (iii) chemical and hydraulic properties are constant within a grid cell; and (iv) sorption is instantaneous and fully reversible, while decay is not reversible.

2.2.3 HELP

Percolation through the cap system was calculated using the HELP model, version 4.0 (Tolaymat and Krause, 2020). The HELP model was developed by USEPA in the 1990s to estimate the head and water balance expected for landfill liner or cover design specifications.

2.3 Description of Existing Model

Site-specific MODFLOW and MT3DMS models were developed to provide simulation results at AP2 in 2010, and updated in 2017 to provide predictive simulations for AP2 closure (OBG, 2017). The 2017 models were used as the base for the EAP closure modeling.

The 2017 models consisted of the following:

- Steady-state MODFLOW/MT3DMS models were developed to represent site conditions prior to 1996. This model was calibrated to a set of groundwater elevation data and concentrations collected in September 1995.
- Calibrated transient MODFLOW and MT3DMS models which simulated groundwater flow and transport at the EAPS from 1996 to 2017. Groundwater elevations and boron concentrations collected throughout this period were used to calibrate the models.

- Predictive simulations to estimate future boron concentrations for a number of closure scenarios for AP2 and AP4. Closure action was modeled over a period of 20 years, beginning in January 2018.

2.4 Modeling Approach

The 2017 flow and transport models were retained and revised as appropriate to perform simulations for the EAP.

EAP Current Conditions

Modifications to the 2017 model were required to simulate conditions at the EAP from initial operations at the EAPS to the current time ("current conditions" model). The existing model used one steady-state period and two transient stress periods to simulate and calibrate historical/current conditions through 2017. Recalibration of the flow and transport model was not performed; however, model results were compared to site concentration and groundwater elevation data collected in 2020 and 2021 to confirm that model simulation results were overall reasonable for assessment of current conditions at the EAPS.

Modifications to the 2017 model are detailed in **Section 3**, but generally consisted of changes to the recharge distributions for the EAP and the polishing ponds for the years 1996 to present, incorporation of changes in recharge for AP2 and AP4 to reflect closure of those units in November 2020, alterations to the time discretization to extend the second stress period from 2017 to November 2020, and addition of a third stress period to represent conditions following closure of AP2 and AP4 up to the present time.

Predictive Modeling

The EAP current conditions model was then used as a starting point for the predictive modeling, which simulates changes in boron concentrations for 50 years following unit closure. These scenarios are intended to represent proposed closure alternatives for the EAP (including anticipated changes to the CCWL) and utilize the design specifications from the *CCR Final Closure Plan*, which is Appendix I of the Construction Permit Application (Geosyntec, 2022a) to which this report is also attached. No action, CIP, and CBR scenarios were simulated:

- No Action – Assumes no closure at the EAP (current conditions retained). Closure of the CCWL was simulated with an estimated completion on February 1, 2025.
- EAP CIP – The EAP will be graded and covered with a geomembrane and soil layers. The CCWL will also be closed, with an estimated completion on December 22, 2023.
- EAP CBR – CCR materials from the EAP will be removed. The existing liner system and 1 foot of material beneath the side slope and bottom liner will be excavated. Closure of the CCWL will also be performed, with the estimated completion date of October 24, 2025.

Details and results of predictive simulations are presented in **Section 4**.

3. MODEL DEVELOPMENT AND CALIBRATION

This section describes the development and calibration of the EAP current conditions MODFLOW and MT3DMS models. The calibrated 2017 model, which was developed to simulate historical flow and transport for AP2, was used as the base for the current conditions model for the EAP. This section describes the overall construction and components of the EAP flow and transport model. Since most of the components of the existing model were retained, this section provides a brief summary of model components that were not changed, with more detail for the modifications made to the model for EAP simulation. Refer to the AP2 model report (OBG, 2017) for further documentation.

3.1 Flow Model Development

The development process for a numerical groundwater flow model consists of construction of a finite-difference grid for the model area, specification of model structure, assignment of boundary conditions, specification of hydraulic parameter values and zones, and selection of appropriate water-level measurements for calibration of the model. These features represent elements of the conceptual site model, which provides the basis for the construction and calibration of the numerical model to observed groundwater flow conditions at the site.

3.1.1 Model Discretization

The model domain is approximately 8,000 feet by 6,000 feet, and encompasses the area of the EAPS and sufficient surrounding areas to accurately simulate flow near the EAP. The northern boundary of the model domain is located beyond the Illinois River, which is the natural discharge for the model domain. The southern edge of the model domain extends approximately 3,500 feet south of the EAPS, and the model domain extends approximately 2,500 feet to the east and west of the EAPS. Vertically, the model domain extends from the water table to top of bedrock. The shale bedrock is relatively impermeable compared to the overlying unconsolidated sediments, and provides a base for the model.

The model grid is rotated 9 degrees from true north to match the approximate alignment of the southern bank of the Illinois River at the site, and consists of a rectangular grid of 157 columns and 112 rows (**Figure 2**). Grid spacing is variable; a uniform 25 by 25 foot grid was specified for the EAPS, with increasing grid spacing moving from the EAPS to the edge of the model domain. The largest grid dimension is 500 feet, at the upgradient (southern) edge of the model domain.

Four model layers were specified to represent the alluvium and glacial outwash materials above bedrock. Natural vertical stratigraphic divisions are not present in the unconsolidated materials beneath the EAPS, so uniform layer bottom elevations were selected. Model layer 1 is unconfined, with the water table representing the top of the layer; the bottom elevation of model layer 1 is 430 feet above mean sea level (amsl), which gives it an approximate, spatially variable saturated thickness of 15 to 20 feet. Layers 2, 3, and 4 were specified with uniform thicknesses of 8 feet, with bottom elevations of 422, 412, and 406 feet amsl, respectively. Bedrock is encountered at an elevation of 400 to 410 feet amsl beneath the EAP.

3.1.1.1 Time Discretization and Stress Periods

The simulation length was revised from the existing model to extend to the current time (2021), and a third stress period was added to simulate closure of AP2 and AP4 in November 2020. The time discretization and stress periods are summarized in **Table A** below.

Table A. Time Discretization and Stress Periods

Date	Operational Change	Previous model	Current Conditions Model
1958-1989	Operation of AP2, with multiple embankment increases	Steady-State initial conditions simulation	Steady-state initial conditions simulation. Heads and concentrations generated were used for initial conditions.
1996-2010	Operation of AP2 and EAP	Stress Period 1	Stress Period 1 (5,099 days)
2010-2020	AP2 was reconfigured with construction of the Leachate Pond and CCWL	Stress Period 2	Stress Period 2, extended from 2017-2020 (3,623 days)
November 2020	Closure of AP2 and AP4 completed	Not applicable	Current Conditions: Stress Period 3 (1,146; 1,553; or 1,818 days for simulation of current conditions until EAP closure remedy completed)
Predictive Scenarios (2023 or 2025 + 50 years)	No Action, EAP CIP, EAP CBR	Not applicable	18,250 days (50 years) for model predictions. Completed as new transient model simulations, using results of current conditions simulation as starting concentrations for the appropriate final closure date

3.1.2 Boundary Conditions

Groundwater flow directions at/near the EAPS are generally aligned with the model grid, from south to north. The upgradient (southern) edge of the model is represented as a constant head boundary, located at sufficient distance from the site to produce a groundwater flow field consistent with observed groundwater elevations at the EAP. The northern edge of the active model domain is defined by river cells which represent the Illinois River in model layer 1, with inactive (no-flow) cells between the edge of the river and the model domain. Boundary conditions are shown on **Figure 2**.

The river cells and constant head cells which define the downgradient and upgradient edges of the model were not modified from the 2017 model. The constant head cells were specified in model layer 1 with an elevation of 458 feet amsl. River cells are specified with an elevation of 444 feet amsl, which represents an average stage of the Illinois River. These values were selected during the 2017 model construction and calibration.

Variation in stage of the Illinois River was not incorporated into the current conditions model for the EAP; since the objective of model simulations for unit closure is to estimate long-term concentrations, steady-state, average stage was used to represent the river. However, periodic flooding of the river can create short-term reversals in groundwater flow direction near the river, which is documented in site reports. The potential effects of river floods on groundwater flow and boron concentrations in Site groundwater were evaluated as part of the AP2 closure process, using a transient model developed specifically to represent these conditions (Ramboll, 2020). As documented in the modeling report, saturation of ash at the former AP2 due to high river stage is unlikely to occur for any but the most extreme flood events, and does not result in appreciable increases in boron concentrations in groundwater compared to current concentration levels. The base of ash at the EAP is higher than at AP2 and does not have the potential for saturation during even extreme recorded flood events.

3.1.3 Recharge Rates

Recharge specified in model layer 1 represents infiltration of precipitation and vertical influx from ash pond operation. A number of recharge rates are used to represent variable infiltration from portions of the EAPS, with changes in time (per stress period) representing changes in the EAPS. Most of the recharge assignments from the 2017 model were maintained for stress periods 1 and 2, although new values were assigned for the EAP and the polishing pond.

Stress period 3 incorporated revisions to the recharge rates for AP2 and AP4, to represent post-closure conditions at these units. The recharge values for the closed units were originally calculated using HELP as part of the 2017 predictive modeling; since construction specifications were consistent with predictive simulations, the original calculated infiltration rate of 1.9 in/yr was assigned to AP2 and AP4.

Figures 3 through 5 present simulated recharge distributions and values for stress periods 1, 2, and 3.

3.1.3.1 Polishing Pond

The infiltration rate and the recharge extent (area) for the polishing pond was revised from the 2017 model to better represent current conditions. The polishing pond was not used for disposal of CCR materials. The pond is lined and currently impounding water, to a constant (managed) elevation of 476 feet amsl. The base of the pond is at 462 feet, and is underlain by four feet of clay placed atop native material. The water table is 16 feet below the base of the pond.

The constant head maintained in the impoundment indicated a head-based calculation of infiltration (Darcy’s Law) was more appropriate than a runoff/water balance model (HELP). Site-specific values of hydraulic conductivity were used where appropriate, with values from the HELP model database (Tolaymat and Krause, 2020) used where site-specific data were not available. Calculated infiltration from the pond to the water table is 9.3 inches per year (in/yr). Calculation details are presented in **Appendix A**.

3.1.3.2 EAP

Although the infiltration rate at the EAP in its current configuration was previously calculated and simulated in the 2017 model, the focus on the EAP for this modeling effort warranted recalculation of infiltration at the EAP for current conditions. The EAP has been slowly accumulating CCR materials over time and is currently impounding water, with standing water in a portion of the total footprint at an elevation of 487 feet amsl. A constant water level is maintained in the EAP through draining of water into the polishing pond. The EAP is lined and was constructed at its base with a 4-foot clay layer, underlain by 1 foot of sand, atop the native glacial outwash material. The base of ash within the EAP is 464 feet amsl and the base of the surface impoundment (i.e., clay) is 460. The approximately 23.5 feet of saturation within the pond indicates that the liner is competent, and the normal water table is encountered approximately 10 to 14 feet below the base of the clay liner.

The constant head maintained in the EAP indicated a head-based calculation of infiltration (Darcy's Law) was more appropriate that a runoff/water balance model (HELP). Site-specific values of hydraulic conductivity were used where appropriate, with values from the HELP model database used where site-specific data were not available. Calculated infiltration from the impoundment is 12.9 in/yr. Calculation details are presented in **Appendix A**.

3.1.4 Hydraulic Conductivity

In constructing the model for the site, representative values for horizontal and vertical hydraulic conductivity of various hydrogeologic units were selected based on the results of hydraulic testing conducted at the site as well as regional information. The hydraulic conductivities specified in the existing MODFLOW model were selected from site data and were carefully adjusted during calibration and sensitivity testing; these values were retained for the EAP modeling. Uniform hydraulic conductivity zones were specified in model layers 1 through 4 to represent different materials.

The highly-permeably glacial outwash deposits present in the northern portion of the model domain were simulated with hydraulic conductivities of 100, 500, and 1,000 feet per day (ft/d); the finer-grained sands present in the southern portion of the model domain was simulated with a hydraulic conductivity of 35 ft/d in all model layers. Two new estimates of hydraulic conductivity of the glacial outwash were obtained from slug tests performed at new wells MW-53 and MW-54 (Ramboll, 2021a), and the averaged results of these wells are consistent with the hydraulic conductivity distribution in the existing model.

Hydraulic conductivity values used in the model were not modified to reflect changes in ash pond operation, since the ash ponds and associated structures (berms, clean water ponds) are located above the water table. **Figure 6** presents the hydraulic conductivity distributions for model layers 1 through 4.

3.2 Transport Model Development

The development process for an MT3DMS transport model consists of construction of a finite-difference grid for the model area, specification of model structure, assignment of boundary conditions, specification of hydraulic parameter values and zones, and selection of appropriate chemical concentrations for calibration of the model. These features represent elements of the conceptual site model, which provides the basis for the construction and calibration of the numerical model to observed groundwater concentration data.

The MT3DMS model for boron developed for AP2 was adapted for the EAP model. Changes made to the 2017 model are detailed below, with summary information provided for the retained model characteristics. A full description of model construction and calibration is presented in the 2017 model report (OBG, 2017).

Since the ash fill is above the water table, the conceptual model for transport assumes the only source of boron to the system originates from boron that leaches to infiltration of process water or rainwater as it percolates through the CCR above the water table. The conceptual transport model assumes that boron concentration in leachate does not vary as a function of time, although the volume of leachate decreases over time as a function of pond dewatering and capping. There is no removal of mass from the groundwater system via adsorption or decay.

3.2.1 Initial Concentration

Initial concentrations for the current conditions model were generated from the 1997 steady-state model which represents the early operation of the EAPS (1958-1996). Simulated boron concentrations in groundwater used to represent 1996 concentrations varied from 0 to 21 mg/L.

3.2.2 Source Concentration

Concentrations of boron in leachate (recharge from the EAPS) were specified for AP2, AP4, and the EAP in Stress Periods 1, 2, and 3. The CCWL and leachate pond also have specified concentrations of boron recharge due to their construction above portions of the former AP2. A few of the recharge concentration settings were modified from the 2017 model to better represent current conditions. In the 2017 model, the polishing pond had been simulated with the same recharge concentration as the EAP (4 mg/L). Since the polishing pond was not used for CCR disposal, the recharge boron concentration at the polishing pond was set to zero in all stress periods. Stress Period 3 incorporated removal of a small portion of the embankments for AP2 nearest the Illinois River, so recharge for this area was set to zero for this period. Boron recharge concentrations are summarized in **Table B** below.

Table B. Boron Recharge Concentrations, mg/L

	SP1	SP2	SP3
Western portion of AP2 (closed in 2020)	9	9	9
Portion of AP2 embankment near the river	5	5	5
AP4 (closed in 2020)	5	5	5
Central portion of AP2 (closed in 2010)	16	16	16
CCWL (formerly AP2)	16	16	16
Leachate Pond (formerly AP2)	16	16	16
Narrow Zone within central/eastern AP2	10/20	10/16	10/16
EAP	4	4	4

SP = stress period

A total of nine porewater samples were collected in 2020 from three new wells completed into ash materials within the EAP (Ramboll, 2021a). Boron concentrations in these samples varied from 2.3 to 4.21 mg/L, which indicates that the 4 mg/L boron recharge concentration simulated for the EAP in the 2017 model is appropriate.

3.2.3 Storage and Effective Porosity

The storage and effective porosity values specified in the 2017 model were retained without modification. Zonation of storage/porosity was coincident with the distribution of hydraulic conductivity, with two zones in each layer and summarized in **Table C** below.

Table C. Storage, Specific Yield, and Effective Porosity Values

Location	Storativity	Specific Yield	Effective Porosity
L1/L4: near river	1×10^{-4}	0.2	0.15
Away from river (all layers)	1×10^{-3}	0.18	0.1
L2/L3: near river	1×10^{-5}	0.25	0.2

3.2.4 Dispersivity and Diffusion

Longitudinal dispersivity was 35 feet, with transverse and vertical dispersion coefficients assuming a ratio of 1/10 and 1/100, respectively (Gelhar et al., 1992). Sensitivity testing performed in 2017 indicated negligible to low sensitivity of model results to dispersivity. Diffusion was set to 0 for the entire model domain.

3.2.5 Retardation and Decay

A distribution coefficient of zero was selected to yield a retardation factor of 1.0. A decay coefficient of zero was modeled, as is appropriate for inorganic constituents. Therefore, this modeling assumed no adsorption and no decay.

3.3 Qualitative Calibration to Current Conditions

Calibration of a groundwater flow or transport model refers to the iterative process of adjusting model parameters and boundary conditions to obtain a reasonable match between observed conditions and simulation results. The calibration of a groundwater flow model should rely on discrete measurements of groundwater elevation to avoid the potential for interpretive bias that may result from attempting to match a contoured potentiometric surface (Konikow, 1978; Anderson and Woessner, 1992). The primary criterion for evaluating the calibration of a groundwater flow model is the difference between observed and simulated water levels at a set of calibration targets. Groundwater transport models are calibrated using concentration targets, with application of the same principles.

Extensive calibration and parameter sensitivity testing was performed during the 2017 model development. Traditional calibration (*i.e.,* residuals and statistics) was not conducted for the minor model revisions of the historical model. A qualitative calibration was performed to evaluate results of stress period 3 (current conditions) and confirm an adequate agreement between observed and simulated groundwater elevations and concentrations.

3.3.1 Groundwater Elevations

Due to the high conductivity of the materials at the site and the flow system geometry, with parallel flux boundaries (constant head cells and river cells), simulated groundwater elevations are relatively uniform across the EAPS, with a gradient consistent with average conditions. This is also true for observed values over time; at any given measurement date, measured groundwater elevations are relatively uniform. However, while groundwater elevations at the site are generally uniform for any particular date, the actual elevations can vary by 8 to 10 feet due to the high sensitivity of groundwater elevation to river stage. Groundwater elevations simulated in the EAP model are within the range of measured groundwater elevations at the site, and maintain the appropriate gradient across the EAPS.

3.3.2 Boron Concentrations

The calibration of the 2017 transport model was limited to data before 2017. Measured boron concentrations from 2020 and 2021 were compared to model results from Stress Period 3 to assess accuracy of transport calibration to the current time. This is important due to the closure of AP2 and AP4 in November 2020.

Table 1 presents a summary of observed boron concentration data for wells at the EAPS in 2020-2021 versus simulated concentrations. Simulated concentrations at the 11 EAP monitoring wells are within 0.1 mg/L of average observed concentrations at six of the wells and are within 0.4 to 0.6 mg/L at the other five wells. Generally, simulated concentrations for SP3 are slightly lower than observed values, but this is not universal. A number of wells show decreasing concentrations during SP3 following closure of AP2 and AP4 (**Figure 7**). Agreement between simulated and observed concentrations is sufficient to enable use of this model as a basis for prediction of concentrations after closure of the EAP.

3.4 Flow and Transport Model Assumptions and Limitations

Simplifying assumptions are necessary when numerically representing the natural environment in a groundwater flow and transport model. Outside of assumptions inherent to the codes used to develop the model, several simplifying assumptions were made, including:

- Leachate instantaneously migrates to groundwater (*e.g.,* rapid migration through the unsaturated zone).
- Fluctuations in river stage are short in duration and do not significantly affect groundwater flow and transport (supported by Ramboll, 2020).
- Hydraulic parameters such as hydraulic conductivity, storage, and recharge, can be represented using homogeneous zones that cover large areas of the model domain.
- Recharge rate outside the impoundment is constant over time.
- Source concentrations remain constant over time.
- Boron minimally adsorbs and does not decay, and mixing and dispersion are the primary attenuation mechanisms in groundwater.
- Cap construction has an instantaneous effect on recharge and percolation because it is constructed over a brief period relative to the length of the model simulation.

The model is limited by the data used for calibration, which adequately define the local groundwater flow system and the source and extent of the plume. Since data used for calibration are near to the EAP, model predictions of transport distant from the impoundment will not be as reliable as predictions of transport near the impoundment.

4. PREDICTIVE SIMULATIONS

The current conditions model for the EAP was extended in time and modified to simulate future conditions and groundwater concentrations of boron for proposed closure alternatives for the EAP. A total of three scenarios were simulated: no action, EAP CIP, and EAP CBR. Simulations were performed for a total of fifty years following completion of closure.

The results of the current conditions simulation, extended through the estimated completion date of each closure scenario, were used as initial conditions (heads and concentrations) for the predictive models. Previous model simulations for impoundment closure assumed instantaneous changes to the impoundment conditions at the time of closure (*i.e.,* the end date for the unit closure represents the step-change in conditions for each simulation), and this convention was retained for the EAP closure predictive modeling. The design specifications and parameters used to simulate EAP closure are described in detail in the CCR Final Closure Plan (Geosyntec, 2022a), which is Attachment I to the Construction Permit Application to which this report is also attached.

Simulated changes in boron concentration for each of the EAP closure scenarios were evaluated by plotting predicted boron concentration at the 11 groundwater wells in the proposed EAP compliance monitoring network (Ramboll, 2021c).

4.1 No Action

A no-action scenario was simulated to predict boron concentrations if closure of the EAP is not completed, and to provide a baseline for evaluation of other closure options. It was assumed that no action was taken to cover or remove existing ash within the EAP; however, closure of the CCWL, which will be performed in conjunction with EAP closure, was simulated.

4.1.1 Landfill Closure

The CCWL was constructed in 2011 above the CCR in the eastern portion of AP2, with a geomembrane liner and leachate collection system installed to limit infiltration. A total of 7,500 cubic yards of bottom ash were placed into the CCWL to protect the liner system; however, no additional CCR or non-CCR materials have been placed into the CCWL since that time. The current configuration of the CCWL was simulated in the 2017 model and the EAP current conditions model with an infiltration rate of 0.3 in/yr and a boron concentration of 16 mg/L.

Closure of the CCWL will consist of excavation of landfilled bottom ash within the CCWL, installation of a geotextile cushion overtop the existing geomembrane and leachate collection system to protect the geomembrane, backfill with 5.5 feet of protective cover soil, and 0.5 feet of vegetative cover soil. The CCWL final surface will be graded to produce slopes of 1 to 2.5 percent. The existing liner and leachate collection system will remain in place. Construction was simulated to be completed on February 1, 2025.

The HELP program was used to estimate infiltration after landfill closure using the specifications from the CCR Final Closure Plan. The estimated recharge rate at the CCWL after closure is 0.013 in/yr. Details of the HELP model simulation are presented in **Appendix A**.

4.2 Closure-in-Place

The proposed plan for CIP of the EAP consists of draining standing water from the EAP, backfilling and grading of the existing CCR materials, and installation of a final cover. The final cover will consist of a 40-mil linear low density polyethylene (LLDPE) geomembrane with protective geotextile cushion, 1.5 feet of sand and gravel fill, and 0.5 feet of sandy clay soil as a vegetative cover layer. CIP of the EAP is predicted to be completed on December 22, 2023. The CCWL will also be closed during this time, as described above.

The HELP model was used to estimate the infiltration rate through the final cover. Cap and cover specifications for the EAP CIP simulation were based upon the current construction of the EAP and the information in the CCR Final Closure Plan. HELP model inputs and outputs are detailed in **Appendix A**. The geotextile cushion used to protect the LLDPE liner was not explicitly simulated in HELP. An infiltration rate of 0.32 in/yr was calculated for the proposed EAP CIP remedy.

The EAP CIP scenario was simulated by changing infiltration rates for the EAP and the CCWL to 0.32 in/yr and 0.013 in/yr, respectively, starting on December 22, 2023. The 4 mg/L boron recharge rate specified for the EAP was retained for simulation of CIP.

Two additional CIP sequences were simulated using HELP to support the *Proposed Alternative Final Protective Layer Equivalency Demonstration* (Geosyntec, 2022b) which is an appendix to the Construction Permit Application to which this report is also attached. Results of these HELP simulations were not incorporated into the MODFLOW model simulations for CIP.

- One CIP sequence was simulated by increasing the thickness of the proposed Final Protective Layer from 24 to 36 inches. This cap construction scenario consisted of the following (listed from ground surface down): a vegetative cover (6 inches thick), protective layer of compacted soil (30 inches thick), and 40-mil LLDPE geomembrane underlain by gypsum.
- The other CIP sequence representing the default cover system provided in 35 I.A.C. § 845.750(c) consisted of the following (listed from ground surface down): a vegetative cover (6 inches thick), protective layer of compacted soil (30 inches thick), and 36 inches of compacted clay with a hydraulic conductivity of 1 x 10^{-7} cm/sec underlain by gypsum.

HELP simulation inputs and output results are presented in **Appendix A**.

4.3 Closure by Removal

The proposed plan for CBR of the EAP consists of unwatering, dewatering, and excavation of the CCR materials within the EAP, and excavation and removal of the 4-foot clay liner from the base and 1 foot of material beneath the liner system. The construction sequence is anticipated to require approximately 31 months to complete and will take place from March 13, 2023 to October 24, 2025. Closure of the CCWL will also be completed during this timeframe.

The HELP model was used to estimate the infiltration rate through base of the EAP following closure. Cap and cover specifications for the EAP CBR simulation were based upon the current construction of the EAP and the information in the CCR Final Closure Plan (Geosyntec, 2022a). HELP model inputs and outputs are detailed in **Appendix A**. An infiltration rate of 9.2 in/yr was calculated for the proposed EAP CBR remedy.

The EAP CBR scenario was simulated by changing infiltration rates for the EAP and the CCWL to 9.2 in/yr and 0.013 in/yr, respectively, starting on October 24, 2025. The boron concentration recharge for the EAP was changed to 0 mg/L to reflect removal of CCR material from the impoundment.

4.4 Evaluation of EAP Closure Scenarios

Boron concentrations were simulated for fifty years after EAP closure. Predicted boron concentrations at the 11 wells in the proposed EAP closure network are summarized below. The highest predicted concentration for the well network in 2020-2021 is 0.89 mg/L prior to unit closure, which is lower than the GWPS of 2 mg/L. **Figure 8** presents predicted boron concentrations over time for CIP and CBR, and indicates that boron concentrations decline rapidly after unit closure and stabilize after approximately 2 to 3 years in both scenarios. Results are summarized in **Table D** below.

Table D. Boron Concentrations at Monitoring Wells after Closure

Well ID	Boron Concentrations (mg/L)			
	Initial Concentration at Closure	No Action - 5 years	CIP - 5 years	CBR - 5 years
7	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
12	0.89	0.88	0.03	0.00
13	0.41	0.41	0.01	0.00
16	0.06	0.06	0.00	0.00
17	0.00	0.00	0.00	0.00
46	0.87	0.86	0.03	0.00
47	0.63	0.62	0.11	0.08
52	0.17	0.17	0.11	0.11
54	0.49	0.49	0.02	0.00
08D	0.00	0.00	0.00	0.00

The simulated changes in infiltration rates at the CCWL and EAP did not result in any appreciable changes in groundwater elevation from current conditions in either of the three scenarios. Predicted boron concentrations in both scenarios decline rapidly from a maximum concentration of 0.89 mg/L to 0.2 mg/L or less within 5 years and remain at or below 0.2 mg/L until the end of the simulation at 50 years. Both closure scenarios demonstrate maintained compliance with the GWPS beyond the post-closure care period of 30 years.

Evaluation of monitoring well data for the EAP has not identified statistically significant seasonal trends in groundwater quality which could affect model applicability for prediction of boron transport.

5. SUMMARY

There are no potential groundwater exceedances of applicable groundwater standards attributable to the EAP. Groundwater flow and transport modeling of the EAP was completed to provide information for assessment of proposed closure alternatives of the EAP.

Groundwater flow and transport at the Hennepin EAP was simulated using site-specific MODFLOW and MT3DMS models, which were modified from the 2017 models used to simulate unit closure at AP2. Predictive source control simulations of EAP closure scenarios indicated boron concentrations at monitoring network wells will remain below 2 mg/L (maintaining compliance with the GWPS) for no action, CIP, and CBR remedial actions. Predicted boron concentrations in both CIP and CBR scenarios decline rapidly from a maximum observed concentration of 0.89 mg/L to 0.2 mg/L or less within 5 years and remain at or below 0.2 mg/L. Both closure scenarios demonstrate maintained compliance with the GWPS beyond the post-closure care period of 30 years.

6. REFERENCES

Anderson, Mary P., and Woessner, William W., 1992. Applied groundwater modeling: simulation of flow and advective transport, Academic Press, Inc., San Diego, CA.

Civil & Environmental Consultants, Inc., 2017. Closure and Post Closure Care Plan, Ash Pond No. 2, Dynegy Midwest Generation, LLC, Hennepin Power Station, Hennepin, IL.

Fetter, C. W., 1988, Applied Hydrogeology, Merrill Publishing Company, Columbus Ohio.

Gelhar, L. W., C. Welty, and K. R. Rehfeldt, 1992. A critical review of data on field-scale dispersion in aquifers, Water Resour. Res., 28(7), 1955– 1974.

Geosyntec, 2022a. CCR Final Closure Plan (Appendix I of the Construction Permit Application).

Geosyntec, 2022b. Proposed Alternative Final Protective Layer Equivalency Demonstration, Hennepin East Ash Pond and Duck Creek GMF Pond CCR Surface Impoundments, Technical Memorandum, January 28, 2022.

Harbaugh, A.W. & McDonald, M.G., 1996. User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model (PDF). Open-File Report 96-485. United States Geological Survey.

Illinois Environmental Protection Agency (IEPA), 2021. *In the Matter of: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New Title 35 Illinois Administration Code 845, Addendum*. April 15, 2021.

Konikow and Bredehoeft, 1978. Computer Model of Two-Dimensional Solute Transport and Dispersion in Ground Water. USGS Techniques of Water-Resources Investigations, Book 7, Chapter C2.

McDonald, M.G., and A.W. Harbaugh, 1988. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: Techniques of Water-Resources Investigations, Techniques of Water Resources of the United States Geological Survey, Book 6, Chapter A1.

Mercer, J.W., and R.K. Waddell, 1993. Contaminant Transport in Groundwater, in Handbook of Hydrology, D.R. Maidment (ed.), McGraw-Hill Inc., pp. 16.1-16.41, New York, NY.

Natural Resource Technology, Inc. (NRT), 2017. Hydrogeologic Site Characterization Report; Hennepin Power Station Putnam County, East Ash Impoundment, Illinois. September 2017.

O'Brien and Gere Engineers, Inc. (OBG), 2017. Groundwater Model Report, Hennepin East Ash Pond No.2, Hennepin, Illinois. Prepared for Dynegy Midwest Generation, LLC. December 2017.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2020, River Flood Evaluation Report, Hennepin East Ash Pond No. 2 and No. 4, Closure Plan Addendum 3, Prepared for Dynegy Midwest Generation, LLC. January 15, 2020.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021a. Hydrogeologic Site Characterization Report, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois. October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021b. History of Potential Exceedances, Gypsum Management Facility Pond, Duck Creek Power Plant, Canton, Fulton County, Illinois*,* October 25, 2021.

Ramboll Americas Engineering Solutions, Inc. (Ramboll), 2021c. Groundwater Monitoring Plan, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois. October 31, 2021.

Tolaymat, T. and M. Krause, 2020. Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual. United States Environmental Protection Agency, Washington, DC, EPA/600/B-20/219.

Zheng, Z., and P.P. Wang, 1998. MT3DMS, a Modular Three-Dimensional Multispecies Transport Model, Model documentation and user's guide prepared by the University of Alabama Hydrogeology Group for the US Army Corps of Engineers.

TABLES

Table 1. Model Calibration to Boron Concentrations, 2020-2021

Groundwater Model Report
East Ash Pond
Hennepin Power Plant
Hennepin, Illinois

Observed Boron Concentrations					Simulated Boron Concentrations
Well ID	**Number of observations 3/1/2020-7/1/2021**	**Minimum observed concentration (mg/L)**	**Maximum observed concentration (mg/L)**	**Average observed concentration (mg/L)**	**Simulated concentrations, Current Conditions Model 11/1/2020-11/1/2021 (mg/L)**
EAP Monitoring Well Network					
7	9	0.06	0.16	0.1	0
8	10	0.11	0.18	0.1	0
12	5	0.20	0.86	0.5	0.9
13	5	0.30	1.34	1	0.4
16	7	0.10	0.13	0.1	0.1
17	7	0.07	0.14	0.1	0
46	3	0.25	0.41	0.3	0.9
47	**3**	**0.15**	**0.19**	**0.2**	**Decreases (1.2 to 0.7)**
52	**6**	**0.12**	**0.23**	**0.2**	**Decreases (0.9 to 0.2)**
54	6	0.68	1.09	0.9	0.5
08D	10	0.09	0.13	0.1	0
Other EAPS Monitoring Wells					
03R	**5**	**0.62**	**1.96**	**1.4**	**Decreases (1.1 to 0.2)**
04R	1	1.67	1.67	1.7	0
05R	6	0.78	4.31	1.8	0.7
6	1	0.26	0.26	0.3	0.1
10	**2**	**0.15**	**0.19**	**0.2**	**Decreases (0.9 to 0.1)**
15	1	0.52	0.52	0.5	0.1
18S	**5**	**3.29**	**5.30**	**4**	**Decreases (3.1 to 0.8)**
18D	**5**	**1.54**	**1.80**	**1.7**	**Decreases (1.3 to 0.6)**
19S	5	1.02	6.21	4	0.6
19D	5	3.45	4.65	4	0.5
40S	5	1.30	4.30	2.2	0.7
05DR	6	0.94	1.17	1	0.6

Notes:

Simulated concencentrations for Model Current Conditions reflect concentrations following the closure of AP2 and AP4 in November 2020. Concentrations remain steady throughout the simulation at a number of wells; however **bolded rows** and a notation of "Decreases" indicates simulated concentrations at the well location decreased during SP3 due to simulated closure of AP2 and AP4.

EAP = East Ash Pond
EAPS = East Ash Pond System
mg/L = milligrams per liter

FIGURES

Y:\Mapping\Projects\22\2285\MXD\MISC\Figure 1_HEN EAP Site Location Map.mxd

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PROJECT: 169000XXXX | DATED: 10/13/2021 | DESIGNER: STOLZSD

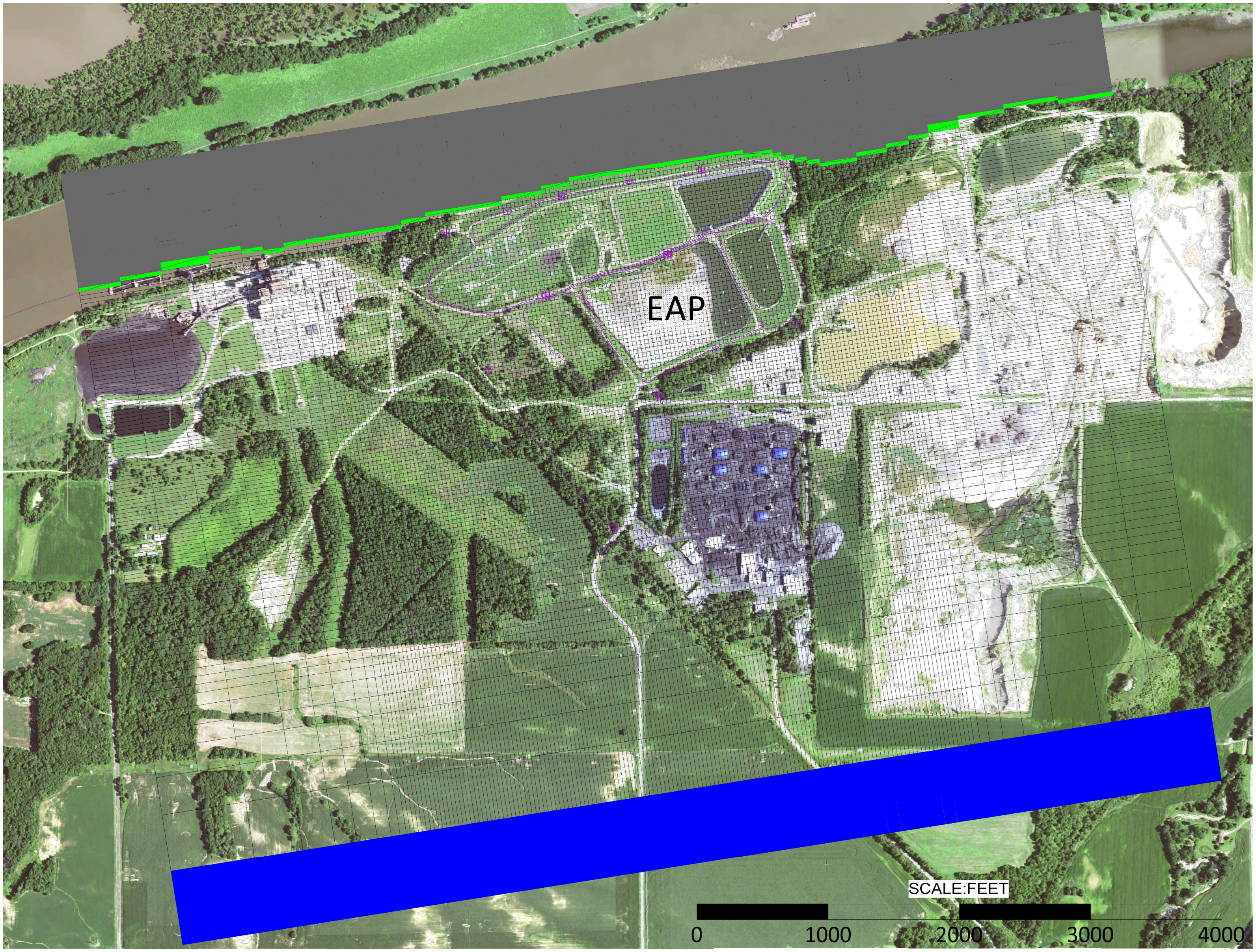
SITE LOCATION MAP

GROUNDWATER MODEL REPORT
EAST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 1

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC.

RAMBOLL



LEGEND

🟦 Constant Head Boundary, Model Layer 1

🟩 River Boundary, Model Layer 1

⬛ Inactive Area (No-Flow Boundary, all layers)

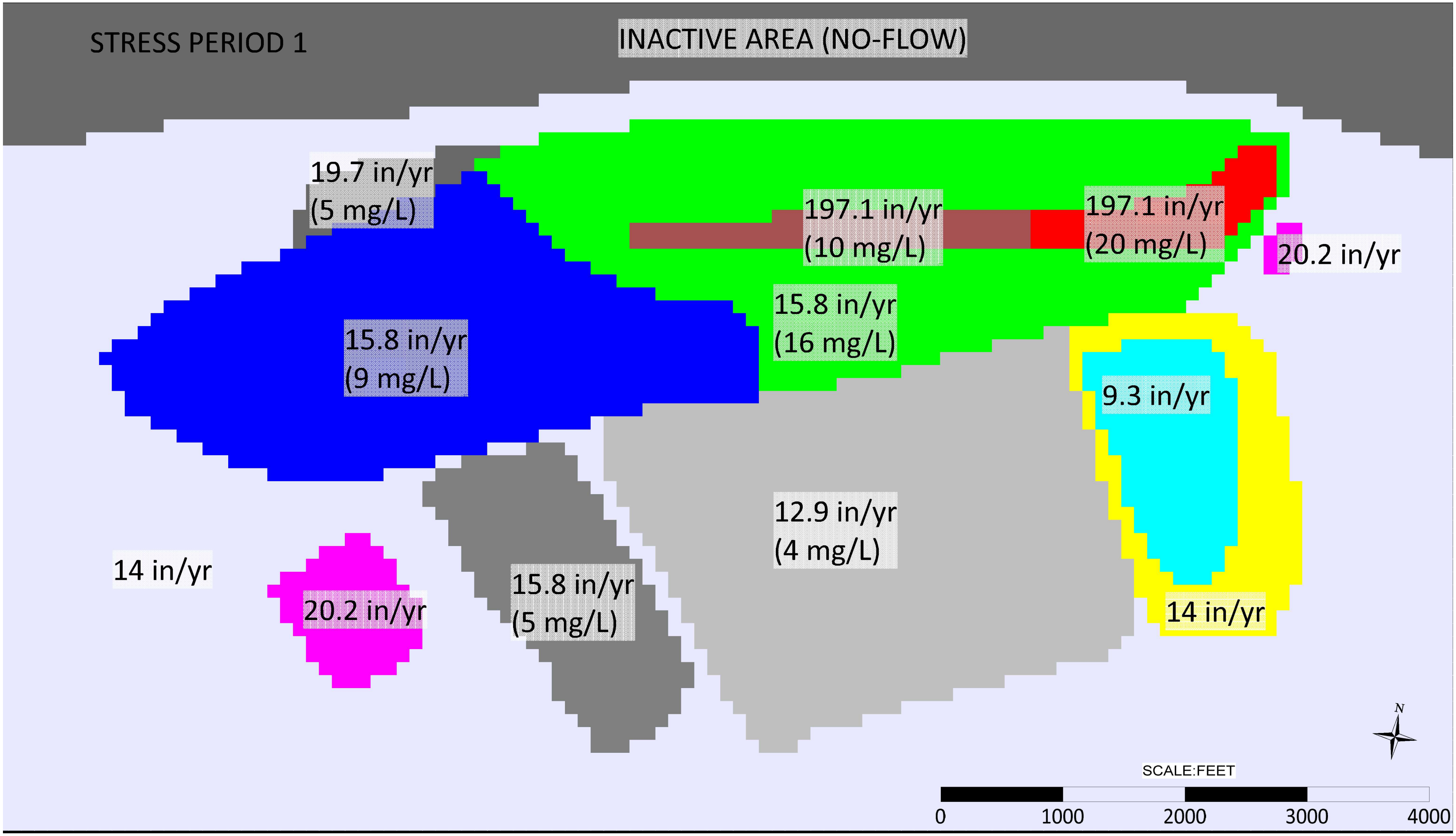
▦ Model Grid (variable spacing of 25 to 300 feet)

GROUNDWATER MODEL REPORT
EAST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 2
BOUNDARY CONDITIONS AND MODEL GRID

RAMBOLL

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC



LEGEND

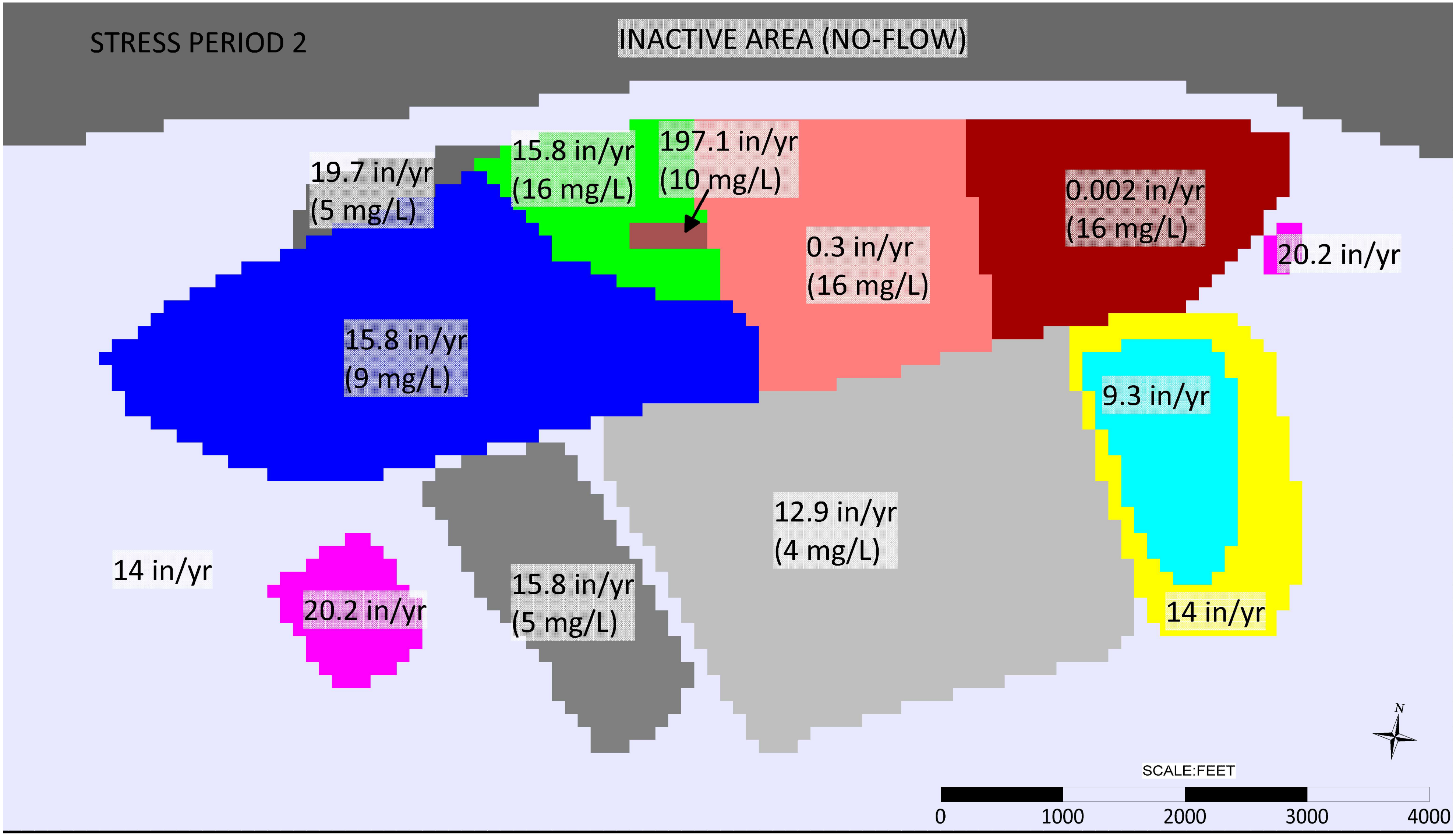
■	Inactive Area (No-Flow Boundary, all layers)
14 in/yr (0 mg/L)	Model recharge, in/yr (Boron concentration recharge, mg/L)

Notes
Stress Period 1 represents conditions present from 1996-2010

GROUNDWATER MODEL REPORT
EAST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 3
MODEL RECHARGE
(STRESS PERIOD 1)

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC



LEGEND

▨ Inactive Area (No-Flow Boundary, all layers)

14 in/yr (0 mg/L) Model recharge, in/yr (Boron concentration recharge, mg/L)

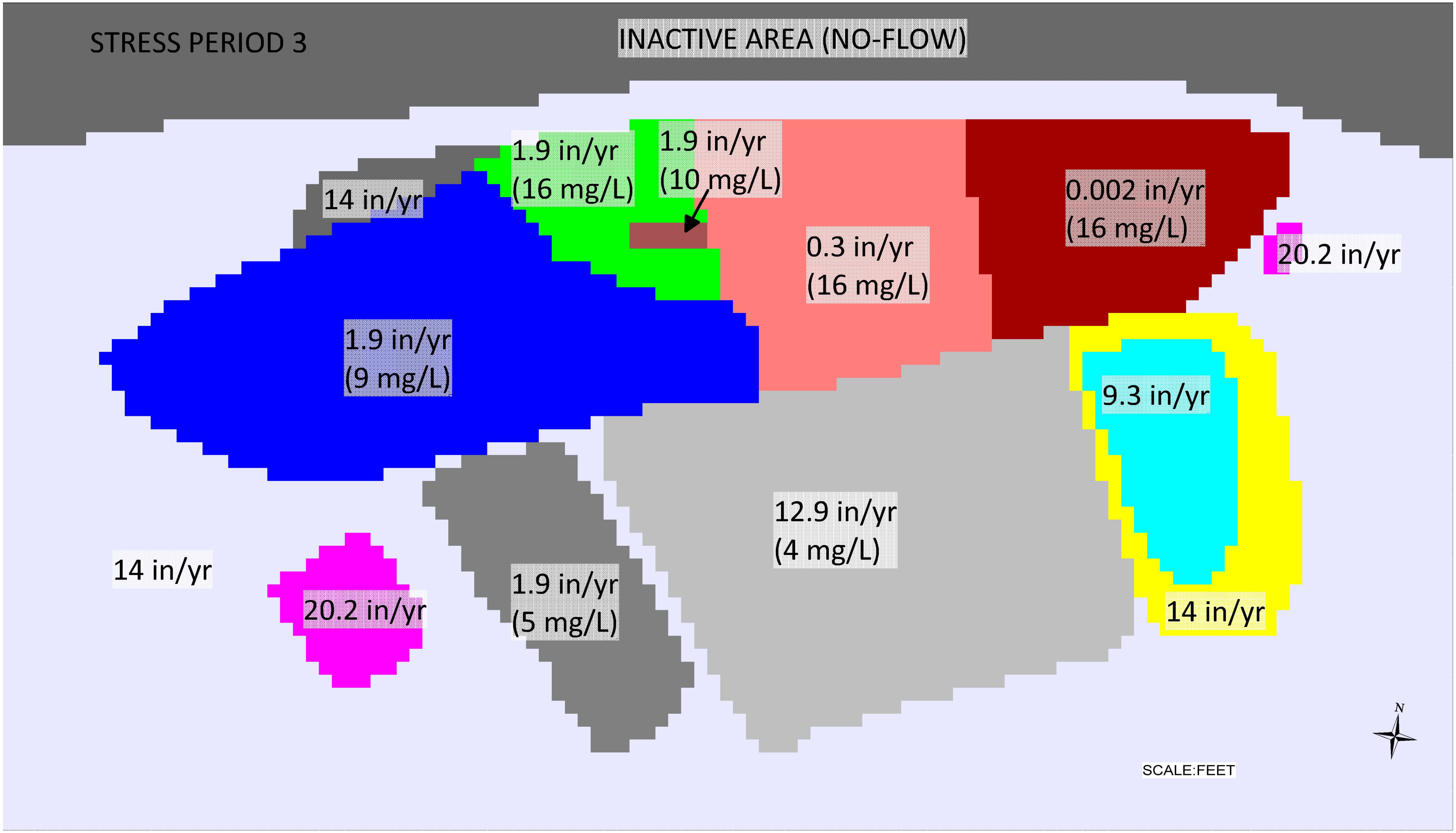
Notes

Stress Period 2 represents conditions present from 2010-2020

GROUNDWATER MODEL REPORT
EAST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 4
MODEL RECHARGE
(STRESS PERIOD 2)

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC



LEGEND

▨ Inactive Area (No-Flow Boundary, all layers)

14 in/yr (0 mg/L) Model recharge, in/yr (Boron concentration recharge, mg/L)

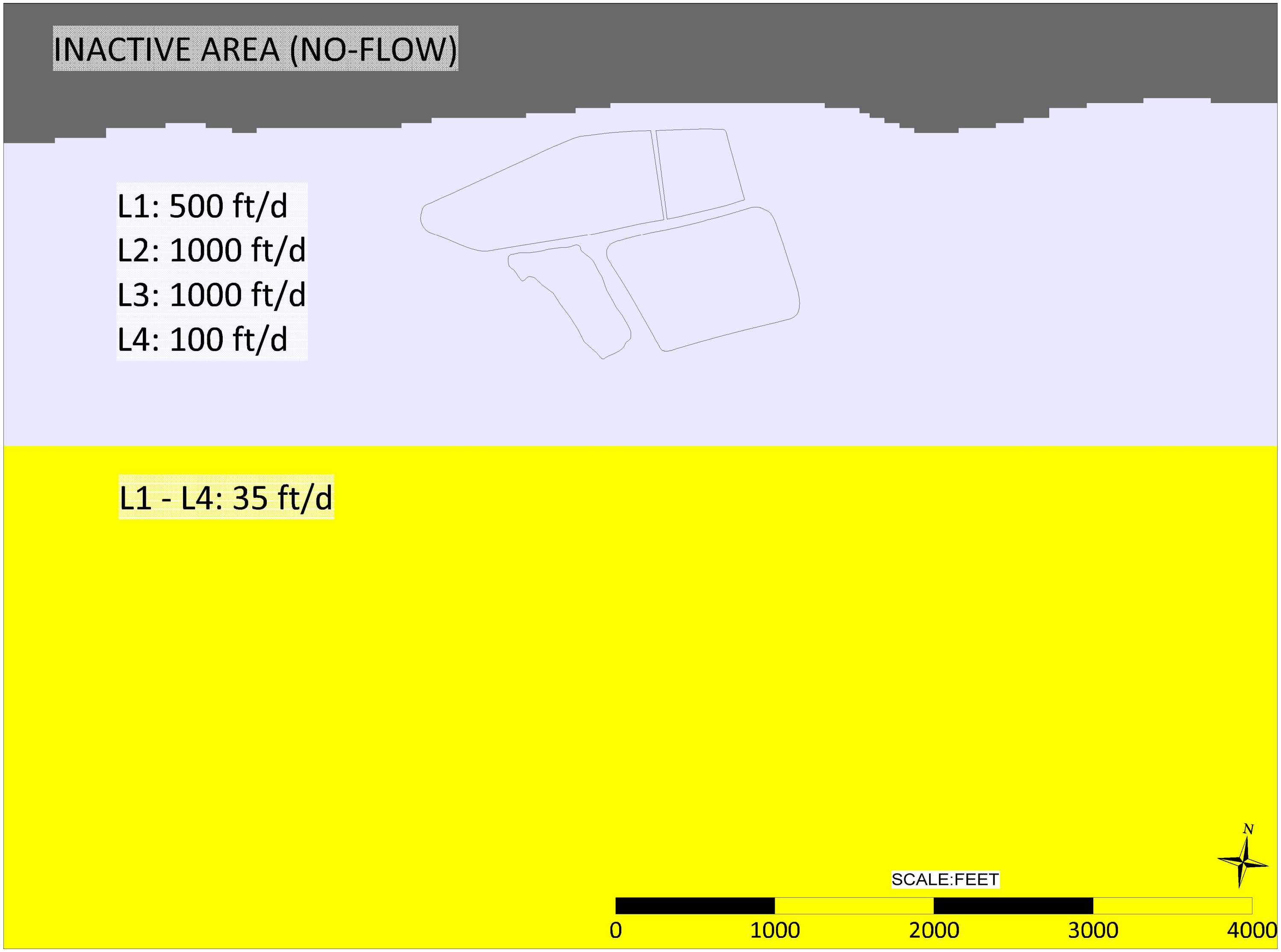
Notes
Stress Period 3 represents conditions following closure of AP2 and AP4 (November 2020-present)

GROUNDWATER MODEL REPORT
EAST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 5
MODEL RECHARGE
(STRESS PERIOD 3)

RAMBOLL

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC



Notes

Model conductivity zones are set with anisotropy of 1 (Kz/Kr=1)

GROUNDWATER MODEL REPORT
EAST ASH POND
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

FIGURE 6
MODEL HYDRAULIC
CONDUCTIVITY

RAMBOLL AMERICAS
ENGINEERING SOLUTIONS, INC

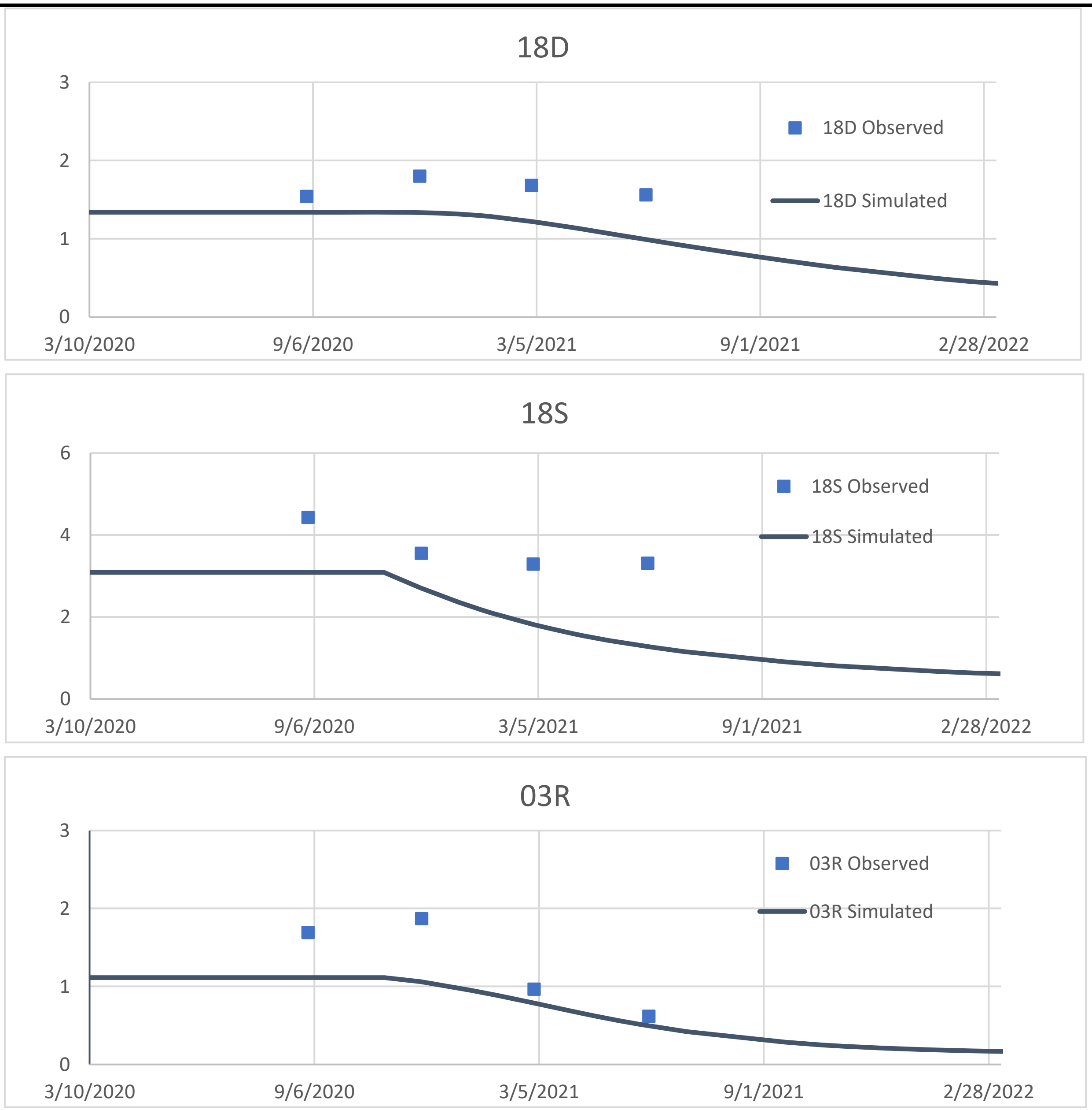


Figure 7

Selected Simulated vs Observed Concentrations, 2020-2021

Groundwater Model Report
Hennepin East Ash Pond
Hennepin Power Plant
Hennepin, Illinois

RAMBOLL

Notes

All concentrations are boron, in mg/L

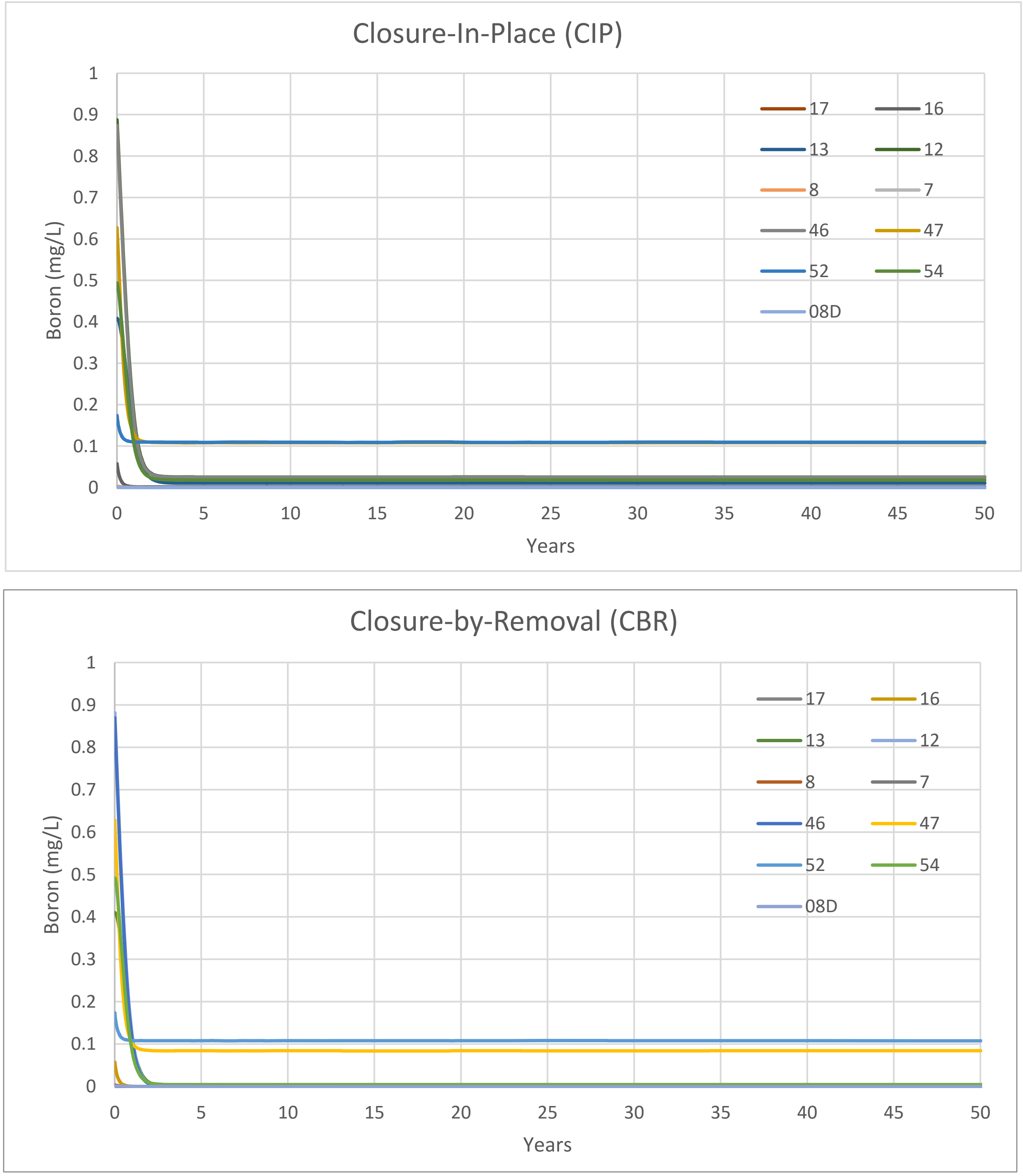


Figure 8

Predicted Boron Concentrations - CIP and CBR

Groundwater Model Report

Hennepin East Ash Pond
Hennepin Power Plant
Hennepin, Illinois

APPENDIX A
INFILTRATION CALCULATIONS

Appendix A
Infiltration Calculations

This appendix describes the calculation of infiltration rates for different portions of the EAPS. Infiltration rates were estimated using the HELP model or Darcy's Law. Calculation sheets and HELP model output are provided in this appendix.

1. Polishing Pond current conditions – Darcy's Law

   The polishing pond was not used for disposal of CCR materials. The pond is lined and currently impounding water, to a constant (managed) elevation of 476 ft amsl. The base of the pond is at 462 feet, and is underlain by four feet of clay placed atop native material. The water table is 16 feet below the base of the impoundment. The constant head maintained in the impoundment indicated a head-based calculation of infiltration (Darcy's Law) was more appropriate that a runoff/water balance model (HELP). Site-specific values of hydraulic conductivity were used where appropriate, with values from the HELP model database (Tolaymat and Krause, 2020) used where site specific data were not available. Calculated infiltration from the impoundment to the water table is 9.3 in/yr. Ths value was incorporated into the current conditions MODFLOW model and predictive scenarios.

2. EAP current conditions – Darcy's Law

   The EAP has been slowly accumulating CCR materials over time and is currently impounding water, with standing water in a portion of the total footprint at an elevation of 487 ft amsl. The impoundment is lined – it was constructed with a 4-foot clay layer, underlain by 1 foot of sand, atop the native glacial outwash material. The base of the impoundment is 464 ft amsl. The approximately 23.5 feet of saturation within the pond indicates that the liner is competent, and the water table is encountered more than ten feet below the base of the liner.

   The constant head maintained in the impoundment indicated a head-based calculation of infiltration (Darcy's Law) was more appropriate that a runoff/water balance model (HELP). Site-specific values of hydraulic conductivity were used where appropriate, with values from the HELP model database used where site specific data were not available. Calculated infiltration from the impoundment is 12.9 in/yr. This value was incorporated into the current conditions MODFLOW model and the no-action predictive simulation.

3. Landfill closure – HELP Model

   Closure of the CCWL will consist of excavation of landfilled bottom ash within the landfill, installation of a geotextile cushion overtop the existing geomembrane and leachate collection system to protect the geomembrane, backfill with 5.5 feet of protective cover soil, and 0.5 feet of vegetative cover soil. The landfill final surface will be graded to produce slopes of 1% to 2.5%. The HELP program was used to estimate infiltration after landfill closure using the specifications from the Draft CCR Final Closure Plan. The calculated recharge rate at the landfill after closure is 0.013 in/yr. This value was used in the predictive MODFLOW simulations.

4. EAP CIP – HELP – 2 feet of cover soil

   The proposed plan for CIP of the EAP consists of draining standing water from the EAP, backfilling and grading of the existing CCR materials, and installation of a final cover. The final cover will consist of a 40-mil LLDPE geomembrane with protective geotextile cushion, 1.5 feet of sand and gravel fill, and 0.5 feet of sandy clay soil as a vegetative cover layer. The HELP model was used to estimate the infiltration rate through the final cover. Cap and cover specifications for the EAP CIP simulation were based upon the current construction of the EAP and the information in the Draft CCR Final Closure Plan. An infiltration rate of 0.32 in/yr was calculated for CIP. This value represents the final simulated infiltration rate used for the EAP CIP predictive MODFLOW model scenario.

5. EAP CIP Sensitivity analysis – HELP (3 feet of cover soil)

   A sensitivity analysis of the EAP CIP proposed cap was performed to evaluate effects of increasing the thickness of the cover soil layer from 2 to 3 feet. An infiltration rate of 0.54 in/yr was calculated for this sequence. This analysis was performed for comparison of different specifications and not included in the MODFLOW model.

6. EAP CIP Sensitivity analysis – HELP (3 feet of cover soil and 3 feet of clay liner)

   A sensitivity analysis of the EAP CIP proposed cap was performed to evaluate effects of increasing the thickness of the cover soil layer from 2 to 3 feet, with the replacement of the LLDPE membrane with a 3 foot layer of clay barrier soil. This analysis was performed for comparison of different specifications and not included in the MODFLOW model. The calculated infiltration rate through this alternate CIP sequence was 1.7 in/yr. This evaluation was performed for comparison only and results were not used in MODFLOW modeling.

7. EAP CBR – HELP

   The proposed plan for closure-by-removal of the EAP consists of dewatering and excavation of the CCR materials within the EAP, and excavation and removal of the 4-foot clay liner and 1 foot of underlying material. The HELP model was used to estimate the infiltration rate through base of the EAP following closure. Cap and cover specifications for the EAP CBR simulation were based upon the current construction of the EAP and the information in the Draft CCR Final Closure Plan. An infiltration rate of 9.2 in/yr was calculated for the proposed EAP CBR remedy.

1. Polishing Pond Current Conditions

Darcy's Law Calculation

Equivalent K for flow at right angles to layer stratification from Domenico and Schwartz, 1990, equation 3.22 (page 69)

Head Information		
Water Level (Pool)	475.97	ft amsl
Base of pond (as built)	462	ft amsl
Groundwater Elevation beneath pond	446	ft amsl
Darcy's Law Calculations		
Head difference (dh)	29.97	feet
Travel distance (dL)	16	feet
Calculated Hydraulic Conductivity (K)	4.00E-07	cm/s
Calculated Hydraulic Conductivity (K)	1.13E-03	ft/d
specific discharge (infiltration rate)	2.12E-03	ft/d
specific discharge (infiltration rate)	**9.30**	in/yr

Stratigraphic Detail		
Layer 1 - Clay Liner		
thickness of layer 1	4	ft
K1	1.00E-07	cm/s
Layer 2 - glacial outwash (native)		
thickness of layer 2	12	ft
K2	1.80E-01	cm/s

2. East Ash Pond Current Conditions

Darcy's Law Calculation

Equivalent K for flow at right angles to layer stratification from Domenico and Schwartz, 1990, equation 3.22 (page 69)

Head Information		
Water Level (Pool)	487.48	ft amsl
Base of pond (as built)	464	ft amsl
Groundwater Elevation beneath pond	446	ft amsl

Darcy's Law Calculations		
Head difference (dh)	41.48	feet
Travel distance (dL)	18	feet
Calculated Hydraulic Conductivity (K)	4.50E-07	cm/s
Calculated Hydraulic Conductivity (K)	1.28E-03	ft/d
specific discharge (infiltration rate)	2.94E-03	ft/d
specific discharge (infiltration rate)	**12.87**	in/yr

Stratigraphic Detail		
Layer 1 - Clay Liner		
thickness of layer 1	4	ft
K1	1.00E-07	cm/s
Layer 2 -fill sand		
thickness of layer 2	1	ft
K2	5.80E-03	cm/s
Layer 3 - glacial outwash (native)		
thickness of layer 3	13	ft
K3	1.80E-01	cm/s

3. Landfill Closure

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN Landfill - Closure **Simulated On:** 8/30/2021 14:44

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness = 6 inches
Porosity = 0.398 vol/vol
Field Capacity = 0.244 vol/vol
Wilting Point = 0.136 vol/vol
Initial Soil Water Content = 0.2488 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-04 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness = 66 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.1045 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-02 cm/sec

Layer 3
Type 2 - Lateral Drainage Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.4212 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec
Slope = 0.5 %
Drainage Length = 900 ft

Layer 4

Type 4 - Flexible Membrane Liner
HDPE Membrane
Material Texture Number 35

Thickness = 0.06 inches
Effective Sat. Hyd. Conductivity = 2.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 4 Holes/Acre
FML Placement Quality = 2 Excellent

Layer 5

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness = 36 inches
Porosity = 0.427 vol/vol
Field Capacity = 0.418 vol/vol
Wilting Point = 0.367 vol/vol
Initial Soil Water Content = 0.427 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
G - Gravel
Material Texture Number 21

Thickness = 18 inches
Porosity = 0.397 vol/vol
Field Capacity = 0.032 vol/vol
Wilting Point = 0.013 vol/vol
Initial Soil Water Content = 0.032 vol/vol
Effective Sat. Hyd. Conductivity = 3.00E-01 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 480 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.187 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 8

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 420 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 80.8
Fraction of Area Allowing Runoff = 0 %
Area projected on a horizontal plane = 5 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 1.696 inches
Upper Limit of Evaporative Storage = 3.222 inches
Lower Limit of Evaporative Storage = 0.852 inches
Initial Snow Water = 0.274951 inches
Initial Water in Layer Materials = 138.054 inches
Total Initial Water = 138.329 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829
3.29051	4.017539	3.401471	3.029886	2.510213	1.863762

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Average Annual Totals Summary

Title: HEN Landfill - Closure
Simulated on: 8/30/2021 14:47

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	645,867.8	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	23.120	[3.256]	419,627.5	64.97
Subprofile1				
Lateral drainage collected from Layer 3	12.1502	[2.1307]	220,526.2	34.14
Percolation/leakage through Layer 5	0.013513	[0.001837]	245.3	0.04
Average Head on Top of Layer 4	67.8086	[8.7079]	---	---
Subprofile2				
Percolation/leakage through Layer 8	**0.012941**	[0.002404]	234.9	0.04
Water storage				
Change in water storage	0.3019	[3.564]	5,479.3	0.85

* Note: Average inches are converted to volume based on the user-specified area.

4. EAP CIP - 2 feet of cover soil

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP CIP (2 ft cover) **Simulated On:** 10/28/2021 14:14

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness = 6 inches
Porosity = 0.398 vol/vol
Field Capacity = 0.244 vol/vol
Wilting Point = 0.136 vol/vol
Initial Soil Water Content = 0.3947 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-04 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness = 18 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.4166 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-02 cm/sec

Layer 3
Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 372 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.1873 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness = 48 inches
Porosity = 0.451 vol/vol
Field Capacity = 0.419 vol/vol
Wilting Point = 0.332 vol/vol
Initial Soil Water Content = 0.4207 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.0649 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 156 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 80.6
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 510 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 3.196 inches
Upper Limit of Evaporative Storage = 3.222 inches
Lower Limit of Evaporative Storage = 0.852 inches
Initial Snow Water = 0.274951 inches
Initial Water in Layer Materials = 107.552 inches
Total Initial Water = 107.827 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829
3.29051	4.017539	3.401471	3.029886	2.510213	1.863762

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Average Annual Totals Summary

Title: HEN EAP CIP (2 ft cover)
Simulated or 10/28/2021 14:16

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	8.075	[3.311]	14,948,903.1	22.69
Evapotranspiration	27.017	[3.834]	50,016,380.0	75.92
Subprofile1				
Percolation/leakage through Layer 3	**0.529518**	[0.021507]	980,296.3	1.49
Average Head on Top of Layer 3	18.5065	[0.739]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**0.319267**	[0.207637]	591,059.7	0.90
Water storage				
Change in water storage	0.1740	[0.9142]	322,172.8	0.49

* Note: Average inches are converted to volume based on the user-specified area.

5. EAP CIP Sensitivity Analysis- 3 feet of cover soil

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure-in-Place **Simulated On:** 1/14/2022 8:20

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness = 6 inches
Porosity = 0.398 vol/vol
Field Capacity = 0.244 vol/vol
Wilting Point = 0.136 vol/vol
Initial Soil Water Content = 0.2488 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-04 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness = 30 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.3063 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-02 cm/sec

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 372 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.1873 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness = 48 inches
Porosity = 0.451 vol/vol
Field Capacity = 0.419 vol/vol
Wilting Point = 0.332 vol/vol
Initial Soil Water Content = 0.4205 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.0646 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 156 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 80.6
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 510 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 1.697 inches
Upper Limit of Evaporative Storage = 3.222 inches
Lower Limit of Evaporative Storage = 0.852 inches
Initial Snow Water = 0.27495054 inches
Initial Water in Layer Materials = 108.323 inches
Total Initial Water = 108.598 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829018
3.29051	4.017539	3.401471	3.029886	2.510213	1.86376189

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435

Average Annual Totals Summary

Title: HEN EAP - CURRENT CONDITIONS
Simulated on: 1/14/2022 8:23

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	7.713	[3.344]	14,279,113.1	21.67
Evapotranspiration	26.948	[3.837]	49,888,594.9	75.73
Subprofile1				
Percolation/leakage through Layer 3	**0.880978**	[0.027359]	1,630,955.3	2.48
Average Head on Top of Layer 3	30.2516	[0.8802]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**0.544600**	[0.386956]	1,008,217.1	1.53
Water storage				
Change in water storage	0.3795	[1.1939]	702,590.4	1.07

* Note: Average inches are converted to volume based on the user-specified area.

6. EAP CIP Sensitivity Analysis - 3 feet of cover soil, 3 feet of clay

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HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure-in-Place **Simulated On:** 10/13/2021 20:45

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.2488	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness	=	30	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.275	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-02	cm/sec

Layer 3

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 372 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.19 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness = 48 inches
Porosity = 0.451 vol/vol
Field Capacity = 0.419 vol/vol
Wilting Point = 0.332 vol/vol
Initial Soil Water Content = 0.419 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.0641 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 156 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 80.6
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 510 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 1.696 inches
Upper Limit of Evaporative Storage = 3.222 inches
Lower Limit of Evaporative Storage = 0.852 inches
Initial Snow Water = 0.27495054 inches
Initial Water in Layer Materials = 123.7 inches
Total Initial Water = 123.975 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829018
3.29051	4.017539	3.401471	3.029886	2.510213	1.86376189

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Average Annual Totals Summary

Title: HEN EAP - Closure-in-Place (CLAY)
Simulated on: 10/13/2021 20:48

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	6.701	[3.161]	12,404,742.9	18.83
Evapotranspiration	26.571	[4.002]	49,190,796.8	74.67
Subprofile1				
Percolation/leakage through Layer 3	**2.261741**	[0.038582]	4,187,161.3	6.36
Average Head on Top of Layer 3	29.5380	[1.1069]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**1.697246**	[0.951224]	3,142,112.4	4.77
Water storage				
Change in water storage	0.6162	[1.663]	1,140,863.6	1.73

* Note: Average inches are converted to volume based on the user-specified area.

7. EAP CBR

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure By Removal **Simulated On:** 10/13/2021 20:18

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
Glacial Outwash
Material Texture Number 44

Thickness	=	156	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.0757	vol/vol
Effective Sat. Hyd. Conductivity	=	1.80E-01	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	96.4	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	510	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	0.472	inches
Upper Limit of Evaporative Storage	=	3.336	inches
Lower Limit of Evaporative Storage	=	0.144	inches
Initial Snow Water	=	0.274951	inches
Initial Water in Layer Materials	=	11.815	inches
Total Initial Water	=	12.09	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829
3.29051	4.017539	3.401471	3.029886	2.510213	1.863762

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Average Annual Totals Summary

Title: HEN EAP - Closure By Removal
Simulated on: 10/13/2021 20:20

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	9.901	[2.412]	18,329,439.3	27.82
Evapotranspiration	16.545	[2.588]	30,628,987.6	46.49
Subprofile1				
Percolation/leakage through Layer 1	**9.153923**	[1.458283]	16,946,657.8	25.72
Water storage				
Change in water storage	-0.0144	[0.7954]	-26,569.1	-0.04

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX B
MODFLOW, MT3DMS, AND HELP MODEL FILES
(ELECTRONIC ONLY)

ATTACHMENT C

History of Construction Report

845.220(a)(1)

Geosyntec consultants

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Chesterfield, MO 63005
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October 11, 2021

Dynegy Midwest Generation, LLC
13498 E. 800th Street
Hennepin, Illinois 61327

Subject: Periodic History of Construction Report Update Letter
USEPA Final CCR Rule, 40 CFR §257.73(c)
Hennepin Power Plant
Hennepin, Illinois

At the request of Dynegy Midwest Generation, LLC (DMG), Geosyntec Consultants (Geosyntec) has prepared this Letter to documents updates to the Initial History of Construction (HoC) report for the Hennepin Power Plant (HPP), also known as the Hennepin Power Station (HEN). The Initial HoC report was prepared by AECOM in October of 2016 [1] in accordance with 40 Code of Federal Regulations (CFR) §257.73(c) of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals Rule, known as the CCR Rule [2]. This letter also includes information required by Section 845.220(a)(1)(B) (Design and Construction Plans) of the state-specific Illinois Environmental Protection Agency (IEPA) Part 845 CCR Rule [3] that is not expressly required by §257.73(c).

BACKGROUND

The CCR Rule required that, by October 17, 2016, Initial HoC reports to be compiled for existing CCR surface impoundments with: (1) a height of five feet or more and a storage volume of 20 acre-feet or more, or (2) a height of 20 feet or more. The Initial HoC report was required to contain, to the extent feasible, the information specified in 40 CFR §257.73(c)(1)(i)-(xii). The Initial HoC report for HPP, which included four existing CCR surface impoundments, the Old West Polishing Pond (OWPP), Old West Ash Pond (Pond No. 1 and Pond No. 3, also known as the OWAP), Ash Pond No. 2 (AP2), and the East Ash Pond (EAP), was prepared and subsequently posted to DMG's CCR Website prior to October 17, 2016.

The CCR Rule requires that Initial HoC to be updated if there is a significant change to any information complied in the Initial HoC report, as listed below:

§ 257.73(c)(2): If there is a significant change to any information complied under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

DMG retained Geosyntec to review the Initial HoC report, review reasonably and readily available information for the OWPP, OWAP, AP2, EAP generated since the Initial HoC report was prepared, and perform a site visit to HPP to evaluate if significant changes may have occurred since the Initial HoC report was prepared. This Letter contains the results of Geosyntec's evaluation and documents significant changes that have occurred at the OWPP, OWAP, AP2, and EAP, as they pertain the requirements of §257.73(c)(1)(i)-(xii)

UPDATES TO HISTORY OF CONSTRUCTION REPORT

Geosyntec's evaluation for the HPP OWPP, OWAP, AP2, and EAP determined that no known significant changes requiring updates to the information in the Initial HoC report pertaining to §257.73(c)(1)(ii), (iv), (v), (vi), (vii), (xi), and (xii) of the CCR Rule had occurred since the Initial HoC report was developed.

However, Geosyntec's evaluation determined that significant changes at the HPP EAP pertaining to §257.73(c)(1)(i), (iii), (viii), (ix), and (x) of the CCR Rule had occurred since the Initial HoC report had been developed. Additionally, information how long the CCR EAP and been operating and the types of CCR in the impoundment, as required by Section 845.220(a)(1)(B) of the Part 845 Rule were not included in the Initial HoC report, as this information is not required by the CCR Rule. Each change and the subsequent updates to the Initial HoC report is described within this section.

Section 845.220(a)(1)(B): A statement of … how long the CCR surface impoundment *has been in operation, and the types of CCR that have been placed in the surface impoundment.*

<u>*East Ash Pond*</u>

The EAP was in operation from 1996 until the HPP was retired in December of 2019, for a total of approximately 23 years [1]. Since December of 2019 the EAP has not been actively receiving CCR but has not yet been closed. As of the date of this report, the EAP has been present for approximately 25 years.

CCR placed in the EAP has included bottom ash and fly ash, in addition to other non-CCR waste streams [1].

Old West Polishing Pond and Old West Ash Pond

The OWAP and OWPP were in operation from 1952 to approximately 1996, for a total of approximately 44 years. The OWAP and OWPP did not receive CCR after 1996 but was not closed until 2020. The OWAP and OWPP were present for a total of approximately 68 years prior to closure.

CCR placed in the OWAP and OWPP included fly ash and bottom ash.

Ash Pond No. 2

AP2 was in operation from 1958 until sometime between 2003 and 2009, for a total of approximately 45 to 51 years. AP2 did not receive CCR after sometime between 2003 and 2009, but was not closed until 2020. AP2 was present for a total of approximately 62 years.

CCR placed in AP2 included fly ash and bottom ash.

§ 257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

State identification numbers (IDs) for the OWPP, OWAP, AP2, and EAP have been assigned by the Illinois Environmental Protection Agency (IEPA). Each ID is listed in **Table 1**.

Table 1 – Results of Updated Discharge Capacity Calculations

CCR Surface Impoundment	State ID
Old West Polishing Pond (OWPP)	W1550100002-01
Old West Ash Pond (OWAP)	W1550100002-03
Ash Pond No. 2 (AP2)	W1550100002-04
East Ash Pond (EAP)	W1550100002-05

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

The OWPP, OWAP, and EAP2 were closed in 2020, in substantial compliance with the written closure plans posted to DMG's CCR Website ([4], [5], [6]), and as documented by certified Notification of Completion of Closures posted to DMG's CCR Website ([7], [8]). Therefore, the OWAP and EAP2 are no longer capable of storing additional CCR or free liquids, and all CCR was removed from the OWPP as part of closure-by-removal.

The HPP was retired in December of 2019, with the generation of electricity ceased at that time. Therefore, the EAP is no longer being used to actively store and dispose of new CCR, as CCR is no longer being generated by the HPP. The EAP also received inflows from East

Ash Pond No. 2 and the Coal Pile Runoff Pond; these inflows have also ceased as part of plant closure.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Instrumentation monitoring at the OWPP, OWAP, and EAP is no longer required as these CCR surface impoundments were closed in accordance with §257.102 ([7], [8]), and the instrumentation network was modified at that time. Therefore, the instrumentation locations shown in Appendix C of the Initial HoC report are no longer applicable to the OWPP, OWAP, and EAP.

§ 257.73(c)(1)(ix): Area-capacity curves for the CCR unit.

An updated area-capacity curve was prepared for the EAP in 2021 and is provided in **Figure 1**.

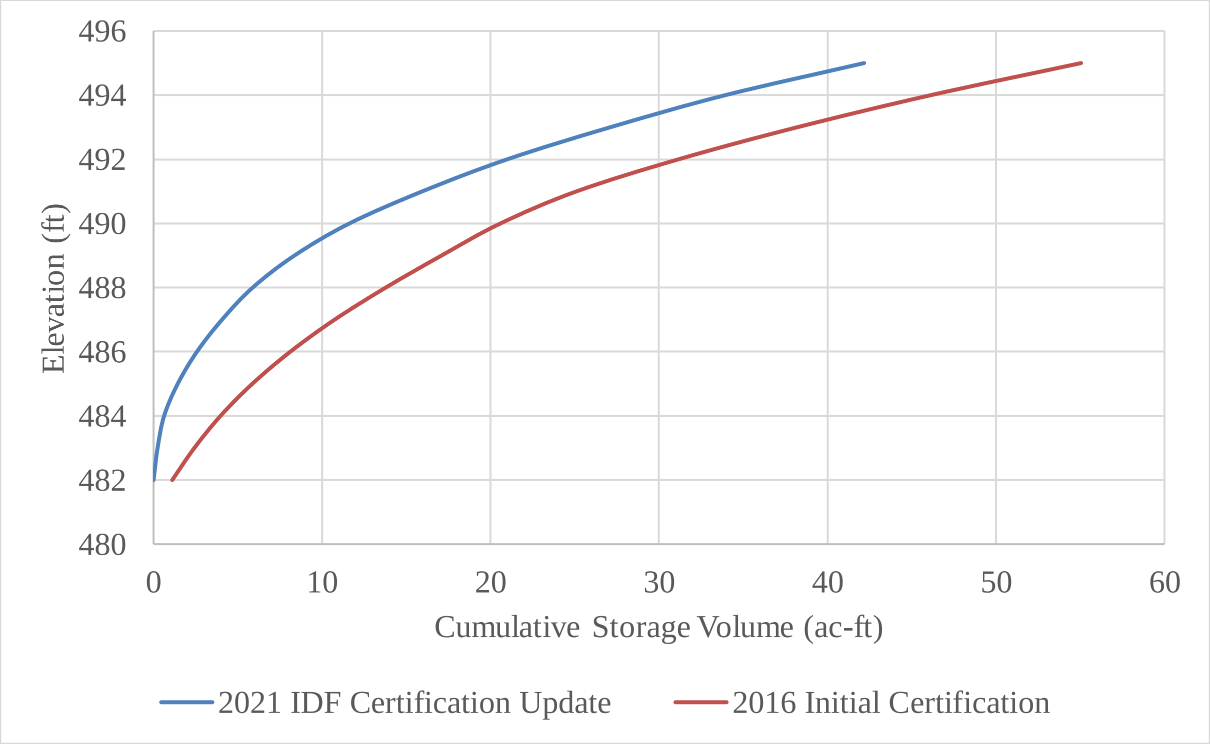

Figure 1 – Area-Capacity Curve for East Ash Pond

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

Updated discharge capacity calculations for the existing spillways of the EAP were prepared in 2021 using HydroCAD 10 modeling software. The calculations indicate that the EAP has sufficient storage capacity and will not overtop the embankments during the 1,000-year, 24-hour, storm event. The results of the calculations are provided in **Table 2**.

Table 2 – Results of Updated Discharge Capacity Calculations

	East Ash Pond
Approximate Berm Minimum Elevation[1], ft	492.0
Approximate Emergency Spillway Elevation[1], ft	Not Applicable
Starting Water Surface Elevation[1] (SWSE), ft	490.0
Peak Water Surface Elevation[1] (PWSE), ft	491.4
Time to Peak, hr	16.8
Surface Area[2], ac	5.0
Storage[3], ac-ft	6.3

Notes:
[1] Elevations are based on the NAVD88 datum
[2] Surface area is defined as the water surface area at the PWSE
[3] Storage is defined as the volume between the SWSE and PWSE

The OWPP, OWAP, and EAP2 no longer retain free water as both CCR surface impoundments were closed in 2020 ([7], [8]). Therefore, the spillways are no longer present and the information regarding the spillways of these structures, as presented in the Initial HoC report, is no longer applicable to the OWPP, OWAP, and EAP2.

CLOSING

This letter has been prepared to document Geosyntec's evaluation of changes that have occurred at the OWPP, OWAP, AP2, and EAP at the HPP since the Initial HoC was developed, based on reasonably and readily available information provided by DMG, observed by Geosyntec during the site visit, or generated by Geosyntec as part of subsequent calculations.

Sincerely,

Lucas P. Carr, P.E.
Senior Engineer

John Seymour, P.E.
Senior Principal

REFERENCES

[1] AECOM, "History of Construction, USEPA Final CCR Rule, 40 CFR § 257.73(c), Hennepin Power Station, Hennepin, Illinois," October 2016.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[4] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Hennepin Power Station, Dynegy Midwest Generation, LLC, Old West Polishing Pond," October 17, 2016.

[5] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Hennepin Power Station, Dynegy Midwest Generation, LLC, Old West Ash Pond," December 17, 2020.

[6] V. Modeer, "Closure Plan for Existing CCR Surface Impoundment, 40 CFR 257.102(b), Hennepin Power Station, Dynegy Midwest Generation, LLC, East Ash Pond," October 17, 2016.

[7] D. Tickner, "Hennepin Power Station; Old West Polishing Pond, Notificaiton of Completion of Closure," Luminant, December 17, 2020.

[8] D. Tickner, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notificaiton of Completion of Closure," Luminant, December 17, 2020.

October 2016

Dynegy Midwest Generation, LLC
13498 E 800th St.
Hennepin, IL 61327

RE: History of Construction
USEPA Final CCR Rule, 40 CFR § 257.73(c)
Hennepin Power Station
Hennepin, Illinois

On behalf of Dynegy Midwest Generation, LLC, AECOM has prepared the following history of construction for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond at the Hennepin Power Station in accordance with 40 CFR § 257.73(c).

BACKGROUND

40 CFR § 257.73(c)(1) requires the owner or operator of an existing coal combustion residual (CCR) surface impoundment that either (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 to compile a history of construction by October 17, 2016 that contains, to the extent feasible, the information specified in 40 CFR § 257.73(c)(1)(i)–(xii).

The history of construction presented herein was compiled based on existing documentation, to the extent that it is reasonably and readily available (see 80 Fed. Reg. 21302, 21380 [April 17, 2015]), and AECOM's site experience. AECOM's document review included construction drawings, geotechnical investigations, operation and maintenance information, etc. for Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond at the Hennepin Power Station.

HISTORY OF CONSTRUCTION

§ 257.73(c)(1)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

Owner:	Dynegy Midwest Generation, LLC
Address:	1500 Eastport Plaza Drive Collinsville, IL 62234
CCR Units:	Old West Polishing Pond Old West Ash Pond (Pond No. 1 and Pond No. 3) Ash Pond No. 2 East Ash Pond, IDNR Dam ID No. IL50363

The Old West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 do not have a state assigned identification number.

§ 257.73(c)(1)(ii): The location of the CCR unit identified on the most recent USGS $7^1/_2$ or 15 minute topographic quadrangle map or a topographic map of equivalent scale if a USGS map is not available.

The locations of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond have been identified on an USGS 7-1/2 minute topographic quadrangle map in **Appendix A**.

§ 257.73(c)(1)(iii): A statement of the purpose for which the CCR unit is being used.

The following captures the purpose of each CCR unit:

- The Old West Polishing Pond (inactive) was used to store and dispose fly ash and bottom ash and is currently being used to clarify stormwater runoff from the Old West Ash Pond prior to discharge in accordance with the station's NPDES permit.
- The Old West Ash Pond (inactive) was used to store and dispose fly ash and bottom ash.
- The Ash Pond No. 2 (inactive) was used to store and dispose fly ash, bottom ash, and other non-CCR waste streams including coal pile runoff.
- The East Ash Pond is being used to store and dispose bottom ash, fly ash, and other non-CCR waste and to clarify process water prior to discharge in accordance with the station's NPDES permit.

Notice of intent to close the Old West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 was provided in November 2015.[1]

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[1] This history of construction report was prepared on a facility-wide basis for CCR surface impoundments at the Hennepin Power Station. The inclusion of the Old West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 in this history of construction report does not concede and should not be construed to concede that the Old

§ 257.73(c)(1)(iv): The name and size in acres of the watershed where the CCR unit is located.

The Hennepin Power Station and the above-referenced CCR units are located at the western edge of the Depue Lake-Illinois River Watershed with a 12-digit Hydrologic Unit Code (HUC) of 071300010804 and a drainage area of 44,525 acres (USGS 2016).

§ 257.73(c)(1)(v): A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

Physical properties of the foundation materials for the Old West Polishing Pond and Old West Ash Pond are described as cohesive material underlain by granular material. The cohesive material consists of lean clay, gravelly clay, silt, clayey silt, and sandy silt. The consistency of the cohesive material varies from very soft to medium stiff. The granular material consists of silty sand and clayey gravel. The relative density of the granular materials varies from loose to very dense and generally increases with depth. An available summary of the engineering properties of the foundation materials for the Old West Polishing Pond and Old West Ash Pond is presented in **Table 1** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 1. Summary of Material Engineering Properties for the Old West Polishing Pond and Old West Ash Pond

Layer	Unit Weight (pcf)	Total (undrained) Shear Strength Parameters		Effective (drained) Shear Strength Parameters	
		ϕ (deg)	***c (psf)***	***ϕ' (deg)***	***c' (psf)***
CL (soft)	120	0	500	28	0
CL (medium stiff gravely clay)	120	28	0	28	0
ML (soft to medium stiff)	125	28	0	28	0
CL-ML (very soft)	120	0	400	26	0
SM (very loose)	125	28	0	28	0
GC (dense)	130	34	0	34	0
GC (very dense)	130	36	0	36	0
Fill: GC (very dense)	130	34	50	34	0

West Polishing Pond, Old West Ash Pond, and Ash Pond No. 2 are subject to the Design Criteria or all Operating Criteria in the CCR Rule.

The Old West Polishing Pond and Old West Ash Pond are enclosed impoundments with dikes and do not have abutments.

Physical properties of the foundation and abutment materials for Ash Pond No. 2 and the East Ash Pond are described as gravel materials with varying amounts of silt and clay. The relative density of the gravel is medium dense to very dense. An available summary of the engineering properties of the foundation materials for Ash Pond No. 2 and the East Ash Pond is presented in **Table 2** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 2. Summary of Foundation and Abutment Material Engineering Properties for the Ash Pond No. 2 and East Ash Pond

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c’ (psf)	Φ’ (°)	c (psf)	Φ (°)
Alluvial Foundation	135	0	38	0	38

§ 257.73(c)(1)(vi): 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 unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

Physical properties of the embankment materials for the Old West Polishing Pond and Old West Ash Pond are described as gravel with occasional zones of clayey sand and lean clay. The gravel has a general relative density of very dense. An available summary of the engineering properties of the embankment materials for the Old West Polishing Pond and Old West Ash Pond is presented in **Table 1** above. The engineering properties are based on previous geotechnical explorations and laboratory testing.

The physical properties of Ash Pond No. 2 embankment construction materials are described in this paragraph. The original embankments are constructed of sand with varying amounts of coal pieces and gravel. The initial embankment raise is constructed of silty clay, clayey sand, sand, and gravel and the later embankment raise is constructed with layers of lean clay, silty clay, clayey silt, clayey, and gravel. An available summary of the engineering properties of the embankment materials for Ash Pond No. 2 is presented in **Table 3** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 3. Summary of Construction Material Engineering Properties for Ash Pond No. 2

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Fill: GP-GM (medium dense)	125	0	32	0	32
Fill: CL (hard)	120	0	32	4000	0
Fill: ML (hard)	120	0	32	4500	0
Fill: SC (medium dense)	120	0	28	0	28

Physical properties of the embankment materials for the East Ash Pond are described as clayey silt and clay. The consistency of both the clayey silt and clay ranges from stiff to hard. The original pond surface is lined with a 4-foot thick compacted clay layer of 1.0 x 10^{-7} cm/s underlain by a 1-foot thick sand layer. The liner system of the embankment raise consists of a (from top to bottom) 45 mil reinforced polyethylene geomembrane, a 1-foot thick clay layer, and an 8 oz/sy polypropylene geotextile. A typical cross section profile of the liner system is shown on drawing C-56 presented in **Appendix B**. An available summary of the construction material engineering properties for the East Ash Pond is presented in **Table 4** below. The engineering properties are based on previous geotechnical explorations and laboratory testing.

Table 4. Summary of Construction Material Engineering Properties for the East Ash Pond

Material	Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Embankment Fill	105	30	32	2500	0
Liner System	120	60	30	2500	0

The method of site preparation and construction of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and the original East Ash Pond are not reasonably and readily available. Site preparation and construction of the 2003 East Ash Pond liner raise were completed in accordance with the applicable construction specification (see § 257.73(c)(1)(xi) below).

Reasonably and readily available approximate dates of construction of each successive stage of construction of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are provided in **Table 5** below.

Table 5. Approximate dates of construction of each successive stage of construction.

Date	Event
1951 to 1952	Construction of historical Ash Pond No. 1
1958	Construction of Ash Pond No. 2
Late 1960's	Construction of historical Ash Pond No. 3
1978	Embankment raise of Ash Pond No. 2
1985	Embankment raise of Ash Pond No. 2 to elevation 484 feet and Ash Pond No. 3 (Old West Ash Pond) to elevation 460 feet
1988 to 1989	Embankment raise of Old West Ash Pond to elevation 465 feet that merged historical Ash Pond No. 1 and Ash Pond No. 3 into one single pond and created the Old West Polishing Pond
1989	Embankment raise of Ash Pond No. 2 to elevation 494 feet
1995 to 1996	Construction of East Ash Pond
2003	Embankment liner raise of East Ash Pond
2009 to 2010	Eastern portion of Ash Pond No. 2 was removed to facilitate construction of the Leachate Pond
2011	Landfill Cell 1 was constructed over placed CCR in Ash Pond No. 2 adjacent to the Leachate Pond
2014	North Embankment tree removal, grading, and vegetation re-establishment of Ash Pond No. 2

§ 257.73(c)(1)(vii): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, 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 unit due to malfunction or mis-operation.

Drawings that contain items pertaining to the requested information for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are listed in **Table 6** below. Items marked as "Not Available" are items not found during a review of the reasonably and readily available record documentation.

Table 6. List of drawings containing items pertaining to the information requested in § 257.73(c)(1)(vii).

	Old West Polishing Pond	Old West Ash Pond	Ash Pond No. 2	East Ash Pond
Dimensional plan view (all zones)	HEN1-B460-2	HEN1-B460-1 to 2	HEN1-B461, HEN1-C117	HEN1-C55
Dimensional cross sections	HEN1-B452 to B457	HEN1-B452 to B457	HEN1-B458-1 to 7, Berm Modification Drawings 7 to 9	HEN1-C56 to C59
Foundation Improvements	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Drainage Provisions	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Spillways and Outlets	Not Available	Not Available	Not Applicable	HEN1-C8 to C9, HEN1-C109, HEN1-C113
Diversion Ditches	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Instrument Locations	Figure 2D	Figure 2C	Figure 2A	Figure 2B
Slope Protection	Not Available	Not Available	Berm Modification Drawings 3 to 9	HEN1-C56 to C59
Normal Operating Pool Elevation	Not Available	Not Available	Not Available	Not Available
Maximum Pool Elevation	Not Available	Not Available	Not Available	Not Available
Approximate Maximum Depth of CCR in 2016	11 feet	15 feet	46 feet	35 feet

All drawings referenced in **Table 6** above can be found in **Appendix B** and **Appendix C**.

Based on the review of the drawings listed above, no natural or manmade features that could adversely affect operation of these CCR units due to malfunction or mis-operation were identified.

§ 257.73(c)(1)(viii): A description of the type, purpose, and location of existing instrumentation.

Existing instrumentation consists of open-standpipe piezometers installed in 2015. The purpose of the piezometers is to measure the pore water pressures within the embankments of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond. There are seven (7) existing piezometers within the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond. A location map of the existing instrumentation is presented in **Appendix C**.

§ 257.73(c)(1)(ix): Area-capacity curves for the CCR unit.

Area-capacity curves for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are not reasonably and readily available.

§ 257.73(c)(1)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

The Old West Polishing Pond contains a 24-inch diameter corrugated metal pipe (CMP) outlet that discharges stormwater to the Illinois River in accordance with the station's NPDES permit. Current capacity and calculation information for the Old West Polishing Pond's discharge capability is not reasonably and readily available.

The Old West Ash Pond contains a 24-inch dia. pipe culvert. Stormwater collected within the CCR unit drains via surface flow and through the pipe culvert into the Old West Polishing Pond. Current capacity and calculation information for the Old West Ash Pond's discharge capability is not reasonably and readily available.

The Ash Pond No. 2 does not contain a spillway or diversion feature. Stormwater collected within the CCR unit drains via surface flow into the East Ash Pond. Current capacity and calculation information for the Ash Pond No. 2's discharge capability is not reasonably and readily available.

The East Ash Pond contains two outlet structures. The southeast outlet is a 5-foot wide stop-log structure that is connected to a 36-inch diameter reinforced concrete pipe (RCP). The 36-inch diameter RCP discharges into the East Polishing Pond. The northeast outlet, located on the northeast corner of the East Ash Pond, is a headwall structure connected to an 18-inch diameter RCP. The 18-inch diameter RCP discharges into the East Leachate Pond. In 2016, the discharge capacity of the East Ash Pond was evaluated using HydroCAD 10 software modeling a 1,000-year, 24-hour rainfall event. The model results indicate that the East Ash Pond has enough storage capacity and will not overtop the embankment during the 1,000-year, 24-hour storm event. The results of the HydroCAD 10 analysis are presented below in **Table 7**.

Table 7. Results of HydroCAD 10 analysis

	East Ash Pond
Approximate Minimum Berm Elevation[1] (ft)	493.0
Approximate Emergency Spillway Elevation[1] (ft)	Not Applicable
Starting Pool Elevation[1] (ft)	490.4
Peak Elevation[1] (ft)	492..2
Time to Peak (hr)	12.5
Surface Area (ac)	6.5
Storage[2] (ac-ft)	8.4

Note: 1. Elevations are based on NAVD88 datum

2. Storage given is from Starting Pool Elevation to Peak Elevation.

§ 257.73(c)(1)(xi): The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

The construction specifications for Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and the original East Ash Pond are not reasonably and readily available. The construction specification for the 2003 East Ash Pond liner raise is located in *Specification J-2616, Rev. A* (presented in **Appendix D**).

The provisions for surveillance, maintenance, and repair of the Old West Polishing Pond and Old West Ash Pond are located in *Hennepin Power Station; West Ash Disposal Pond Maintenance Plan* (2013) (presented in **Appendix E**). The provisions for surveillance, maintenance, and repair of Ash Pond No. 2 are located in *Hennepin Power Station; Old East Ash Disposal Pond Maintenance Plan* (2013) (presented in **Appendix F**). The provisions for surveillance, maintenance, and repair of the East Ash Pond are located in *Hennepin Power Station; East Ash Disposal Pond Maintenance Plan* (2014) (presented in **Appendix G**).

The operations and maintenance plans for the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond are currently being revised by Dynegy Midwest Generation, LLC.

§ 257.73(c)(1)(xii): Any record or knowledge of structural instability of the CCR unit.

There is no record or knowledge of structural instability of the Old West Polishing Pond, Old West Ash Pond, Ash Pond No. 2, and East Ash Pond at the Hennepin Power Station.

LIMITATIONS

The signature of AECOM's authorized representative on this document represents that to the best of AECOM’s knowledge, information and belief in the exercise of its professional judgment, it is AECOM’s professional opinion that the aforementioned information is accurate as of the date of such signature. Any recommendation, opinion or decisions by AECOM are made on the basis of AECOM's experience, qualifications and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data and that actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

Sincerely,

Claudia Prado

Claudia Prado	Victor Modeer, P.E., D.GE
Project Manager	Senior Project Manager

REFERENCES

United States Environmental Protection Agency (USEPA). (2015). *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.* 40 CFR Parts 257 and 261, 80 Fed. Reg. 21302, 21380 April 17, 2015.

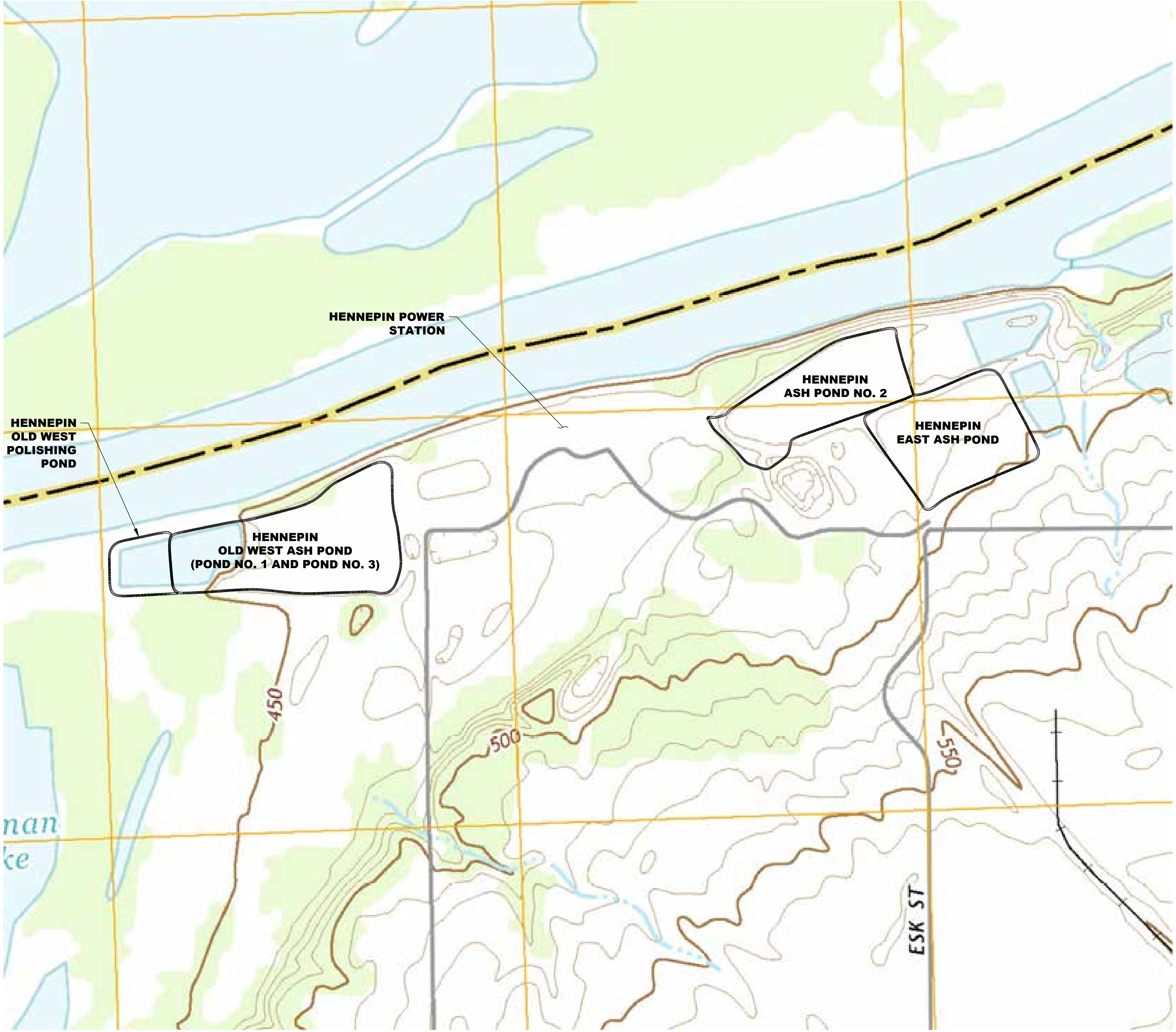
United States Geological Survey (USGS). (2016). The National Map Viewer. http://viewer.nationalmap.gov/viewer/. USGS data first accessed in March of 2016.

APPENDICES

Appendix A: History of Construction Vicinity Map
Appendix B: Hennepin Power Station Drawings
Appendix C: Hennepin Power Station Piezometer Locations
Appendix D: Specification J-2616, Rev. A, Primary Ash Pond Modifications
Appendix E: Hennepin Power Station; West Ash Disposal Pond Maintenance Plan (2013)
Appendix F: Hennepin Power Station; Old East Ash Disposal Pond Maintenance Plan (2013)
Appendix G: Hennepin Power Station; East Ash Disposal Pond Maintenance Plan (2014)

Appendix A: History of Construction Vicinity Map

AECOM DRAWING PATH: P:\Projects\Geotech\60428794_DynegyCCR\13_Construction History\04 Technical Production\4_Hennepin\Reference Documents\Vicinity Location Map References\Figures\C-01 History of Construction Vicinity Map (Hennepin) – MJN.dwg NANAK, MATT, 9/28/2016 4:11 PM

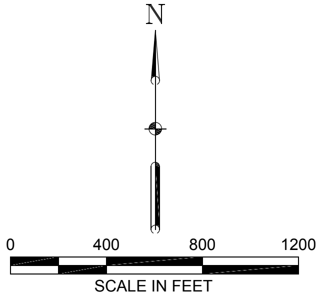


LEGEND

▭ CCR UNITS

SOURCE:
MAP PROVIDED FROM ELECTRONIC USGS DIGITAL RASTER GRAPHIC 7.5 MINUTE TOPOGRAPHIC MAP OF DEPUE ILLINOIS, REVISED 2015.

QUADRANGLE LOCATION



AECOM
1001 Highlands Plaza Drive, Suite 300
St. Louis, Mo. 63110
314 429-0100 (phone)
314-429-0462 (fax)

DYNEGY MIDWEST GENERATION, L.L.C.
13498 East 800th Street
Hennepin, IL 61327

HISTORY OF CONSTRUCTION

HENNEPIN POWER STATION
HENNEPIN, ILLINOIS

ISSUED FOR BIDDING ________ DATE BY

ISSUED FOR CONSTRUCTION ________ DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
△		
△		

AECOM PROJECT NO:	60489731
DRAWN BY:	DJD
DESIGNED BY:	DJD
CHECKED BY:	MN
DATE CREATED:	2016-04-13
PLOT DATE:	
SCALE:	1" = 400'
ACAD VER:	2014

SHEET TITLE

HISTORY OF CONSTRUCTION VICINITY MAP

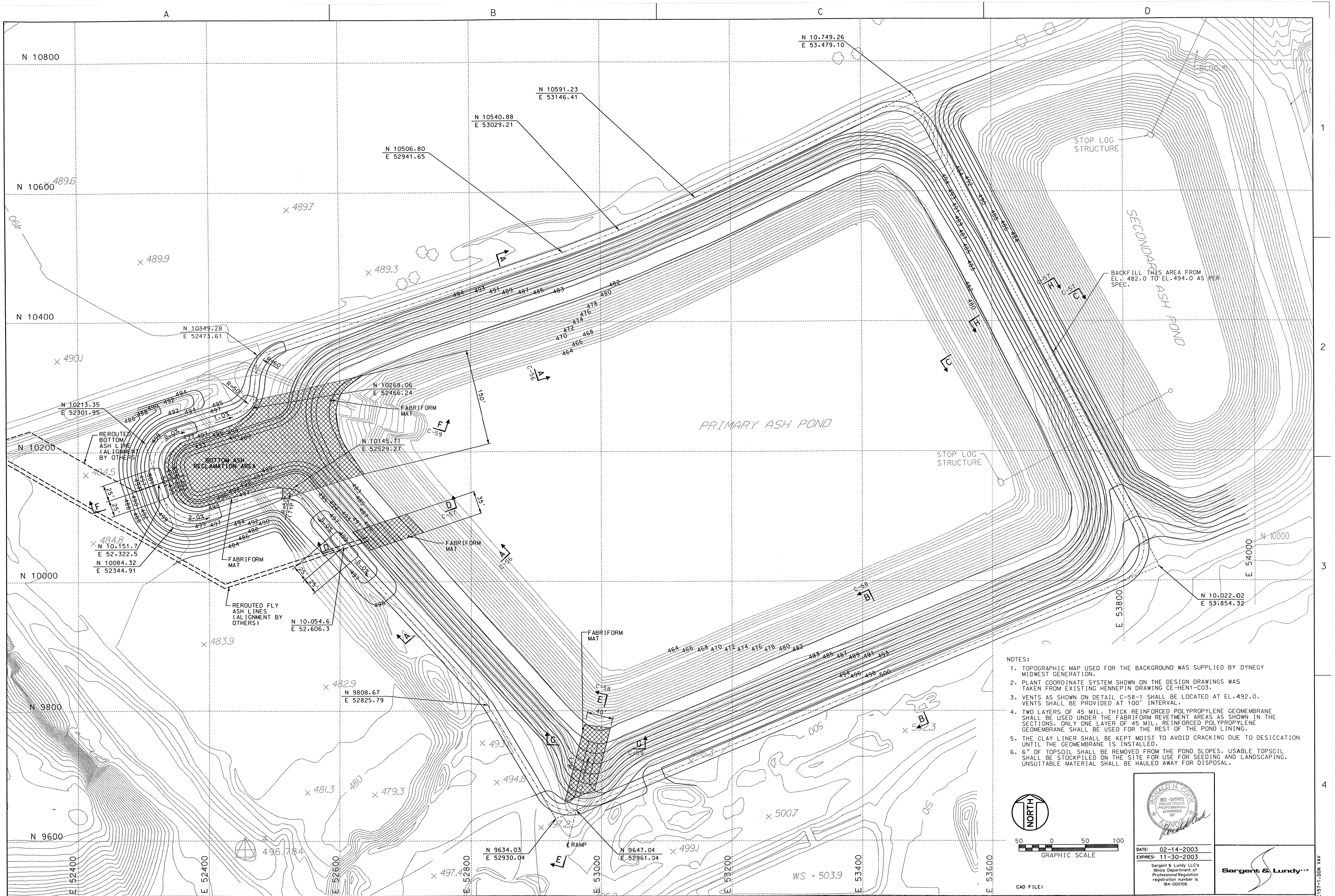
01

Appendix B: Hennepin Power Station Drawings

1. “Plan of Primary Ash Pond, Modification to Primary Ash Pond”, Drawing No. C-55, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
2. “Sections and Details – Sheet 1, Modification to Primary Ash Pond”, Drawing No. C-56, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
3. “Sections and Details – Sheet 2, Modification to Primary Ash Pond”, Drawing No. C-57, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
4. “Sections and Details – Sheet 3, Modification to Primary Ash Pond”, Drawing No. C-58, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
5. “Sections and Details – Sheet 4, Modification to Primary Ash Pond”, Drawing No. C-59, Revision 0.1, 14 February, 2003, Sargent & Lundy, LLC.
6. “Cross Sections of Ash Pond Berm Extension, Sta 1+00, 5+00 & 9+50”, Drawing No. E-HEN1-B452, Revision 0, 4 November, 1997, Illinois Power Company.
7. “Cross Sections of Ash Pond Berm Extension, Sta 14+25, 20+80 & 26+00”, Drawing No. E-HEN1-B453, Revision 0, 4 November, 1997, Illinois Power Company.
8. “Cross Sections of Ash Pond Berm Extension, Sta 30+00, 35+00 & 39+00”, Drawing No. E-HEN1-B454, Revision 0, 4 November, 1997, Illinois Power Company.
9. “Cross Sections of Ash Pond Berm Extension, Sta 40+00, 42+00, 44+90”, Drawing No. E-HEN1-B455, Revision 0, 4 November, 1997, Illinois Power Company.
10. “Cross Sections of Ash Pond Berm Extension, Sta 47+00, 51+00 & 56+00”, Drawing No. E-HEN1-B456, Revision 0, 4 November, 1997, Illinois Power Company.
11. “Cross Sections of Ash Pond Berm Extension, Sta 61+50”, Drawing No. E-HEN1-B457, Revision 0, 4 November, 1997, Illinois Power Company.
12. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-1, Revision 0, 8 March, 1990, Illinois Power Company.
13. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-2, Revision 0, 8 March, 1990, Illinois Power Company.
14. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-3, Revision 0, 8 March, 1990, Illinois Power Company.
15. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-4, Revision 0, 8 March, 1990, Illinois Power Company.
16. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-5, Revision 0, 8 March, 1990, Illinois Power Company.
17. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-6, Revision 0, 8 March, 1990, Illinois Power Company.
18. “Cross Sections, East Ash Pond Extension”, Drawing No. E-HEN1-B458-7, Revision 0, 8 March, 1990, Illinois Power Company.
19. “Plan-Unit #1 Ash Pond Extension, Sheet #1”, Drawing No. E-HEN1-B460-1, 2 February, 1988, Illinois Power Company.
20. “Plan-Unit #1 Ash Pond Extension, Sheet #2”, Drawing No. E-HEN1-B460-2, 2 February, 1988, Illinois Power Company.

Appendix B: Hennepin Power Station Drawings (continued)

21. “Contour and Grading Plan, Unit #2 Ash Pond Extension”, Drawing No. CE-HEN1-B461, Revision 0, 8 March, 1990, Illinois Power Company.
22. “Pond 2 East, Flexible Membrane Liner and Structures”, Drawing No. HEN1-C109, Revision 0, 28 July, 2010, Civil & Environmental Consultants, Inc.
23. “Pond 2 East, Details”, Drawing No. HEN1-C113, Revision 0, 28 July, 2010, Civil & Environmental Consultants, Inc.
24. “Landfill Phase 1 Construction, Existing Conditions”, Drawing No. HEN1-C117, Revision 0, 28 November, 2010, Civil & Environmental Consultants, Inc.
25. “Layout-Pond Discharge Structures, 1995 Ash Facility”, Drawing No. CE-HEN1-C8, Revision 0, 17 September, 1996, Illinois Power Company.
26. “Details: Pond Discharge Structure, 1995 Ash Facility”, Drawing No. CE-HEN1-C9, Revision 0, 17 September, 1996, Illinois Power Company.
27. “East Berm Modification, Existing Site Conditions”, Drawing No. 3, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
28. “East Berm Modification, Proposed Site Plan”, Drawing No. 4, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
29. “East Berm Modification, Proposed Grading Plan 1 of 2”, Drawing No. 5, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
30. “East Berm Modification, Proposed Grading Plan 2 of 2”, Drawing No. 6, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
31. “East Berm Modification, Proposed Sections Sta 1+00 to 15+00”, Drawing No. 7, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
32. “East Berm Modification, Proposed Sections Sta 16+00 to 23+50”, Drawing No. 8, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.
33. “East Berm Modification, Berm and Erosion Control Details”, Drawing No. 9, Revision 3, 4 February, 2015, Civil & Environmental Consultants, Inc.



NOTES:

1. TOPOGRAPHIC MAP USED FOR THE BACKGROUND WAS SUPPLIED BY DYNEGY MIDWEST GENERATION.
2. PLANT COORDINATE SYSTEM SHOWN ON THE DESIGN DRAWINGS WAS TAKEN FROM EXISTING HENNEPIN DRAWING CE-HEN1-C03.
3. VENTS AS SHOWN ON DETAIL C-58-1 SHALL BE LOCATED AT EL.492.0. VENTS SHALL BE PROVIDED AT 100' INTERVAL.
4. TWO LAYERS OF 45 MIL. THICK REINFORCED POLYPROPYLENE GEOMEMBRANE SHALL BE USED UNDER THE FABRIFORM REVETMENT AREAS AS SHOWN IN THE SECTIONS. ONLY ONE LAYER OF 45 MIL. REINFORCED POLYPROPYLENE GEOMEMBRANE SHALL BE USED FOR THE REST OF THE POND LINING.
5. THE CLAY LINER SHALL BE KEPT MOIST TO AVOID CRACKING DUE TO DESICCATION UNTIL THE GEOMEMBRANE IS INSTALLED.
6. 6" OF TOPSOIL SHALL BE REMOVED FROM THE POND SLOPES. USABLE TOPSOIL SHALL BE STOCKPILED ON THE SITE FOR USE FOR SEEDING AND LANDSCAPING. UNSUITABLE MATERIAL SHALL BE HAULED AWAY FOR DISPOSAL.

RONALD H. COOK
062-048602

DATE: 02-14-2003
EXPIRES: 11-30-2003

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

Sargent & Lundy LLC

CAD FILE:

REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D	NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	———						

SCALE: 1"=50'
DWN. M.DOWNS DATE 02-12-03
CHK. V.PATEL DATE 02-14-03
APPV. DATE

DYNEGY

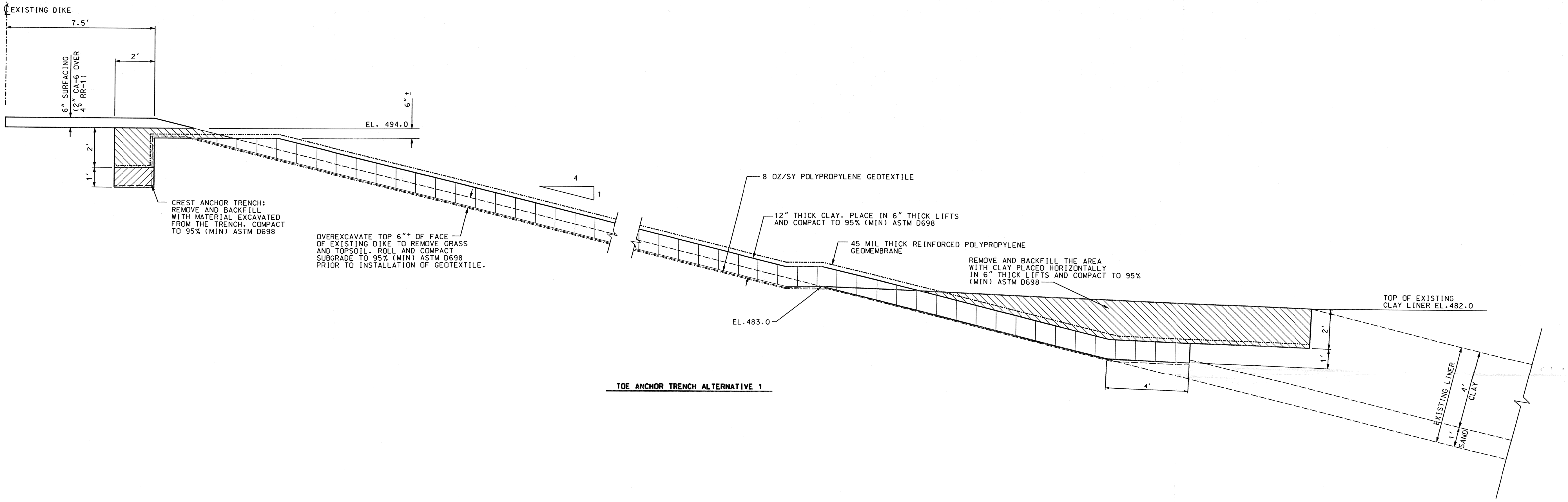
PLAN OF PRIMARY ASH POND

MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

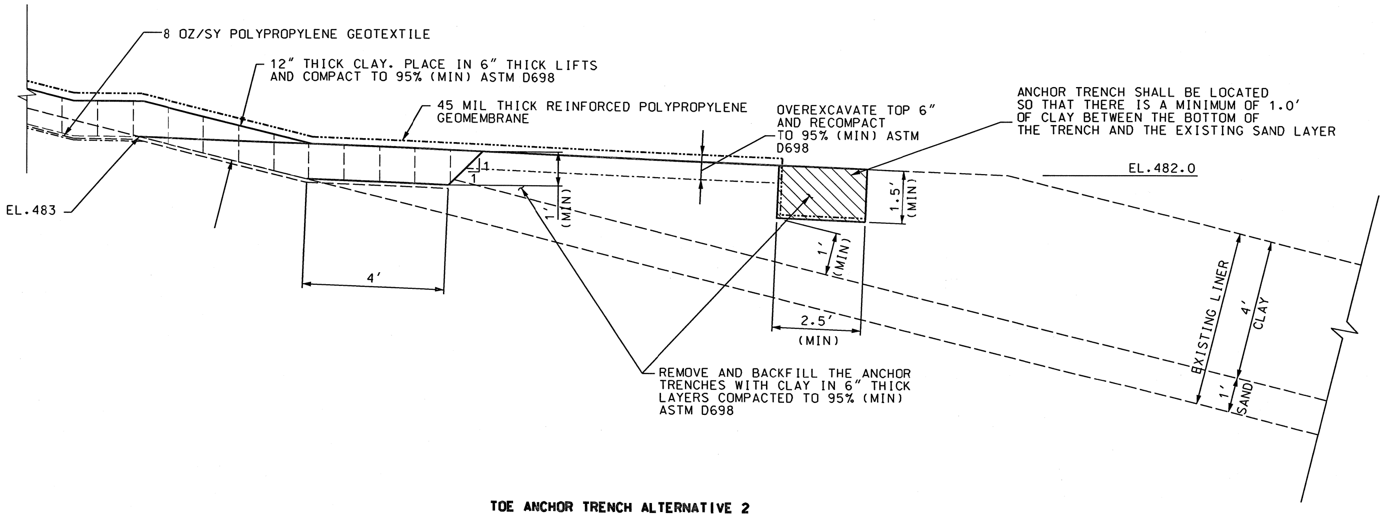
PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-55
REV. 0.1

E-WDR1-E157-1.DGN VAV
07-10-2001

02-13-03 ALS



TOE ANCHOR TRENCH ALTERNATIVE 1



TOE ANCHOR TRENCH ALTERNATIVE 2

SECTION A

SEE DWG C-55

GRAPHIC SCALE
HOR 1/2″=1′-0″

GRAPHIC SCALE
VER 1/2″=1′-0″

NOTES:

1. CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING EXISTING ELEVATIONS AND DIMENSIONS PRIOR TO FABRICATION OF THE GEOMEMBRANE LINER.
2. CONTRACTOR MAY USE EITHER ALTENATIVE 1 OR ALTERNATIVE 2 AS APPROVED BY THE BUYER FOR ALL TOE ANCHOR TRENCH DETAILS.
3. DIMENSIONS WERE TAKEN FROM TYPICAL SECTION ON DRAWING CH-HEN1-C6.1 DATED 12-9-93.

RONALD H. COOK 062-048602 REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS

Ronald Cook

DATE: 02-14-2003
EXPIRES: 11-30-2003

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

Sargent & Lundy LLC

CAD FILE:

REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D	NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	——						

SCALE:
DWN. M.DOWNS DATE 02-12-02
CHK. V.PATEL DATE 02-14-03
APPV. DATE

DYNEGY

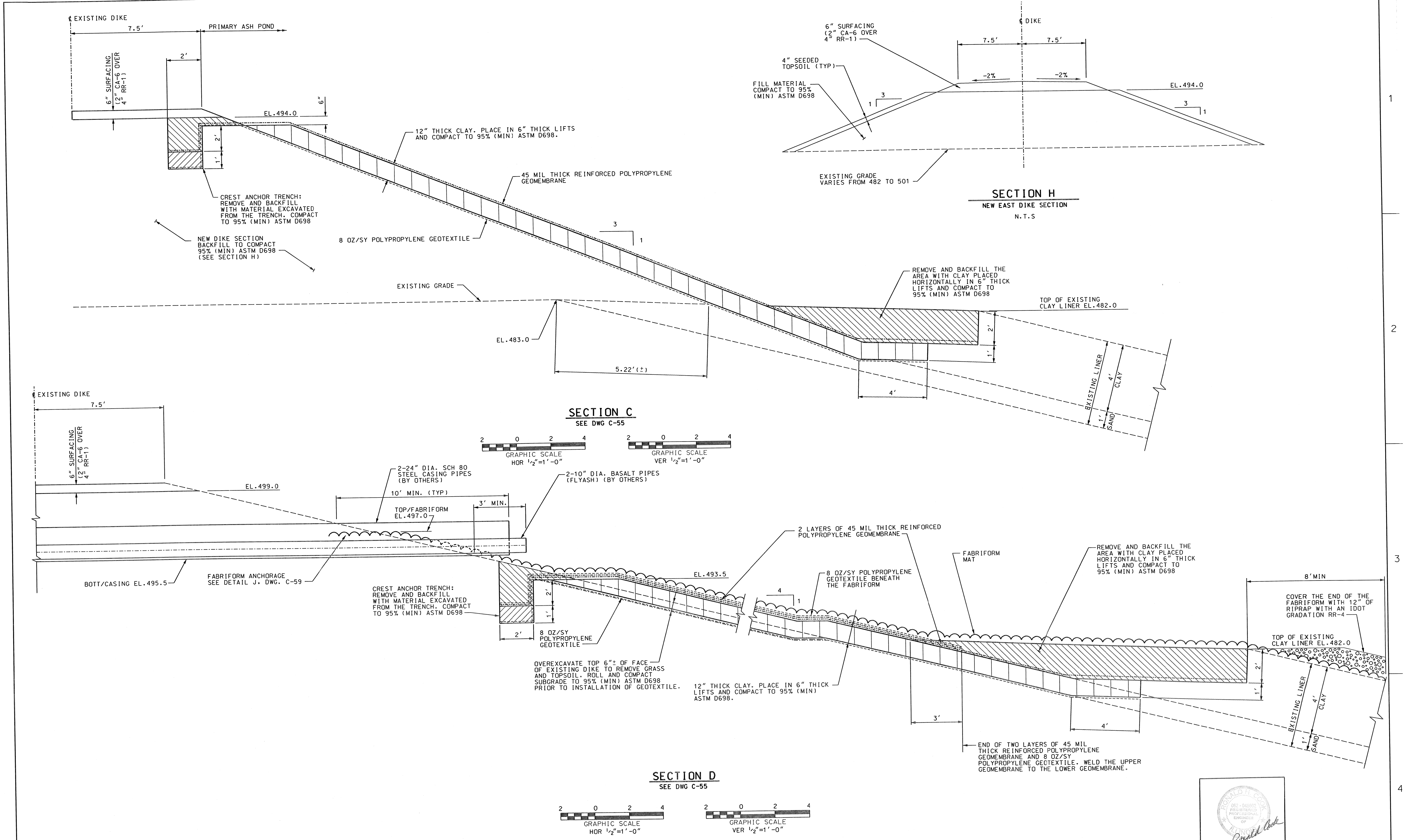
SECTIONS AND DETAILS - SHEET 1

MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-56
REV. 0.1

E-WDR1-E157-1.DGN VAV
07-10-2001

02-13-03 ALS



SECTION C

SEE DWG C-55

GRAPHIC SCALE
HOR 1/2"=1'-0"

GRAPHIC SCALE
VER 1/2"=1'-0"

SECTION H

NEW EAST DIKE SECTION

N.T.S

SECTION D

SEE DWG C-55

GRAPHIC SCALE
HOR 1/2"=1'-0"

GRAPHIC SCALE
VER 1/2"=1'-0"

RONALD H. COOK
062-048602
REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS
Ronald Cook

DATE: 02-14-2003
EXPIRES: 11-30-2003
Sargent & Lundy LLC's Illinois Department of Professional Regulation registration number is 184-000106

Sargent & Lundy LLC

CAD FILE:

E-WDR1-E157-1.DGN VAV

DYNEGY CONFIDENTIAL
This drawing is the property of DYNEGY INC. Neither this drawing, nor reproductions of it, nor information derived from it, shall be given to others without the expressed written consent of DYNEGY INC.
No use is to be made of it which is, or may be, injurious to DYNEGY INC.

REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D	NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	———						

SCALE: 1/2"=1'-0"
DWN. M.DOWNS DATE 02-12-02
CHK. V.PATEL DATE 02-14-03
APPV. DATE

DYNEGY

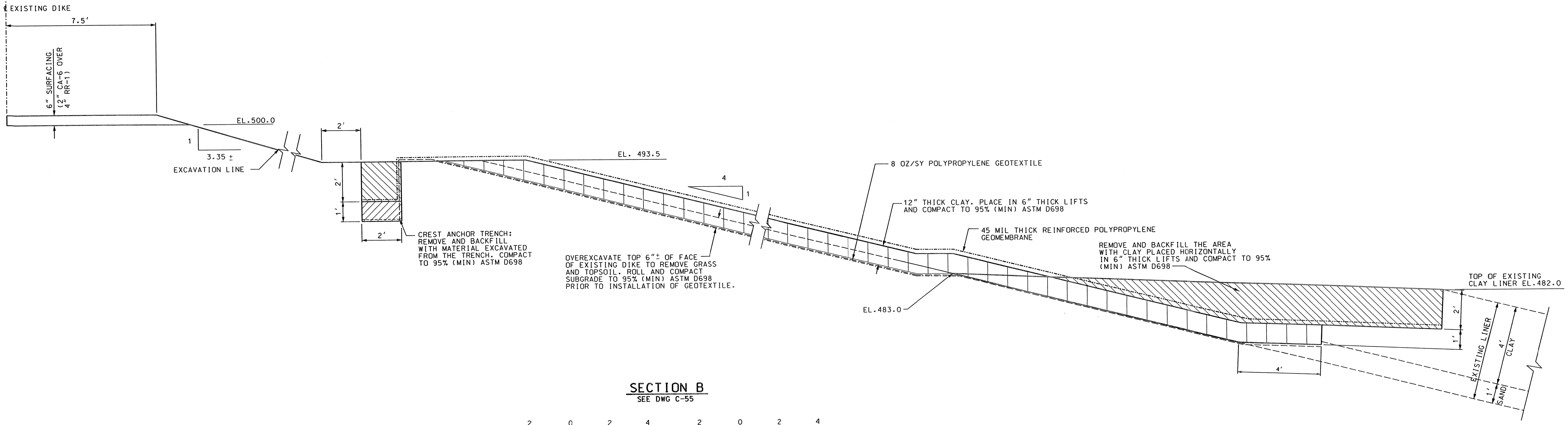
SECTIONS AND DETAILS - SHEET 2

MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-57
REV. 0.1

07-10-2001

02-13-03 ALS

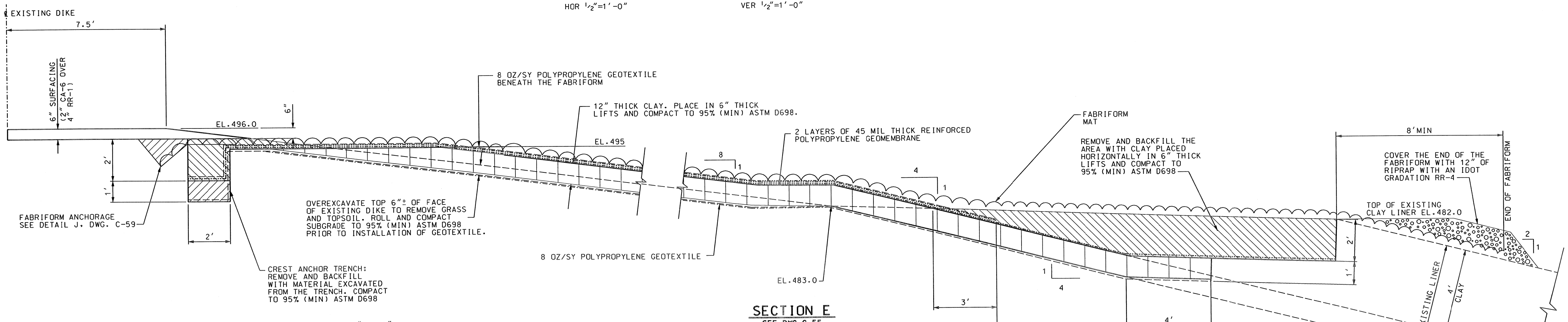


SECTION B

SEE DWG C-55

GRAPHIC SCALE HOR 1/2″=1′-0″ (2 0 2 4)

GRAPHIC SCALE VER 1/2″=1′-0″ (2 0 2 4)

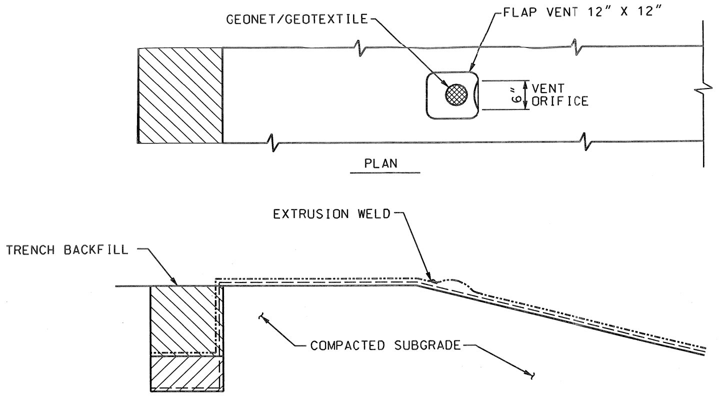


SECTION E

SEE DWG C-55

GRAPHIC SCALE HOR 1/2″=1′-0″ (2 0 2 4)

GRAPHIC SCALE VER 1/2″=1′-0″ (2 0 2 4)



PLAN

SECTION

DETAIL C-58-1

MAXIMUM INTERVAL SHALL BE 100′

CAD FILE:

Ronald H. Cook 062-048602 Registered Professional Engineer of Illinois

Ronald Cook

DATE: 02-14-2003
EXPIRES: 11-30-2003

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

Sargent & Lundy LLC

DYNEGY CONFIDENTIAL
This drawing is the property of DYNEGY INC. Neither this drawing, nor reproductions of it, nor information derived from it, shall be given to others without the expressed written consent of DYNEGY INC. No use is to be made of it which is, or may be, injurious to DYNEGY INC.

REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D	NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	——						

SCALE: 1/2″=1′-0″
DWN. M.DOWNS DATE 02-14-03
CHK. V.PATEL DATE 02-14-03
APPV. DATE

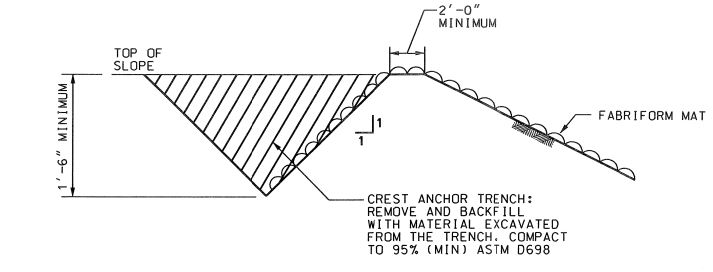
DYNEGY

SECTIONS AND DETAILS - SHEET 3

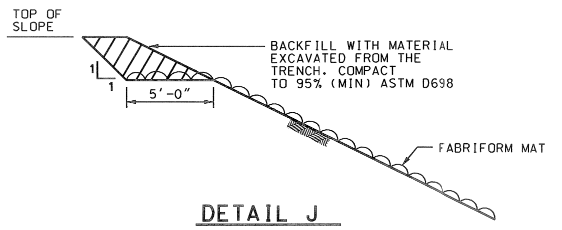
MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-58
REV. 0.1

E-WDR1-E157-1.DGN VAV
07-10-2001
02-12-03 ALS

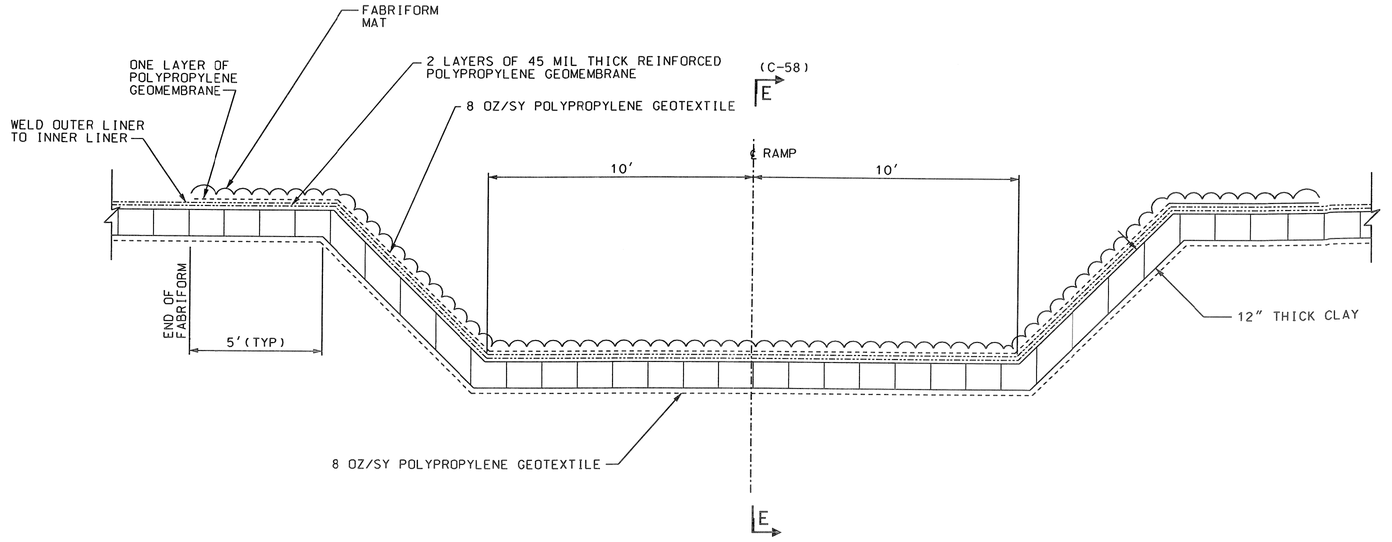


ANCHORAGE IF PROTECTION IS PROVIDED TO THE TOP OF THE SLOPE



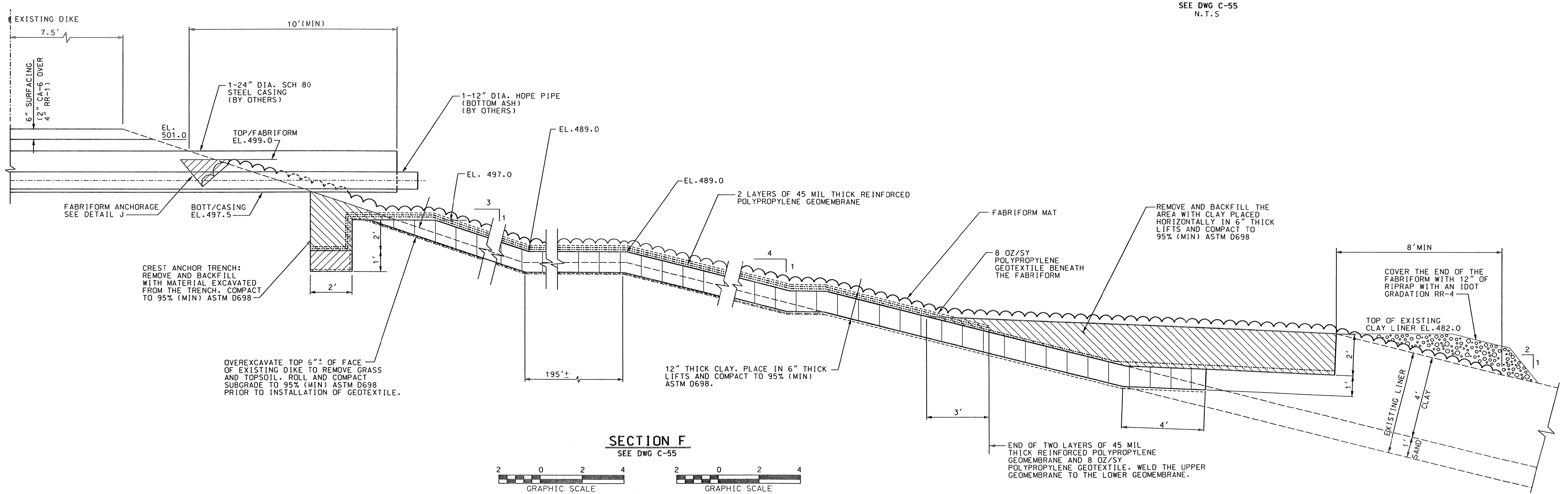
DETAIL J

ANCHORAGE FOR FABRIFORM MAT
N.T.S.



SECTION G

SEE DWG C-55
N.T.S



SECTION F

SEE DWG C-55

2 0 2 4
GRAPHIC SCALE
HOR 1/2"=1'-0"

2 0 2 4
GRAPHIC SCALE
VER 1/2"=1'-0"

062-048602 RONALD H. COOK

Ronald Cook

DATE: 02-14-2003
EXPIRES: 11-30-2003
Sargent & Lundy LLC's
Illinois Department of
Professional Regulation
registration number is
184-000106

Sargent & Lundy LLC

CAD FILE:

REFERENCE DRAWINGS

NO.	DATE	REVISION	PREP'D	REV'D	APPR'D	NO.	DATE	REVISION	PREP'D	REV'D	APPR'D
0.1	02-14-2003	FOR PERMIT	MED	VP	——						

SCALE: 1/4"=1'-0"
DWN. M.DOWNS DATE 02-12-02
CHK. V.PATEL DATE 02-14-03
APPV. DATE

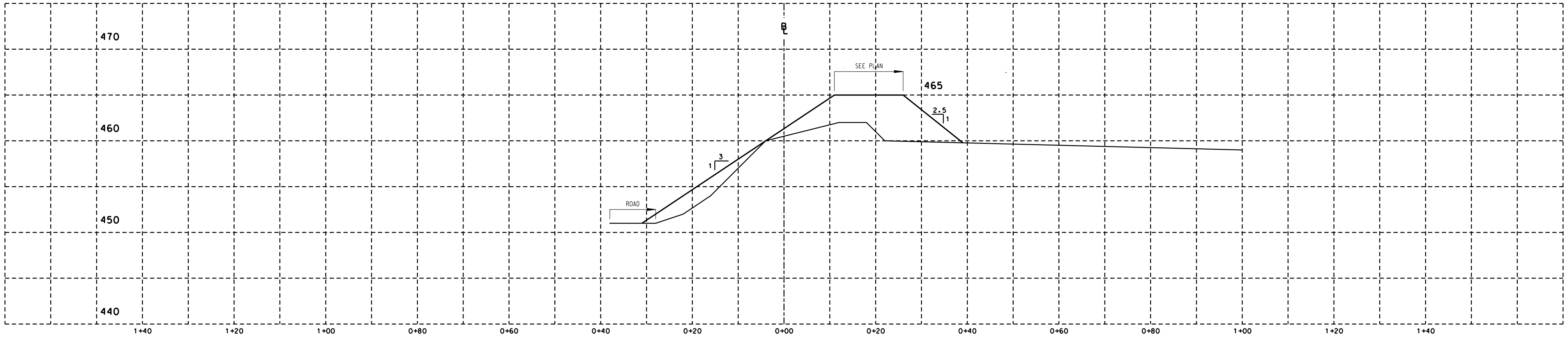
DYNEGY

SECTIONS AND DETAILS - SHEET 4

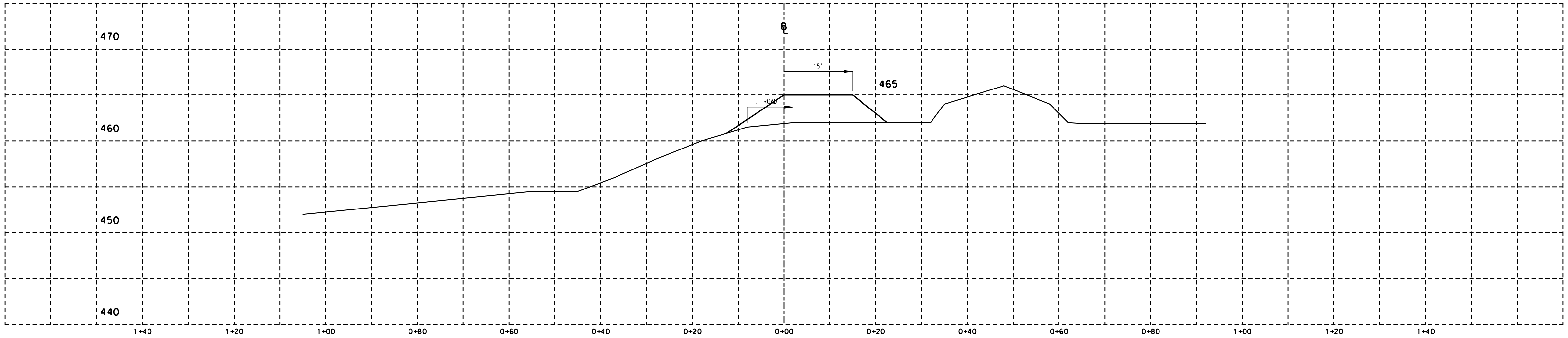
MODIFICATION TO PRIMARY ASH POND
HENNEPIN POWER STATION

PROJECT NO.: 08820-331
CLIENT: DYNEGY MIDWEST GENERATION
DWG. NO.: C-59
REV. 0.1

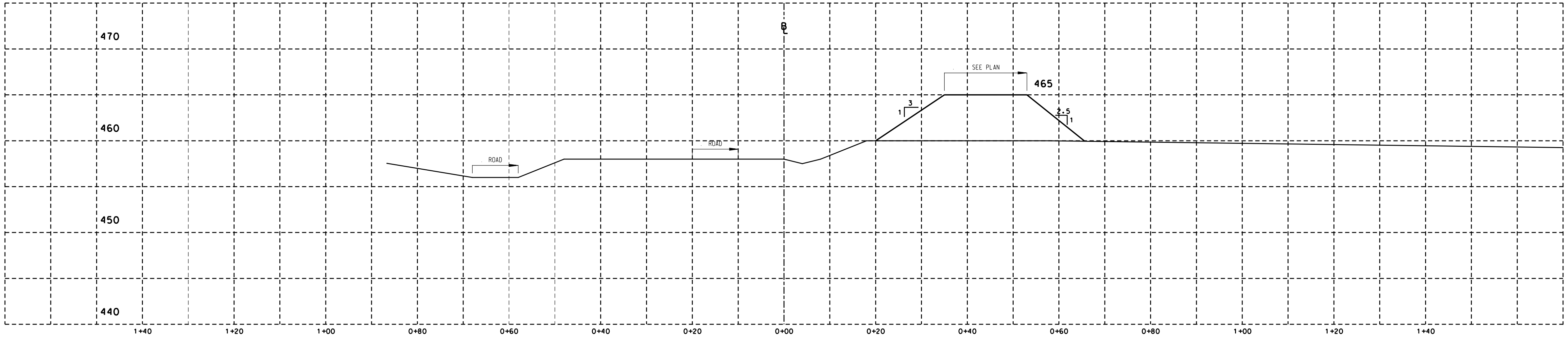
E-WDR1-E157-1.DGN VAV
07-10-2001
02-13-03 ALS



STATION 9+50



STATION 5+00



STATION 1+00

LEDGEND

BL	REFERENCE BASE LINE SHOWN ON PLAN
—	OLD BERM
—	NEW BERM
▽	WATER LINE
*	ESTIMATED ELEVATION

E-HEN1-B452

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

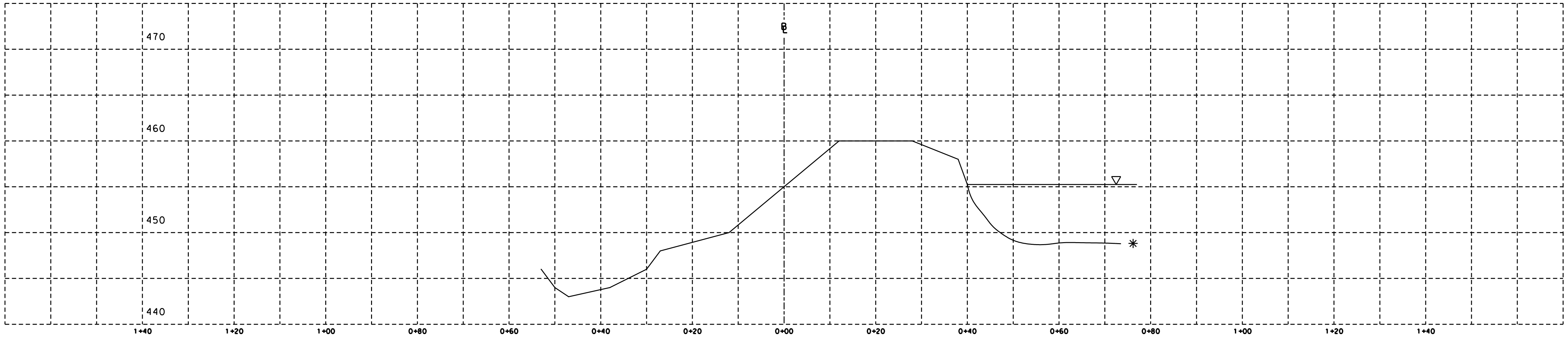
REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
⓪

ILLINOIS POWER COMPANY
DECATUR

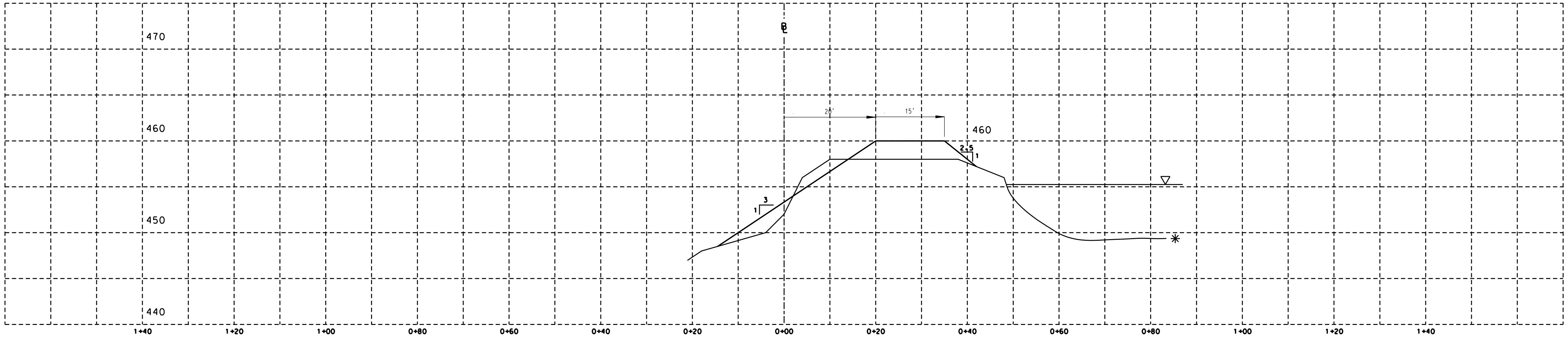
CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 1+00, 5+00 & 9+50
HENNEPIN POWER STATION

DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H,1"=5'V
APP APP	PLOTTED 11-4-97	E-HEN1-B452

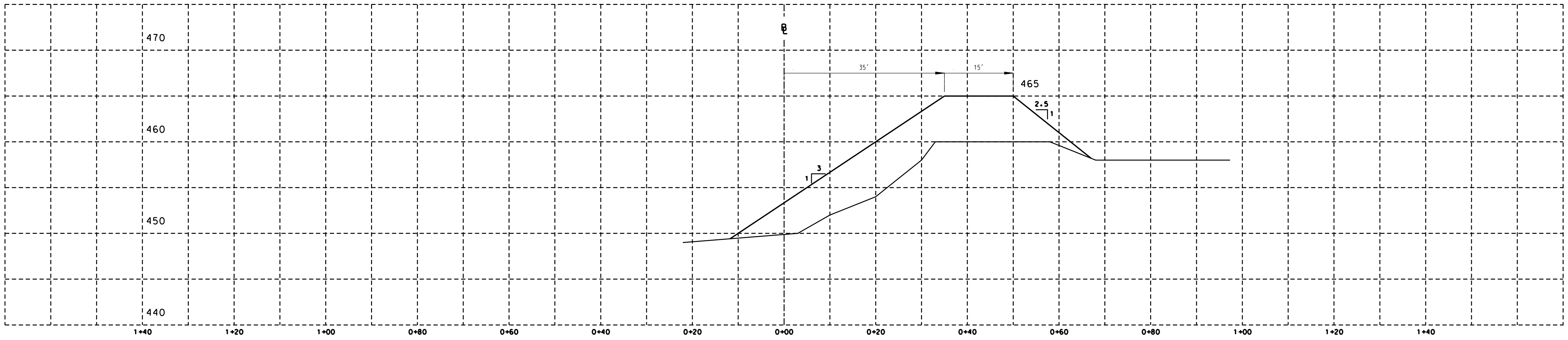
COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 26+00



STATION 20+80



STATION 14+25

LEDGEND

BL REFERENCE BASE LINE SHOWN ON PLAN

──── OLD BERM

━━━━ NEW BERM

▽ WATER LINE

✳ ESTIMATED ELEVATION

E-HEN1-B453

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

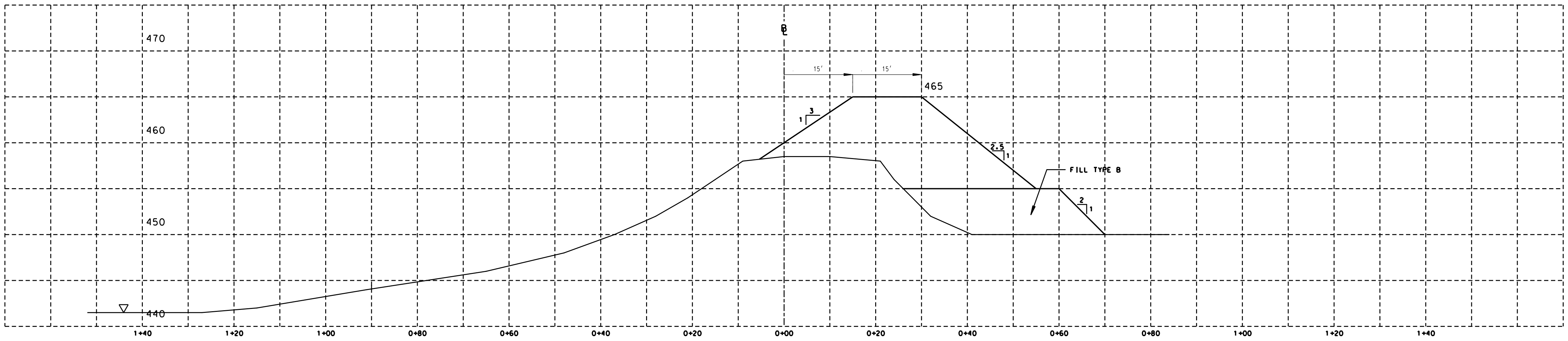
REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD
⓪

ILLINOIS POWER COMPANY
DECATUR

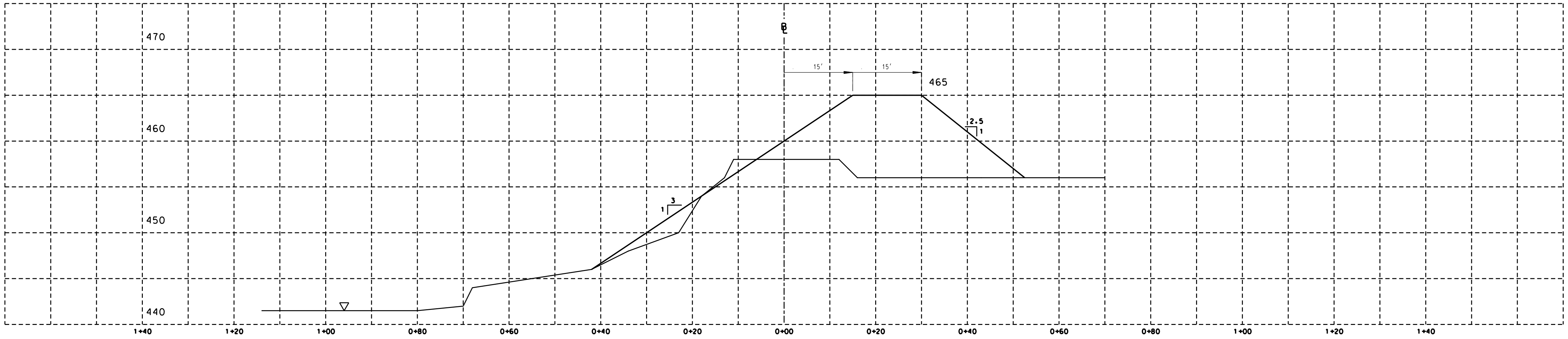
CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 14+25, 20+80 & 26+00
HENNEPIN POWER STATION

DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H,1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B453
APP		

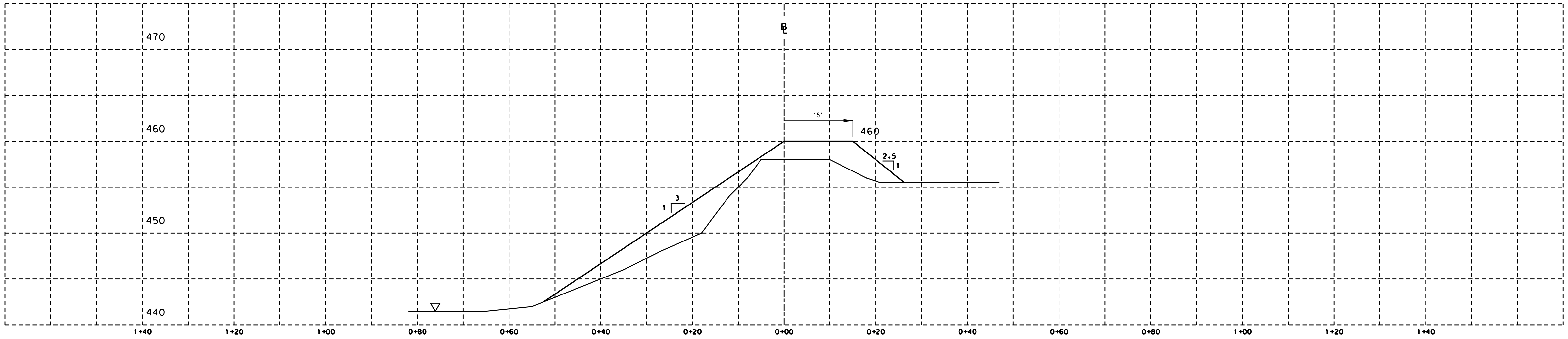
COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 39+00



STATION 35+00



STATION 30+00

LEDGEND

℄ REFERENCE BASE LINE SHOWN ON PLAN
— OLD BERM
— NEW BERM
▽ WATER LINE
✳ ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
⓪

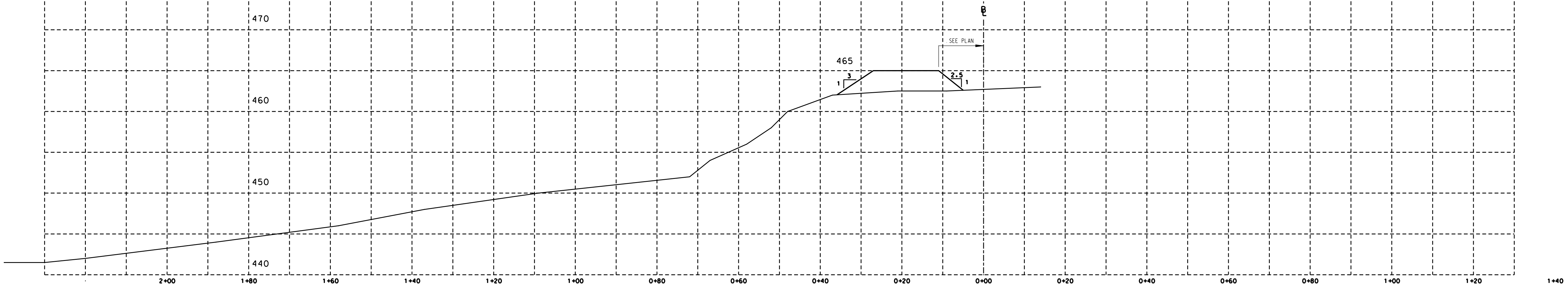
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS OF ASH POND BERM EXTENSION STA 30+00, 35+00 & 39+00 HENNEPIN POWER STATION

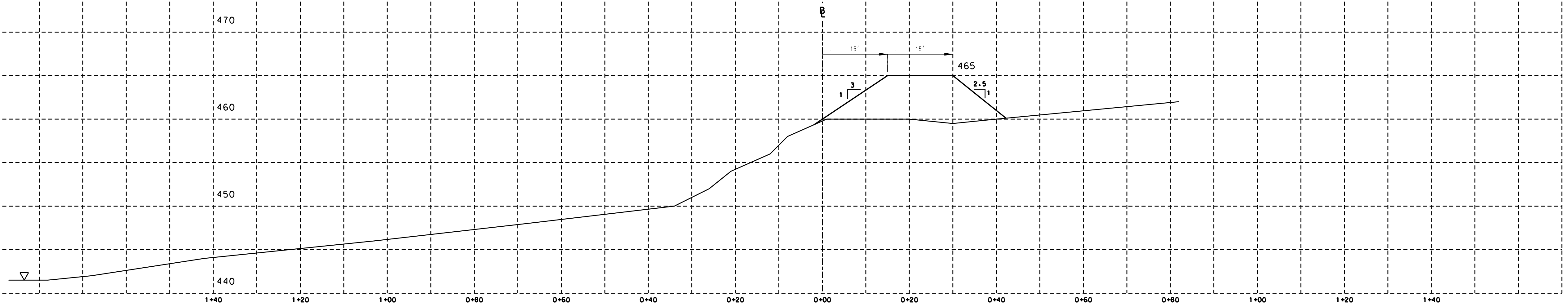
DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H,1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B454
APP		

E-HEN1-B454

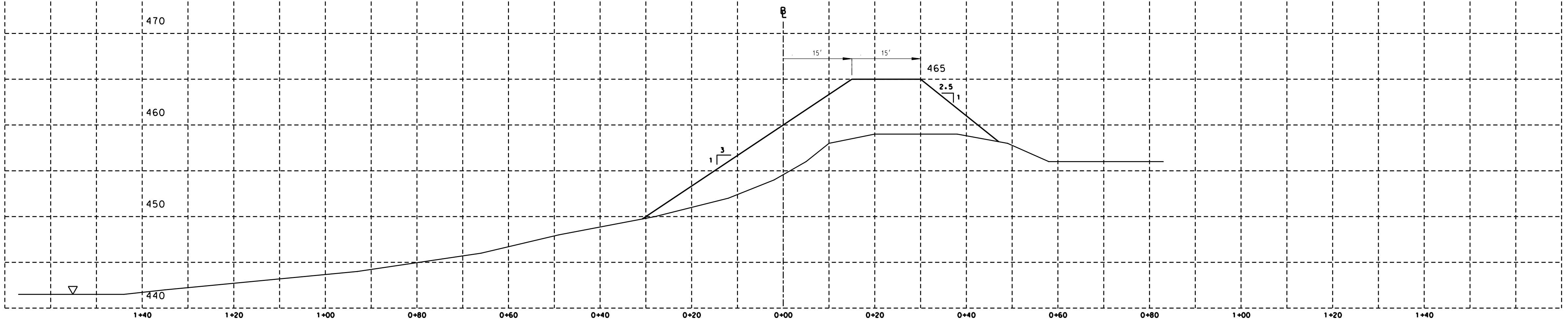
COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 44+90



STATION 42+00



STATION 40+00

LEDGEND

BL	REFERENCE BASE LINE SHOWN ON PLAN
───	OLD BERM
━━━	NEW BERM
▽	WATER LINE
✳	ESTIMATED ELEVATION

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
⓪

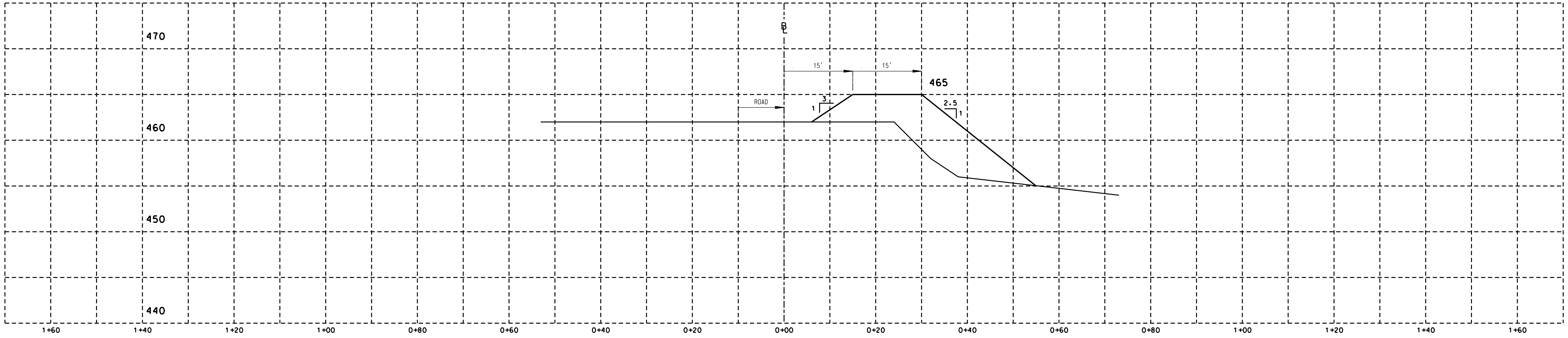
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 40+00, 42+00 & 44+90
HENNEPIN POWER STATION

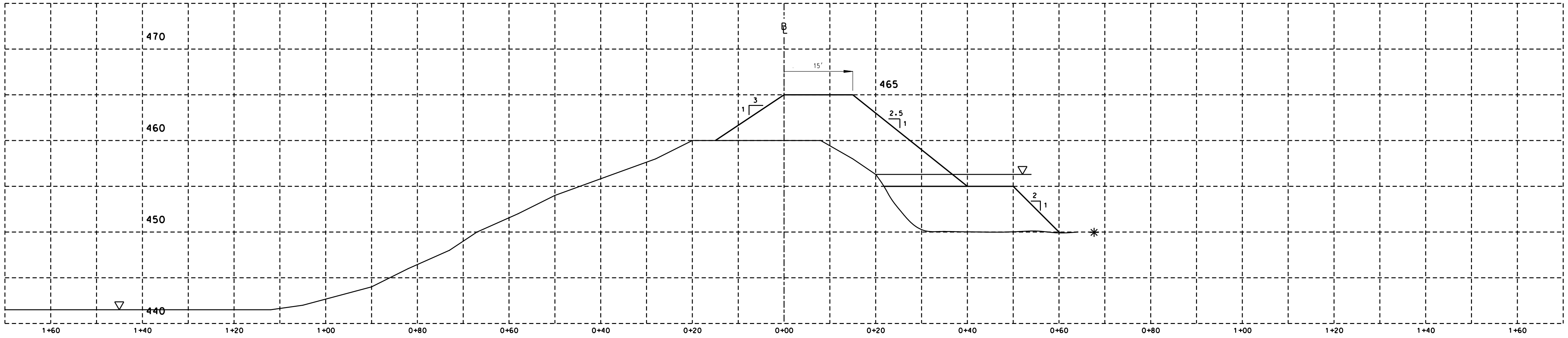
DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H, 1"=5'V
APP	PLOTTED 11-4-97	E-HEN1-B455
APP		

E-HEN1-B455

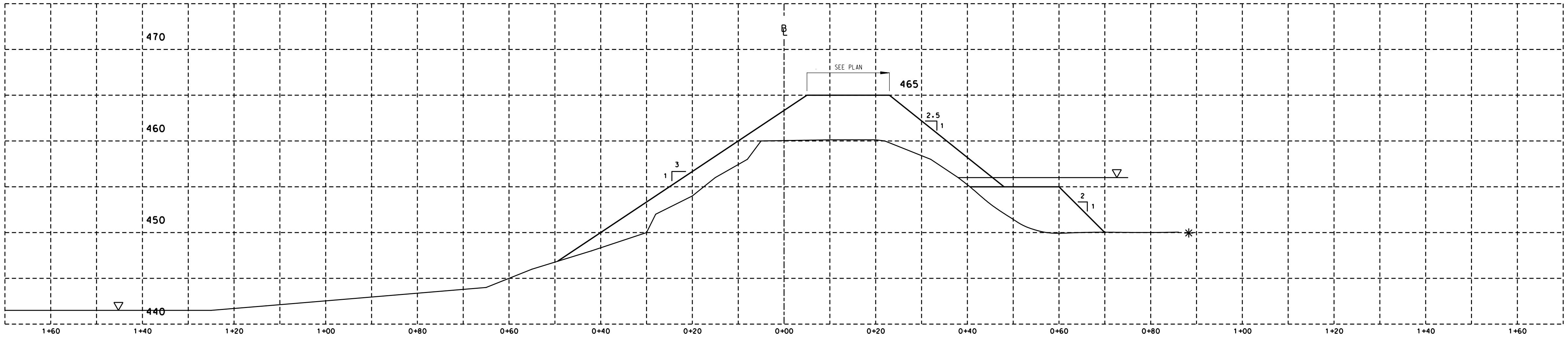
COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 56+00



STATION 51+00



STATION 47+00

LEDGEND

℄ REFERENCE BASE LINE SHOWN ON PLAN
— OLD BERM
— NEW BERM
▽ WATER LINE
✳ ESTIMATED ELEVATION

E-HEN1-B456

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

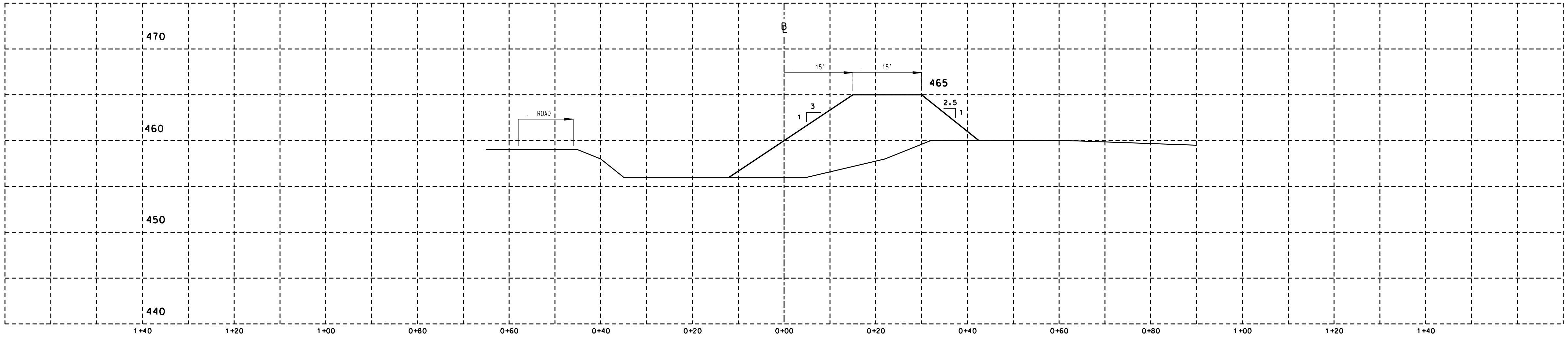
REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD
⓪

ILLINOIS POWER COMPANY
DECATUR

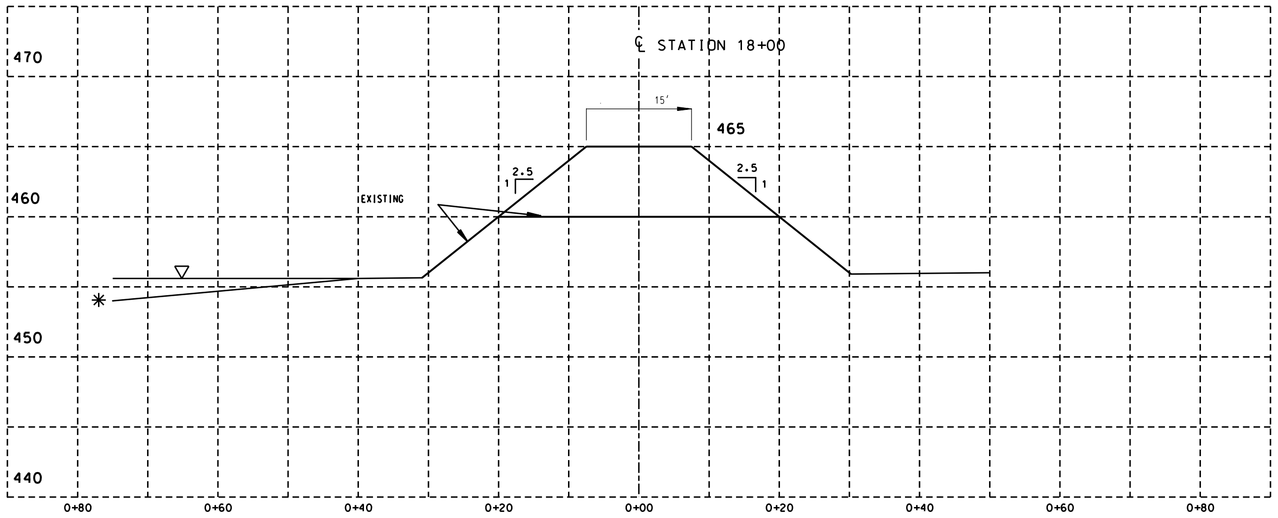
CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 47+00, 51+00 & 56+00
HENNEPIN POWER STATION

DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H, 1"=5'V
APP APP	PLOTTED 11-4-97	E-HEN1-B456

COMPUTER DWG. - DO NOT REVISE MANUALLY



STATION 61+50



SECTION A-A

LEDGEND

BL	REFERENCE BASE LINE SHOWN ON PLAN
—	OLD BERM
—	NEW BERM
▽	WATER LINE
✳	ESTIMATED ELEVATION

E-HEN1-B457

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
⓪													

NOTES

REFERENCES

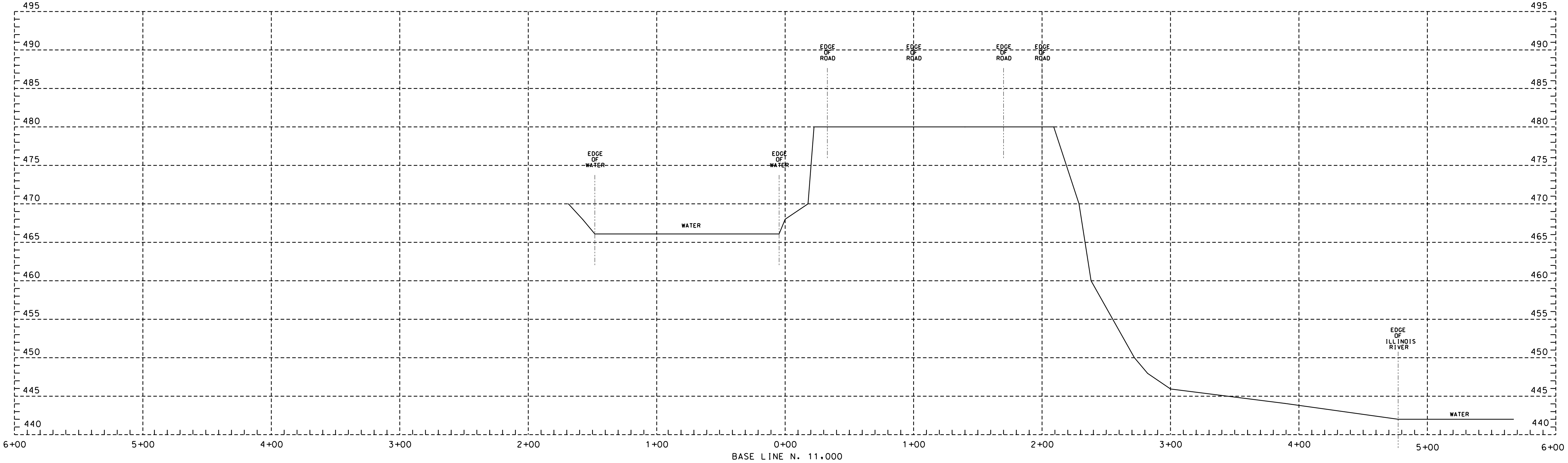
REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD
⓪

ILLINOIS POWER COMPANY
DECATUR

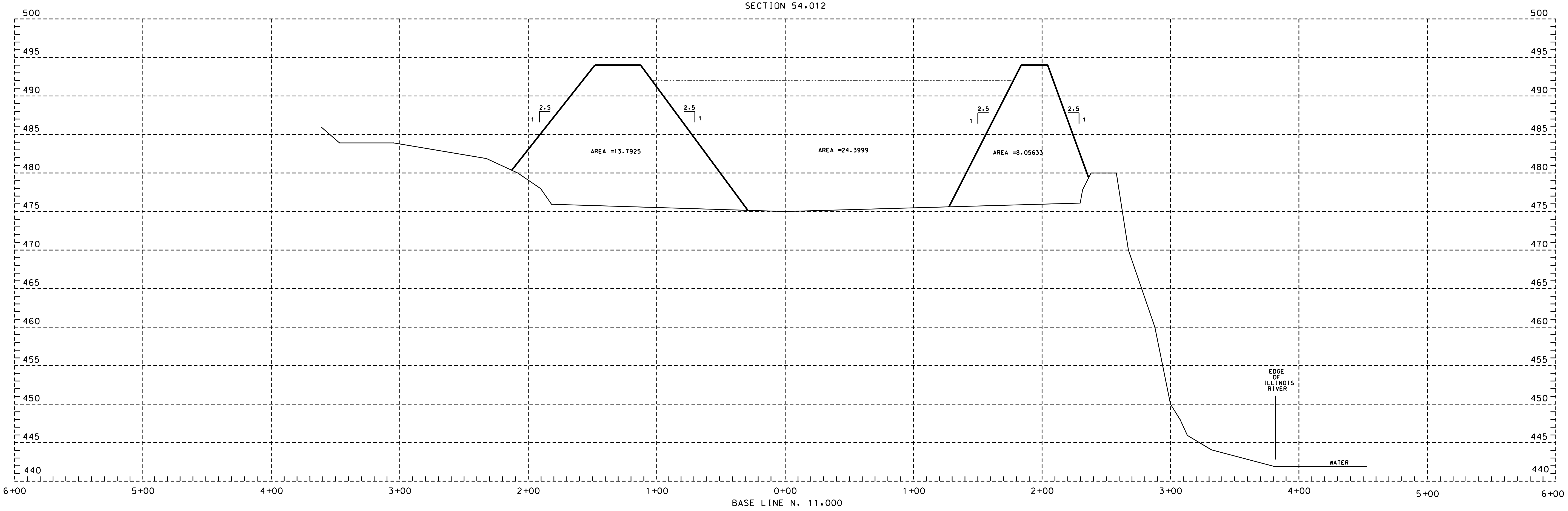
CROSS SECTIONS OF
ASH POND BERM EXTENSION
STA 61+50
HENNEPIN POWER STATION

DR GRH	CAD EM	DATE 12-30-87
OK	CKD	SCALE 1"=10'H.1"=5'V
APP APP	PLOTTED 11-4-97	E-HEN1-B457

COMPUTER DWG. - DO NOT REVISE MANUALLY



SECTION 54.012



SECTION E. 53.812

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

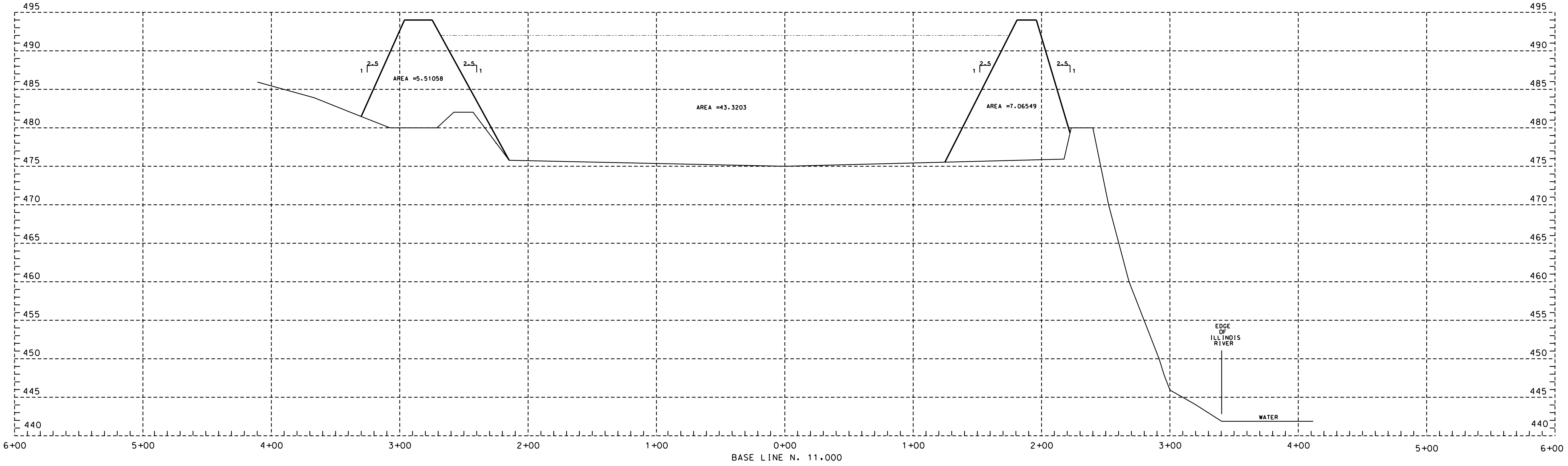
REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD

0				

ILLINOIS POWER COMPANY
DECATUR

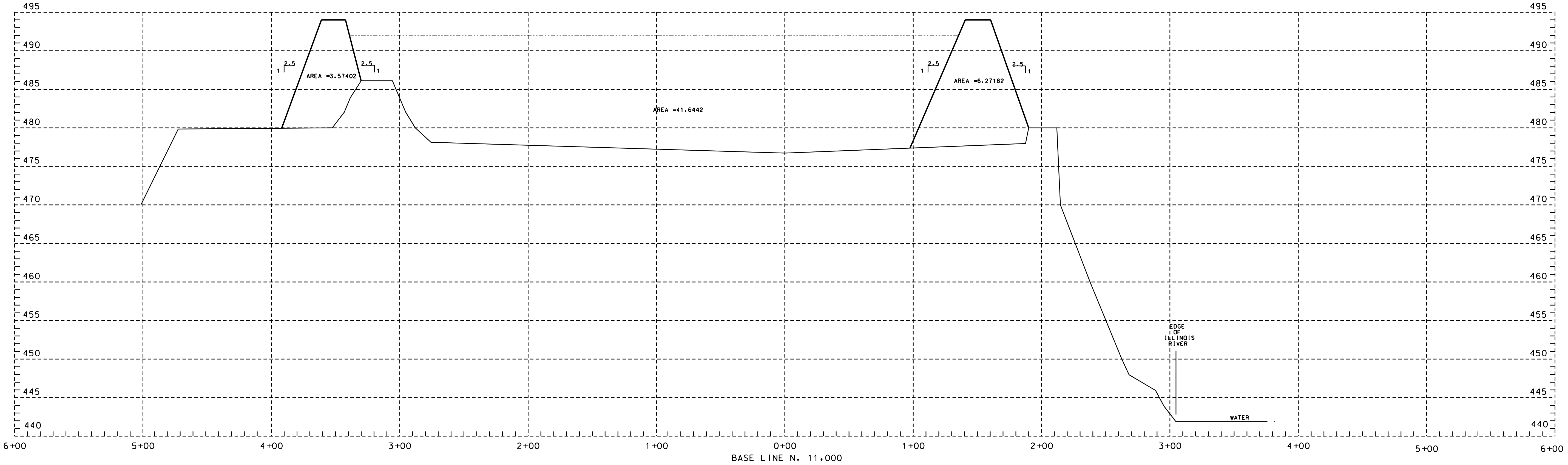
CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-11-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-1
APP		



BASE LINE N. 11,000

SECTION E. 53,692



BASE LINE N. 11,000

SECTION E. 53,492

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450
DATED NOV. 4, 1987, REV. 0

2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION
TIEING TO J.L. FISHER'S PANELS.

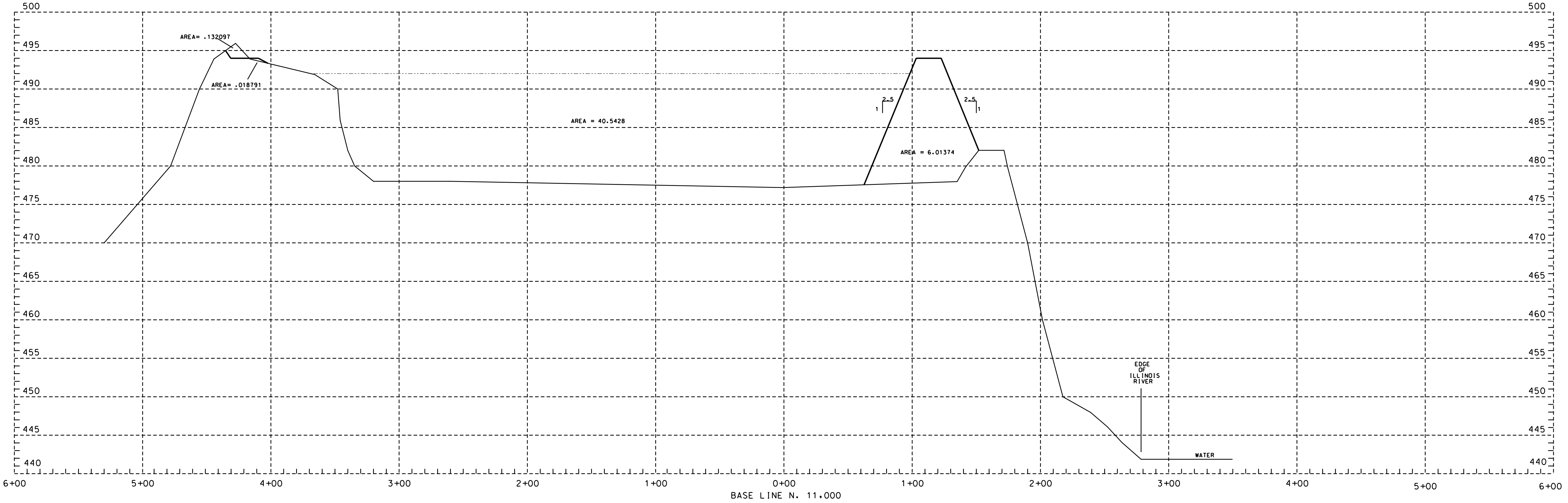
REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
0

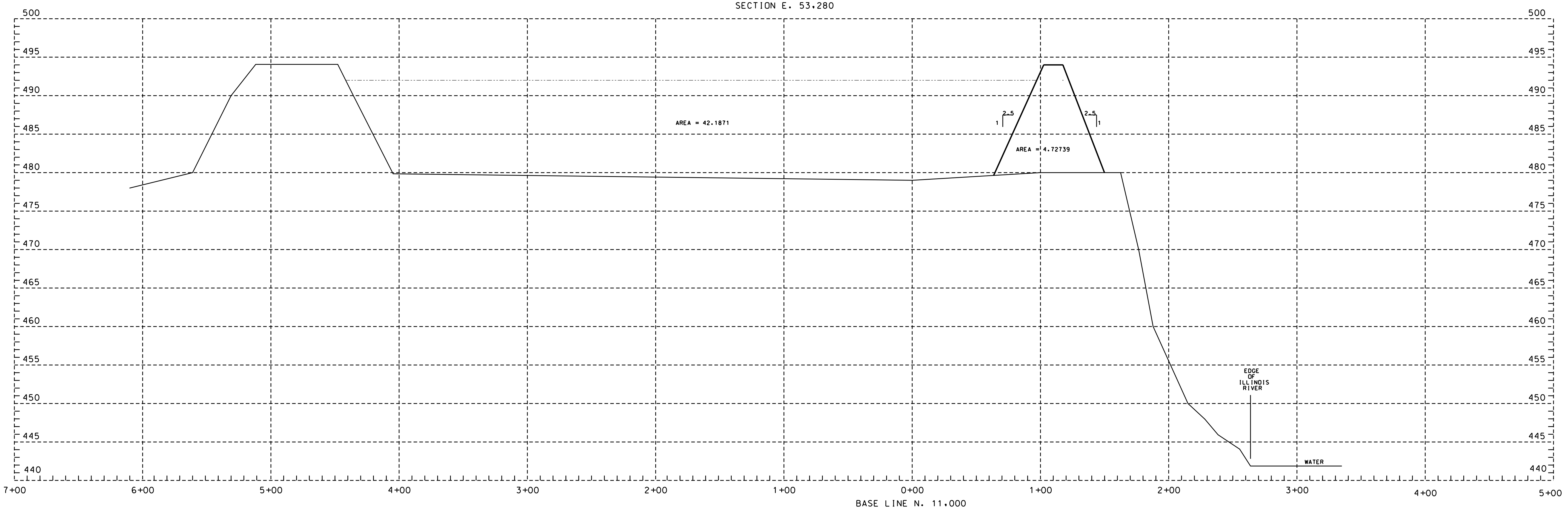
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-2
APP		



SECTION E. 53.280



SECTION E. 53.080

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

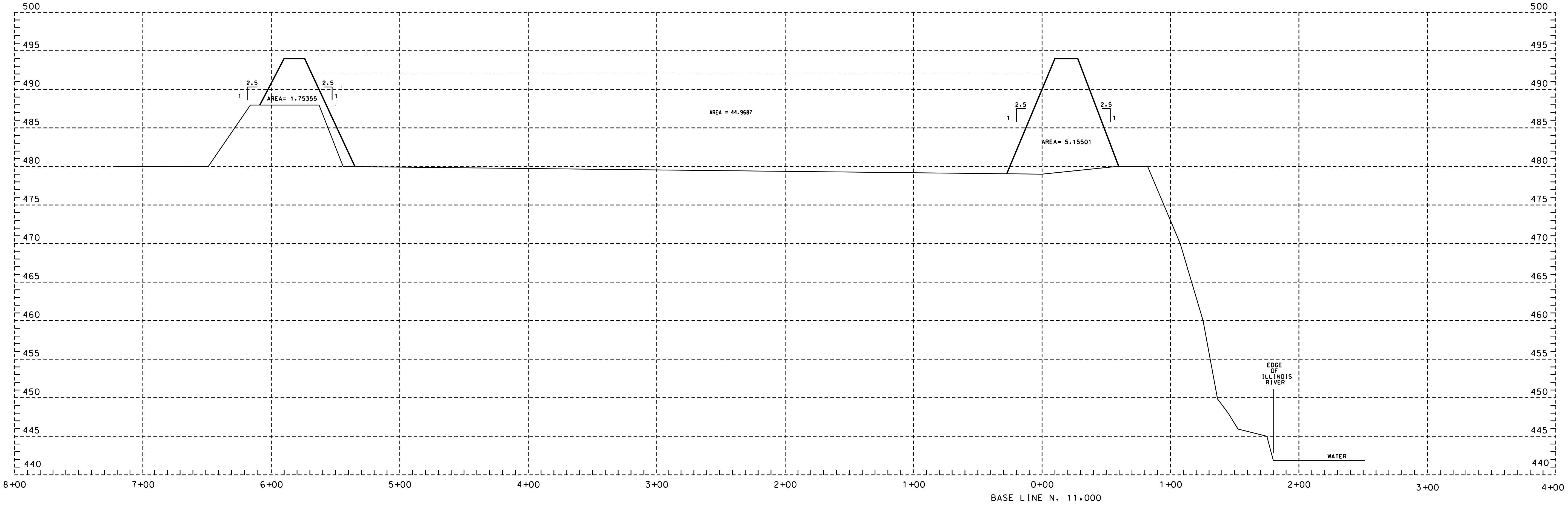
REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
0

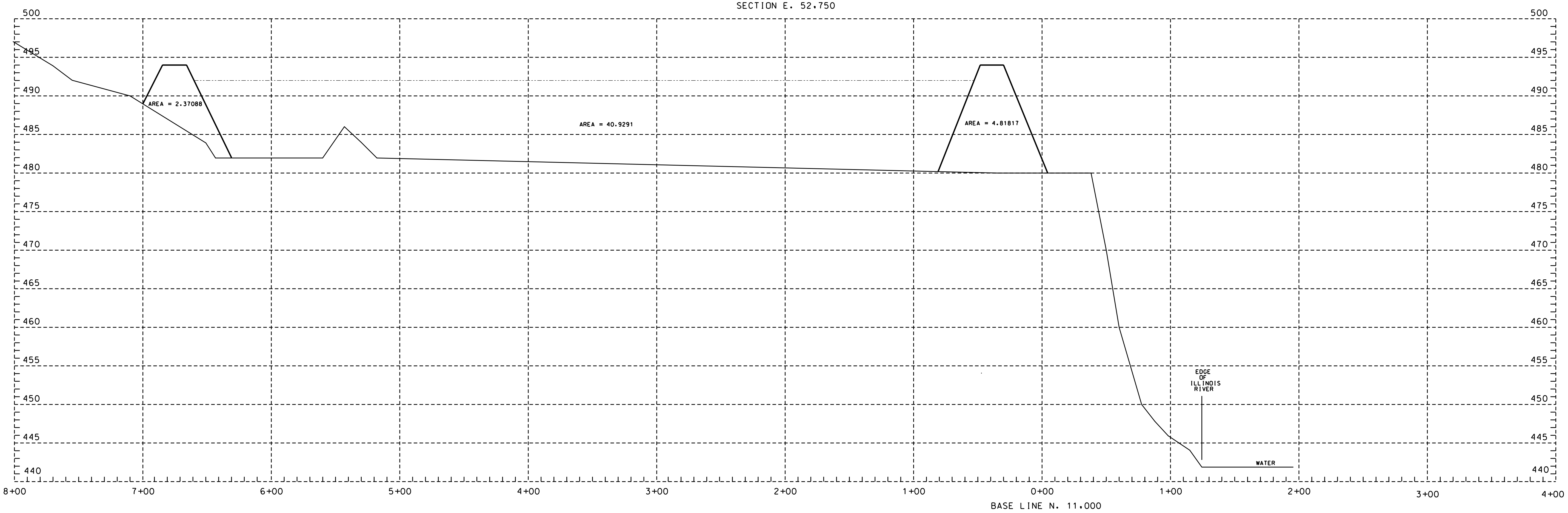
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-3
APP		



SECTION E. 52.750



SECTION E. 52.448

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0

2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

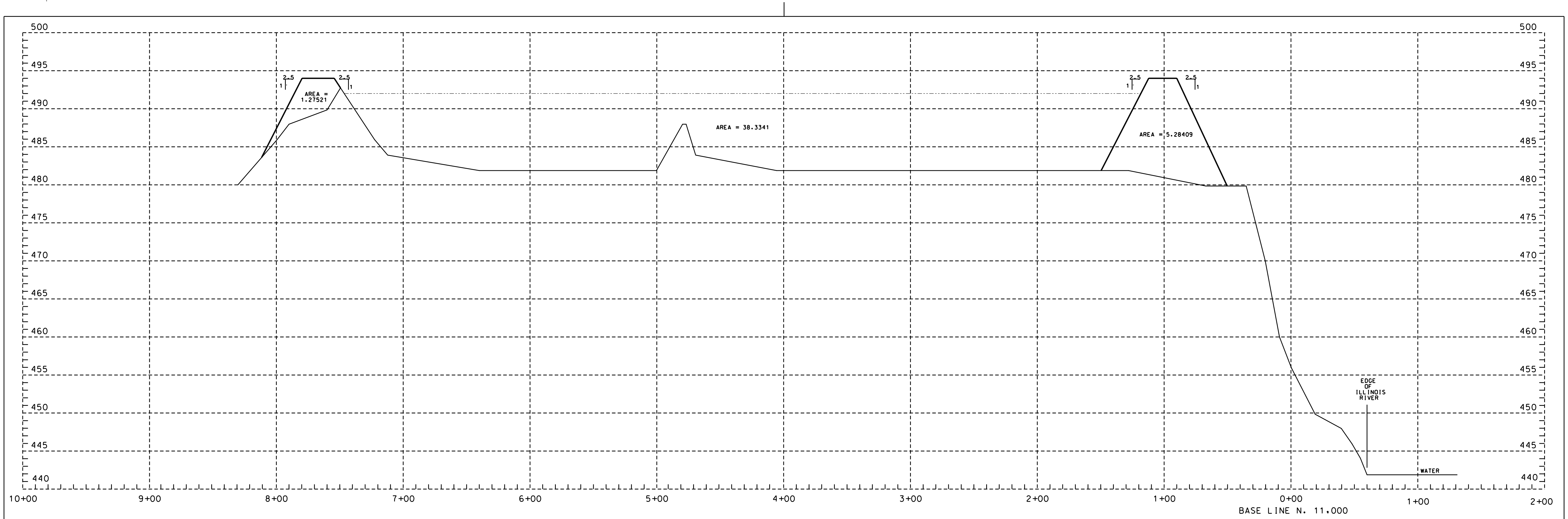
REVISION STATUS
□ -CONSTRUCTION
○ -RECORD

0

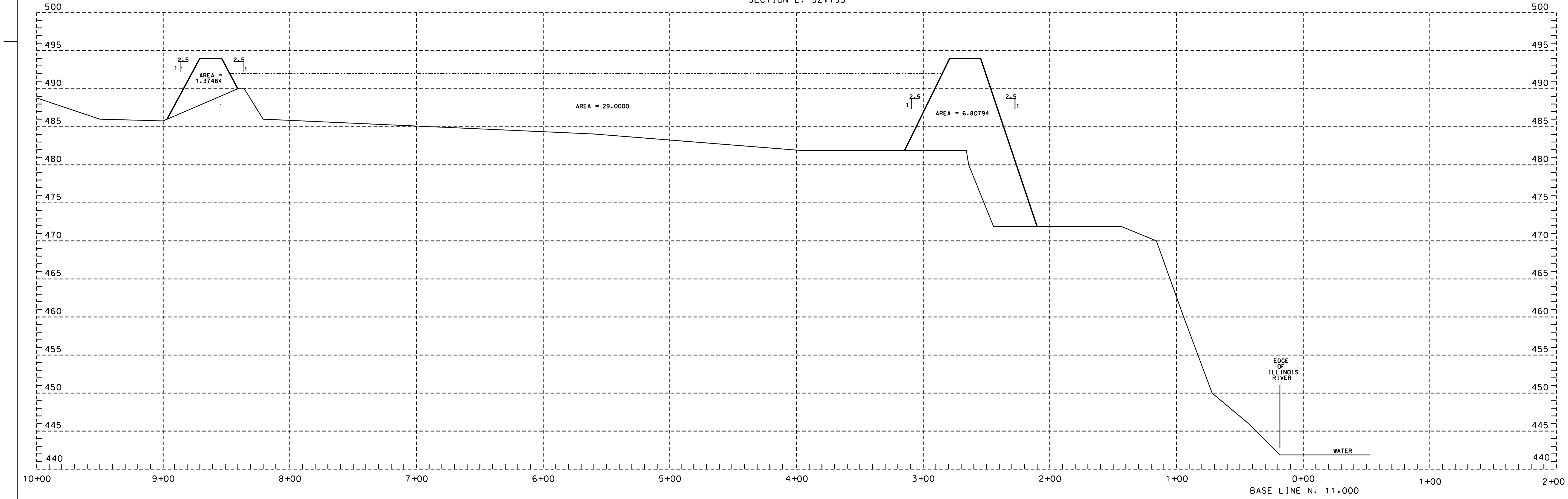
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-4
APP		



SECTION E. 52.195



SECTION E. 51.920

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

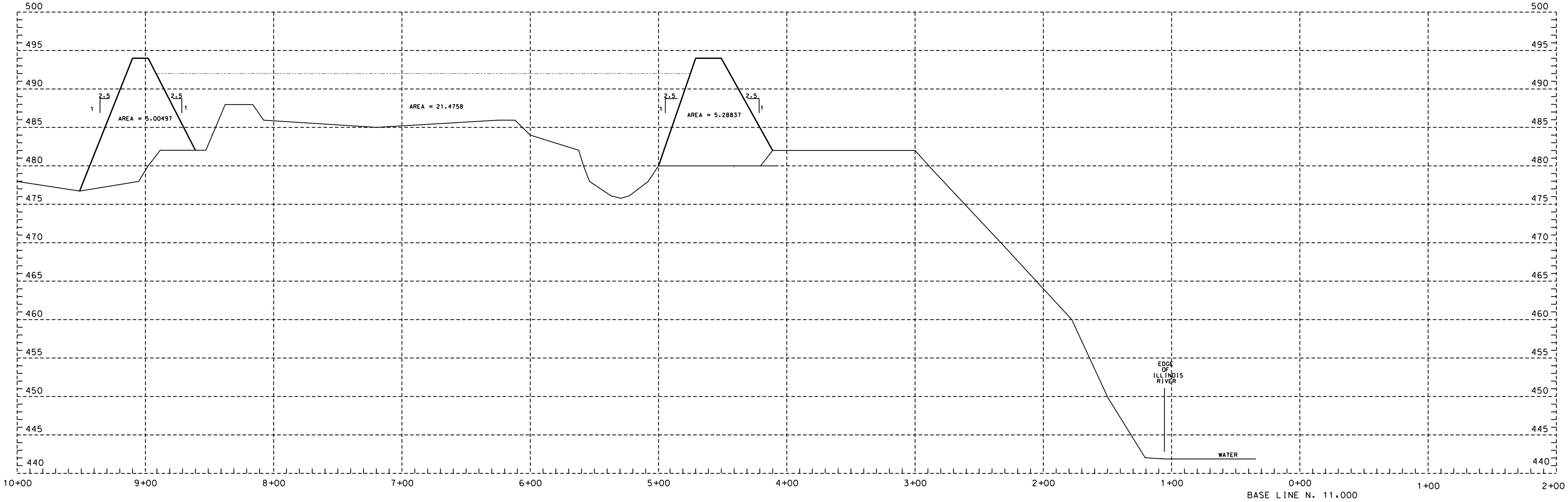
REVISION STATUS
□ -CONSTRUCTION
○ -RECORD

0

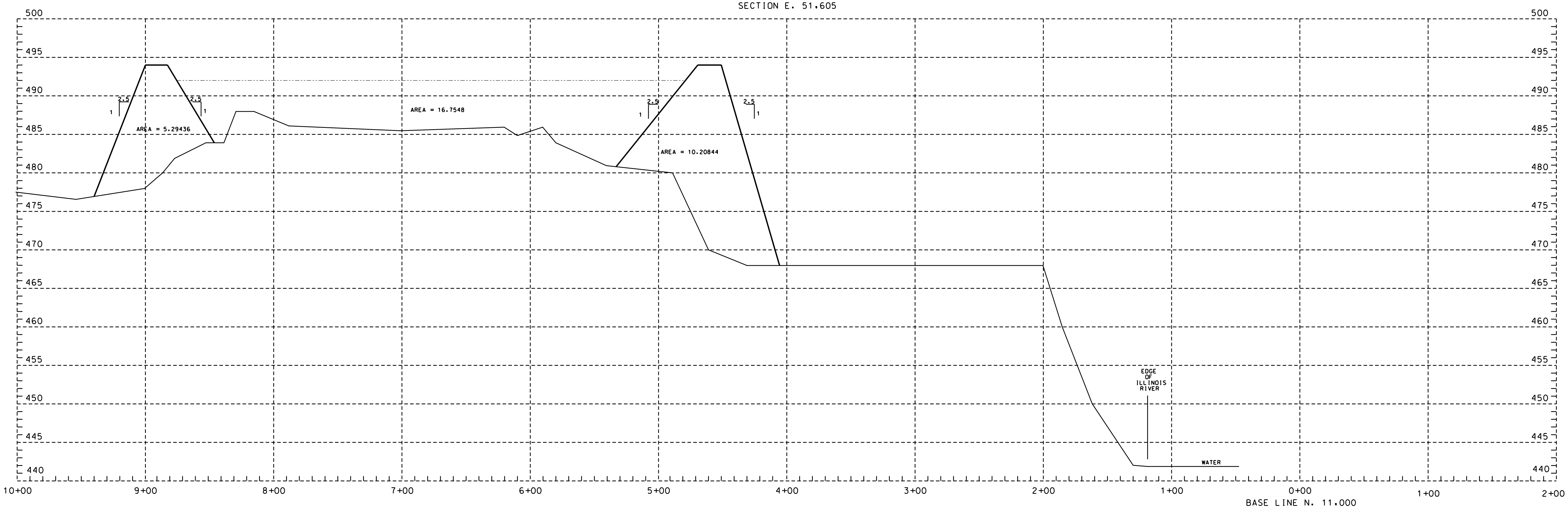
ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-5
APP		



SECTION E. 51.605



SECTION E. 51.552

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

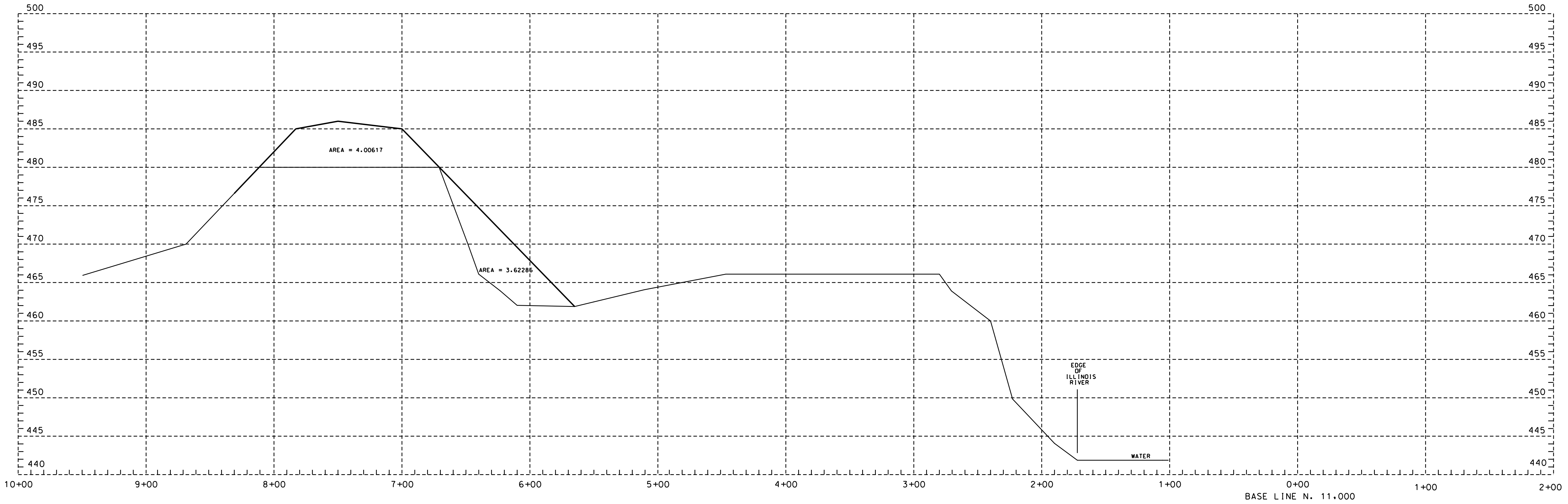
REFERENCES

REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
0

ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-6
APP		



SECTION E. 51,285

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

1. DATA COLLECTED FROM TOPO ON DWG. CE-HEN1-B-450 DATED NOV. 4, 1987, REV. 0
2. COORDINATES WERE SUPPLIED BY G. DECKARD FIELD INFORMATION TIEING TO J.L. FISHER'S PANELS.

REFERENCES

REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD

0

ILLINOIS POWER COMPANY
DECATUR

CROSS SECTIONS
EAST ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM	CAD WJM	DATE 1-12-89
OK	CKD	SCALE 1"=5' V. 1"=30' H.
APP	PLOTTED 03-08-90	CE-HEN1-B458-7
APP		

CE-HEN1-B460-1

REVISIONS

REVISION STATUS
○ = CONSTRUCTION
○ = RECORD

ILLINOIS POWER COMPANY

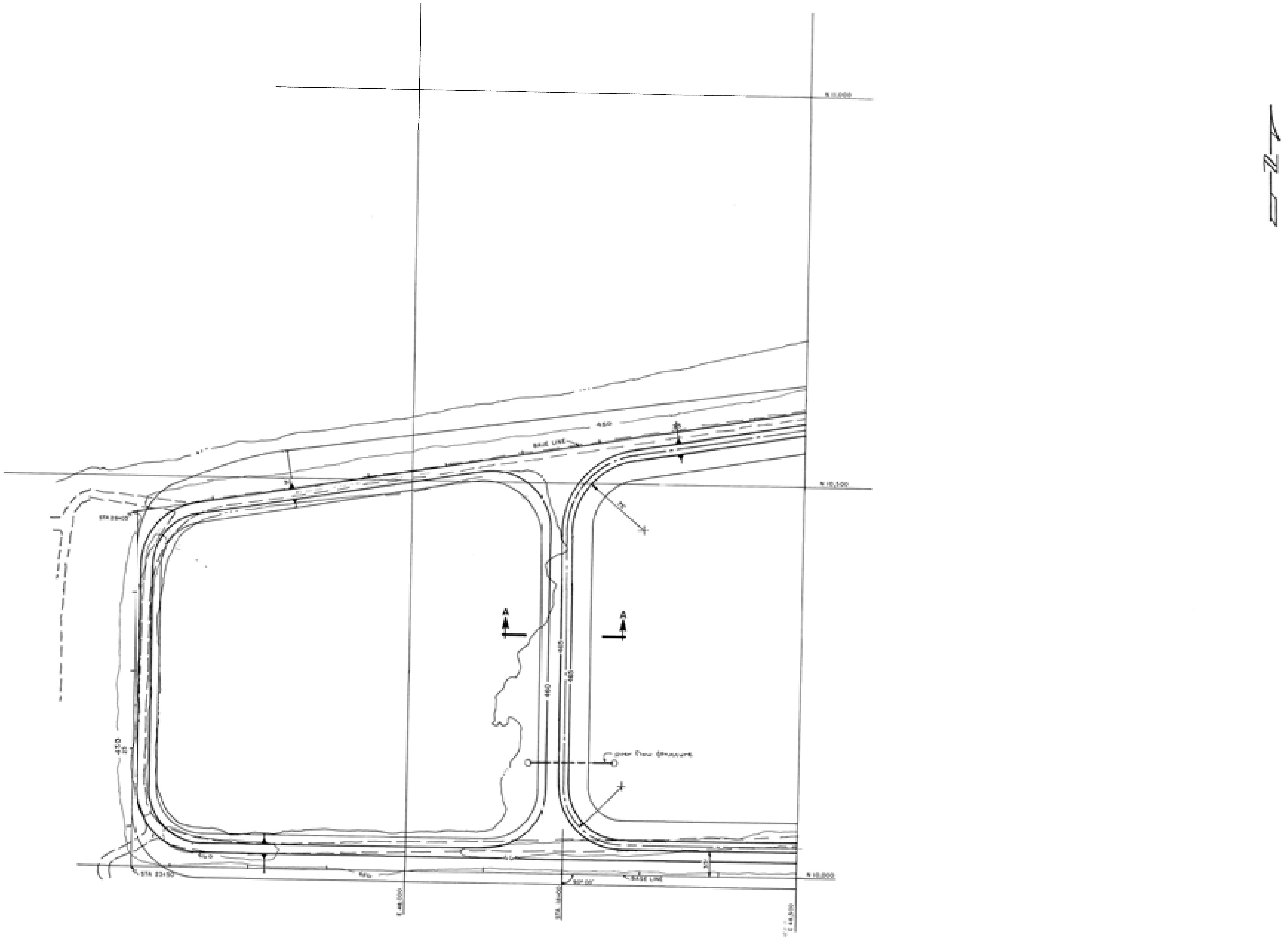
DECATUR

PLAN-UNIT#1 ASH POND EXTENSION
HENNEPIN POWER STATION
SHEET # 1

DR. C.R.H.
CK. [illegible]
APP. [illegible]
APP.
DATE 2-2-88
SCALE 1"=50'

E-HEN1-B460-1

PLATE NO. 1



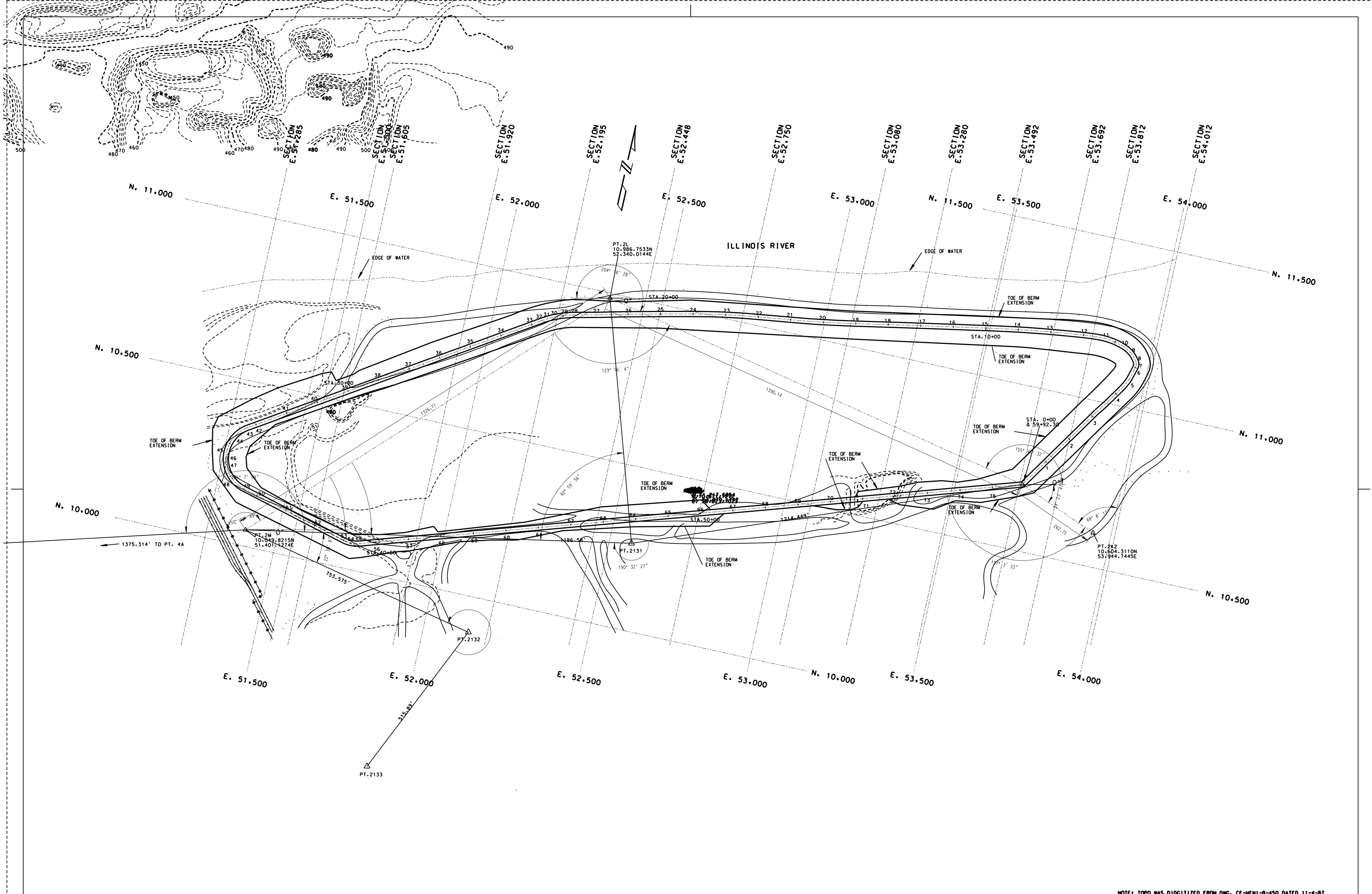
ILLINOIS POWER COMPANY
DECATUR

PLAN - UNIT#1 ASH POND EXTENSION
HENNEPIN POWER STATION
SHEET #2

DR. G.E.H.	TR.	DES.
CK. [illegible]	DATE 2-2-88	SCALE 1"=50'
APP.	PRINTED	E-HEN1-B460-2

REVISIONS

PLATE NO. 1



NOTE: TOPO WAS DIDGITIZED FROM DWG. CE-HEN1-B-450 DATED 11-4-87

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

NOTES

REFERENCES

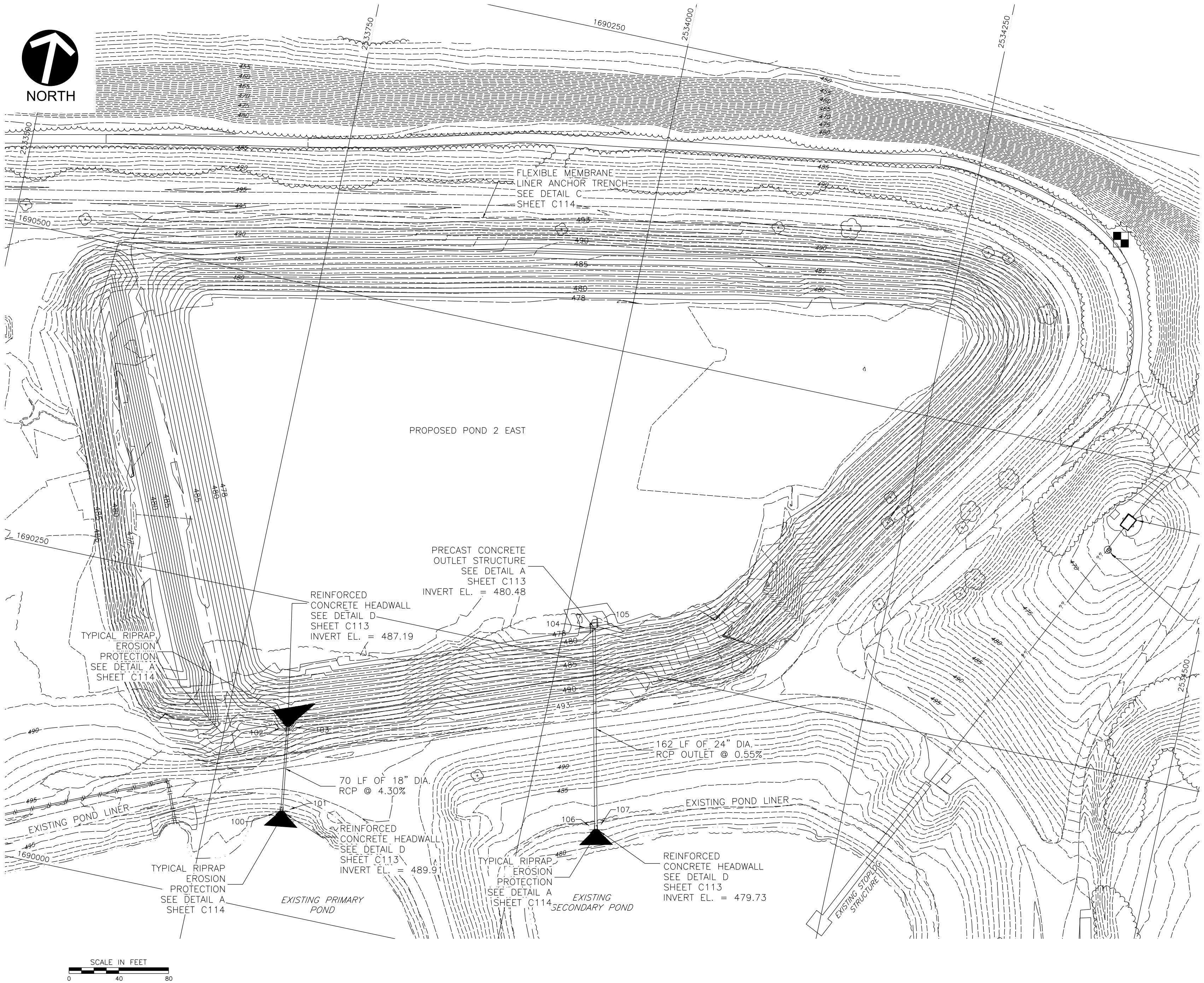
REVISION STATUS
□ -CONSTRUCTION
○ -RECORD
0

ILLINOIS POWER COMPANY
DECATUR

CONTOUR AND GRADING PLAN
UNIT #2 ASH POND EXTENSION
HENNEPIN POWER STATION

DR WJM
CAD WJM
DATE 1-11-89
OK
CKD
SCALE 1"=100"
APP
APP
PLOTTED 03-08-90
CE-HEN1-B461

0V0.1.2.3.4.5



DRAWING NOT TO SCALE IF SCALE BAR DOES NOT MEASURE 2 INCHES

REFERENCE

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON OCTOBER 26, 2008.

STRUCTURE TABLE		
Point #	Northing	Easting
100	1690080.864	2533807.450
101	1690081.207	2533809.928
102	1690149.246	2533797.977
103	1690149.589	2533800.456
104	1690276.331	2534020.790
105	1690282.205	2534024.973
106	1690118.909	2534057.560
107	1690119.451	2534060.003

NOTE

THE LOCATION OF THE ABOVE AND BELOW GRADE STRUCTURES SHOWN ON THESE DRAWINGS ARE APPROXIMATE. PRIOR TO PERFORMING EXCAVATIONS, THE CONTRACTOR SHALL FIELD LOCATE STRUCTURES THAT MAY BE WITHIN THE LIMITS OF WORK AND PROTECT THEM ACCORDINGLY.

LEGEND

——495——	PROPOSED INDEX CONTOURS
——495——	PROPOSED INTERMEDIATE CONTOURS
— —495— —	EXISTING INDEX CONTOURS
- - -495- - -	EXISTING INTERMEDIATE CONTOURS
——??——	EXISTING STORM WATER DRAINS
- - - - - -	EXISTING ACCESS ROAD

Civil & Environmental Consultants, Inc.
5910 Haper Road, Suite 106 - Solon, OH 44139
Ph: 330.310.6800 · 866.507.2324
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REFERENCE DRAWINGS

NO.	DATE	REVISION	BY	APPROVED

NO.	DATE	REVISION	BY	APPROVED
⓪	7/28/10	RECORD REVISION - 082-255	DFB	SFP

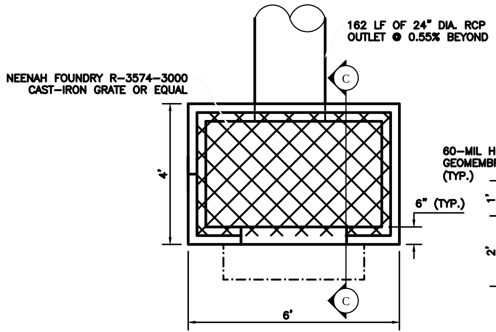
SCALE: AS_NOTED
DWN. DFB DATE 07/05/2010
CHK. RTM DATE 07/12/2010
APPV. SFP DATE 07/12/2010

DYNEGY

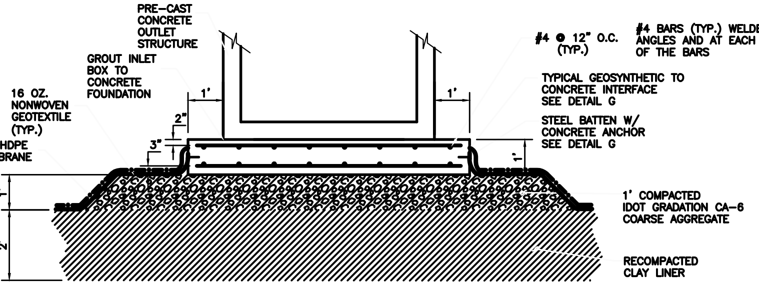
DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
POND 2 EAST
FLEXIBLE MEMBRANE LINER AND STRUCTURES

PROJECT NO.: 082-255
CLIENT: DYNEGY
DWG. NO.: HEN1-C109
REV. ⓪

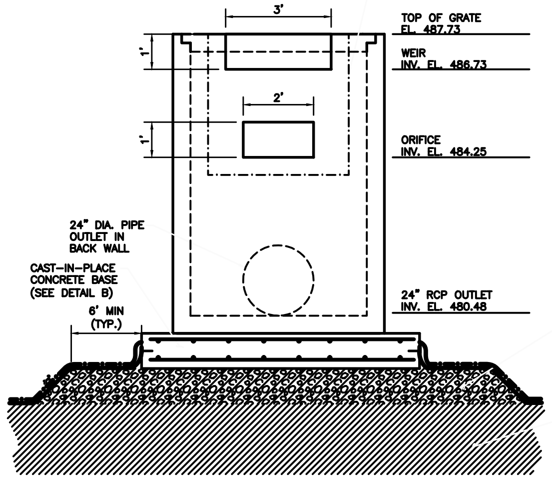
HENNEPIN HEN1-C109 DFB 07/05/2010



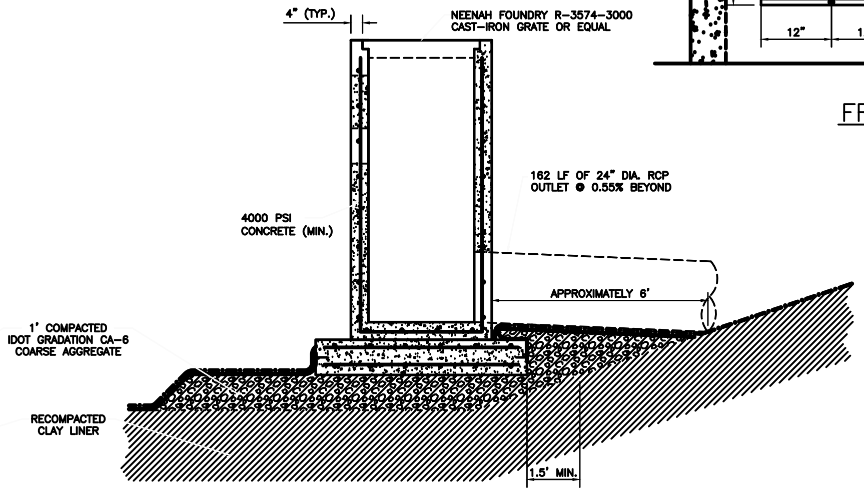
TOP VIEW



DETAIL B



FRONT VIEW



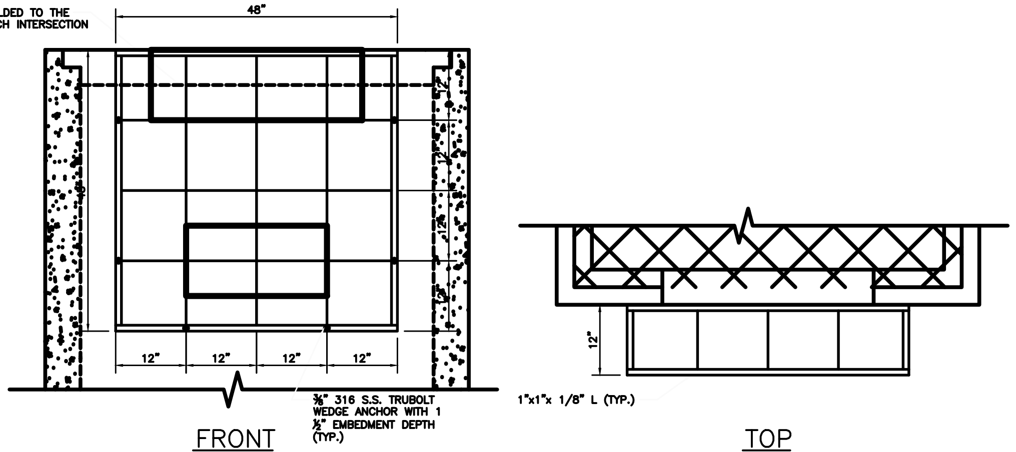
SECTION C-C

DETAIL A
PRECAST CONCRETE OUTLET STRUCTURE

N.T.S.

NOTES

1. REFER TO ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT) STANDARD FOR OUTLET REINFORING.

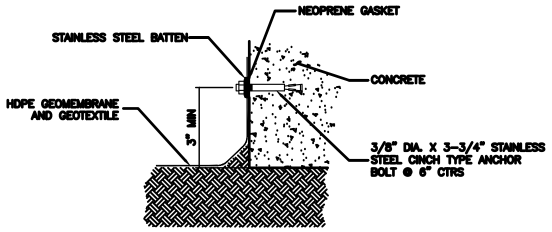


FRONT

TOP

DETAIL F
TRASH RACK

N.T.S.



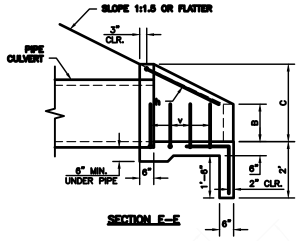
STEEL BATTEN W/ CONCRETE ANCHOR

DETAIL G
TYPICAL GEOSYNTHETIC TO CONCRETE INTERFACE

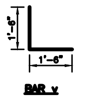
N.T.S.

NOTES

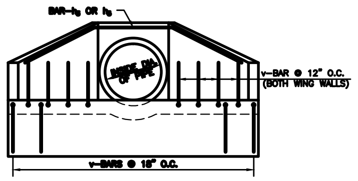
1. EARTH ADJACENT TO CONCRETE TO BE WELL COMPACTED TO PREVENT FUTURE DIFFERENTIAL SETTLEMENT.
2. ALL CONCRETE COLLARS TO BE CHAMFERED A MINIMUM OF 1" (TYP.) @ ALL CORNERS IN CONTACT WITH LINER



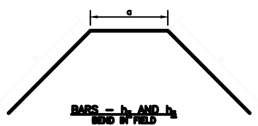
SECTION E-E



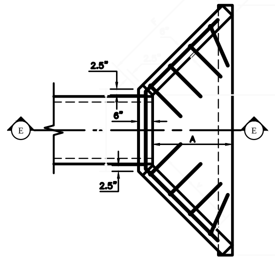
BAR v



END VIEW



BARS – h_3 AND h_5
BEND IN FIELD
ONE REQUIRED IN EACH HEADWALL



PLAN

DETAIL D
REINFORCED CONCRETE HEADWALL

N.T.S.

NOTES

1. REFER TO IDOT STANDARD 542101-02 REINFORCED CONCRETE HEADWALL DETAIL FOR FINAL DESIGN.

DIMENSIONS OF BARS-h_3 AND h_5

BAR	a	b
h_3	2'-1"	3'-2.50"
h_5	2'-9"	4'-1.50"

DIMENSIONS AND QUANTITIES

DESIGN NO.	NOMINAL INSIDE DIA. OF PIPE	SLOPE OF WING WALLS	DIMENSIONS (A)	DIMENSIONS (B)	DIMENSIONS (C)	DIMENSIONS (D)	DIMENSIONS (E)	DIMENSIONS (F)	CONCRETE 2 END SECS. CU. YDS.	NO.4 REBAR h-BARS (BAR)	NO.4 REBAR h-BARS (LENGTH)	NO.4 REBAR v-BARS NO.	NO.4 REBAR TOTAL WT. 2 END SECS. LBS.
D18-2	1'-6"	1 TO 2	2'-2"	1'-1"	2'-2"	2'-3"	6'-10.50"	3'-3.25"	1.30	h_3	8'-6"	22	60
D24-2	2'-0"	1 TO 2	2'-10"	1'-4"	2'-9"	2'-11"	8'-10.50"	4'-2.50"	2.00	h_5	11'-0"	28	70

Civil & Environmental Consultants, Inc.
5910 Haper Road, Suite 106 - Solon, OH 44139
Ph: 330.310.6800 · 866.507.2324
www.cecinc.com

REFERENCE DRAWINGS

NO.	DATE	REVISION	BY	APPROVED	NO.	DATE	REVISION	BY	APPROVED
					⓪	7/28/10	RECORD REVISION - 082-255	DFB	SFP

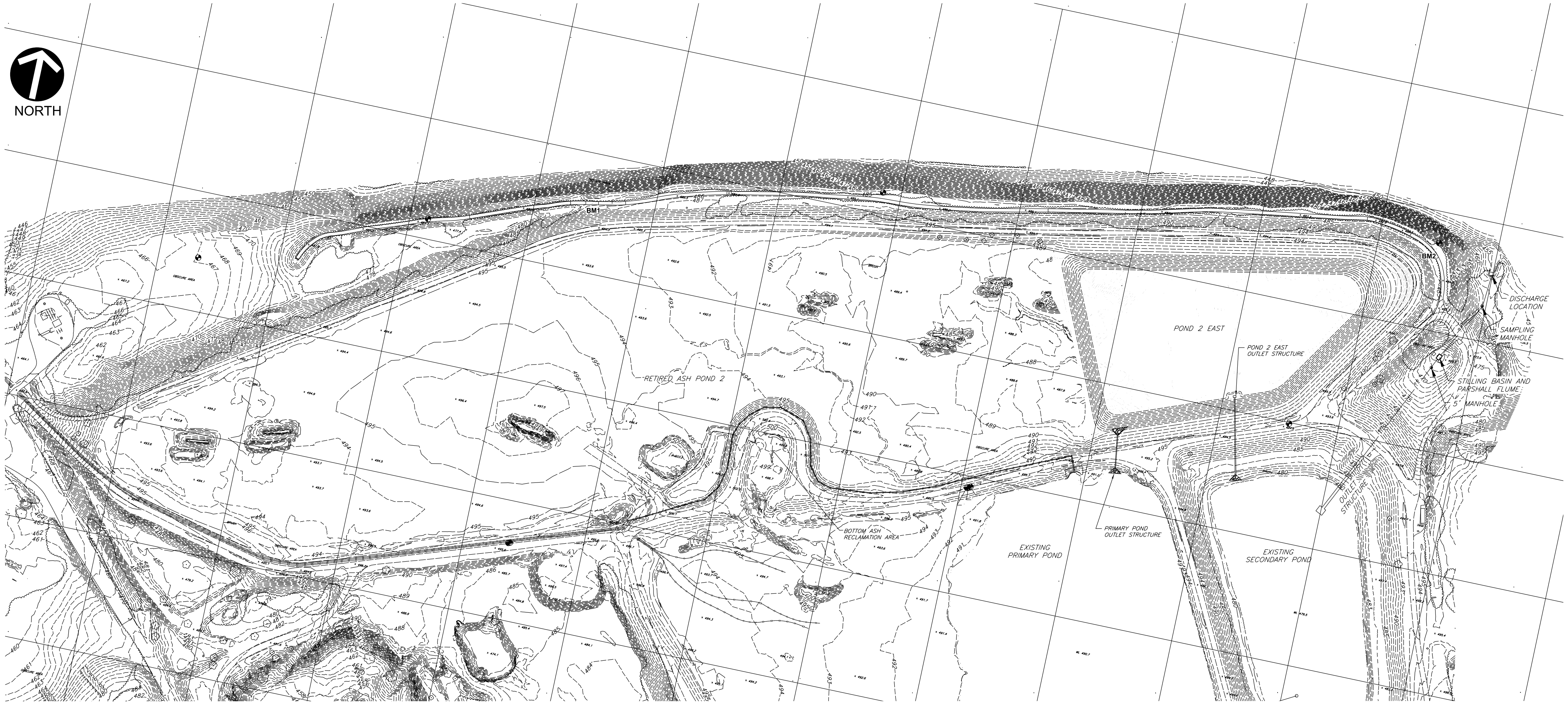
SCALE: AS_NOTED
DWN. DFB DATE 07/05/2010
CHK. RTM DATE 07/12/2010
APPV. SFP DATE 07/12/2010

DYNEGY

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
POND 2 EAST
DETAILS

PROJECT NO.: 082-255
CLIENT: DYNEGY
DWG. NO.: HEN1-C113
REV. ⓪

HENNEPIN HEN1-C113 DFB 07/05/2010



BENCHMARK LOCATIONS			
NUMBER	NORTHING	EASTING	ELEVATION
1	1690395.43	2532618.60	482.19
2	1690670.86	2534372.87	484.00
3*	1689478.87	2534643.99	506.80
4*	1688458.82	2533256.76	499.45
5*	1688781.84	2531352.15	468.27
6*	1689875.08	2531310.12	463.75

* BENCHMARKS BEYOND DRAWING BOUNDARY.

SCALE IN FEET
0 100 200
DRAWING NOT TO SCALE IF SCALE BAR DOES NOT MEASURE 2 INCHES

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.

   DUE TO CONSTRUCTION ACTIVITIES, ACTUAL FIELD TOPOGRAPHY MAY VARY.

2. POND 2 EAST CONTOURS FROM CONSTRUCTION DRAWINGS SUBMITTED AUGUST 2009.

LEGEND

——— ? ———	MISCELLANEOUS FLOW PIPING
——— ?? ———	EXISTING STORMWATER DRAINS
¿¿¿¿¿¿¿¿¿¿¿¿	EXISTING TREELINE
—+—+—+—+—	EXISTING PIPING
— — — — —	EXISTING ACCESS ROAD
—— · · · —— · · · ——	EXISTING PONDS/STREAMS
——·——·——·——	EXISTING FENCE
▚	EXISTING BENCHMARK
——— ——— -500- ——— ———	EXISTING INDEX CONTOUR
– – – – –499– – – – –	EXISTING INTERMEDIATE CONTOUR
▨	EXISTING ROCK CHANNEL PROTECTION
◕	EXISTING MONITORING WELL

Civil & Environmental Consultants, Inc.
5910 Haper Road, Suite 106 - Solon, OH 44139
Ph: 330.310.6800 · 866.507.2324
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DYNEGY CONFIDENTIAL
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REFERENCE DRAWINGS

NO.	DATE	REVISION	BY	APPROVED

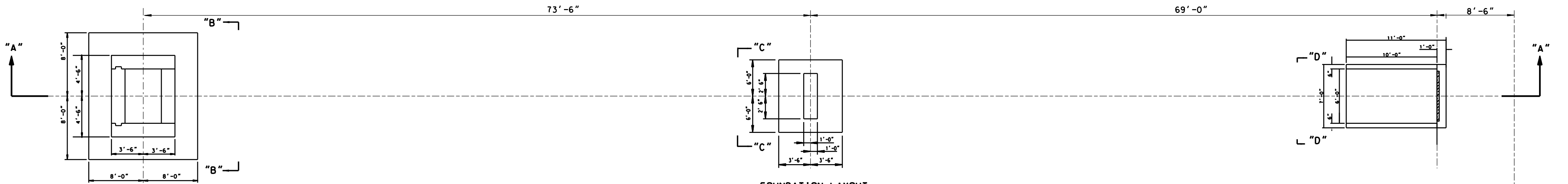
NO.	DATE	REVISION	BY	APPROVED
⓪	11/28/10	RECORD REVISION - 082-255	DFB	SFP

SCALE:	AS_NOTED
DWN. DFB	DATE 11/05/2010
CHK. RTM	DATE 11/12/2010
APPV. SFP	DATE 11/12/2010
EAPP_BY	EABD
FEAPP_BY	FEABD

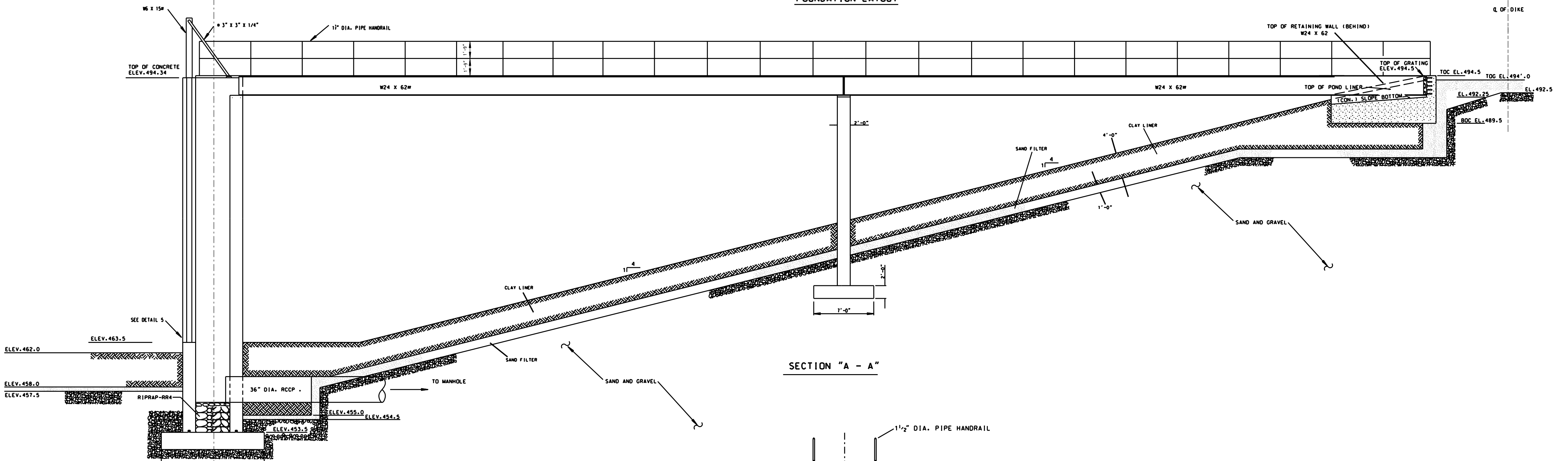
DYNEGY

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
LANDFILL PHASE 1 CONSTRUCTION
EXISTING CONDITIONS

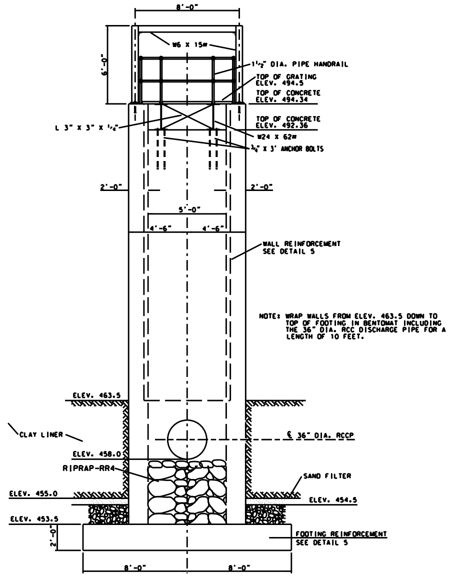
PROJECT NO.: 082-255
CLIENT: DYNEGY
DWG. NO.: HEN1-C117
REV. ⓪



FOUNDATION LAYOUT

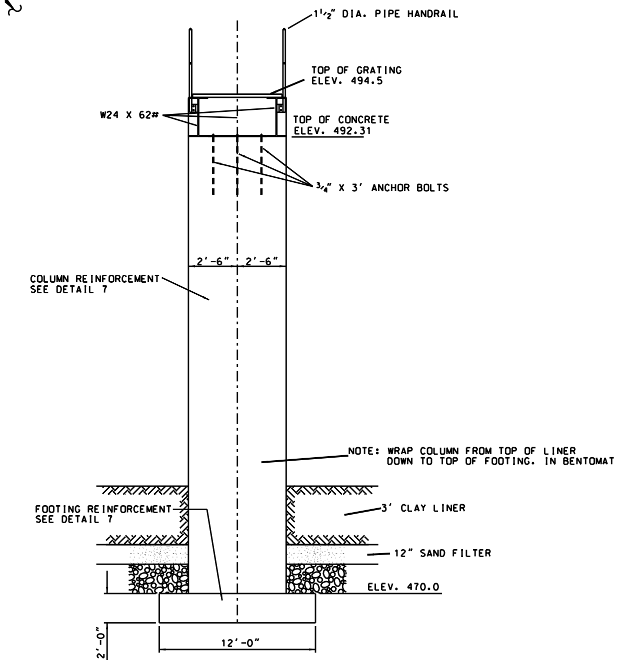


SECTION "A - A"



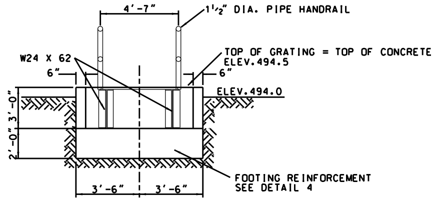
NOTE: WRAP WALLS FROM ELEV. 463.5 DOWN TO TOP OF FOOTING IN BENTOMAT INCLUDING THE 36" DIA. RCC DISCHARGE PIPE FOR A LENGTH OF 10 FEET.

SECTION "B"-"B"



NOTE: WRAP COLUMN FROM TOP OF LINER DOWN TO TOP OF FOOTING. IN BENTOMAT

SECTION "C"-"C"



SECTION "D"-"D"

NOTE: WRAP BOTTOM 2'-0" OF FOOTING IN BENTOMAT.

NO	DATE	DRF	DESCRIPTION	E	C	A	NO	DATE	DRF	DESCRIPTION	E	C	A
0													

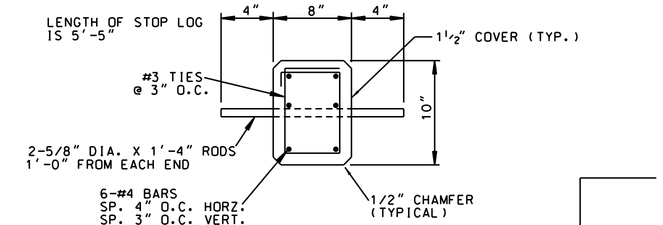
REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD
⓪

p0019275.dgn

ILLINOIS POWER COMPANY
DECATUR

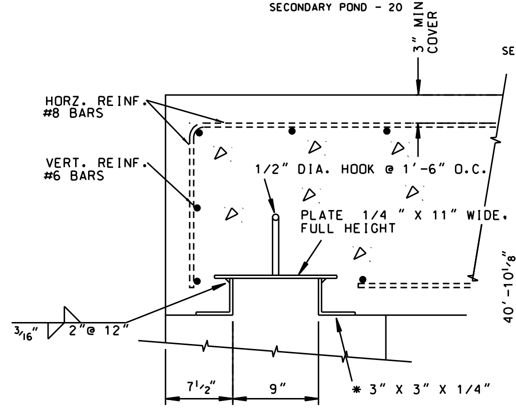
LAYOUT-POND DISCHARGE STRUCTURES
1995 ASH FACILITY
HENNEPIN POWER STATION

DR G.R.H.	CAD G.R.H.	DATE 1/5/94
OK	CKD	SCALE NO SCALE
APP APP	PLOTTED 9/17/96	CE-HEN1-C8

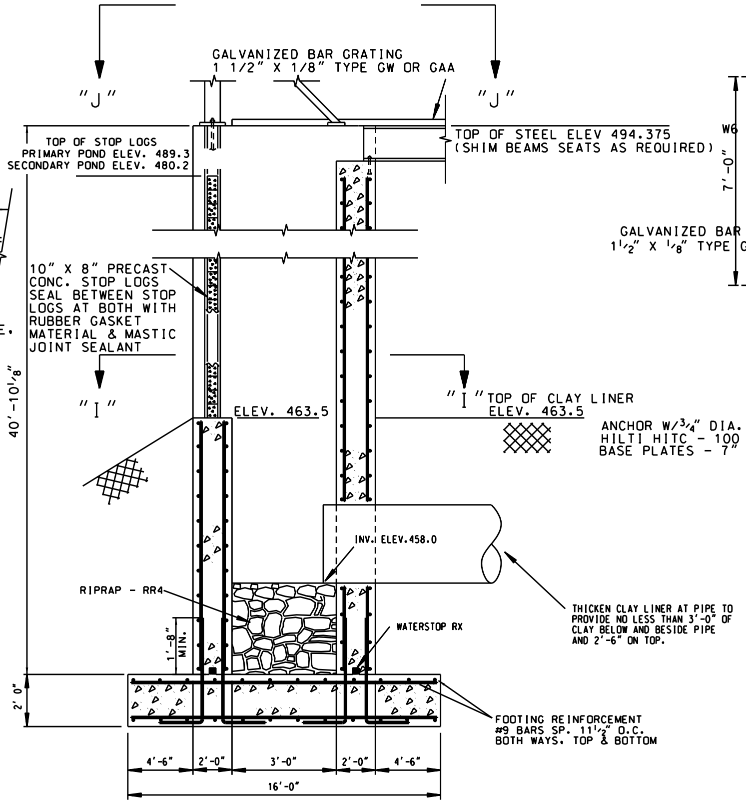


STOP LOG DETAIL

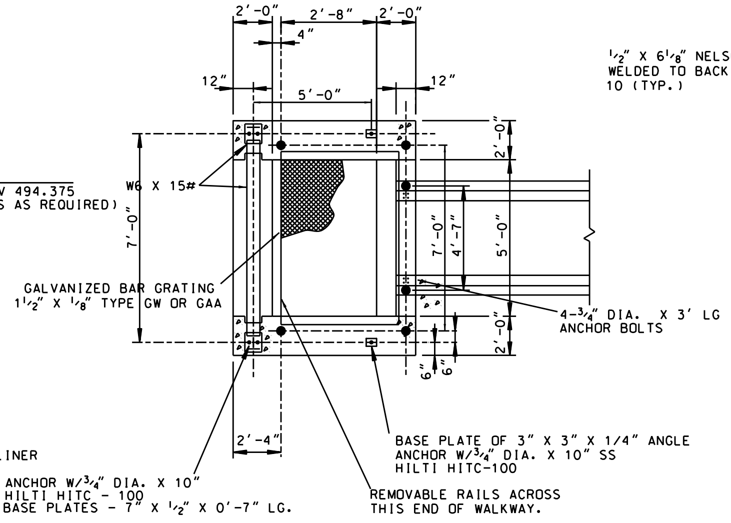
(51 REQUIRED INITIALLY.
PROVIDE COMPANY WITH 10 EXTRA)
PRIMARY POND - 31
SECONDARY POND - 20



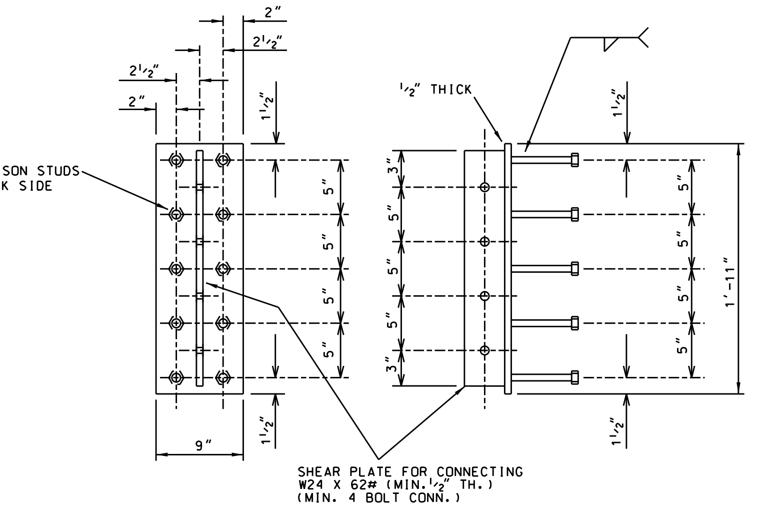
DETAIL 6



DETAIL 5

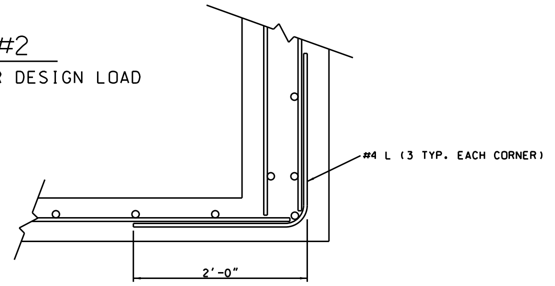


SECTION J-J

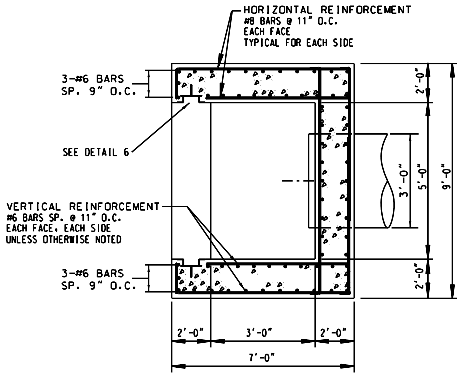


DETAIL #2

SEE CATWALK PLAN FOR DESIGN LOAD



DETAIL #4



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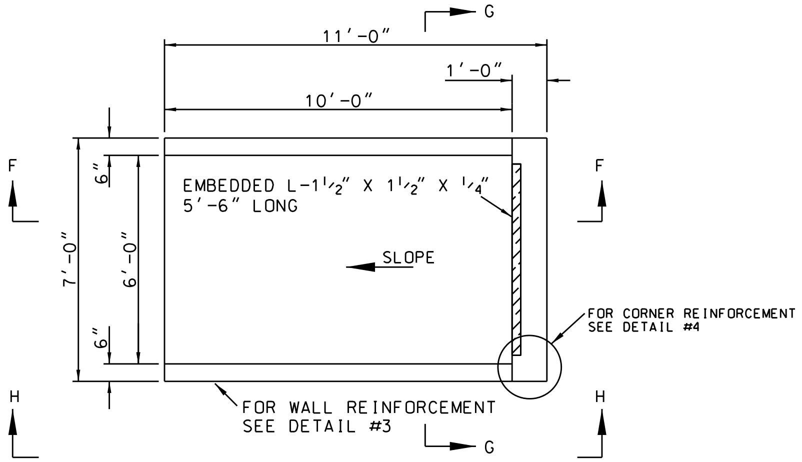
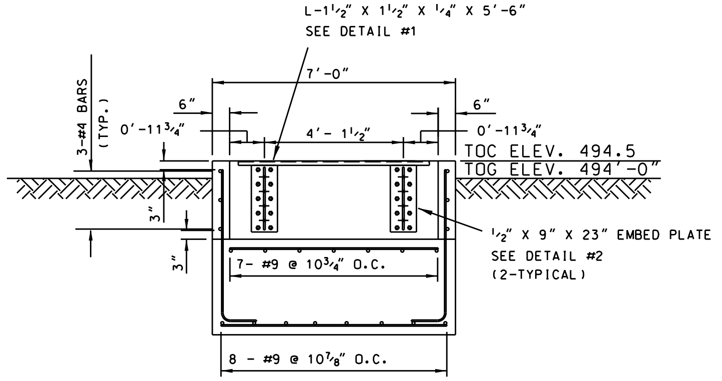


PLAN: CATWALK FOUNDATION



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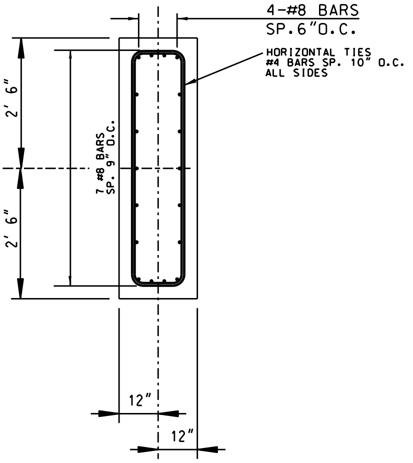

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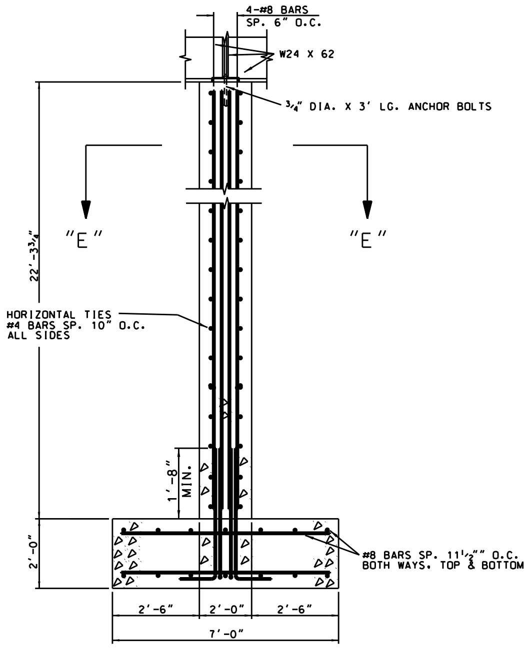

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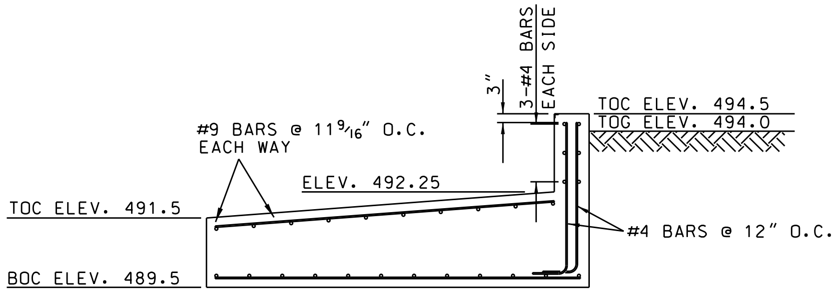

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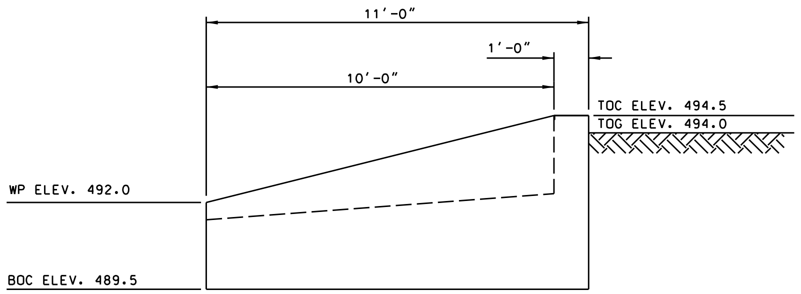

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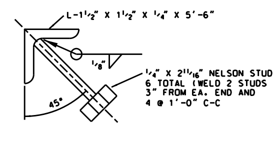

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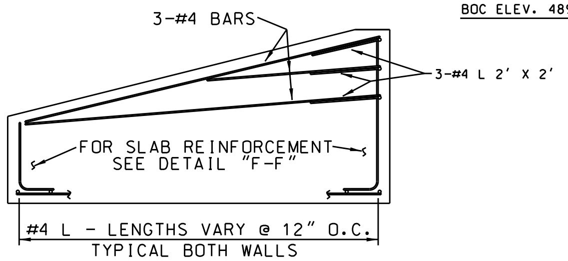


DETAIL #3

REVISION STATUS
☐ -CONSTRUCTION
○ -RECORD
⓪

p0019276.dgn

ILLINOIS POWER COMPANY
DECATUR

DETAILS: POND DISCHARGE STRUCTURE
1995 ASH FACILITY
HENNEPIN POWER STATION

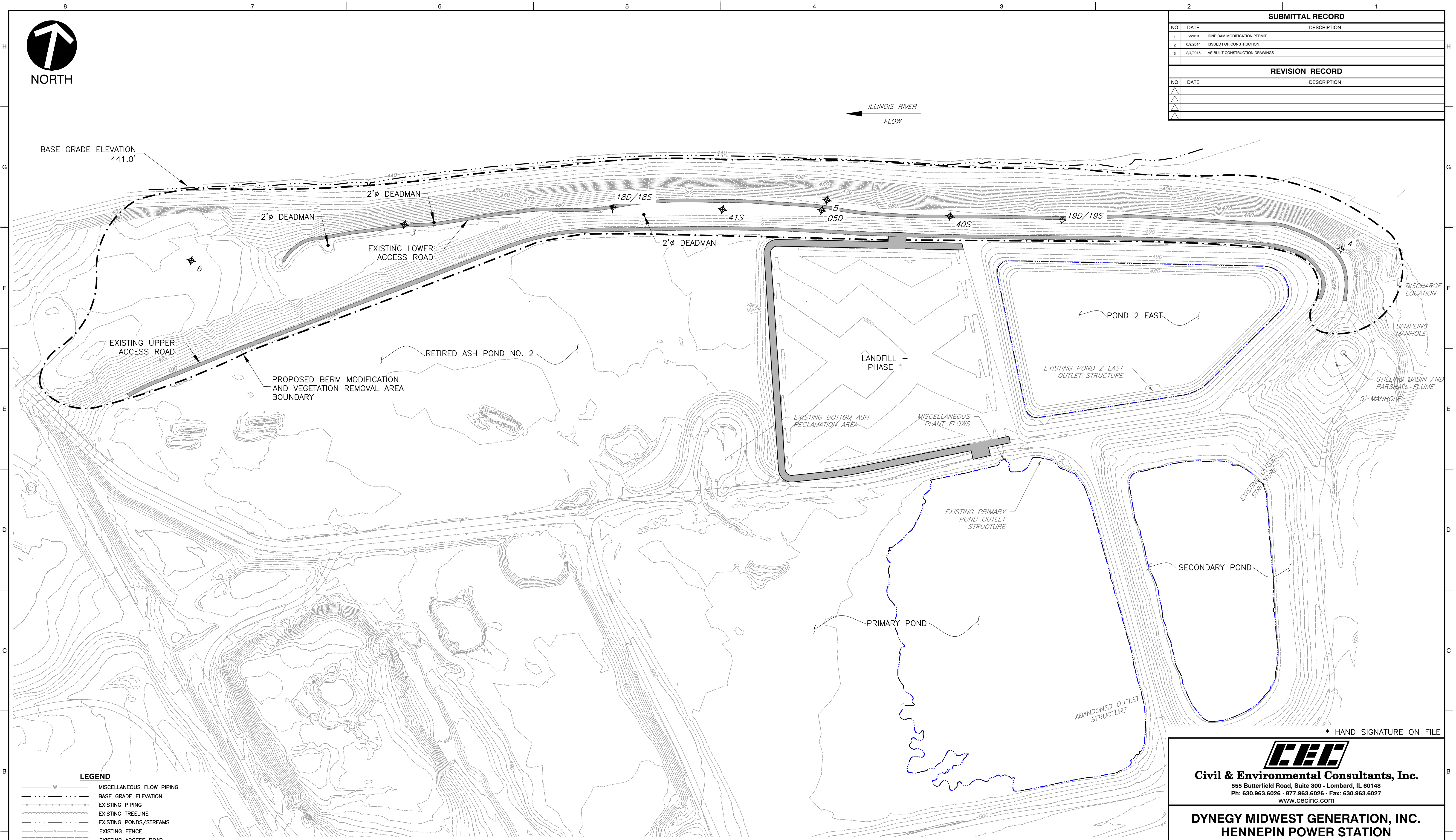
DR G.R.H.	CAD G.R.H.	DATE 1/5/94
OK	CKD	SCALE AS NOTED
APP	PLOTTED 9/17/96	CE-HEN1-C9
APP		

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
△		
△		
△		
△		



* HAND SIGNATURE ON FILE

LEGEND

—— W ——	MISCELLANEOUS FLOW PIPING
—··—··—	BASE GRADE ELEVATION
‑‑‑‑	EXISTING PIPING
⌒⌒⌒⌒	EXISTING TREELINE
—··—··—	EXISTING PONDS/STREAMS
—×—×—×—	EXISTING FENCE
- - - -	EXISTING ACCESS ROAD
—— ST ——	EXISTING STORM WATER PIPING
—— P ——	EXISTING UNDERGROUND PLANT FLOW PIPING
‑‑‑‑	EXISTING PLANT FLOW PIPING
—— 495 ——	EXISTING INDEX CONTOURS
- - - -	EXISTING INTERMEDIATE CONTOURS
⌖ 18D	EXISTING MONITORING WELL LOCATIONS
▨	EXISTING ACCESS ROAD
—·—·—	PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017-DAM I.D. NO. 50663
4. AS-BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

AS-BUILT CONSTRUCTION PLANS

SCALE IN FEET
0 100 200

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DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

EXISTING SITE CONDITIONS PLAN

DRAWING NO.: 3

SHEET 3 OF 9

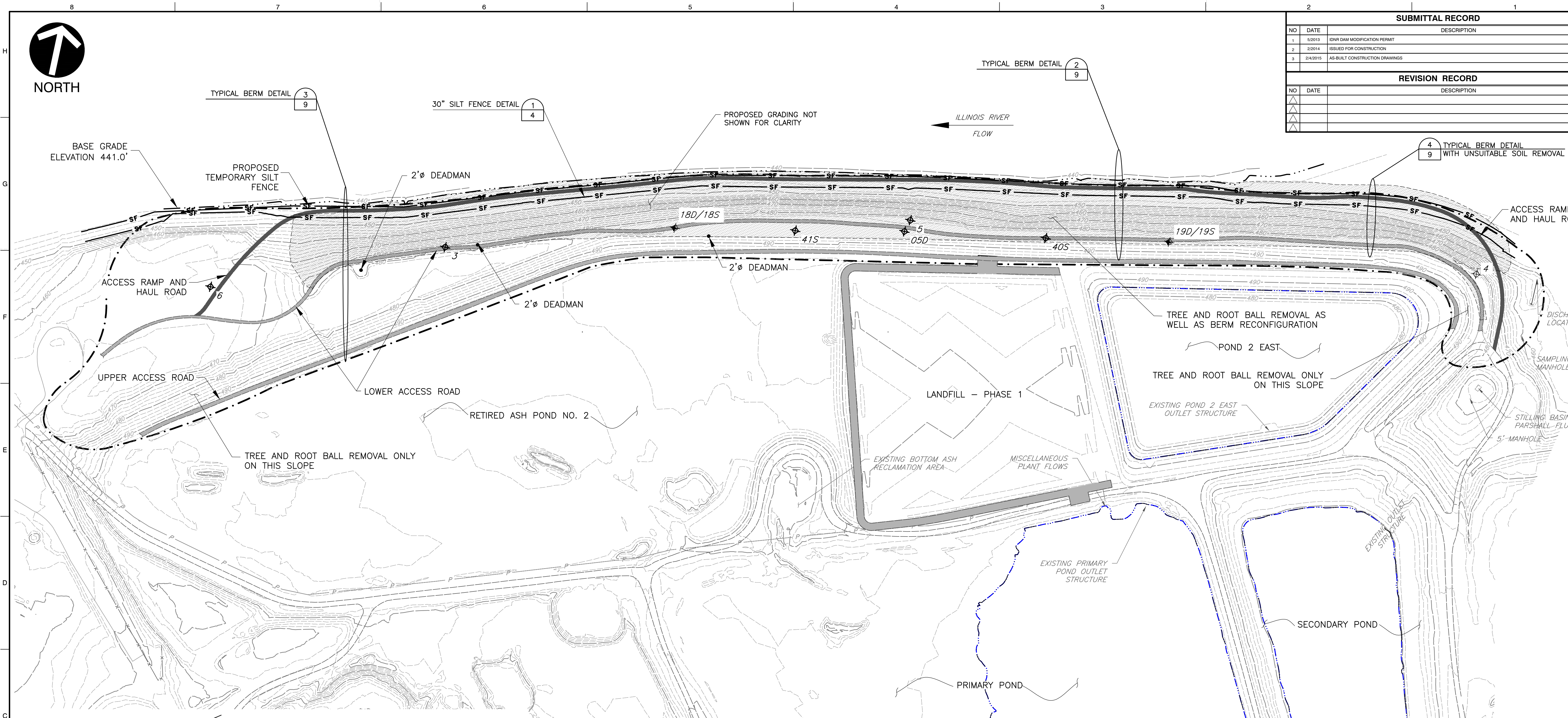
p:\2013\132-650.0200\-CADD\Dwg\CV02\132650-CV02-C100-Existing Conditions.dwg{EXISTING SITE CONDITIONS PLAN} LS:(2/11/2015 - thootman) - LP: 2/17/2015 10:43 AM

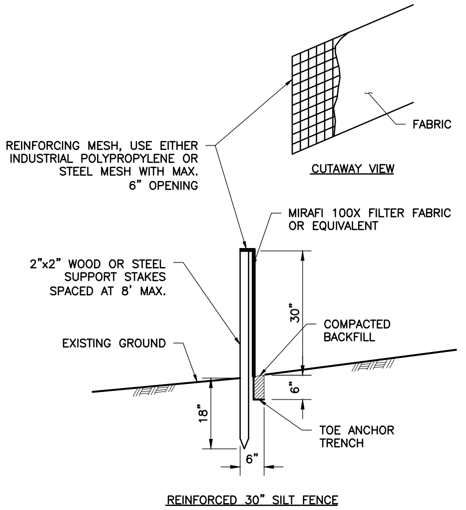
SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	2/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
△		
△		
△		
△		





DETAIL 1
30" SILT FENCE DETAIL

N.T.S.

SILT FENCE NOTES:

1. SILT FENCE SHALL BE PLACED ON LEVEL GRADE, WHERE POSSIBLE, AND BOTH ENDS OF THE SILT FENCE SHALL BE EXTENDED UP THE SLOPE.
2. SILT FENCE SHALL NOT BE PLACED IN ANY AREA OF CONCENTRATED FLOW NOR IN AREAS WHERE ROCK OR ROCKY SOILS PREVENT THE FULL AND UNIFORM ANCHORING OF THE FENCE TOE.
3. THE CONTRACTOR SHALL INSPECT THE SILT FENCE AFTER EVERY PRECIPITATION EVENT AND IMMEDIATELY REPAIR ANY DEFICIENCIES.
4. THE CONTRACTOR SHALL REMOVE ACCUMULATED SEDIMENTS AS REQUIRED TO KEEP THE FENCE FUNCTIONAL. IN ALL CASES, THE CONTRACTOR SHALL REMOVE DEPOSITS WHERE ACCUMULATIONS REACH ONE–HALF THE ABOVE GROUND HEIGHT OF THE FENCE.
5. THE CONTRACTOR SHALL IMMEDIATELY REPAIR ALL UNDERCUTTING OR EROSION OF THE ANCHOR TOE WITH A ROCK FILTER OUTLET.
6. THE CONTRACTOR SHALL CONFORM TO ANY RECOMMENDATIONS BY THE MANUFACTURER FOR REPLACING FILTER FABRIC FENCE DUE TO WEATHERING.

SITE PLAN

SCALE: 1" = 100'

LEGEND

——— W ———	MISCELLANEOUS FLOW PIPING
— · · · — · · · —	BASE GRADE ELEVATION
⊣⊢⊣⊢⊣⊢	EXISTING PIPING
⌒⌒⌒⌒⌒	EXISTING TREELINE
— · · · — · · · —	EXISTING PONDS/STREAMS
—×—×—×—	EXISTING FENCE
▨	EXISTING ACCESS ROAD
——— ST ———	EXISTING STORM WATER PIPING
——— P ———	EXISTING UNDERGROUND PLANT FLOW PIPING
⊢⊢⊢⊢⊢	EXISTING PLANT FLOW PIPING
—— 495 ——	EXISTING INDEX CONTOURS
— — — — —	EXISTING INTERMEDIATE CONTOURS
⌖18D	EXISTING MONITORING WELL LOCATIONS
■	PROPOSED CONSTRUCTION ACCESS ROAD
—— · —— · ——	PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY
——— SF ———	PROPOSED SILT FENCE
▨	PROPOSED GRADING LIMITS

AS-BUILT CONSTRUCTION PLANS

NOTE:
MONITORING WELLS EXIST WITHIN THE PROPOSED BERM MODIFICATION AREA. CONTRACTOR SHALL PROTECT EXISTING MONITORING WELLS WHILE PERFORMING BERM MODIFICATION ACTIVITIES.

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

SCALE IN FEET
0 100 200

* HAND SIGNATURE ON FILE

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www.cecinc.com

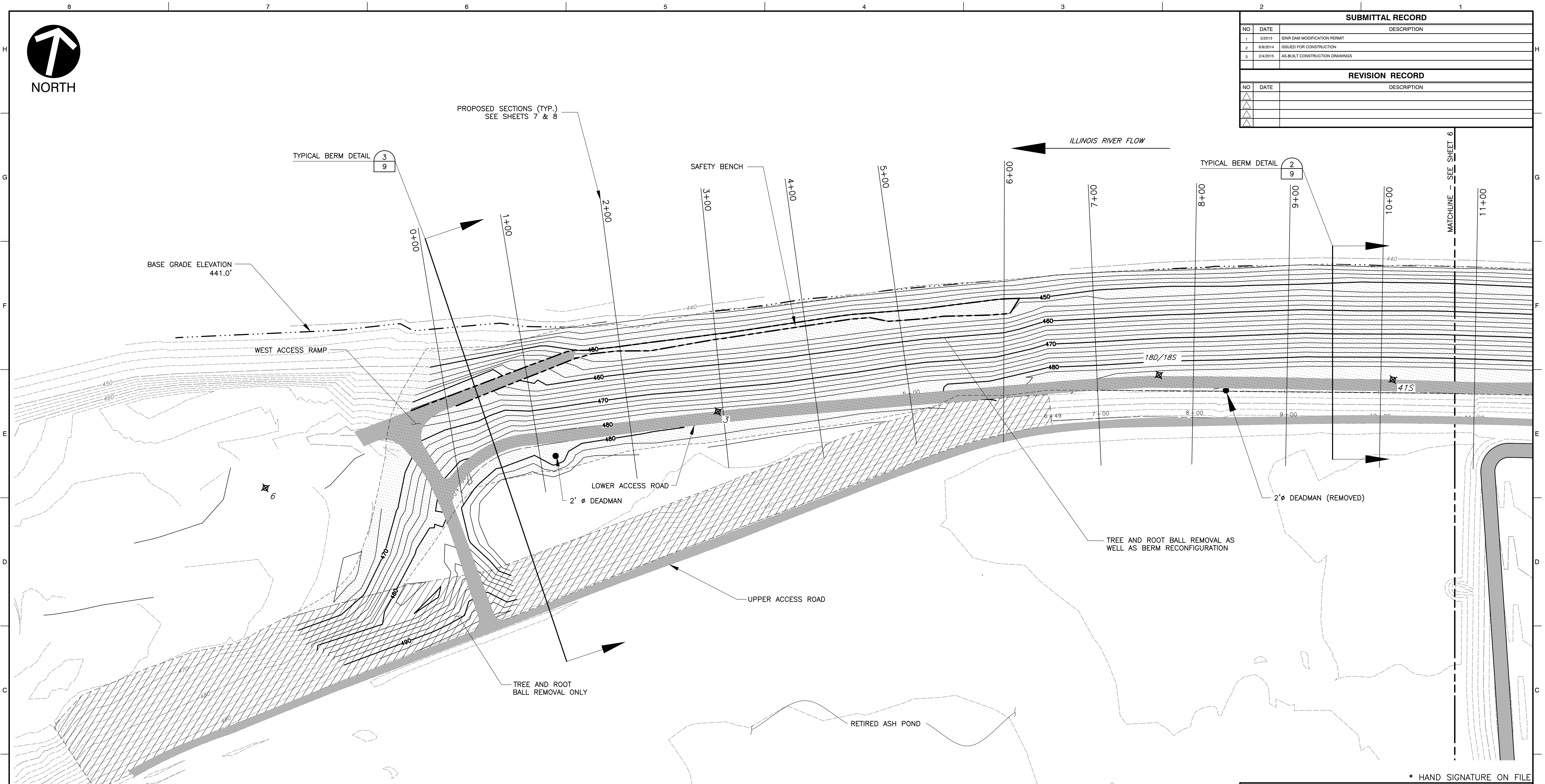
DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED SITE PLAN

DRAWING NO.: 4
SHEET 4 OF 9

p:\2013\132-650.0200\-CADD\Dwg\CV02\132650-CV02-C200-Construction Conditions.dwg{PROPOSED SITE PLAN} LS:(2/11/2015 – thootman) – LP: 2/17/2015 10:43 AM



SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
△		
△		
△		
△		

LEGEND

- MISCELLANEOUS FLOW PIPING
- BASE GRADE ELEVATION
- EXISTING TREELINE
- EXISTING PONDS/STREAMS
- EXISTING FENCE
- EXISTING ACCESS ROAD
- EXISTING STORM WATER PIPING
- EXISTING UNDERGROUND PLANT FLOW PIPING
- EXISTING PLANT FLOW PIPING
- 495 EXISTING INDEX CONTOURS
- EXISTING INTERMEDIATE CONTOURS
- 18D EXISTING MONITORING WELL LOCATIONS
- EXISTING ACCESS ROAD
- PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED SAFETY BENCH

▨ TREE/ROOT BALL REMOVAL ONLY

░ TREE/ROOT BALL REMOVAL WITH BERM RECONFIGURATION

AS-BUILT CONSTRUCTION PLANS

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
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4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

SCALE IN FEET
0 50 100

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EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED GRADING PLAN
1 OF 2

DRAWING NO.: 5

SHEET 5 OF 9

p:\2013\132–650.0200\–CADD\Dwg\CV02\132650–CV02–C300–Proposed Grading Plan.dwg{PROPOSED GRADING PLAN – 1 OF 2} LS:(2/17/2015 – dbronchik) – LP: 2/17/2015 10:43 AM

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
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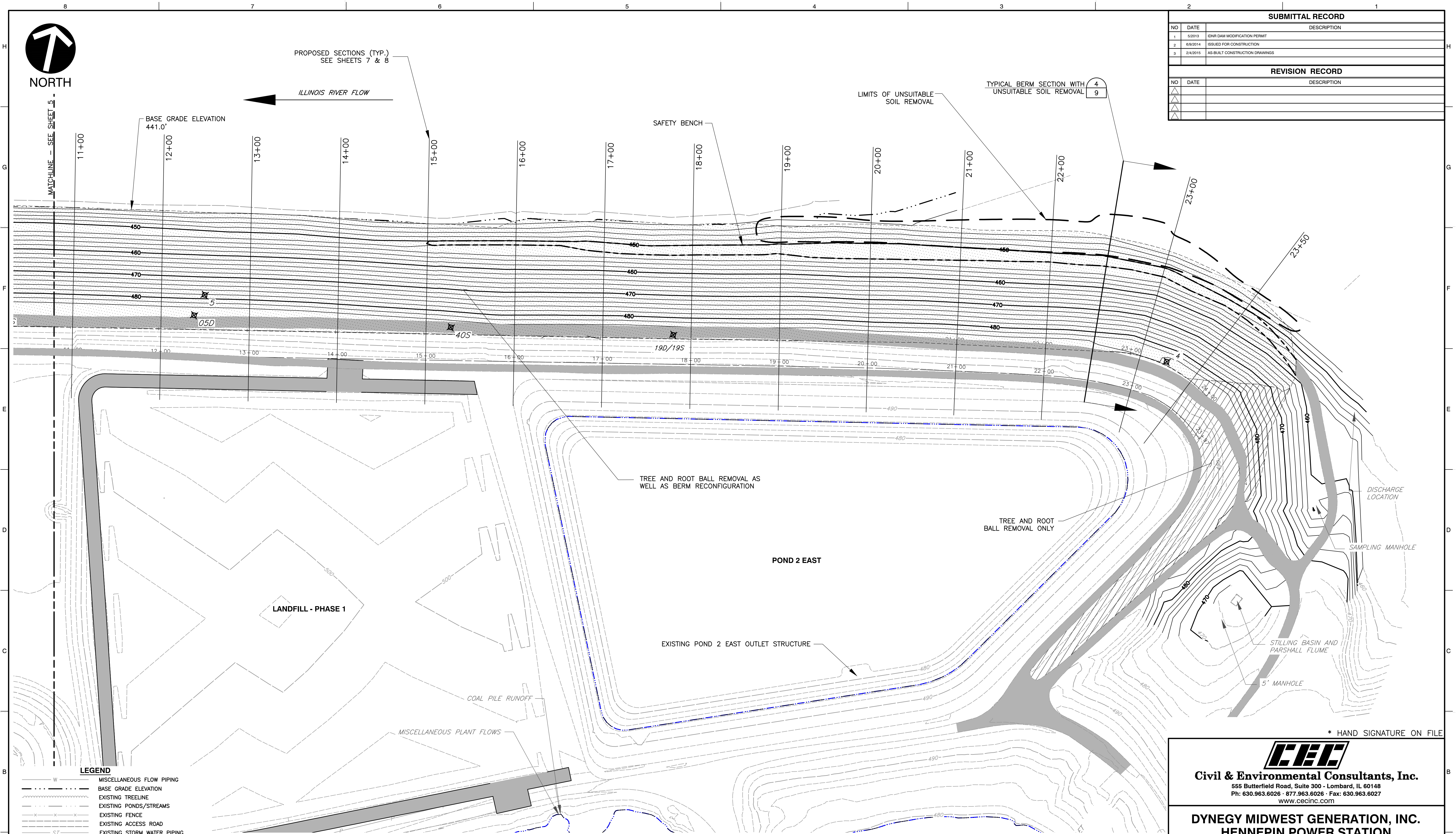

* HAND SIGNATURE ON FILE

LEGEND

—— W ——	MISCELLANEOUS FLOW PIPING
— · · · —	BASE GRADE ELEVATION
⌒⌒⌒⌒	EXISTING TREELINE
— · · —	EXISTING PONDS/STREAMS
—×—×—	EXISTING FENCE
– – – –	EXISTING ACCESS ROAD
—— ST ——	EXISTING STORM WATER PIPING
—— P ——	EXISTING UNDERGROUND PLANT FLOW PIPING
┼┼┼┼┼	EXISTING PLANT FLOW PIPING
— — 495 — —	EXISTING INDEX CONTOURS
– – – –	EXISTING INTERMEDIATE CONTOURS
⌖ 18D	EXISTING MONITORING WELL LOCATIONS
▬	EXISTING ACCESS ROAD
— · — · —	PROPOSED EAST BERM MODIFICATIONS AREA BOUNDARY
——	PROPOSED INDEX CONTOUR
——	PROPOSED INTERMEDIATE CONTOUR
— – —	PROPOSED SAFETY BENCH
▨	TREE/ROOT BALL REMOVAL ONLY
⬚	TREE/ROOT BALL REMOVAL WITH BERM RECONFIGURATION

AS-BUILT CONSTRUCTION PLANS

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

SCALE IN FEET
0 50 100

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DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED GRADING PLAN
2 OF 2

DRAWING NO.: 6
SHEET 6 OF 9

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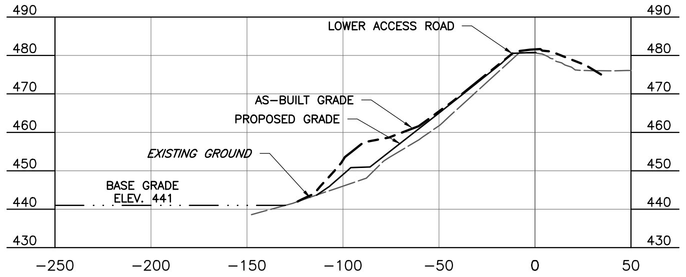

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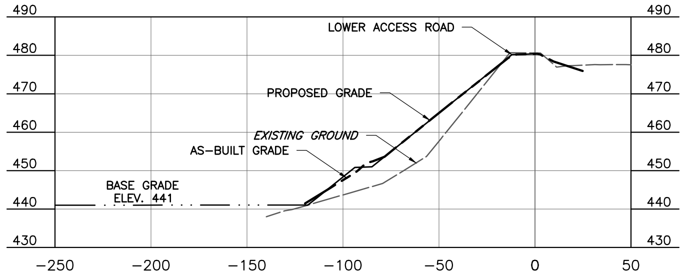

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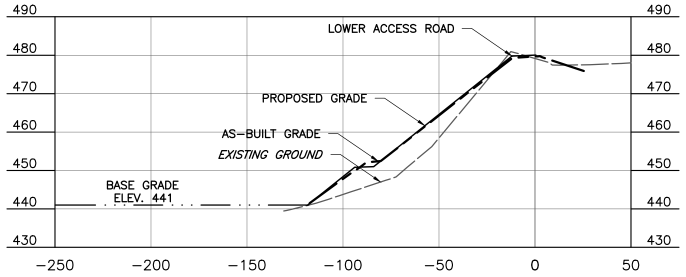

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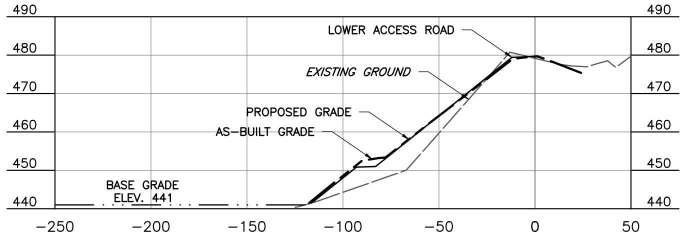

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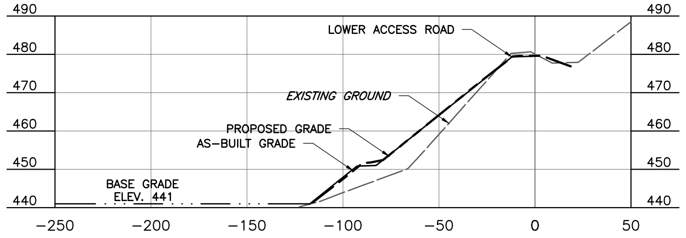

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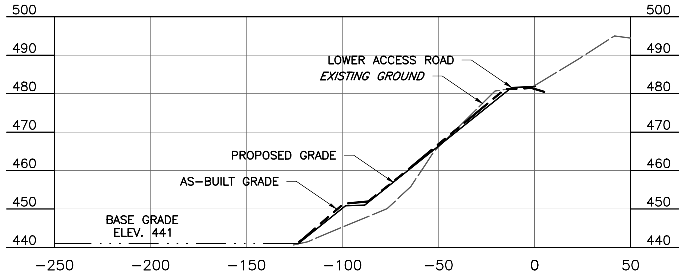

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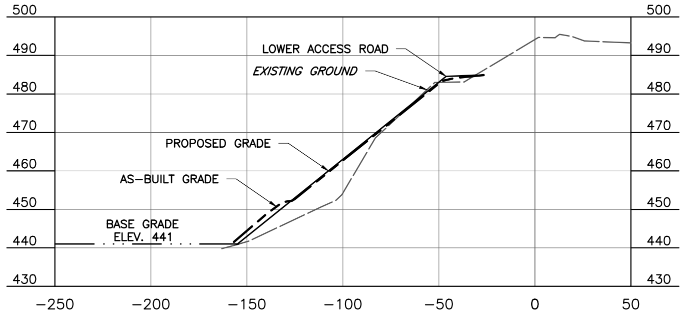

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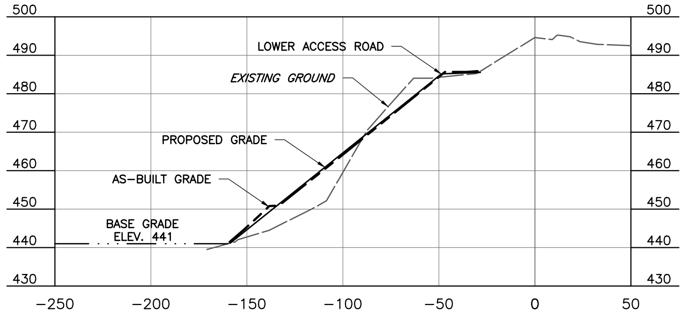

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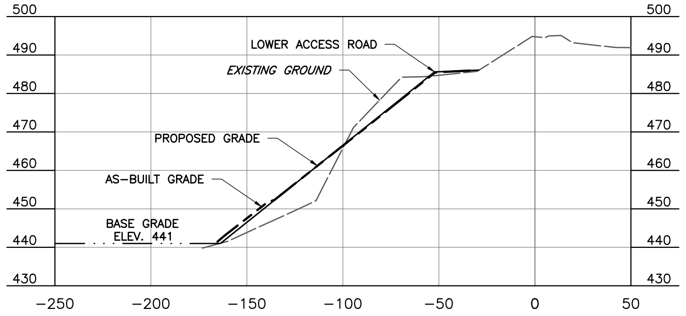

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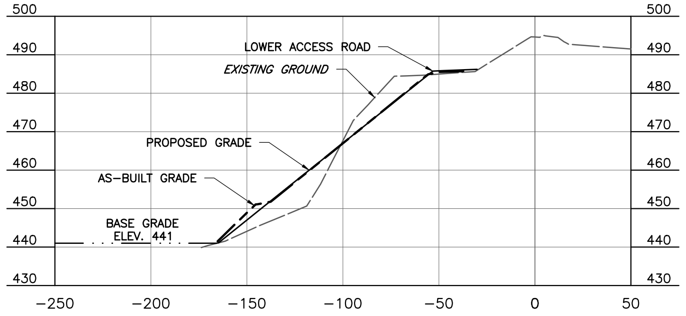

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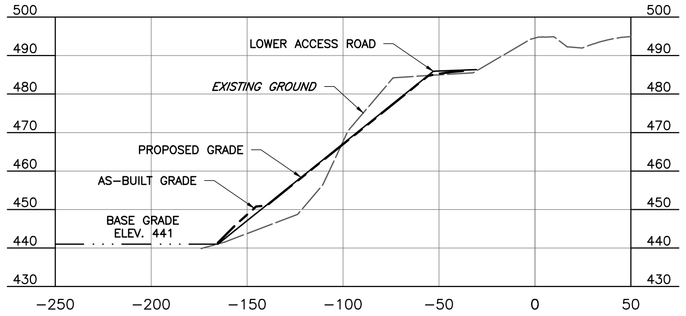

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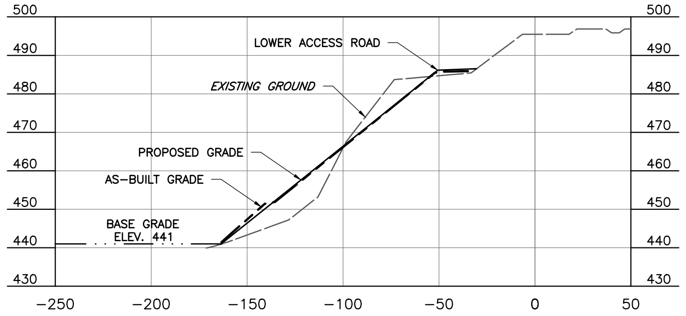

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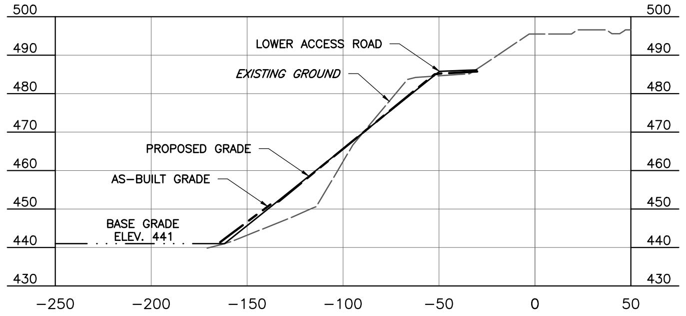

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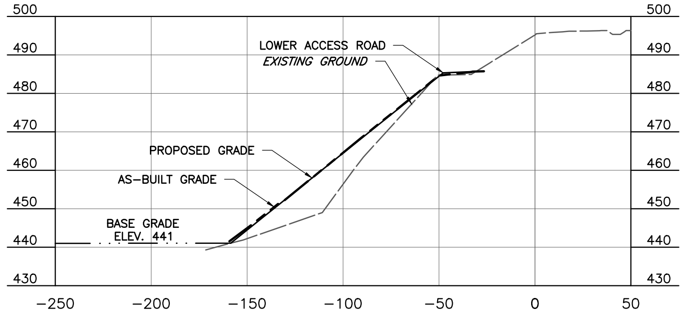

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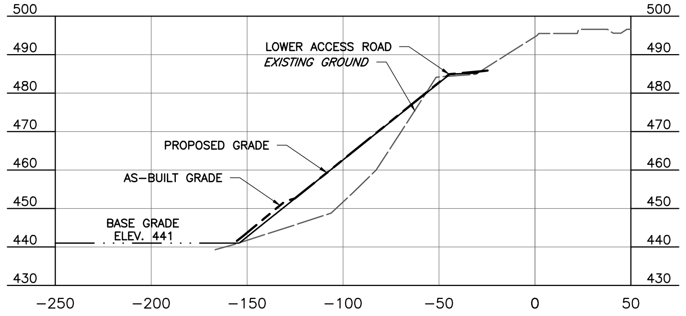

STA 15+00

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
△		
△		
△		
△		

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

AS-BUILT CONSTRUCTION PLANS

HORIZONTAL
SCALE IN FEET
0 50 100

VERTICAL
SCALE IN FEET
0 25 50

* HAND SIGNATURE ON FILE

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DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

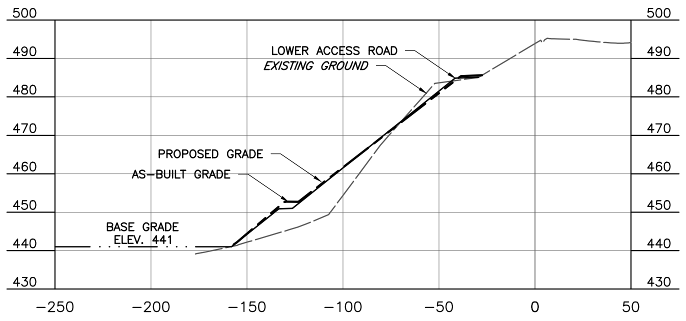
DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED SECTIONS
STA 1+00 TO 15+00

DRAWING NO.:
7

SHEET 7 OF 9

p:\2013\132-650.0200\-CADD\Dwg\CV02\132650-CV02-C300-Proposed Grading Plan.dwg{CROSS SECTIONS (1)} LS:(2/17/2015 – dbronchik) – LP: 2/17/2015 10:43 AM



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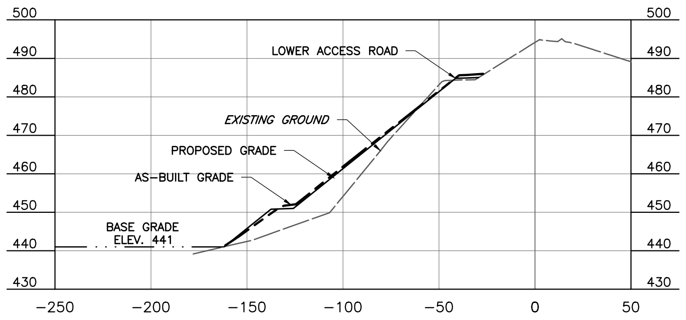

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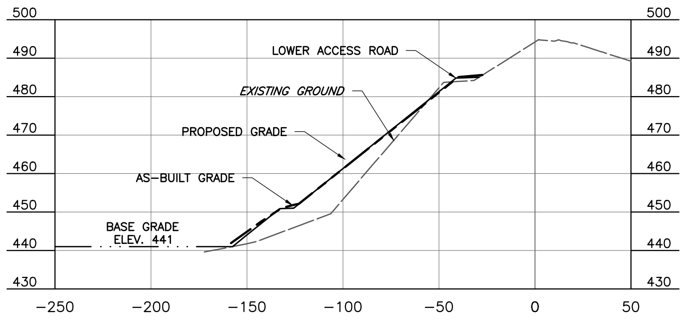

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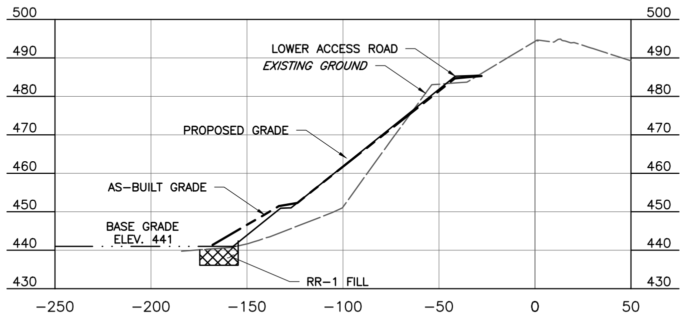

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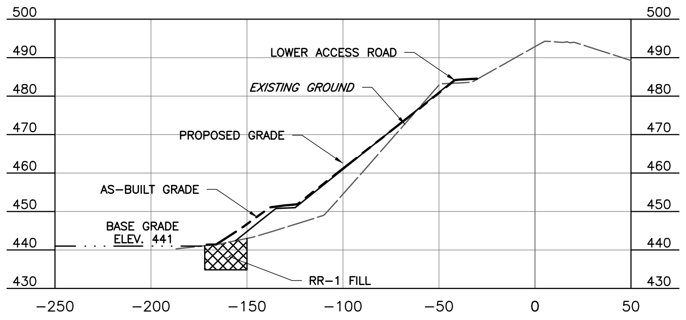

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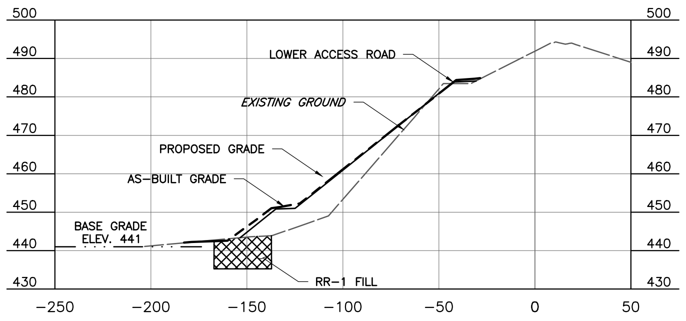

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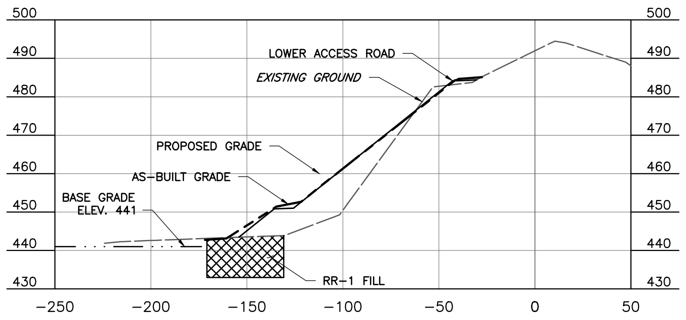

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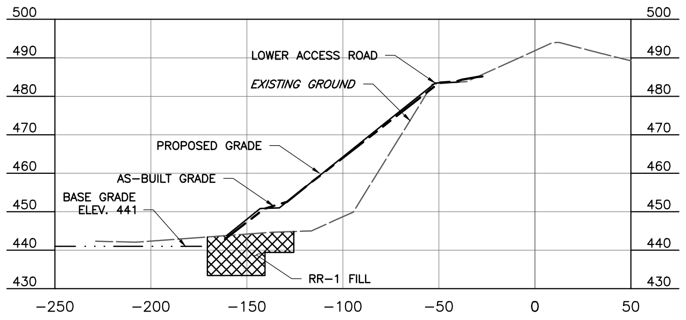

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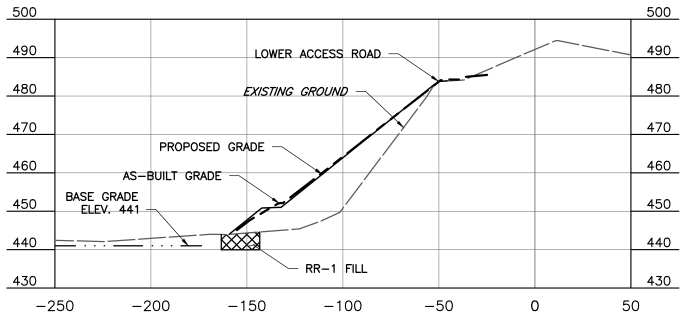


STA 23+50

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

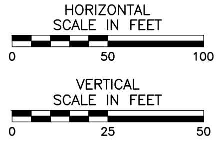
REVISION RECORD

NO	DATE	DESCRIPTION
△		
△		
△		
△		

REFERENCE:

1. TOPOGRAPHIC INFORMATION BASED UPON AERIAL SURVEY CONDUCTED BY SURDEX CORPORATION FLOWN ON SEPTEMBER 10, 2008.
2. EMBANKMENT AREA SURVEY RECEIVED BY CEC FROM DLZ ON MARCH 4, 2013 AND JANUARY 10, 2014.
3. IL DNR PERMIT NO. DS2014017–DAM I.D. NO. 50663
4. AS–BUILT SURVEY RECEIVED BY CEC FROM DLZ, DECEMBER 12, 2014.

AS-BUILT CONSTRUCTION PLANS



* HAND SIGNATURE ON FILE

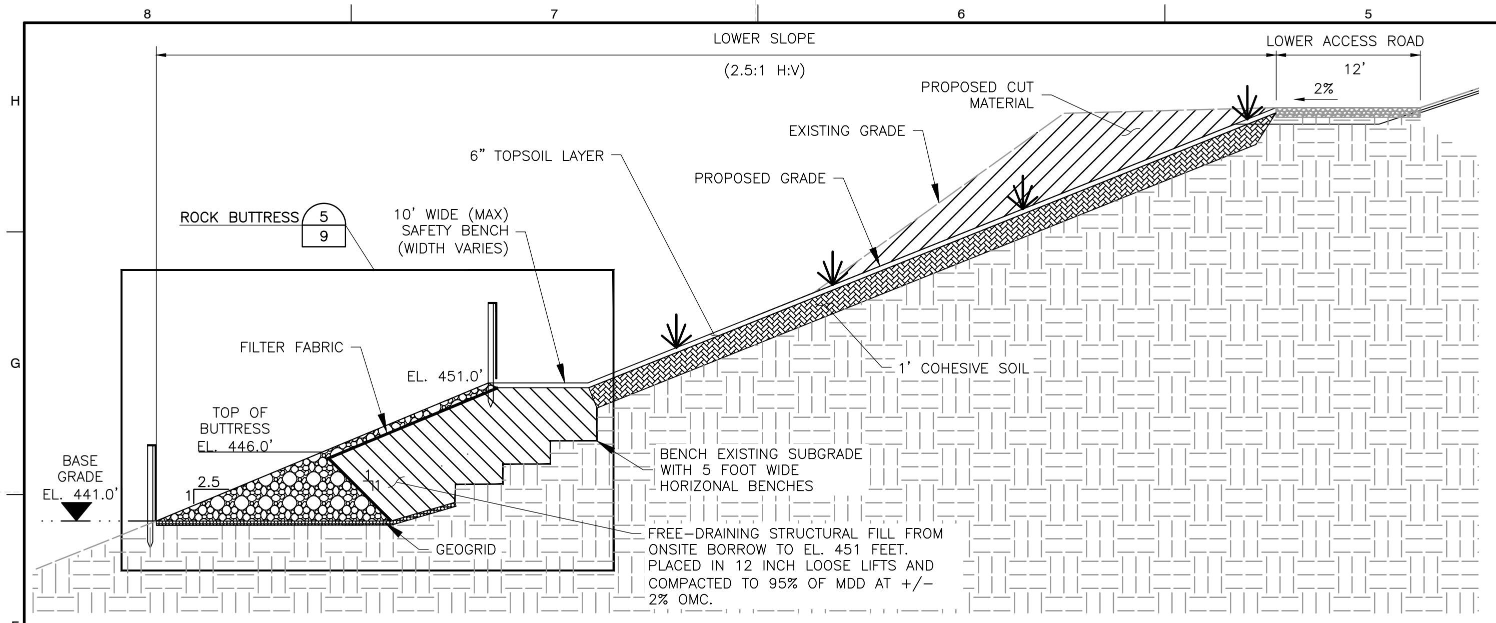
Civil & Environmental Consultants, Inc.
555 Butterfield Road, Suite 300 - Lombard, IL 60148
Ph: 630.963.6026 · 877.963.6026 · Fax: 630.963.6027
www.cecinc.com

DYNEGY MIDWEST GENERATION, INC.
HENNEPIN POWER STATION
EAST BERM MODIFICATION
HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

PROPOSED SECTIONS
STA 16+00 TO 23+50

DRAWING NO.: **8**
SHEET **8** OF **9**



DETAIL 2
TYPICAL BERM DETAIL

SCALE: NTS

LEGEND

- ▨ PROPOSED CUT MATERIAL
- ▧ PROPOSED STRUCTURAL FILL
- ▩ UNSUITABLES/RR1 FILL
- ● RIPRAP
- ▨ DRAINAGE LAYER
- ─── PROPOSED GRADELINE
- — — EXISTING GRADELINE
- —·· WATER SURFACE ELEVATION
- ↓ VEGETATION

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1	5/2013	IDNR DAM MODIFICATION PERMIT
2	6/9/2014	ISSUED FOR CONSTRUCTION
3	2/4/2015	AS-BUILT CONSTRUCTION DRAWINGS

REVISION RECORD

NO	DATE	DESCRIPTION
△		
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△		
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REFERENCE:

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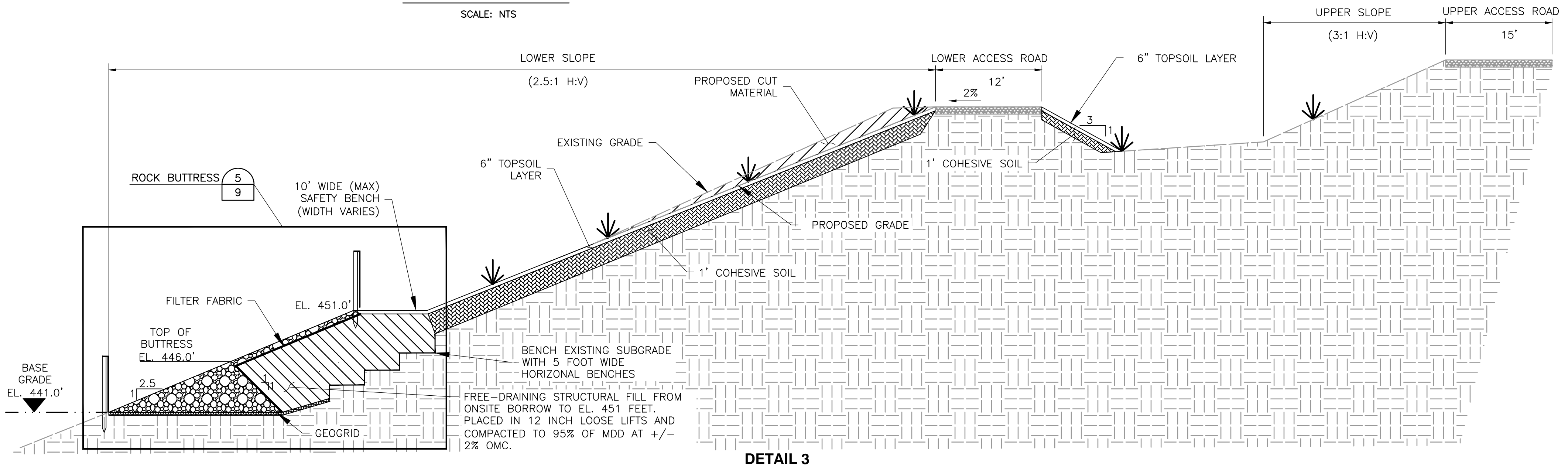
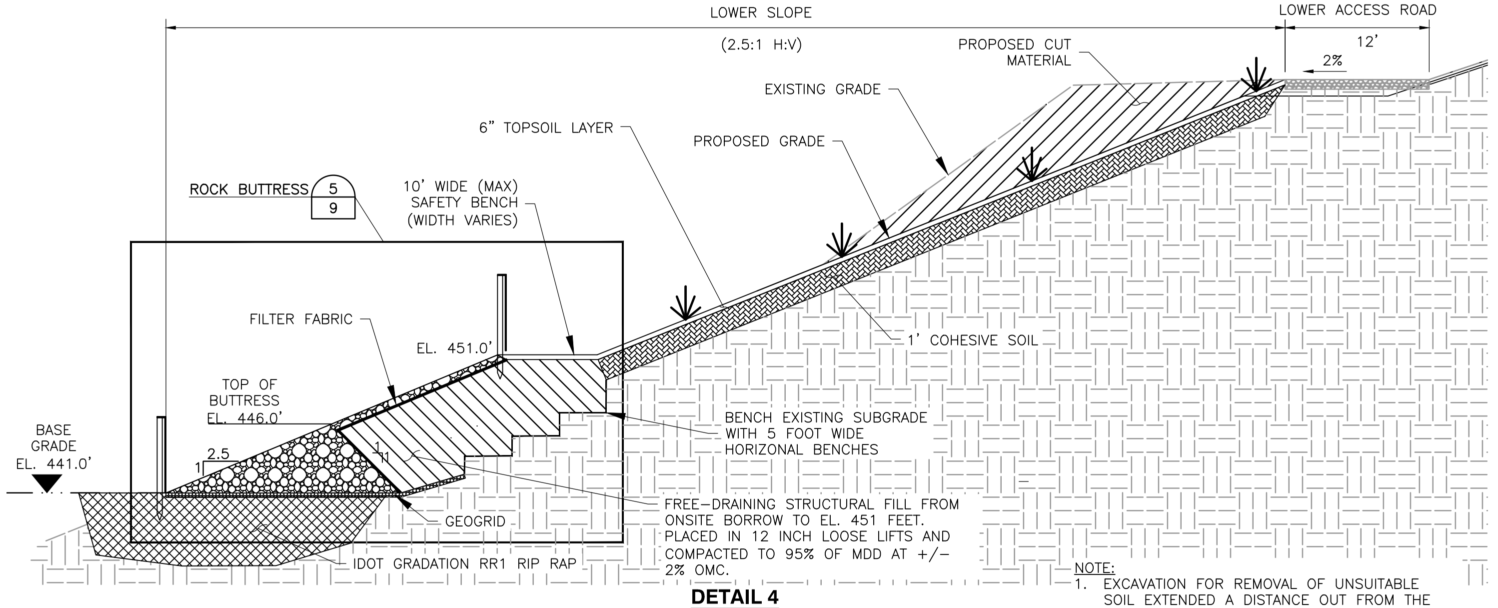


DETAIL 3
TYPICAL BERM DETAIL

SCALE: NTS

NOTE:

1. TEMPORARY SILT FENCE WAS INSTALLED PRIOR TO ROCK BUTTRESS INSTALLATION. UPON COMPLETION OF ROCK BUTTRESS. SILT FENCE WAS INSTALLED UP SLOPE OF ROCK BUTTRESS AND TEMPORARY SILT FENCE REMOVED.
2. AFTER PLACING TOPSOIL AND SEEDING, EROSION CONTROL BLANKETS WERE INSTALLED ON ALL SLOPES STEEPER THAN 3:1 FOR EROSION PROTECTION AND SEED ESTABLISHMENT. STRAW WATTLES WERE PLACED AT MID-HEIGHT OF BERM FOR ADDITIONAL EROSION PROTECTION.



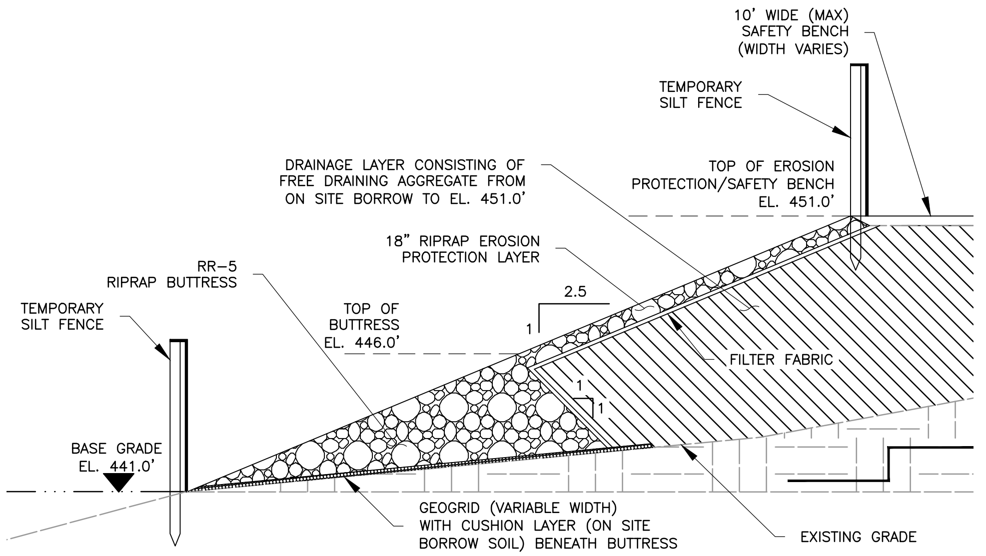
DETAIL 4
TYPICAL BERM WITH UNSUTABLE SOIL REMOVAL DETAIL

SCALE: NTS

NOTE:

1. EXCAVATION FOR REMOVAL OF UNSUITABLE SOIL EXTENDED A DISTANCE OUT FROM THE TOE OF BERM EQUAL TO THE DEPTH OF EXCAVATION.

AS-BUILT CONSTRUCTION PLANS



DETAIL 5
ROCK BUTRESS AND EROSION PROTECTION LAYER DETAIL

SCALE: NTS

* HAND SIGNATURE ON FILE

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HENNEPIN, ILLINOIS

DRAWN BY:	DFB	CHECKED BY:	MDJ	APPROVED BY:	*MDJ
DATE:	FEBRUARY 2015	DWG SCALE:	AS NOTED	PROJECT NO:	132-650

BERM AND EROSION CONTROL DETAILS

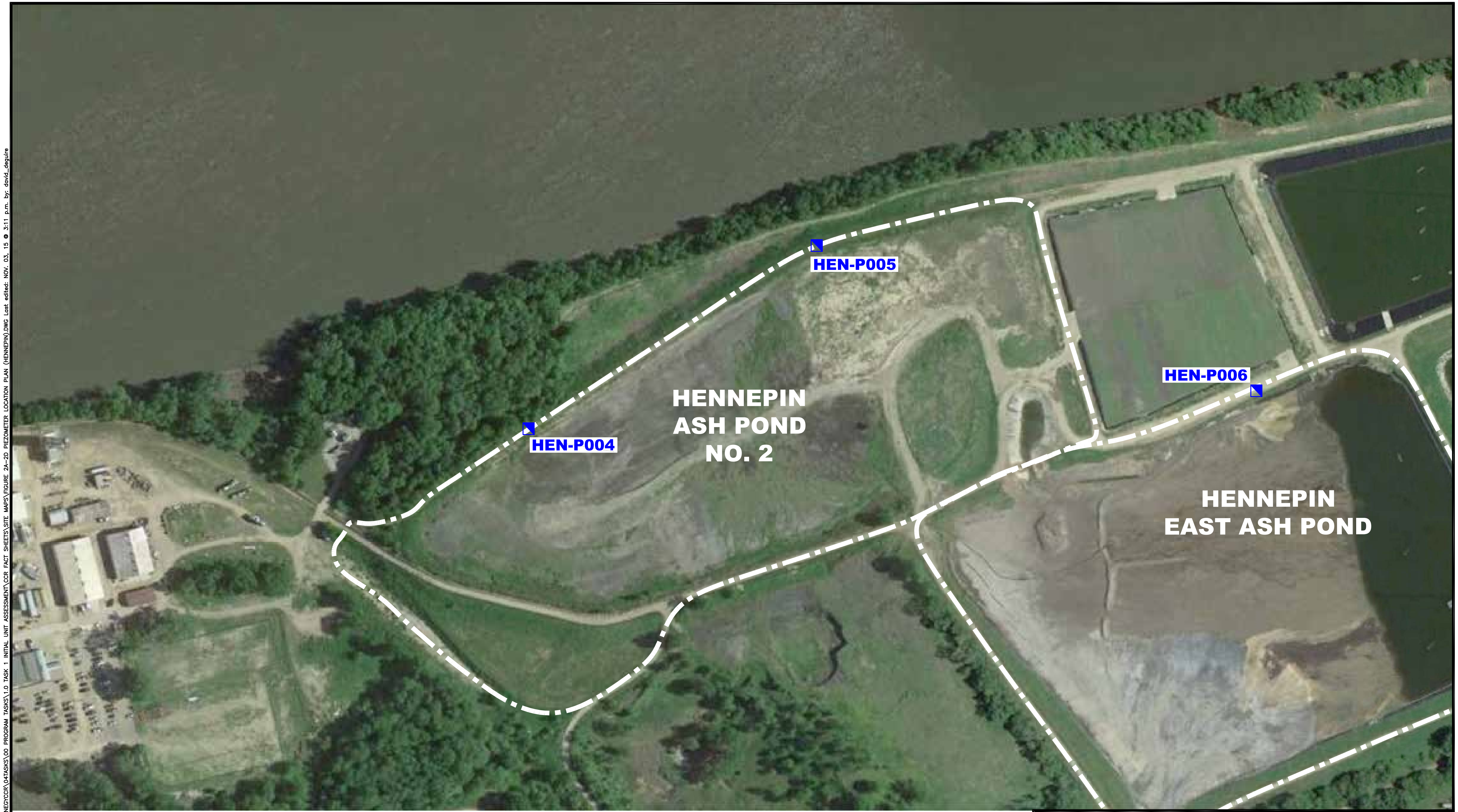
DRAWING NO.: 9

SHEET 9 OF 9

p:\2013\132-650.0200\-CADD\Dwg\CV02\132650-CV02-C900-Erosion Control Details.dwg{DETAILS 22X34} LS:(2/17/2015 - dbronchik) - LP: 2/17/2015 10:43 AM

Appendix C: Hennepin Power Station Piezometer Locations

File: P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire



◪ XXX-X###
EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)
ID NUMBER
STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

◪ PIEZOMETER LOCATION

▬ ▪ ▬ CCR UNIT BERM ALIGNMENT

0 200
APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC

PROJECT NO.
60439752

AECOM

DRN. BY: djd October 2015
DSGN. BY: eg
CHKD. BY: eg

Hennepin Ash Pond No. 2
Piezometer Locations

FIG. NO.
2A

▧ XXX–X###

EXPLORATION METHOD
(B=BORING, C=CPT,
P=PIEZOMETER)

ID NUMBER

STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

▧	PIEZOMETER LOCATION
▬ ▪ ▬	CCR UNIT BERM ALIGNMENT

0 200

APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC

PROJECT NO.
60439752

AECOM

DRN. BY:djd October 2015
DSGN. BY:eg
CHKD. BY:eg

Hennepin East Ash Pond
Piezometer Locations

FIG. NO.
2B

File: P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

◩ XXX–X###

EXPLORATION METHOD
(B=BORING, C=CPT,
P=PIEZOMETER)

ID NUMBER

STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

◩	PIEZOMETER LOCATION
▬ ▪ ▬	CCR UNIT BERM ALIGNMENT

0 200
APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC

PROJECT NO.
60439752

AECOM

DRN. BY: djd October 2015
DSGN. BY: eg
CHKD. BY: eg

Hennepin Old West Ash Pond
(Pond No. 1 and Pond No. 3)
Piezometer Locations

FIG. NO.
2C

File: P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

▨ XXX-X###
- EXPLORATION METHOD (B=BORING, C=CPT, P=PIEZOMETER)
- ID NUMBER
- STATION ABBREVIATION

SOURCE:
MAP PROVIDED BY GOOGLE EARTH PRO 2015

LEGEND

▨ PIEZOMETER LOCATION

— · — CCR UNIT BERM ALIGNMENT

0 100
APPROXIMATE SCALE FEET

DYNEGY MIDWEST GENERATION, LLC

PROJECT NO.
60439752

AECOM

DRN. BY: djd October 2015
DSGN. BY: eg
CHKD. BY: eg

Hennepin Old West Polishing Pond
Piezometer Locations

FIG. NO.
2D

File: P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\04TASKS\00 PROGRAM TASKS\1.0 TASK 1 INITIAL UNIT ASSESSMENT\CCR FACT SHEETS\SITE MAPS\FIGURE 2A-2D PIEZOMETER LOCATION PLAN (HENNEPIN).DWG Last edited: NOV. 03, 15 @ 3:11 p.m. by: david_deguire

Appendix D: Specification J-2616, Rev. A, Primary Ash Pond Modifications

3

Sargent & Lundy LLC

DYNEGY MIDWEST GENERATION
HENNEPIN POWER STATION

SPECIFICATION J-2616, REV. A
PERMIT APPLICATION

PRIMARY ASH POND MODIFICATIONS

Prepared By:
Sargent & Lundy, LLC
55 East Monroe Street
Chicago, Illinois 60603

PRIMARY ASH POND MODIFICATIONS

ISSUE SUMMARY

Rev.	Purpose of Issue	Date	Sections Affected
A	Spec No. J-2616 Released for Permit Application	02/14/03	All

CERTIFICATION OF SPECIFICATION

FOR

PRIMARY ASH POND MODIFICATION

I certify that this Specification was prepared by me or under my supervision and that I am a registered professional engineer under the laws of the State of Illinois.

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

Certified By: Ronald Cook　　Date: Feb 14, 2003

RONALD H. COOK
062-048602

EXP. 11-30-03

Seal

Revision: ______　Certified By: ______________　Date: __________

PRIMARY ASH POND MODIFICATIONS

TABLE OF CONTENTS

Notes:

(1) Where Division and/or Sections are not included, work under the unlisted headings is not part of the Work.

(2) This Table of Contents will indicate the date of issue for the latest complete issue or revision issue of each section and any subsequent revision issue thereto.

(3) The numbering and subsequent Revisions to the Specification are in sequence with the previously issued Revision mark number.

FABRIC FORMED CONCRETE MATS

ISSUE SUMMARY

Rev.	Purpose of Issue	Date	Sections Affected	Prepared By	Reviewed By	Approved By
A	Permit Application	02/14/03	ALL	Ronald Cook	Daniel C. Kovich	Ronald Cook

FABRIC FORMED CONCRETE MATS

TABLE OF CONTENTS

Notes:

(1) This Table of Contents will indicate the date of issue for the latest complete issue or revision issue of each section and any subsequent revision issue thereto.

(2) The numbering and subsequent Revisions to the Specification are in sequence with the previously issued Revision mark number.

Fabric Formed Concrete Mats - Technical Specification and Optional Features/Accessories

1.0
Scope of Work

The intent of this specification is to define the material and installation requirements for fabric formed concrete mats installed in accordance with the Design Drawings, technical data and as specified herein.

1.1
Work Included

The work shall include, but not be limited to, the following items as indicated:

A. Preparation and grading of surfaces to receive fabric mats.

B. Placing fabric mats and filling them with a pumpable sand/cement slurry to form a stable erosion protection system.

C. Offsite disposal of excess or unsuitable materials and debris.

2.0
Codes and Standards

A. 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.

B. 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.

C. Abbreviations listed indicate the form used to identify the reference documents in the specification text.

2.1
ASTM – American Society for Testing and Materials

A. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.

B. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

C. ASTM C 143 – Standard Test Method for Slump of Hydraulic Cement Concrete.

D. ASTM C 172 – Standard Practice for Sampling Freshly Mixed Concrete.

E. ASTM C 173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

F. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

G. ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Portland-Cement Concrete.

H. ASTM D 543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.

I. ASTM D 751 – Standard Test Methods for Coated Fabrics.

J. ASTM D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

K. ASTM D1777 – Standard Test Method for Thickness of Textile Materials.

L. ASTM D2101 – Standard Test Method for Tensile Properties of Single Man-Made Textile Fibers Taken From Yarns and Tows.

M. ASTM D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.

N. ASTM D3786 – Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics (Mullen Burst).

O. ASTM D3787 – Standard Test Method for Bursting Strength of Knitted Goods: Constant-Rate-of Traverse (CRT) Ball Burst Test.

P. ASTM D3885 – Standard Test Method for Abrasion Resistance of Textile Fabrics.

Q. ASTM D4355 – Standard Test Methods for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.

R. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

S. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

T. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

U. ASTM D5034 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

V. ASTM D5035 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method).

3.0
Supplier's Drawings and Data Submittals

A. Supplier shall submit drawings and data as specified. Supplier's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Buyer's information systems specified by the Buyer.

3.1
Submittals Prior to Installation

The Supplier shall submit the following items at least 30 days prior to scheduled delivery of materials:

A. Manufacturer's literature providing specifications on the fabric mats that will be supplied.

B. Manufacturer's certification that the fabric mats to be supplied comply with the requirements of this Technical Specification.

C. Manufacturer's Quality Control and Construction Quality Control Plans. The MQC Plan shall state the frequency that index tests are performed on the fabric mat during manufacturing.

D. If requested by the Buyer, four samples of each fabric mat suitable for testing.

E. Required concrete grout slurry mix design, including requirements for compressive strength, slump, air content and maximum temperature.

3.2
Submittals During and After Installation

The Supplier shall submit the following items on a daily basis during installation and a complete set of data within 30 days of the completion of the work:

A. Results of tests performed on the concrete grout fill.

4.0
Construction Quality Assurance

A. The Supplier shall examine the areas and conditions under which the work is to be installed and notify Buyer in writing of conditions detrimental to the proper and timely completion of the work that have changed from the time of the bidder's walkdown.

B. Material and installation procedures are subject to inspection and tests conducted by an Independent Testing Service employed by the Buyer. Such inspections and tests will not relieve the Supplier of responsibility for providing material and installation procedures in compliance with specified requirements. The Buyer reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

C. The Supplier shall correct deficiencies in the work which inspections and laboratory test reports have indicated to be not in compliance with requirements. The Supplier 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.

D. The Supplier shall promptly correct errors or flaws in material or placement of the protection mats identified during construction. The Supplier shall make immediate substitution of non-complying component or make field changes to make the non-complying component acceptable. Whether the correction is made by substitution or field correction, it shall be performed without cost to the Buyer.

4.1
Testing

4.1.1
Independent Testing Service

An Independent Testing Service shall perform the following:

A. Test material for the concrete slurry fill and prepare initial test cylinders in accordance with the requirements specified herein.

B. Prepare test cylinders and determine the compressive strength of job concrete fill test cylinders.

4.1.2
Concrete Grout Testing

A. Obtaining and testing concrete grout shall be by the Independent Testing Service in accordance with the following specifications:

- Sampling freshly mixed grout shall be done in accordance with ASTM C172.
- Making and curing concrete test specimens shall be in accordance with ASTM C31.
- Slump test shall be in accordance with ASTM C143.
- Air Content tests shall be in accordance with ASTM C173 or ASTM C231.
- Tests for the temperature of the freshly mixed grout shall be in accordance with ASTM C1064.
- Compressive strength test shall be in accordance with ASTM C39.

B. The frequency of testing shall be as directed by Buyer as follows:

- At least one test shall be made for each day's placement of grout, but not less than once for each 100 cubic yards or part thereof placed.
- A test shall consist of a minimum of four cylinders taken from the same truck. One 7-day and two 28-day tests shall be performed by the laboratory with results submitted to the Buyer as soon as possible. One spare cylinder shall be made and used as directed by the Buyer.
- A slump test and air content test shall be performed on every 100 cubic yards of concrete grout.
- The temperature of each 100 cubic yards shall be recorded in the field prior to placement. If the concrete grout temperature is in excess of 100°F, the concrete shall be rejected.

5.0
Materials

5.1
Fabric Design

A. Fabric-forming material shall consist of double-layer, open-selvage fabric joined in a mat configuration. The fabric shall be woven of 100% continuous multi-filament nylon fiber of which 50% by weight shall be bulk textured fiber. The use of staple yarns will not be permitted.

B. The fabric shall be woven in such a manner as to provide interwoven points of attachment on spaced centers. These points of attachment shall serve to control the thickness of the finished product and to also act as a filter point to provide relief of hydrostatic uplift pressure beneath the completed revetment. The fabric shall be woven in a basket or other open pattern to provide permeability at the filter points and the main fabric field.

C. The spacing of the filter points is indicated on the Design Drawings. This spacing will result in an average revetment thickness that is consistent with the average thickness published by the manufacturer for the designated style specified.

5.2
Fiber and Fabric Material

A. The warp fiber shall be 1260 Denier Nylon, 18.5 ends/inch per single layer and the fill fiber shall be 1900 Denier Nylon, 14 picks/inch per single layer. The fiber and fabric material shall meet the minimum requirements listed in Table 1.

TABLE 1
MATERIAL PROPERTIES

PROPERTY	ASTM TEST METHOD	MINIMUM TEST VALUE
Fiber count	-	0.164 g/m
Trapezoidal tear breaking force on the warp fiber at 70% elongation	D 4533	80 lbs/in
Trapezoidal tear breaking force on the fill fiber at 70% elongation	D 4533	40 lbs/in
Density	D 792	1.00 g/cm^3
Fiber dry breaking strength at 48% elongation	D 2101	20 lbs
Fiber wet breaking strength at 53% elongation (soaked in water for 2 hours)	D 2101	19 lbs
Tensile strength in the warp direction after exposure to 300 hours of Ca (OH) at a pH of 10	D 543	180 lbs/in
Tensile strength in the warp direction after exposure to 300 hours of H_2SO_4	D 543	170 lbs/in
Tensile breaking strength in the warp direction on a strip of the fabric at 39% elongation (1)	D 5034, D 5035	160 lbs/in
Tensile breaking strength in the fill direction on a strip of the fabric at 34% elongation (1)	D 5034, D 5035	190 lbs/in
Mass/unit area for a single layer of fabric	D 3776	7.8 oz/sq yd
Thickness of a single layer of fabric	D 1777	31 mils
Falling head permittivity of two layers of fabric woven together	D 4491	0.28 s^{-1} 0.04 cm/s (3)
Falling head permittivity of a single layer of fabric	D 4491	1.3 s^{-1} 0.12 cm/s
Seam strength (2)	D 751	35 lbs/in
Abrasion resistance in the warp direction	D 3885	160 lbs/in
Grab strength in the warp direction at 31% elongation	D 4632	350 lbs
Grab strength in the fill direction at 41% elongation	D 4632	275 lbs
Breaking strength in the warp direction after exposure to 500 hours of UV light	D 4355	190 lbs/in
Mullen burst test	D 3786	750 psi
Puncture test	D 3787	80 lbs

Notes for Table 1:

(1) 3" x 8" sample gripped along full width of the specimen with 3" of separation between grips. Strip test to be performed on single layer of fabric at cross-head speed of 5 inches per minute.

(2) Seam centered between grips 3" apart and gripped the full width of the specimen.

(3) Applies to Filter Points only

5.3
Fabric Assembly

A. Adjacent fabric panels shall be connected by sewing or by means of zipper.

B. The two top layers of fabric and the two bottom layers of fabric shall be joined separately permitting full mat thickness between the two parallel seams. A single seam in which all four layers of the fabric are joined at one point will not be permitted.

C. If required, grout stops may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of the concrete fill. Grout stops shall be so designed as to produce full mat thickness along the full length of the grout stop.

5.4
Concrete Grout

A. The concrete grout shall consist of a mixture of Portland cement, fine aggregate and water so proportioned and mixed as to provide a readily pumpable slurry.

B. Admixtures and/or a pozzolan may be used with the approval of the Buyer. The use of superplasticizers and/or silica fume require special precautions and the approval of the Buyer.

C. The hardened concrete shall exhibit a minimum compressive strength of 2,500 psi at 28 days when specimens are made and tested in accordance with the provisions of ASTM C 31 and ASTM C 39.

5.5
Acceptable Materials

The following companies manufacture products that meet the requirements of the specification:

A. Fabriform Filter Point Fabric as manufactured by Construction Techniques, Inc., Cleveland, Ohio, 440-572-8300.

B. Other approved by Buyer.

6.0
Execution

6.1
Acceptance and Storage at the Project Site

6.1.1
Handling of Rolls

A. The method of off-loading the fabric at the project site shall not cause any damage to the fabric, its core, nor its protective covering.

B. Any protective covering that is accidentally damaged or stripped off of a pallet or roll shall be immediately repaired or the pallet or roll shall be moved to an enclosed facility until the repair can be made.

6.1.2

Storage at the Field Site

A. The Buyer shall provide on-site storage space in a location near where the fabric will be placed such that on-site transportation and handling are minimized. The Supplier shall be responsible for protecting the stored material from theft and vandalism.

B. Rolls or pallets of fabric shall be stored in such a manner that cores are not crushed, the fabric damaged, and as required to provide protection from exposure to ultraviolet light, inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious condition.

C. Outdoor storage of rolls or pallets shall not exceed the manufacturer's recommendations or longer than six months, whichever is less.

6.2

Inspection upon Delivery

A. Upon delivery of the materials to the site, the Supplier shall conduct a visual inspection of all rolls of fabric 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 Buyer, the manufacturer and the carrier that transported the material. Any roll, or portion thereof, which, in the judgement of the Buyer, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Buyer.

6.3

Fabric Placement

A. Prior to concrete injection, the fabric shall be positioned over a geotextile on the grade as indicated on the Design Drawings making appropriate allowances for contraction of the fabric mats as a result of injecting the concrete grout.

B. Anchoring of fabric shall be as shown on the Design Drawings.

C. Fabric panels may be factory assembled in predetermined sizes and joined together side-by-side at the project site by field sewing or by means of zipper closures attached to the upper and lower layers of the fabric. In no case will simple unattached butt joints between panels be allowed. Overlapping shall be allowed only if approved by the Buyer.

6.4

Concrete Injection

A. Following placement of the fabric mats the specified concrete grout shall be injected between the top and bottom layers of the fabric through small slits cut in the upper layer of the fabric. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap, or similar material, during pumping to seal the joint between the injection pipe and the slit. After pumping, the burlap shall be pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of the concrete slurry onto the surface of the revetment.

B. The sequence of concrete slurry injection shall be such as to insure complete filling of the revetment-forming fabric to average thickness indicated by the manufacturer for the designated style specified on the Design Drawings.

C. Foot traffic will not be permitted on the freshly pumped mat since such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary.

D. Excess concrete slurry which has been inadvertently spilled on the mat surface shall be cleaned up with a broom and shovel. The use of a water hose to remove spillage from the surface of a freshly pumped mat will not be permitted.

E. During concrete slurry injection, the mat thickness shall be measured by inserting a short piece of stiff wire through the crowns of the mats midway between the filter points at several locations from the crest to the toe of the slope. Any mat measurements less than 90% of the average of all thickness measurements shall be re-injected until the average thickness indicated for the style specified has been attained.

TEMPORARY AND PERMANENT SEEDING (ILLINOIS)

ISSUE SUMMARY

Rev.	Purpose of Issue	Date	Sections Affected	Prepared By	Reviewed By	Approved By
A	Permit Application	02/14/03	ALL	Ronald Cook	Daniel C [illegible]	Ronald Cook

TEMPORARY AND PERMANENT SEEDING (ILLINOIS)

TABLE OF CONTENTS

Notes:

(1) This Table of Contents will indicate the date of issue for the latest complete issue or revision issue of each section and any subsequent revision issue thereto.

(2) The numbering and subsequent Revisions to the Specification are in sequence with the previously issued Revision mark number.

Temporary and Permanent Seeding (Illinois) – Technical Specification and Optional Features/Accessories

1.0
Scope of Work

The intent of this specification is to define the minimum requirements for material and work for establishing a vegetative cover by planting grass seed.

1.1
Purpose and Use

A. All graded areas, slopes, and ditches which will not be paved or otherwise surfaced shall be provided with permanent seeding.

B. Graded areas subject to erosion shall not remain unprotected for longer than 30 days. Temporary seeding shall be provided by the Supplier to protect graded areas from erosion where permanent protection is not scheduled to be installed for 2 to 12 months after grading is completed.

1.2
Method of Seed and Mulch Application

Seed may be spread by a conventional method of application such as broadcasting, grass drill, or cultipacker followed by an application of mulch or by a hydro seeding procedure consisting of spraying a slurry mixture of water, seed, mulch, fertilizer, and tackifier onto the prepared seedbed.

1.3
Work Included

A. Furnish all materials.

B. Subgrade preparation.

C. Seedbed preparation, including placing topsoil and the addition of lime and fertilizer.

D. Seeding using broadcast, grass drill, or the cultipacker method and mulching, or hydro seeding with a mixture that contains seed, mulch and a tackifier.

E. Installation of matting where specified for erosion control.

F. Protection.

G. Maintenance.

H. Repairing and reseeding.

2.0
Codes and Standards

A. 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.

B. 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.

C. Abbreviations listed indicate the form used to identify the reference documents in the Specification text.

2.1
USDA - United States Department of Agriculture, Soil Conservation Service

A. USDA-SCS Soil Classification. Supplement to Soil Classification System (7th Approximation), SCS, USDA, Second Printing, March 1967.

2.2
ASTM - American Society for Testing and Materials

A. C602 - Specification for Agricultural Liming Materials.

B. D977 - Specification for Emulsified Asphalt.

C. D2026 - Specification for Cutback Asphalt (Slow-Curing Type).

D. D2027 - Specification for Cutback Asphalt (Medium-Curing Type).

E. D2028 - Specification for Cutback Asphalt (Rapid-Curing Type).

F. D2397 - Specification for Cationic Emulsified Asphalt.

G. D5268 - Specification for Topsoil Used for Landscaping Purposes.

3.0
Supplier's Drawings and Data Submittals

Supplier shall submit drawings and data not less than 30 days before material is to be delivered. Supplier's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Buyer's information systems specified by the Buyer.

3.1
Topsoil

A. Topsoil Material:
- A copy of laboratory reports on two representative samples of topsoil. Laboratory tests shall be performed for:
- Percent deleterious material.
- Total organic content.

- Silt and clay contents.
- Sand content.
- pH.

B. If it is anticipated that topsoil stripped from either the present site or the borrow area will be used for permanent seeding, if requested by the Buyer, the Supplier shall provide two 50-pound samples to the Buyer's Testing Service for analyses.

3.2
Seed

A. A certified copy of a statement signed by the seed supplier that each lot of seed has been tested by a recognized seed-testing laboratory within six months before the date of delivery to the plant site.

B. A certified statement signed by the seed supplier that the maximum percentage of noxious weeds in the seed mixture complies with state law.

3.3
Data on Materials as Applied

As applied data on the following items:

A. Seed mixture and seed application rate.

B. Limestone application rate.

C. Fertilizer type, trademark name (if any), chemical composition, and application rate.

D. Mulch.

E. Tackifier.

3.4
Binder Spray

Data on the binder spray (tackifier) to be used on straw mulch or with hydro seeding. If a synthetic binder (tackifier) will be used, the Supplier shall provide a complete set of Manufacturer's specifications at least 30 days prior to anticipated use. Manufacturer's specifications shall contain a description of the binder material, the recommended method of application, and the recommended application rate.

3.5
Matting

Catalog data on the proposed erosion control matting and Manufacturer's literature on the recommended method of installation.

3.6
Samples

If requested by the Buyer, submit a sample of each material designated by the Buyer for laboratory testing.

4.0
Products

4.1
Topsoil

A. Topsoil shall consist of sandy clay loam, sandy loam, loam, clay loam, silty clay loam or silt loam as defined by the SCS Soil Classification System.

B. Topsoil shall be relatively free from large roots, sticks, weeds, brush or stones larger than 1 inch in diameter or other litter and waste products. It shall have at least 90 percent passing the No. 10 sieve.

C. The topsoil shall meet requirements of ASTM D5268 as follows:

- It shall contain not less than 2 percent nor more than 20 percent total organic matter.
- It shall contain not less than 35 percent nor more than 70 percent silt and clay.
- It shall contain not less than 20 percent nor more than 60 percent sand.
- The pH of the sample shall not be lower than 5.0 nor higher than 7.5.
- The percent deleterious material (rock, gravel, slag, cinder, roots, sod) shall not exceed 5 percent.

4.2
Seed

4.2.1
General Requirements

A. Grasses, legumes, or cover crop seed of the type specified herein shall conform to the standards of the United States Department of Agriculture for seed certification.

B. Seed or seeding mixtures shall be furnished in sealed bags or containers in accordance with standard commercial practice.

C. Each bag or container shall be tagged or labeled in accordance with state law. As a minimum, the tag or label shall provide the following information:

- Name and address of the supplier.
- Common name of seed.
- Lot number.
- Net weight.
- Guaranteed percentage of germination.
- Percentage of weed seed and inert material content.

D. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

E. All seed furnished shall be free of primary noxious weed seed such as Russian or Canadian Thistle, European Birdweed, Johnson Grass and Leafy Spurge. The maximum allowable percentage of noxious weed seed in the seed mixture shall comply with state law.

4.2.2
Seed Storage

If it is necessary to store seeds after their arrival on the site, they shall be stored in an approved weatherproof building in such a manner as to protect the seeds from deterioration and to permit easy access for inspection. The Buyer's approval for the storage building and the method of storage shall not relieve the Supplier of responsibility for the quality and fitness of the seeds at the time of their use.

4.2.3
Seed Mixture

A. Seed species, rate per acre, and other data relevant to permanent seeding are given in Table 1.

B. Seed species, rate per acre, and other data relevant to temporary seeding are given in Table 2.

TABLE 1
ACCEPTABLE MIXTURES FOR PERMANENT SEEDING

Mixture	Seed Species (1)	Seeding Rate, Pure Live Seed for Conventional Seed Application (2)		Suitable pH	Site Suitability			Acceptable Dates for Seeding
		Lbs. per acre	Lbs. per 1,000 sq. ft.		Sunny, Dry	Well Drained	Wet	
1	Smooth Bromegrass or Tall Fescue	30	0.75	6.0-7.5	X	X	X	4-1 to 6-1 8-1 to 9-1
	Alfalfa or Birdsfoot Trefoil	10	0.25					
2	Smooth Bromegrass or Tall Fescue	30	0.75	6.0-8.0	X	X		4-1 to 6-1 8-1 to 9-1
	Crown Vetch	20	0.50					
3	Tall Fescue	15	0.35	5.5-7.5		X	X	4-1 to 6-1 8-1 to 9-1
	Timothy or Redtop	3	0.07					
	Birdsfoot Trefoil	15	0.35					
4	Reed Canary Grass	15	0.35	5.5-7.5	X	X		4-1 to 6-1 8-1 to 9-1
	Smooth Bromegrass or Tall Fescue	15	0.35					
	Ladino (optional)	3	0.07					

Notes: (1) Mixtures as defined by SCS for Illinois.

(2) Triple the seeding rate shown in the table when hydro seeding.

TABLE 2
ACCEPTABLE MIXTURES FOR TEMPORARY SEEDING

MIXTURE	SEED SPECIES	MAXIMUM WEED SEED (percentage)	SEEDING RATE PER ACRE	SUITABLE pH	PLANTING DEPTH	ACCEPTABLE DATES FOR SEEDING
1	Wheat	0.50	150 lbs	5.5 to 7.0	1" to 1 ½"	3-1 to 5-15 7-1 to 10-15
2	Cereal Rye	0.50	150 lbs	5.5 to7.0	1" to 1 ½"	3-1 to 5-15 7-1 to 10-15
3	Spring Oats	0.50	100 lbs	5.5 to 7.0	1"	3-1 to 7-1
4	Perennial Ryegrass	0.50	40 lbs	5.0 to 7.5	1/4"	4-1 to 6-1 8-1 to 9-15

4.3

Lime (Agricultural Ground Limestone)

Agricultural lime shall be flour grade meeting the requirements of ASTM C602.

4.4

Fertilizer

A. Fertilizer shall be a standard brand commercial grade of inorganic fertilizer furnished in unopened containers. The material may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid and water-soluble potash in the amounts specified. If materials are separate, the Buyer shall be present when the separate fertilizers are mixed in the field. The fertilizer shall be odor free.

B. Fertilizer shall be supplied in one of the following forms:

- A dry free-flowing granular fertilizer suitable for application by an agricultural fertilizer spreader.
- A soluble form that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

C. The following information shall be shown on the fertilizer container or on a tag attached thereto:

- Name and address of manufacturer.
- Name, brand or trademark.
- Number of net pounds of ready-mixed material in the package.
- Chemical composition or analysis.
- Guarantee of analysis.

4.5

Mulch

4.5.1

Straw Mulch

A. Straw shall be stalks of small grain straw of wheat, rye, oats, barley or other approved grain. Straw shall be air dried and free of grain and noxious weed seed, other materials detrimental to plant life, and mold.

B. Straw shall be seasoned before bailing or loading. Straw mulch shall be suitable for spreading with mulch blower equipment.

C. Old dry straw which breaks up in the crimping process instead of bending, or straw in such advanced stages of decomposition that it will smother or retard the normal growth of grass, is not acceptable.

4.5.2

Wood Cellulose Fiber Mulch

A. Wood cellulose fiber shall be partly digested wood fibers.

B. The material shall be dyed green.

C. The material shall not contain growth or organism inhibiting agents.

D. The material shall be air-dried with a minimum of 30 percent of the fibers 3.7 mm (0.145 inch) or longer.

4.5.3
Binder Sprays

A. Cutback Asphalt shall be in accordance with ASTM D2026 (Slow-Curing Type), ASTM D2027 (Medium-Curing Type) or ASTM D2028 (Rapid-Curing Type).

B. Emulsified Asphalt shall be in accordance with D977 (Emulsified Asphalt) or D2397 (Cationic Emulsified Asphalt).

4.6
Tackifier (Synthetic Binder)

A. Tackifier material shall be an acrylic copolymer or a polyvinyl acetate emulsion in a liquid form. The material may contain additives to enhance its ability to penetrate the soil.

B. The material shall be non-toxic, non-flammable, and biodegradable.

C. Approved Materials:

- Soil Seal Concentrate manufactured by Soil Seal Corp., 1111 W. Sixth St., Los Angeles, California 90017, telephone number 213-481-7185.
- Reinco Mulch Binder and Terra Tac manufactured by Rienco Mulch Binder Corp., 520 North Avenue, Plainfield, New Jersey 07060, telephone number 1-800-526-7687.
- Aerospray 70 Binder manufactured by American Cyanamid Company, Mobile, Alabama 36601, telephone number 205-476-5800.

4.7
Inoculant

A. The inoculant for treating legume seeds shall be a pure culture of nitrogen fixing bacteria prepared specifically for the species and shall not be used later than the date indicated on the container. A mixing medium, as recommended by the manufacturer, shall be used to bond the inoculant to the seed.

B. All legumes not pre-inoculated shall be inoculated within 12 hours of seeding. If the seed was pre-inoculated more than 60 days prior to seeding then it must be reinoculated.

4.8
Matting for Erosion Control

A. Matting for erosion control may be one of the following unless a specific matting is specified on the Design Drawings.

- Jute mat shall be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48 inches in width, plus or minus 1 inch and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus 5 percent, with approximately 78 warp ends per width of cloth and 41 weft ends per linear yard of cloth. The yarn shall be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than one-half its nominal diameter.

- Excelsior mat shall be wood excelsior, 48 inches in width plus or minus 1 inch and weighing 0.8 pounds per square yard plus or minus 10 percent. The excelsior material shall be covered with a netting to facilitate handling and to increase strength.
- Glass fiber matting of bonded textile glass fibers with an average fiber diameter of 8 to 12 microns, 2 to 4 inch strands of fiber bonded with phenol formaldehyde resin. Mat shall be roll type, water permeable, minimum thickness 1/4 inch, maximum thickness 1/2 inch, density not less than 3 pounds per cubic foot.

B. Staples for anchoring soil stabilizing materials shall be No. 11 gauge wire or heavier. Their length shall be 6 to 10 inches. Ten inch long staples shall be used on loose, unstable soils.

5.0
Execution

5.1
Site Preparation

A. Prior to seeding, install all erosion control facilities specified on the Design Drawings. These include: diversions, berms, sediment control traps, silt fences and straw bale dikes.

B. Grade areas as specified on the Design Drawings. Gullied and uneven areas shall be smoothed before starting seedbed preparation.

5.2
Limestone for pH Adjustment

A. The Supplier shall apply limestone as required to raise the pH of the subsoil. Apply a minimum of 4 tons of limestone per acre for clayey soils, 3 tons of limestone per acre for sandy loam, and 2 tons of limestone per acre for loamy sand or silty soils.

B. Thoroughly work the limestone into the subsoil to a depth of 2 to 3 inches with a harrow or disk. The limestone may be applied prior to or concurrently with the fertilizer described.

5.3
Fertilizer

A. The Supplier shall apply a 12-12-12 fertilizer to the subsoil at a rate of 300 pounds per acre.

B. Work the fertilizer into the soil to a depth of 2 to 3 inches with a harrow, disk, or rake. On slopes, operate the disk or rake across the slope.

C. If hydro seeding is used, the fertilizer may be added to the hydroseed mixture.

5.4
Tilling of Subsoil

Prior to placing the topsoil, scarify the subsoil to a depth of 3 inches immediately prior to spreading topsoil to ensure bonding of the topsoil and the subsoil. Repeat scarification in areas where equipment used for hauling and spreading topsoil has compacted the subsoil.

5.5

Placing Topsoil

Note: topsoil does not have to be placed for temporary seeding. Topsoil must be placed prior to permanent seeding.

A. Place topsoil during dry weather on a dry, unfrozen subgrade. Topsoil shall not be spread if it is frozen or muddy.

B. Remove large pieces of organic matter and foreign non-organic material from topsoil while spreading. There shall be no large roots, branches or trash of any kind in the topsoil.

C. Spread the topsoil to provide a compacted thickness of not less than 4 inches.

D. Compact the topsoil with a roller not exerting more than 100 pounds per square inch. The topsoil must be loose enough for water infiltration and root penetration. The soil surface on slopes shall be roughened to catch seeds if they are to be broadcast.

5.6

Seeding (Conventional Method)

A. Tables 1 and 2 list acceptable seed mixtures that may be used for seeding. The Supplier shall select a mixture from the appropriate table and plant within the dates shown in that table for that mixture.

B. Apply seed uniformly at the rate shown in the appropriate table with a rangeland grass drill or cultipacker type seeder, or broadcast seed uniformly. The seeding methods and equipment shall be submitted to the Buyer for approval prior to beginning work.

C. All seeders shall be calibrated and adjusted to sow seeds at the proper rate. Equipment shall be operated to ensure a complete and even coverage. Do not seed areas greater than that which can be mulched on the same day.

D. Do not sow immediately following a rain, where the ground is too dry, during windy periods, or otherwise when conditions are not proper for seeding.

E. No seeds shall be sown until the purity test has been completed for the seeds to be used and the tests show that the seed meets the noxious weed seed requirements.

F. Within 12 hours, all seeded areas shall be rolled at right angles to the runoff with a cultipacker or approved roller to compact the seedbed and place the seed in contact with the soil. The optimum depth for planting shall be 1/4 inch. Rolling is not required if the seeding equipment is equipped with a roller that achieves the desired compaction or a grass drill has been used. Note: For temporary seeding planted without topsoil, the optimum planting depth is shown in Table 2.

5.7

Mulching (Conventional Method)

5.7.1

Straw Mulching

A. All seeded areas shall be mulched with straw mulch within 24 hours after seeding. The mulch may be hand or machine applied. The mulch shall be uniformly applied in a loose enough condition to permit air to circulate, but compact enough to reduce erosion. About 25 percent of the solid surface should show through the mulch. If baled mulch material is used, care shall be taken that the material is in a loosened condition and contains no lumps or knots of compacted material.

B. Straw mulch shall be applied at the rate of 2 tons per acre, or 75 to 100 (two bales) pounds per 1,000 square feet.

C. Straw mulch shall be anchored immediately after placement to minimize loss by wind or water. Straw mulch shall be anchored using a mulch anchoring tool or by spraying with a liquid binder.

5.7.2
Anchoring Mulch Using a Mulch Anchoring Tool

A. The mulch anchoring tool shall be designed to punch and anchor the mulch into the top 2 to 3 inches of soil at 6 inch intervals. As an alternative, a smooth disk set in a straight position may be used.

B. On slopes flatter than 3 horizontal to 1 vertical, mulch anchoring shall cross the contour of the land (across slopes). On slopes steeper than 3 horizontal to 1 vertical, the mulch shall be anchored by tracking a bulldozer with 1-1/2 inch track cleats up and down slope making grooves running across the slope.

5.7.3
Anchoring Using a Sprayed Liquid Binder

A. A sprayed liquid binder may be used in lieu of crimping to anchor the mulch. The binder may be sprayed into the mulch as it leaves the blower pipe or it may be applied as an over spray. If over sprayed, the binder spray should be heavier at the edges where wind catches the mulch, in valleys and at crests of banks. Binder shall be applied uniformly over the remainder of the area. Caution shall be used when spraying binder near areas occupied by construction personnel.

B. Binder Spray shall be applied at the following rates:

- Cutback asphalt - Rapid curing (RC-70, RC-250, and RC-800) or medium curing (MC-250 or MC-800). Apply 5 gallons per 1,000 square feet or 218 gallons per acre.
- Emulsified asphalt - (SS-1, CSS-l, CMS-2, MS, RS-l, RS-2, CRS-l, and CRS-2). Apply 5 gallons per 1,000 square feet or 218 gallons per acre.
- Synthetic binders - Synthetic binders such as Acrylic Dir (Agri-Tac), DCA-70, Petroset or Terra Tack may be used at rates recommended by the manufacturer to anchor mulch material.

5.7.4
Repairing and Reseeding

A. Areas not mulched and anchored within 24 hours after seeding shall be reseeded and mulched.

B. Areas not properly mulched, or damaged due to construction activities, shall be repaired, reseeded, and remulched.

5.8
Hydro Seeding

A. Hydro seeding consists of spraying a slurry mixture of water, seed, fertilizer, mulch, and a tackifier on a prepared seed bed.

B. The slurry mixture shall be mixed and applied using a hydraulic seeder. Hydraulic seeding equipment shall include a pump rated and operated at not less than 100 gallons per minute and 100 psi pressure. The tank shall have a mechanical agitator powerful enough to keep the slurry mixture in a uniform suspension in water.

C. Hydrated lime **shall not** be added to the slurry mixture.

D. The slurry mixture shall contain a maximum of 55 percent solids (125 pounds of solids per 100 gallons of water).

E. The seed mixture shall be as specified in Table 1 or Table 2 except that the weight of seed in the slurry mixture shall be a minimum of three times the weight of pure live seed per acre specified in the appropriate table for conventional seed application.

F. The slurry mixture shall contain a minimum of 1500 pounds of wood cellulose fiber mulch per acre or 2000 pounds of straw mulch per acre.

G. The amount of tackifier provided per acre shall be in accordance with Manufacturer's recommendations.

H. The slurry-mixture shall contain a minimum of 1000 pounds of grade 12-12-12 fertilizer per acre or the equivalent weight of chemicals if another grade is used.

I. The soil surface shall be moist when the slurry mixture is applied.

5.9
Laying and Securing Matting

5.9.1
Laying and Securing Jute Matting

A. Prepare the seed bed as specified and lime, fertilize, and seed, except that when using jute matting, apply approximately one-half of the seed after laying the mat.

B. Most drainage channels will require multiple widths of jute matting. The total width shall be as specified on the Design Drawings. Unroll matting starting at the upper end of the channel allowing a 4 inch overlap of mattings along center of channel.

C. Bury the top ends of jute matting in a narrow trench. Backfill the trench and tamp firmly to conform to channel cross-section. Secure the matting with a row of staples about 4 inches down slope from the trench. Spacing between staples shall be a maximum of 6 inches.

D. Staple the 4 inch overlap in the center of the channel using an 18 inch spacing between staples. Before stapling the outer edges of the matting, make sure the matting is smooth and in firm contact with the soil. Staples shall be placed 2 feet apart along the outer edge of matting.

E. Where one roll of jute matting ends and another begins, the end of the top strip shall overlap the upper end of the lower strip by 4 inches, shiplap fashion.

F. Where matting crosses erosion stops, reinforce with a double row of staples placed six (6) inches apart in a staggered pattern on either side of erosion stop. Likewise, overlaps joining the length of matting together and the discharge end of the matting liner should be similarly secured with 2 double rows of staples.

5.9.2
Laying and Securing Excelsior Matting

A. Provide the same seedbed preparation as specified for jute matting with the exception that all seeding must be completed before laying excelsior matting.

B. Bury the top ends of excelsior matting in a trench as described for jute matting. As the blankets are unrolled down slope, the matting must be on top with the wood fibers in contact with the soils. Butt snugly at the ends and sides before stapling.

C. Using two (2) foot spacing between staples, excelsior matting shall be secured with four rows for each strip, with one row along each edge and alternating parallel rows down the center. The stapling over erosion stops, entrance and discharge ends of matting and butted end joints shall be the same as described for jute matting.

5.10
Construction Completed after Acceptable Seeding Dates

When construction is completed between October 15 and March 1 prepare the seedbed, fertilize and mulch as specified. Apply seed for permanent seed sometime between December 1 and March 1 increasing the seeding rates shown in Table 1 by 50 percent.

6.0
Protection

Planted areas shall be protected from damage and erosion. The Supplier shall provide and erect temporary barriers and signs as necessary to prevent vehicles, equipment and foot traffic from damaging seeded areas.

7.0
Maintenance

The Supplier shall perform the following maintenance tasks:

A. Keep seedbed continually moist with light, frequent sprinklings several times a day to prevent seedlings from drying out.

B. Inspect periodically after planting to see that vegetative stands are adequately established. Immediately reseed areas which show bare spots larger than 2 feet by 2 feet after germination.

C. Check for erosion damage after storm events and repair damage. Reseed and mulch, if necessary.

D. Fertilize newly permanent seeded areas one year after seeding with 300 pounds per acre of a complete (N-P-K) 10-10-10 or equivalent turf type slow release fertilizer.

- Application rate per acre shall be:

  Nitrogen (N) - 120 pounds of actual nitrogen.

Phosphorus (P) - 120 pounds of P_20_5.

Potassium (K) - 120 pounds of K_20.

Appendix E: Hennepin Power Station; West Ash Disposal Pond Maintenance Plan (2013)

DYNEGY MIDWEST GENERATION, LLC

Hennepin Power Station
Hennepin, Illinois

Putnam County

West Ash Disposal Pond

IDNR Permit No. (not permitted)

Dam ID No. (not permitted)

Maintenance Plan

September 2013

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1.0 GENERAL

The following operations and maintenance procedures are provided to maintain the structural integrity of the west ash storage surface impoundment at the Hennepin Power Station, which is unclassified and unpermitted, by the Illinois Department of Natural Resources, Office of Water Resources.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during major storm events or routine inspection, which may constitute an emergency, shall be handled as follows. Notice of any type of emergency involving the dikes or outfall shall be made to the Shift Leader on duty [(815) 339-9211]. The Shift Leader on duty shall notify the Station Manager, Ted Lindenbusch [home: (815) 875-2381], or, in his absence, the Environmental Coordinator, John P. Augspols [home: (815) 925-7488]. One of the above designated personnel shall notify the following city, county, state and federal regulatory authorities of the emergency condition.

- Division of Water Resources, Dam Safety Section, Dam Safety Engineers (217) 782-3862
- Illinois Emergency Management Agency, 24-hour service 1-(800) 782-7860
- Putnam County Sheriff/Hennepin Police Department (815) 925-7015
- Senior Director – Environmental Compliance, Dynegy Operating Company (618) 206-5912

2.2 Dewatering

The Station Manager or the Environmental Coordinator shall have the responsibility of determining how repairs shall be accomplished and whether dewatering of the disposal facility is necessary. Emergency dewatering shall be accomplished by portable pumps.

3.0 MAINTENANCE

3.1 Vegetation

Dikes shall be maintained to protect the structural integrity of the disposal facility. Damaged and barren areas shall be repaired as soon as appropriate after being discovered. Damaged areas shall be filled with topsoil. Limed, fertilized, and seeded with appropriate vegetation. Trees and shrubs observed during semiannual inspections shall be cut and removed from the dikes and discharge channel. This shall be done as frequently as is necessary to insure that no tree reaches a size where the root structure would require removal and filling. Woody vegetation, shrubs, and trees shall be removed during the early stages of growth before reaching a three-inch diameter.

Low growing vegetation, a prairie grass mixture that grows to a height of no more than six inches, shall be planted and maintained to facilitate inspections.

3.2 Discharge Structure

The discharge structure shall be inspected periodically for significant corrosion and deterioriation. Any defects discovered shall be promptly repaired.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by filling with grout.

3.4 Restriction of Unauthorized Vehicles

Facility approaches shall be posted with signs restricting unauthorized travel on the roadways and slopes.

3.5 Inspections/Remedial Measures

3.5.1 Weekly Inspections

Weekly inspections of the perimeter berms shall be conducted, looking for seepage and slumping, and unusual seepage at and/or blockage of the outfall structures in each cell. All findings shall be entered into the weekly inspection checklist, discussed in Section 4.0. Maintenance activities shall be initiated, if required. Refer to Section 4.0 for the recommended inspection checklist to be used for the weekly inspections.

3.5.2 Quarterly Inspections

Inspections shall be made quarterly by Station personnel to determine the general condition of the dam and embankments. During these inspections, embankment erosion, tree growth, and embankment seepage shall be monitored. Seepage shall be observed for change in quantity and coloration. Refer to Section 4.0, for the recommended inspection checklist to be used for documenting the quarterly inspections.

3.5.3 Annual Inspections

An annual inspection shall be made by a licensed professional engineer. This inspection shall follow the Illinois Department of natural Resources (IDNR) *Guidelines and Forms for Inspection of Illinois Dams*, and shall be followed by verbal and written reports by the consulting engineer. Based on the findings of the inspection, the Station Manager shall implement corrective action as required to promote dam safety. Procedures and methods for corrective action shall be performed in accordance with recommendations of the consulting engineer and as outlined above. Because the dam is not permitted by the IDNR, copies of the engineer's report, along with corrective action taken, will not be reported to the IDNR.

4.0 INSPECTION CHECKLISTS

The following Inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: **Hennepin Power Station – West Ash Pond**

Owner: **Dynegy Midwest Generation, LLC, Havana Power Station**

Permit No.: **Not permitted** **Class of Dam: Not classified**

Type of Dam: **Homogeneous earth dam**

Type of Spillway: **Drop structure**

Date Inspected: ________________________

Weather Conditions: ____

Pool Elevation: ________________________

Inspection Personnel:

______________________________________ ___________________________

Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest		
Unusual Movement or Cracking at or Beyond Toe		
Seepage		
Vegetative Cover		
Embankment Erosion		
Structural Cracking		
Outfall Structures		
Other		

QUARTERLY DAM INSPECTION FORM

Dam Location: **Hennepin Power Station – West Ash Pond**

Owner: **Dynegy Midwest Generation, LLC, Hennepin Power Station**

Permit No.: Not permitted **Class of Dam:** Not classified

Type of Dam: Homogeneous earth dam

Type of Spillway: Drop structure

Date Inspected: ________________

Weather Conditions: ____

Pool Elevation: ______________________

Inspection Personnel:

____

Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest	Good condition, with no significant issues	
Downstream Fill Slopes	Good condition, with no significant issues	
Upstream Fill Slopes	Good condition, with no significant issues	
Unusual Movement or Cracking at or Beyond Toe	Good condition, with no significant issues	
Seepage (Condition/Color)	Good condition, with no significant issues	
Vegetative Cover (Tree growth)	Good condition, with no significant issues	
Animal Damage	Good condition, with no significant issues	
Embankment Erosion	Good condition, with no significant issues	
Water Passages	Good condition, with no significant issues	
Structural Cracking	Good condition, with no significant issues	
Outfall Structures	Good condition	
Other		

Appendix F: Hennepin Power Station; Old East Ash Disposal Pond Maintenance Plan (2013)

DYNEGY MIDWEST GENERATION, LLC

Hennepin Power Station
Hennepin, Illinois

Putnam County

Old East Ash Disposal Pond

IDNR Permit No. (not permitted)

Dam ID No. (not permitted)

Maintenance Plan

September 2013

TABLE OF CONTENTS

1.0 GENERAL

The following operations and maintenance procedures are provided to maintain the structural integrity of the old east ash storage surface impoundment at the Hennepin Power Station, which is unclassified and unpermitted, by the Illinois Department of Natural Resources, Office of Water Resources.

This is primarily the @ 0.5 mile significant berm system that extends along the Illinois River. The old east ash pond system consists of the inactive cells # 2 and # 4. As a result of the May 2011 USEPA dam assessment, a dam safety permit was submitted to IDNR in May 2013, to address major modifications to this significant berm. These major modifications include extensive tree removal and resloping. Resloping is required to improve slope stability and allow safe access to slope, for long-term mowing and maintenance.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during major storm events or routine inspection, which may constitute an emergency, shall be handled as follows. Notice of any type of emergency involving the dikes or outfall shall be made to the Shift Leader on duty [(815) 339-9211]. The Shift Leader on duty shall notify the Station Manager, Ted Lindenbusch [home: (815) 875-2381], or, in his absence, the Environmental Coordinator, John P. Augspols [home: (815) 925-7488]. One of the above designated personnel shall notify the following city, county, state and federal regulatory authorities of the emergency condition.

- Division of Water Resources, Dam Safety Section, Dam Safety Engineers (217) 782-3862
- Illinois Emergency Management Agency, 24-hour service 1-(800) 782-7860
- Putnam County Sheriff/Hennepin Police Department (815) 925-7015
- Senior Director – Environmental Compliance, Dynegy Operating Company (618) 206-5912

2.2 Dewatering

Not applicable.

3.0 MAINTENANCE

3.1 Vegetation

Dikes shall be maintained to protect the structural integrity of the disposal facility. Damaged and barren areas shall be repaired as soon as appropriate after being discovered. Damaged areas shall be filled with topsoil. Limed, fertilized, and seeded with appropriate vegetation. Trees and shrubs observed during semiannual inspections shall be cut and removed from the dikes and discharge channel. This shall be done as frequently as is necessary to insure that no tree reaches a size where the root structure would require removal and filling. Woody vegetation, shrubs, and trees shall be removed during the early stages of growth before reaching a three-inch diameter.

Low growing vegetation, a prairie grass mixture that grows to a height of no more than six inches, shall be planted and maintained to facilitate inspections.

3.2 Discharge Structure

Not applicable.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by filling with grout.

3.4 Restriction of Unauthorized Vehicles

Facility approaches shall be posted with signs restricting unauthorized travel on the roadways and slopes.

3.5 Inspections/Remedial Measures

3.5.1 Weekly Inspections

Weekly inspections of the perimeter berms shall be conducted, looking for seepage and slumping. All findings shall be entered into the weekly inspection checklist, discussed in Section 4.0. Maintenance activities shall be initiated, if required. Refer to Section 4.0 for the recommended inspection checklist to be used for the weekly inspections.

3.5.2 Quarterly Inspections

Inspections shall be made quarterly by Station personnel to determine the general condition of the dam and embankments. During these inspections, embankment erosion, tree growth, and embankment seepage shall be monitored. Seepage shall be observed for change in quantity and coloration. Refer to Section 4.0, for the recommended inspection checklist to be used for documenting the quarterly inspections.

3.5.3 Annual Inspections

An annual inspection shall be made by a licensed professional engineer. This inspection shall follow the Illinois Department of natural Resources (IDNR) *Guidelines and Forms for Inspection of Illinois Dams*, and shall be followed by verbal and written reports by the consulting engineer. Based on the findings of the inspection, the Station Manager shall implement corrective action as required to promote dam safety. Procedures and methods for corrective action shall be performed in accordance with recommendations of the consulting engineer and as outlined above. Because the dam is not permitted by the IDNR, copies of the engineer's report, along with corrective action taken, will not be reported to the IDNR.

4.0 INSPECTION CHECKLISTS

The following Inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – Old East Ash Pond

Owner: Dynegy Midwest Generation, LLC, Havana Power Station

Permit No.:Not permitted **Class of Dam: Not classified**

Type of Dam: Homogeneous earth dam___________

Type of Spillway: ____N/A__________

Date Inspected: ________________________

Weather Conditions: ____

Pool Elevation: _________________________

Inspection Personnel:

______________________________________ ___________________________

Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest		
Unusual Movement or Cracking at or Beyond Toe		
Seepage		
Vegetative Cover		
Embankment Erosion		
Structural Cracking		
Outfall Structures		
Other		

QUARTERLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – Old East Ash Pond

Owner: Dynegy Midwest Generation, LLC, Hennepin Power Station

Permit No.: Not permitted **Class of Dam: Not classified**

Type of Dam: Homogeneous earth dam

Type of Spillway: Not applicable

Date Inspected: __________________

Weather Conditions: ____

Pool Elevation: _________________________

Inspection Personnel:

____

Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest	Good condition, with no significant issues	
Downstream Fill Slopes	Good condition, with no significant issues	
Upstream Fill Slopes	Good condition, with no significant issues	
Unusual Movement or Cracking at or Beyond Toe	Good condition, with no significant issues	
Seepage (Condition/Color)	Good condition, with no significant issues	
Vegetative Cover (Tree growth)	Good condition, with no significant issues	
Animal Damage	Good condition, with no significant issues	
Embankment Erosion	Good condition, with no significant issues	
Water Passages	Good condition, with no significant issues	
Structural Cracking	Good condition, with no significant issues	
Outfall Structures	Good condition	
Other		

Appendix G: Hennepin Power Station; East Ash Disposal Pond Maintenance Plan (2014)

DYNEGY MIDWEST GENERATION, LLC

Hennepin Power Station
Hennepin, Illinois

Putnam County

East Ash Disposal Pond

Small Class III Dam

IDNR Permit No. DS2011079

Dam ID No. IL50363

Maintenance Plan

Revised – August 2014

TABLE OF CONTENTS

1.0 GENERAL

The following operations and maintenance procedures are provided to maintain the structural integrity of the east ash storage surface impoundment at the Hennepin Power Station, which is classified as a small Class III dam by the Illinois Department of Natural Resources, Office of Water Resources. The primary pond's maximum normal poll elevation will be 489.5 msl with a dam crest at elevation 494.0 msl. The secondary pond's maximum normal pool elevation will be 480.5 with a dam crest at 494.0 msl.

2.0 EMERGENCY OPERATIONS

2.1 Unusual Conditions

Any unusual condition discovered during major storm events or routine inspection, which may constitute an emergency, shall be handled as follows. Notice of any type of emergency involving the dikes or outfall shall be made to the Shift Leader on duty [(815) 339-9211]. The Shift Leader on duty shall notify the Managing Director, Byron Veech [cell: (309) 543-8714], or, in his absence, the Environmental Coordinator, John P. Augspols [home: (815) 925-7488]. One of the above designated personnel shall notify the following city, county, state and federal regulatory authorities of the emergency condition.

- Division of Water Resources, Dam Safety Section, Dam Safety Engineers (217) 782-3862
- Illinois Emergency Management Agency, 24-hour service 1-(800) 782-7860
- Putnam County Sheriff/Hennepin Police Department (815) 925-7015
- Senior Director – Environmental Compliance, Dynegy Operating Company (618) 343-7761

2.2 Dewatering

The Station Manager or the Environmental Coordinator shall have the responsibility of determining how repairs shall be accomplished and whether dewatering of the disposal facility is necessary. Dewatering shall be accomplished by manually removing the concrete beams from the primary and/or secondary pond structures until the desired water level is reached.

3.0 MAINTENANCE

3.1 Vegetation

Dikes shall be maintained to protect the structural integrity of the disposal facility. Damaged and barren areas shall be repaired as soon as appropriate after being discovered. Damaged areas shall be filled with topsoil. Limed, fertilized, and seeded with appropriate vegetation. Trees and shrubs observed during periodic inspections shall be cut and removed from the dikes and discharge channel. This shall be done as frequently as is necessary to insure that no tree reaches a size where the root structure would require removal and filling. Woody vegetation, shrubs, and trees shall be removed during the early stages of growth before reaching a three-inch diameter.

Low growing vegetation shall be planted and maintained to facilitate inspections.

3.2 Discharge Structure

The discharge structure shall be inspected periodically for significant corrosion, spalling, and cracking. Any defects discovered shall be promptly repaired.

3.3 Animal Damage and Repairs

Animal burrows discovered during inspections shall be promptly repaired by filling with grout.

3.4 Restriction of Unauthorized Vehicles

Facility approaches shall be posted with signs restricting unauthorized travel on the roadways and slopes.

3.5 Inspections/Remedial Measures

3.5.1 Weekly Inspections

Weekly inspections of the perimeter berms shall be conducted, looking for seepage and slumping, and unusual seepage at and/or blockage of the outfall structures in each cell. All findings shall be entered into the weekly inspection checklist, discussed in Section 4.0. Maintenance activities shall be initiated, if required. Refer to Section 4.0 for the recommended inspection checklist to be used for the weekly inspections.

3.5.2 Quarterly Inspections

Inspections shall be made quarterly by Station personnel to determine the general condition of the dam and embankments. During these inspections, embankment erosion, tree growth, and embankment seepage shall be monitored. Seepage shall be observed for change in quantity and coloration. Refer to Section 4.0, for the recommended inspection checklist to be used for documenting the quarterly inspections.

3.5.3 Five-Year Inspections

Every five years, an inspection shall be made by a licensed professional engineer. This inspection shall follow the Illinois Department of natural Resources (IDNR) *Guidelines and Forms for Inspection of Illinois Dams*, and shall be followed by verbal and written reports by the consulting engineer. Based on the findings of the inspection, the Station Manager shall implement corrective action as required to promote dam safety. Procedures and methods for corrective action shall be performed in accordance with recommendations of the consulting engineer and as outlined above. Copies of the engineer's report, along with corrective actin taken, shall be reported to the IDNR.

3.6 Annual Statement

An annual statement on forms furnished by IDNR, certifying compliance with this maintenance plan, shall be submitted to IDNR.

4.0 INSPECTION CHECKLISTS

The following Inspection checklists should be used during the weekly and quarterly inspections.

WEEKLY DAM INSPECTION FORM

Dam Location: **Hennepin Power Station – East Ash Pond**
Owner: **Dynegy Midwest Generation, LLC, Havana Power Station**
Permit No.:DS2011079 **Class of Dam: III**
Type of Dam: **Homogeneous earth dam, with clay and geosynthetic / clay liner**
Type of Spillway: **Drop structure and stop logs**

Date Inspected: ________________________
Weather Conditions: ____
Pool Elevation: ________________________

Inspection Personnel:

______________________________________ ________________________
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest		
Unusual Movement or Cracking at or Beyond Toe		
Seepage		
Vegetative Cover		
Embankment Erosion		
Structural Cracking		
Outfall Structures		
Other		

QUARTERLY DAM INSPECTION FORM

Dam Location: Hennepin Power Station – East Ash Pond
Owner: Dynegy Midwest Generation, LLC, Hennepin Power Station
Permit No.:DS2011079 **Class of Dam: III**
Type of Dam: Homogeneous earth dam, with clay and geosynthetic / clay liner
Type of Spillway: Drop structure and stop logs

Date Inspected: ____________________
Weather Conditions: ____
Pool Elevation: ____________________________

Inspection Personnel:

____
Name / Title **Signature**

Inspection Item	Conditions	Location of Problem and Recommended Remedial Measures and Implementation Schedule
Vertical and Horizontal Alignment of Crest	Good condition, with no significant issues	
Downstream Fill Slopes	Good condition, with no significant issues	
Upstream Fill Slopes	Good condition, with no significant issues	
Unusual Movement or Cracking at or Beyond Toe	Good condition, with no significant issues	
Seepage (Condition/Color)	Good condition, with no significant issues	
Vegetative Cover (Tree growth)	Good condition, with no significant issues	
Animal Damage	Good condition, with no significant issues	
Embankment Erosion	Good condition, with no significant issues	
Water Passages	Good condition, with no significant issues	
Structural Cracking	Good condition, with no significant issues	
Outfall Structures	Good condition	
Other		

ATTACHMENT D

Types of CCR and Chemical Constituents

845.220(a)(2)(A)

DYNEGY

Safety Data Sheet

Section 1
Identification of the Substance and of the Supplier

1.1 Product Identifier

Product Name/Identification:	ASTM Class C Fly Ash
Synonyms:	Coal Fly Ash, Pozzolan
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 damage to lungs after repeated/prolonged exposure via inhalation.* *May cause respiratory irritation.* *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.* *Wear protective gloves/protective clothing/eye protection/face protection.* *Wash thoroughly after handling.* *Do not eat drink or smoke when using this product.* *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*	*30 - 60%*	*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	*71243-67-9* *1327-36-2*	*30 - 60%*	*Single Exposure STOT, Category 3*
Iron oxide	*1309-37-1*	*1 - 10%*	*Not Classified*
Calcium oxide (CaO)	*1305-78-8*	*20 - 30%*	*Skin Irritant, Category 2* *Eye Irritant, Category 1* *Single Exposure STOT, Category 3*
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*	*1-8%*	*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*
Bromide salt (calcium)	*7789-41-5*	*See Footnote 2*	*Toxic to Reproduction, Category 2*

Footnote 1: *The percentage of respirable crystalline silica has not been determined. Therefore, a GHS classification of Carcinogen, Category 1A has been assigned.*

Footnote 2: *Analytical data are not available to demonstrate that the concentration of bromide salt is <0.1%; therefore, a GHS classification of Toxic to Reproduction, Category 2 has been assigned.*

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. Repeated exposure to dusts containing inorganic bromide salts may affect fertility and/or result in effects to the unborn child.

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 Crystalline Silica	0.05	0.05	0.025	0.05
Titanium dioxide	Total	15	2.4 (fine) 0.3 (ultrafine)	10	10
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): Not Determined	**Specific gravity or relative density:** 2.2 – 2.9
Melting point/freezing point (°C): Not applicable	**Water Solubility:** Slight
Initial boiling point/boiling range (°C): NA	**Partition coefficient: n-octane/water:** NA
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. Inorganic bromide salts have been shown to have adverse effects on reproductive parameters in some animal studies.
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 C (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

- 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
Manganese oxide-as manganese compounds	1313-13-9; Various	No	No	Yes	Yes
Phosphorus pentoxide (or phosphorus oxide)	1314-56-3	Yes	Yes	Yes	No
Potassium oxide	12136-45-7	No	Yes	No	No
Silica-crystalline (SiO2), 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.

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.

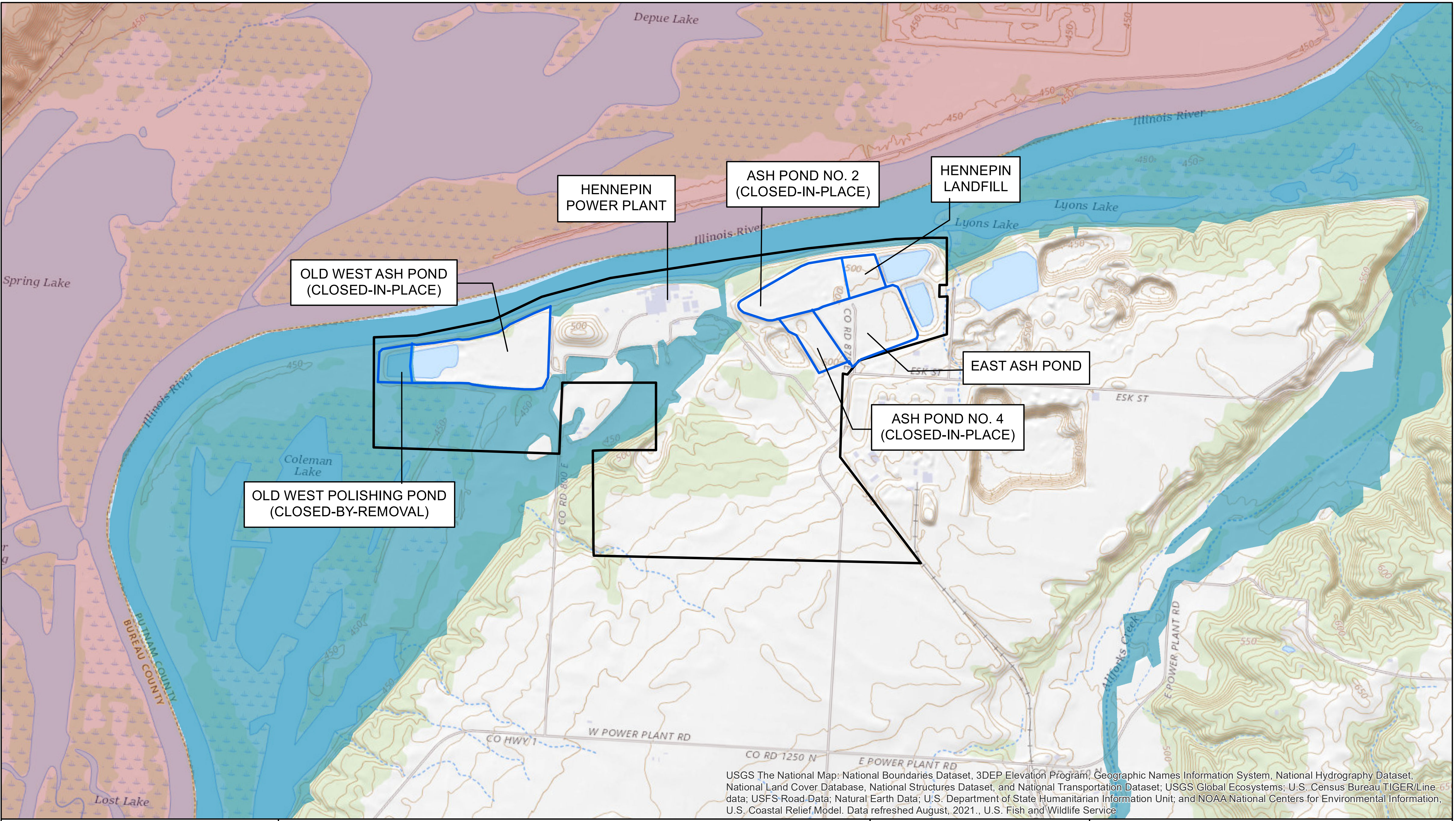
DISCLAIMER:

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.

ATTACHMENT E

Site Location Maps

845.220(a)(3)



USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021., U.S. Fish and Wildlife Service

Legend

- Approximate CCR Unit Limits
- Approximate Site Boundary
- FEMA 100-Year Flood Zone
- Critical Habitat

NOTE:
The basemap for this figure includes the 2021 USGS US 7.5-minute series quadrangle map for Depue, IL.

Critical Habitat areas derived from 2020 US Fish and Wildlife Critical Habitat for Threatened and Endangered Species locations.

No Dedicated Illinois Nature Preserves or designated historic and archaeological sites per the Illinois National Historic Preservation Act were listed within 1,000 meters of the Site.

The FEMA 100-Year Flood Zone boundaries were taken from the FEMA Flood Map Service Center and were adjusted in the vicinity of the Old West Ash Pond based on site-specific survey data showing this top of final cover to be above the 100-year flood level of El. 416.9 ft (Civil & Environmental Consultants, Inc., 2020).

Prevailing Wind

N

0 500 1,000 2,000
Feet

SITE LOCATION MAP
HENNEPIN POWER STATION

Geosyntec
consultants

ATTACHMENT E

GLP8026

JANUARY 2022

Document Path: \\stlouismo-01\Company\Projects_post_2014\GLP8026_HEN_845_Const_Permit\500_Technical\570_Permit_App\GIS Figures\Site Location Map\Site Location Map.mxd

ATTACHMENT F

Site Plan Map and On-Site Transportation Plan

845.220(a)(4) and 845.220(a)(2)(E)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

◓ MONITORING WELLS
- - BURIED GAS LINE
- - HIGH VOLTAGE OVERHEAD ELECTRIC
═ ONSITE TRANSPORTATION ROUTES FOR CLOSURE
- - PUBLIC ROADWAY
☐ CCR UNIT LIMITS - APPROXIMATE
☐ APPROXIMATE FACILITY (SITE) BOUNDARY

NOTE:
CCR unit limits and Site boundary locations are approximate. All high-voltage electric line alignments and gas line alignments were based off available aerial imagery data, should be considered approximate, may vary in the field, and should not be considered comprehensive. Local utilities including, but not limited to, service electric lines, gas lines, water and sewer lines, telecommunication lines, plant utilities, and/or private utilities are not shown on this figure and shall be verified in the field prior to any site work

N

0 250 500 1,000
Feet

SITE PLAN MAP AND TRANSPORTATION PLAN HENNEPIN POWER STATION

Geosyntec consultants

ATTACHMENT F

GLP8026

JANUARY 2022

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ATTACHMENT G

Final Closure Plan and Proposed Closure Schedule (including Closure Alternatives Analysis/ Corrective Measures Assessment)

845.210, 845.220(a)(5-6), 845.720(b), 845.220(d)(2)

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

CCR SURFACE IMPOUNDMENT
FINAL CLOSURE PLAN

HENNEPIN POWER PLANT
EAST ASH POND
(IEPA ID W1550100002-05)
Hennepin, Illinois

Prepared by

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engineers | scientists | innovators

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1. INTRODUCTION

Dynegy Midwest Generation, LLC (Dynegy) is the owner of the coal-fired Hennepin Power Plant (HPP), also referred to as Hennepin Power Station (HEN), in Hennepin, Illinois. Five Coal Combustion Residuals (CCR) surface impoundments are present at the Hennepin Power Station; all were closed prior to promulgation 35 Ill. Admin. Code 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) except for the East Ash Pond (EAP). This Closure Plan is for the EAP only. The EAP has an Illinois Environmental Protection Agency (IEPA) identification number of W1550100002-05.

1.1. Selected Closure Method

Section 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.*

Based on the Closure Alternatives Analysis, closure with a final cover system has been identified as the most appropriate closure method, also known as Closure-in-Place (CIP, per Section 845.740). An alternatives analysis, provided in **Attachment A**, was prepared to evaluate CIP versus Closure by Removal (CBR, per Section 845.750) and CIP was the most appropriate closure method for the EAP. Information developed to support the Closure Alternatives Analysis is provided in **Attachment B**.

1.2. Organization of Final Closure Plan

This Final Closure Plan is organized in the following manner:

- **Section 2** includes the Final Closure Plan, as required by Section 875.720(a)(1);
- **Section 3** includes a summary of amendments of the Closure Plan;
- **Section 4** includes a discussion of how the closure using a final cover system will comply with the performance and design requirements of Sections 845.720 and 845.750;
- **Section 5** includes additional information regarding the closure, and
- **Section 6** includes a Certification from a Qualified Professional Engineer;
- **Section 7** includes reference documents used in the development of this Final Closure Plan.

2. FINAL CLOSURE PLAN

Section 845.720(a)(1): Content of the Preliminary Closure Plan. The owner or operator of a new CCR surface impoundment or an existing CCR surface impoundment not required to close under Section 845.700 must prepare a preliminary written closure plan that describes the steps necessary to close the CCR surface impoundment at any point during the active life of the CCR surface impoundment consistent with recognized and generally accepted engineering practices.

This section includes the final closure plan for the EAP, as required by Section 845.720(a)(1). Specific requirements of the closure plan and the relevant regulatory citations are included in the following sections.

2.1. Narrative Closure Description

Section 845.720(a)(1)(A): A narrative description of how the CCR surface impoundment will be closed in accordance with this Part.

The EAP will be closed in place and covered with a final cover compliant with 40 C.F.R. § 257.102(d)(3) and Section 845.720(a)(1)(C). The EAP is a lined CCR surface impoundment. The bottom liner includes a 4-ft thick compacted clay liner with a design permeability of 1×10^{-7} cm/sec overlying a 1-ft thick layer of sand. The side slope liner consists of two layers of 45-mil reinforced polypropylene geomembrane overlying 1-ft of compacted clay [1]. Therefore, closing the EAP with a final cover system will result in the CCR retained within the EAP being encapsulated within a continuous liner system on the sides, bottom, and top of the CCR.

Closure of the EAP with a final cover system will include the following tasks:

- Preparing the site for closure by establishing perimeter stormwater Best Management Practices (BMPs), as and if needed, at the construction limits of disturbance.
- Removing free liquids by solidifying waste, as needed, and removing liquid waste by removing liquids and pumping them to the adjacent Leachate Pond or Polishing Pond (non-CCR surface impoundments) for ultimate discharge at National Pollutant Discharge Elimination System (NPDES) Outfall 003.
- Abandoning existing outflow structures and culverts connecting the EAP to the adjacent Leachate Pond or Polishing Pond, in order to prevent CCR from migrating through these conduits during post-closure conditions, by:
    - For the primary spillway structure, demolishing the above-grade portions of the concrete intake structure and catwalk. Below-grade portions will be left in place

  and placed beneath by the final cover system. The interior of the riser and culvert will then be cleaned via pressure washing and sealed by filling with cement-bentonite grout.

  - For the 18-inch diameter spillway connecting the EAP to the Leachate Pond, cleaning the interior of the pipe via pressure washing and sealing by filling the interior of the pipe with cement bentonite grout.

  - For the two, 12-inch plastic pipes, cutting off the pipes behind the existing EAP side-slope geomembrane liner, capping the pipes, backfilling the area with soil, and patching the EAP geomembrane liner.

- Abandoning existing geotechnical piezometers HEN-P006 and HEN-P007 that will not be utilized as post-closure instrumentation. Abandonment will be performed in accordance with Illinois monitoring well regulations.

- Establishing a temporary dewatering and water management system within the EAP consisting of ditches and sumps to support passive (i.e., gravity) dewatering of CCR for stabilization and to collect contact stormwater during closure and maintain the EAP in an unwatered state. Contact stormwater, during construction, will be pumped to the Leachate Pond or Polishing Pond for discharge at NDPES Outfall 003.

- Stabilizing the EAP by excavating unsaturated CCR from the west side of the EAP and using it as subgrade fill within the lower east side of the EAP. CCR will be placed in lifts and compacted to provide a subgrade suitable for construction of a final cover system. Dewatering will be performed, as needed to support construction activity and fill placement, using the water management system.

  - Approximately 7,000 CY (9,500 tons) of bottom ash ballast will be excavated from the adjacent Hennepin CCR Landfill and beneficially used as compacted subgrade fill, to supplement CCR excavated from within the EAP. The bottom ash ballast material is the only CCR that has been placed in the Hennepin Landfill and was utilized to provide freeze protection for the underlying liner system. Production CCR was never placed in the Hennepin Landfill.

- Modifying the dike between the EAP and adjacent Polishing Pond by lowering the grades to be consistent with the final cover subgrades, thereby allowing stormwater to flow by gravity into the Polishing Pond. The Polishing Pond will remain in-place as a post-closure, non-CCR, stormwater management pond.

- Constructing a final cover system extending over the entire footprint of the EAP that contains CCR, and includes, from bottom to top:

    - A 40-mil linear low-density polyethylene (LLDPE) geomembrane, placed on a prepared subgrade with rocks no larger than one inch in diameter and other sharp objects removed prior to placement;

    - A nonwoven geotextile cushioning layer, to protect the geomembrane from rocks and/or sharp objects in the cover soil;

    - Based on a demonstration included in **Attachment C**, pursuant to Section 845.750(c)(2), final cover system including an alternative 1.5 ft thick protective layer (e.g., cover soil) to protect the geomembrane and 0.5 ft of topsoil capable of supporting vegetation, for a total cover soil thickness of 2 ft.

    - The final cover system grades will be approximately 2.5% over the majority of the EAP, although 20% (5 horizontal to 1 vertical [5H:1V]) grades will be used in limited areas, where needed to tie the final cover system into existing grades.

    - The final cover system will include an anchor trench for the geosynthetic materials along the entire perimeter of the EAP to secure the final cover system into existing grades. The anchor trench will be placed beyond the current limits of the bottom liner to provide a continuous containment system and encapsulation for the retained CCR.

    - Existing groundwater monitoring wells MW-52, MW-53, MW-54, MW-55, XPW-01, XPW-02, and XPW-03 will be retained and modified by extending the wells through the final cover system, sealing the penetration with a pipe boot, and constructing a new surface completion on top of the final cover.

- Constructing a post-closure non-contact stormwater management system consisting of:

    - Stormwater channels leading from west to east to convey stormwater into the Polishing Pond; and

    - Riprap-lined downchutes where channels flow from the EAP final cover and lead into the Polishing Pond, to reduce erosion.

- Establishing vegetation on the final cover system by:
    - Fertilizing the topsoil, as needed to support vegetation, based on agronomical soil tests;
    - Seeding the topsoil with a suitable grass seed for local climatic and soil conditions;
    - Providing temporary BMPs measures such as mulch, erosion control blankets, silt fences, and/or straw wattles, as necessary to reduce the potential for soil erosion until vegetation is established; and
    - Restoring the site, after vegetation is established and the site is stabilized, by removing stormwater BMPs and temporary stabilization measures that are no longer needed.

Permit-level engineering drawings and material specifications for the closure are provided in **Attachment D**.

2.2. Decontamination of CCR Surface Impoundment

Section 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 EAP will be closed-in-place and will not be closed by removal of CCR. Therefore, 845.720(a)(1)(B) is not applicable.

2.3. Final Cover System

Section 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.

A description of the final cover system design, methods and procedures used for installation, and how the final cover system will achieve the Section 845.750 performance standards is provided in **Section 4** of this Closure Plan.

2.4. Maximum CCR Inventory

Section 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.

The maximum inventory of CCR ever on-site within the EAP is approximately 680,000 cubic yards. This inventory will increase by approximately 7,000 CY to approximately 687,000 CY through the excavation of currently present, onsite-generated, bottom ash ballast from the Hennepin Landfill and utilizing it in the EAP as compacted subgrade fill.

2.5. Largest Surface Area Estimate

Section 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.

The largest surface area of the EAP, in plan view, is approximately 21.1 acres [2]. Final cover will be placed over an area of approximately 22.5 acres to extend completely across the surface area of the EAP and beyond the limits of CCR and the existing liner system in plan view. This will provide a continuous encapsulation system consisting of the final cover on the top of the EAP and the existing liner system on the sides and bottom of the EAP.

2.6. Closure Completion Schedule

Section 845.720(a)(1)(F): 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.

A milestone closure completion schedule has been prepared and is provided in **Table 1**. Key sequential phases and sub-tasks that will be completed as part of the closure will include:

- Agency Coordinating, Approvals, and Permitting
    - Approval of the closure Construction Permit Application by IEPA.

  - Obtaining a modification to the existing NPDES permit to allow the disposal of water generated from unwatering and dewatering operations to the Illinois River *via* the existing NPDES-permitted Outfall 003 for the Site;
  - Obtaining a construction permit from the Illinois Department of Natural Resources (IDNR), Office of Water Resources (OWR), Dam Safety Program (DSP) to allow the embankment and spillways of the EAP to be modified as part of closure;
  - A construction 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).
- Final Design and Bidding
  - Completion of final design documents, including drawings and specifications.
  - Bidding and selection of a closure construction contractor.
- Dewater and Stabilize CCR, Install Final Cover System
  - Closure contractor mobilization and material procurement.
  - Installing stormwater BMPs around the construction area, per the Land Disturbance Permit.
  - Unwatering the EAP by pumping impounded water to the Polishing Pond.
  - Abandoning existing outfall structures and culverts.
  - Stabilizing the subgrade through dewatering and the placement of compacted CCR fill.
  - Constructing design final cover subgrades, including stormwater channel subgrades and modifications to the EAP east dike.
  - Installing the final cover system geosynthetics and anchor trench.
  - Placing cover soil and topsoil over the geosynthetics.
- Site Restoration
  - Constructing riprap-lined letdown structures.

- Seeding and stabilizing the surface of the final cover system and other disturbed areas and allowing the vegetation to become established.
- Removing temporary stormwater BMPs and other temporary stabilization measures, after vegetation is established.
- Closure contractor demobilization from the site.

The project is expected to be completed by April of 2026. Additional project schedule may be required if delays in permitting or significant weather delays occur.

Table 1 – Closure Completion Milestone Schedule

Milestone	**Timeframe (Preliminary Estimates)**
Final Closure Plan Submittal	February 2022
Agency Coordination, Approvals, and Permitting • Obtain state permits, as needed, for dewatering, water discharge, land disturbance, and dam modifications.	6 to 12 months after Final Closure Plan Approval
Final Design and Bid Process • Complete final design of the closure and select a construction contractor.	2 to 18 months after Agency Coordination, Approvals, and Permitting
Dewater and Stabilize CCR, Install Final Cover System • Complete contractor mobilization, installation of stormwater BMPs, and unwatering of the EAP • Abandon outfall structures, stabilize the EAP, and complete grading. • Install the final cover system and stormwater downchutes.	3 to 8 months after necessary permits are issued
Site Restoration • Seed and stabilize the EAP. • Complete contractor demobilization.	1 to 5 months after the final cover system is complete
Timeframe to Complete Closure	Prior to April 2026

Section 845.720(a)(1)(F) (Continued): 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).

The time required to complete closure construction is not currently expected to exceed the timeframe specified in Section 845.760(a). Therefore, closure extensions for the EAP are not being sought at this time.

3. AMENDMENTS OF FINAL CLOSURE PLAN

Section 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.*

If revisions are required for this Final Closure Plan, the owner will submit a request to modify the construction permit within 60 days following the triggering event.

Table 2. CCR Final Closure Plan Revisions

Revision Number and Date	Pages or Section	Description of Revision	Professional Engineer Certifying Plan

4. CLOSURE WITH FINAL COVER SYSTEM

This section includes a description of the final closure with a final cover that will be completed for the EAP surface impoundment, including principal design and construction features, material specifications, and a discussion of how each feature is in accordance with the requirements of Section 845.750. Drawings showing each design feature and material specifications are provided in **Attachment D**.

4.1. Minimization of Post-Closure Infiltration and Releases

<u>Section 845.750(a)(1):</u> *The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will: Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere.*

Closure will, to the maximum extent feasible, minimize the post-closure infiltration of liquids into the retained CCR through the installation of a final cover system with the following design features and specifications:

- A 40-mil LLDPE geomembrane low-permeability layer will placed on the prepared subgrade to control, minimize vertical infiltration into the surface impoundment. The geomembrane will be constructed on a subgrade that is free of sharp rocks or other debris and will be protected from damage by installing a geotextile cushion layer and a total of two feet of cover soil and topsoil over the top of the geomembrane.

- Surface stormwater will be routed off of the top of the final cover by the construction of a free-draining post-closure stormwater management system including channels and letdown structures. The stormwater management system will drain by gravity and preclude water impoundment on top of the final cover system, thereby minimizing post-closure infiltration into the CCR.

Releases of CCR leachate and/or contaminated run-off into the groundwater, surface waters, and/or atmosphere will be minimized, to the maximum extent feasible, as:

- The EAP includes an existing liner system, consisting of both compacted clay on lower portion and the bottom of the liner system and a geomembrane on the side slopes of the impoundment. This liner system will be retained and will continue to control lateral migration of water into the unit and minimize any releases of CCR leachate into ground or surface waters, in addition to minimizing any lateral migration of CCR leachate out of the EAP.

  - The final cover system will tie into the existing liner system, by constructing a final cover anchor trench at or beyond the horizontal limits of the liner system. The final cover will therefore provide continuous encapsulation between the CCR and surrounding environment on the top, bottom, and sides of the CCR, utilizing the final cover and existing liner system.

  - This continuous barrier will result in the CCR being physically isolated from the surrounding environment on all sides, including the groundwater, surface water, and atmosphere and therefore minimize the releases of CCR, leachate, or contaminated run-off into the ground, surface waters, and atmosphere.

- CCR leachate (e.g., pore water within the CCR) volumes will be minimized via the installation of the final cover system including a low-permeability geomembrane layer. The final cover system will minimize infiltration and therefore the amount of leachate within the CCR.

- Releases of CCR leachate via the existing outlet culverts will be prevented by sealing all culverts connecting the EAP to adjacent areas. Sealing will include the capping of plastic culverts and the cleaning of concrete pipe culverts and filling with cement-bentonite grout, thereby removing potential flow paths that could otherwise allow leachate to be released.

- The EAP is located above the groundwater table on the bottom and sides. Therefore, there is no potential for the direct discharge of CCR leachate into the groundwater.

4.2. Preclusion of Future Impoundment

<u>*Section 845.750(a)(2):*</u> *Preclude the probability of future impoundment of water, sediment, or slurry.*

A final cover system will be installed on top of the EAP. All areas of the final cover system will be sloped to positively drain to the exterior of the EAP and preclude future impoundment of water, sediment, or slurry. This will include installing cross-slopes at approximately 2.5% grades, slopes at up to 20% (e.g., 5 horizontal to 1 vertical [5H:1V]) grades at the tie-in between the final cover system and existing grades, and stormwater channel grades at 1% slopes. Stormwater channels will flow by gravity into the adjacent non-CCR Polishing Pond via riprap-lined downchutes. Hydrologic and hydraulic calculations used to design the stormwater channels and other control features to preclude impoundment are provided in **Attachment E**.

4.3. Provisions for Preventing Instability, Sloughing and Movement

<u>Section 845.750(a)(3):</u> *Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.*

The perimeter berms of the EAP are constructed out of compacted fill materials and are founded on a layer of dense to very dense sand and gravel. The east berm between the EAP and Polishing Pond will be modified during closure to allow for stormwater to gravity-flow into the Polishing Pond. The west berm between the EAP and East Ash Pond No. 4 will generally be maintained as-is, although the final cover system will extend over the top of the berm. The effects of these modifications have been evaluated by performing global slope stability analyses considering post-closure conditions. The resulting factors of safety exceed typical regulatory minimum values for static and seismic loading conditions. Slope stability analyses are provided in **Attachment F**.

Sloughing and movement of the final cover system will be minimized by constructing the final cover system at relatively flat slopes, including 2.5% over most of the final cover and 20% (5H:1V) at the edges of the final cover, as necessary to tie into existing grades. The limited areas of 5H:1V slope are 10 ft or less in total slope height. The potential for sloughing and movement of the final cover system has been evaluated by performing veneer stability analyses for the various interfaces within the final cover system. The resulting factors of safety exceed typical minimum values for static and seismic loading conditions. Veneer stability analyses are provided in **Attachment F**.

4.4. Minimize the Need for Further Maintenance

<u>Section 845.750(a)(4):</u> *Minimize the need for further maintenance of the CCR surface impoundment.*

Future maintenance needs will be minimized using the following design features:

- The final cover system will be installed at gentle 2.5% slopes over most of the final closure with 20% slopes in limited areas at the extents of the final cover, with maximum heights of 10 ft, as needed to tie into existing grades.
    - These relatively flat slopes will minimize erosion of the final cover soils and thereby minimize maintenance needs by reducing stormwater flow velocities relative to steeper slopes.
    - The relatively flat slopes will also promote routine mowing of vegetation of the final cover system by allowing tractor-based mowing equipment to operate on the slopes with a reduced risk of equipment flip-over.

- The final cover, outside of stormwater channels, will be stabilized by placing topsoil, fertilizing the topsoil, establishing vegetation using suitable grass species.
    - The vegetation will minimize erosion of the final cover system by stabilizing the topsoil.
    - The use of fertilizer and selection of a suitable grass species will minimize maintenance required to repair areas of poor vegetation establishment.
- Stormwater channels will be stabilized with erosion control blankets and straw wattles. Where the stormwater channels pass through the EAP east perimeter dike and flow into the Polishing Pond they will be armored with riprap erosion protection. Erosion control blankets and riprap will minimize post-closure erosion and associated maintenance for stormwater channels.
    - Calculations used to design the stormwater channel stabilization and riprap armoring were based on the 100-year, 24-hour, and 25-year, 24-hour storms. These calculations are provided in **Attachment E**.

4.5. Be Completed in Shortest Amount of Time

Section 845.750(a)(5): *Be completed in the shortest amount of time consistent with recognized and generally accepted engineering practices.*

Closure construction is expected to be completed within an amount of time that is consistent with recognized and generally accepted timeframes required to permit, design, bid, and construct a CCR impoundment final closure system, with a consideration of other permits form multiple agencies that are also required for the project. An estimated closure construction schedule is provided in **Section 2.6**. It should be noted that this schedule may change based on contractor, equipment, and material availability and actual weather conditions at the time at which closure occurs.

4.6. Drainage and Stabilization

Section 845.750(b)(1): *Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues.*

Section 845.750(b)(2): *Remaining wastes must be stabilized sufficiently to support the final cover system.*

Prior to installing the final cover system, free liquids will be eliminated by removing the liquid waste from the EAP. Engineering measures necessary to remove liquid waste that is readily separable under ambient temperature are pressure are being evaluated.

The removal of free liquids will result in the stabilization of the remaining CCR and will therefore allow the final cover to be placed on a stable subgrade

4.7. Final Cover System

Section 845.750(c): *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) unless the owner or operator demonstrates that another construction technique or material provides equivalent or superior performance to the requirements of this subsection (c) and is approved by the Agency. 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.*

A final cover system has been designed consistent with the requirements of Section 845.720(c). The final cover will use a geomembrane as a low-permeability layer. The design of the final cover system is discussed within this section.

4.7.1. Low Permeability Layer - Geomembrane

<u>Section 845.750(c)(1)(B):</u> *A geomembrane constructed in accordance with the following standards: i) The geosynthetic membrane must have a minimum thickness of 40 mil (0.04 inches) and, in terms of hydraulic flux, must be equivalent or superior to a three-foot layer of soil with a hydraulic conductivity of 1 x 10-7 cm/sec; ii) The geomembrane must have strength to withstand the normal stresses imposed by the waste stabilization process; and (iii) The geomembrane must be placed over a prepared base free from sharp objects and other materials that may cause damage.*

The geomembrane will consist of a 40-mil linear low-density polyethylene (LLDPE) layer. Ramboll completed a Hydrologic Evaluation of Landfill Performance (HELP) [3] model to compare flux through the geomembrane cover to an equivalent cover system with 3 ft of 1×10^{-7} cm/sec clay, in order to demonstrate that the geomembrane final cover is superior to a soil-only cover. The HELP modeling estimated a total infiltration of 0.53 in of water per year (in/yr) for the geomembrane cover system, relative to 2.3 in/year for the cover system using 3 ft of 1×10^{-7} cm/sec clay [4]. Therefore, the geomembrane final cover system is superior to a cover system using 3 ft of 1×10^{-7} cm/sec clay, as infiltration is reduced by a factor of approximately 4.3.

The geomembrane will be installed on a prepared subgrade, after the underlying CCR has been stabilized. Therefore, additional normal stresses will not be imparted on the geomembrane due to the waste stabilization process.

The subgrade (e.g., base) for the geomembrane will be visually inspected and sharp objects such as rocks or debris that may damage the geomembrane will be removed, prior to deployment of the geomembrane.

4.7.2. Final Protective Layer

<u>Section 845.750(c)(2):</u> *The final protective layer must meet the following requirements…*

> *A) Cover the entire low permeability layer;*
>
> *B) Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;*
>
> *C) Consist of soil material capable of supporting vegetation;*
>
> *D) Be placed as soon as possible after placement of the low permeability layer; and*
>
> *E) Be covered with vegetation to minimize wind and water erosion.*

A final protective layer will be placed over and extend slightly beyond the entire geomembrane low-permeability layer in plan. Based on the demonstration included in **Attachment C**, pursuant to Section 845.750(c)(2), the protective layer will include, from bottom to top, a nonwoven geotextile, a 1.5-ft thick cover soil layer, and a 0.5-ft thick topsoil layer, for a total thickness of 2 ft.

The nonwoven geotextile and 1.5-ft thick cover soil layer will protect the geomembrane from root penetration. Geomembranes are not susceptible to freeze damage, as discussed in **Attachment C**. The geotextile and cover soil will be placed as soon as practical after the geomembrane has been deployed and both quality assurance and quality control testing has been performed on the geomembrane seams.

The 0.5-ft thick topsoil layer will be fertilized, as necessary to support appropriate grass species, in order to vegetate the final protective layer.

4.8. Certification

Section 845.750(c)(4): *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 design of the final cover system meets the requirements of this section.*

The undersigned qualified professional engineer registered in Illinois certifies that the design of the final cover system meets the requirements of Section 845.750.

Lucas P. Carr
Printed Name

1/28/2022
Signature Date

062066694 IL 11/30/2023
Registration Number State Expiration Date

LUCAS PHILIP CARR
062066694

Affix Seal

4.9. Uses of CCR in Closure

Section 845.750(d): *This subsection specifies the allowable uses of CCR in the closure of CCR surface impoundments closing under Section 845.700. Notwithstanding the prohibition on further placement in Section 845.700, CCR may be placed in these surface impoundments, but only for purposes of grading and contouring in the design and construction of the final cover system, if: 1) The CCR placed was generated at the facility and is located at the facility at the time closure was initiated; 2) CCR is placed entirely above the elevation of CCR in the surface impoundment, following dewatering and stabilization (see subsection (b)); 3) The CCR is placed entirely within the perimeter berms of the CCR surface impoundment.*

Approximately 7,000 cubic yards (9,500 tons) of bottom ash were beneficially placed over the primary geomembrane liner system in the adjacent Hennepin Landfill [5]. Production CCR was never placed in the Hennepin Landfill and this bottom ash is the only material that has been placed in the Hennepin Landfill to date. This bottom ash was generated onsite.

This bottom ash will be excavated from the Hennepin Landfill and transported to the adjacent EAP to be beneficially used as compacted subgrade fill below the final cover system. The bottom ash will be placed on top of the existing subgrade (i.e., existing elevation of CCR in the surface impoundment) after dewatering of the EAP and used as a free-draining subgrade stabilization layer. CCR placement will only occur completely beneath the limits of the EAP final cover system. This is in accordance with the Section 845.750(d) criteria.

4.10. Final Cover System Slopes

<u>Section 845.750(d)(4):</u> *The final cover system is constructed with either: A) A slope not steeper than 5% grade after allowance for settlement; or B) At a steeper grade, if the Agency determines that the steeper slope is necessary, based on conditions at the site, to facilitate run-off and minimize erosion, and that side slopes are evaluated for erosion potential based on a stability analysis to evaluate possible erosion potential. The stability analysis, at a minimum, must evaluate the site geology; characterize soil shear strength; construct a slope stability model; establish groundwater and seepage conditions, if any; select loading conditions; locate critical failure surface; and iterate until minimum factor of safety is achieved.*

Final cover slopes will typically consist of 2.5% cross-slopes and 1% stormwater flowline slopes within the limits of final cover, which are less than 5%.

However, short lengths of 20% final cover slopes, up to 10 ft in height, will be used in limited areas near the perimeter of the final cover, as needed to tie the final cover into the existing grades, as shown in the drawing package provided in **Attachment D**. Twenty percent slopes will be utilized to allow most of the final cover, in area, to drain towards the east, and route stormwater into the Polishing Pond. This will reduce the volume of post-closure stormwater runoff that is routed to the west (towards the closed East Ash Pond No. 4) and the north (towards the closed East Ash Pond No. 2 and the inactive Hennepin Landfill), as only the limited portions of the site that utilize a 20% final cover slope will drain to the west and north. This approach will minimize maintenance at these other CCR units that could be induced if significant stormwater flows from the EAP were routed onto the CCR units.

The stability of 20% final cover slopes has been evaluated both for the final cover system itself (e.g., veneer stability) and the global stability of the slope. These calculations included characterizing soil shear strength based on site geology, constructing slope stability models, establishing groundwater seepage conditions, selecting loading conditions, locating the critical failure surface, and iterating until minimum factors of safety were calculated. These calculations are provided in **Attachment F**. Resulting factors of safety exceed typical minimum factors of safety for both global and veneer stability.

5. ADDITIONAL INFORMATION

Both the lateral migration of groundwater and vertical infiltration of liquids, and releases of CCR, and leachate, and contaminated run-off into and out of the EAP will be controlled, minimized or eliminated, to the maximum extent feasible, under post-closure conditions.

- The EAP is lined with a four-foot-thick compacted clay bottom liner (1×10^{-7} cm/sec) and a composite side slope liner including a 45-mil polypropylene geomembrane, overlying 1-ft of compacted clay and an 8-ounce geotextile, as discussed in **Section 2.1**.

- Closure of the EAP will include constructing a final cover system that ties into the existing liner system, thereby completely encapsulating CCR within the EAP on the top, bottom, and sides, as discussed in **Section 4.**

- CCR within the EAP will be located above the uppermost aquifer level under normal conditions and is expected to be perennially above the uppermost aquifer level during higher-water conditions in the adjacent Illinois River. Additionally, there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations, including the seasonal high-water table.

- Groundwater levels beneath the EAP have been typically monitored monthly using two piezometers (HEN-P006 and HEN-P007) since 2015. During a review of data collected between October 27, 2015, and April 23, 2021 (a period of over five years), the normal groundwater elevation was typically El. 452 ft or lower, although spikes to El. 456 ft and El. 457 ft occurred during flooding events on the Illinois River in May of 2019 and May of 2020. The May 2020 flooding event was over a 100-year flood [6].

- The lowest elevation of CCR within the EAP is approximately El. 464 ft, as shown in Sheet C-102 in **Attachment D**. This is 12 ft above the normal groundwater elevation and 7 ft above the maximum recorded groundwater elevation that occurred during a greater-than 100-year flood event on the Illinois River.

6. CERTIFICATION FROM A QUALIFIED PROFESSIONAL ENGINEER

Section 845.720(b)(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.*

I, Lucas P. Carr, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this construction permit application has been prepared in accordance with the accepted practice of engineering and the requirements of Title 35, Subtitle G, Chapter I, Subchapter j, Section 845.720 of the Illinois Administrative Code.

Lucas P. Carr
Printed Name

1/22/2022
Signature Date

062066694 IL 11/30/2023
Registration Number State Expiration Date

LUCAS PHILIP
CARR
062066694

Affix Seal

7. REFERENCES

[1] AECOM, "CCR Certification Report: Liner Design Criteria Evaluation for East Ash Pond at Hennepin Power Station," St. Louis, MO, October 2016.

[2] IngenAE, LLC, "Luminant, Dynegy Midwest Generation, LLC, Hennepin Power Plant, CCR Facility Boundary Exhibit," Earth City, MO, September 21, 2021.

[3] United States Environmental Protection Agency, "Walkthrough to Install and Operate the Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07," 2017.

[4] Ramboll, "Groundwater Model Report, East Ash Pond, Hennepin Power Plant, Henenpin, Illinois," January 2022.

[5] D. Jones and S. F. Putrich, "Construction Documentation, Hennepin Station - Phase 1 Landfill Frost Protection Layer Installation, CEC Project No. 082-255.6006," March 3, 2011.

[6] Geosyntec Consultants, "2021 USEPA CCR Rule Periodic Certificaiton Report, §257.73(a)(2), (c)(, (d), (e) and §257.82, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois," Chesterfield, Missouri, October 11, 2021.

ATTACHMENT A

Closure Alternatives Analysis

Closure Alternatives Analysis
East Ash Pond
Hennepin Power Plant
Hennepin, Illinois

January 28, 2022

GRADIENT

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
BMP	Best Management Practice
CAA	Closure Alternatives Analysis
CBR-Offsite	Closure-by-Removal with Off-Site CCR Disposal
CCR	Coal Combustion Residual
CIP	Closure-in-Place
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CQA	Construction Quality Assurance
CY	Cubic Yard
DMG	Dynegy Midwest Generation, LLC
EAP	East Ash Pond
EJ	Environmental Justice
GHG	Greenhouse Gas
GWPS	Groundwater Protection Standards
IAC	Illinois Administrative Code
ID	Identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
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
US DOT	United States Department of Transportation
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 East Ash Pond (EAP) located on Dynegy Midwest Generation, LLC's (DMG) Hennepin Power Plant property near the Village of Hennepin, Illinois. 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). Gradient evaluated two specific closure scenarios for the EAP: Closure-in-Place (CIP) and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). The CIP scenario entails capping the EAP with a new cover system consisting of, from bottom to top, a geomembrane layer, a geotextile cushion if needed, and 24 inches of vegetated soil. The CBR-Offsite scenario entails excavating all of the CCR from the EAP and transporting it to an off-Site landfill for disposal. DMG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the EAP as an alternative to disposal.

IAC Section 845.710(c)(2) requires CAAs to "[i]dentify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not, whether constructing an onsite landfill is possible" (IEPA, 2021a). There is an existing CCR landfill at the Hennepin site: the Hennepin Landfill. However, the single cell at the Hennepin Landfill is only 4.5 acres in size (Geosyntec, 2022a). This landfill does not currently have the capacity to contain all of the CCR that would be excavated from the EAP under the CBR-Offsite scenario (Geosyntec, 2022a). Due to the presence of other closed impoundments in the immediate vicinity of the landfill, the landfill also cannot be expanded in order to increase its capacity. No other areas on the property were identified that are suitable for construction of a new on-Site landfill (Geosyntec, 2022a). Construction of a new on-Site landfill would also interfere with existing plans to re-develop the property for use in utility-scale solar generation and battery storage; construction of the new on-Site landfill (and other closure activities) would need to occur concurrently with solar re-development activities, resulting in increased traffic on Site access roads and greater risks to workers due to on-Site accidents (Geosyntec, 2022a). In summary, neither expansion of the existing on-Site landfill nor construction of a new on-Site landfill is a viable alternative at this Site.

Table S.1 summarizes the expected impacts of the CIP 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 additional details provided in Section 2 of this report, CIP has been identified as the most appropriate closure scenario for the EAP. Key benefits of the CIP scenario relative to the CBR-Offsite scenario include the more rapid re-development of the Site for use in utility-scale solar generation and greatly reduced impacts to workers, community members, and the environment during construction (*e.g.*, fewer constructed-related accidents, lower energy demands, less air pollution and greenhouse gas [GHG] emissions, less traffic, and potentially lower impacts to environmental justice [EJ] communities).

Table S.1 Comparison of Proposed Closure Scenarios

Evaluation Factor (Report Section; IAC Part 845 Section)	Closure Scenario	
	CIP	**CBR-Offsite**
Closure Alternative Descriptions (Section 2.1, IAC Section 845.710(c))	The EAP will be capped in place with a new cover system consisting of, from bottom to top, a geomembrane layer, a geotextile cushion if needed, and 24 inches of vegetated soil.	All CCR and existing liner materials will be excavated from the EAP and transported to an off-Site landfill for disposal.
Type and Degree of Long-Term Management, Including Monitoring, Operation, and Maintenance (Section 2.2.3, IAC Section 845.710(b)(1)(C))	Monitoring will be performed for 30 years post-closure or until groundwater protection standards (GWPSs) are achieved, whichever is longer. The final cover system for the EAP will undergo 30 years of annual inspections, mowing, and maintenance.	Monitoring will be performed for 3 years post-closure or until GWPSs are 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 EAP. Because there are no current risks, and dissolved constituent concentrations are expected to decline post-closure, 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 EAP. Because there are no current risks, and dissolved constituent concentrations are expected to decline post-closure, no risks to human or ecological receptors are expected post-closure.
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 is 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 will 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 is 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 is no risk of CCR releases due to dike failure.

Evaluation Factor (Report Section; IAC Part 845 Section)	Closure Scenario	
	CIP	CBR-Offsite
Worker Risks (Section 2.2.4.1, IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))	An estimated 0.0021 worker fatalities and 0.32 worker injuries are expected to occur on-Site under this closure scenario. An additional 0.0023 worker fatalities and 0.17 worker injuries are expected to occur off-Site due to vehicle accidents during hauling, labor and equipment mobilization and demobilization, and material deliveries. In total, 0.0044 worker fatalities and 0.49 worker injuries are expected under this closure scenario (a smaller number than under the CBR-Offsite scenario). Simultaneous with closure activities, the Hennepin 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 CBR-Offsite scenario.	An estimated 0.0016 worker fatalities and 0.25 worker injuries are expected to occur on-Site under this closure scenario. An additional 0.015 worker fatalities and 0.88 worker injuries are expected to occur off-Site due to vehicle accidents during hauling, labor and equipment mobilization and demobilization, and material deliveries. In total, 0.017 worker fatalities and 1.1 worker injuries are expected under this closure scenario (a greater number than under the CIP scenario). Simultaneous with closure activities, the Hennepin 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 CBR-Offsite scenario is expected to result in more traffic congestion – and, hence, a greater increase in risks to workers – than the CIP scenario.
Community Risks (Section 2.2.4.2, IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))		

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
Off-Site Impacts on Nearby Residents and EJ Communities	Off-Site impacts on nearby residents and EJ communities (including accidents, traffic, noise, and air pollution) will be much smaller under this closure scenario because it requires significantly less off-Site vehicle and equipment travel miles than the CBR-Offsite scenario: 345,000 total off-Site travel miles are required for the CIP scenario, whereas 3,940,000 total off-Site travel miles are required for the CBR-Offsite scenario. In total, an estimated 0.0020 fatalities and 0.096 injuries are expected to occur among community members due to off-Site activities. A haul truck is likely to pass a location near the Site every 11 minutes on average during working hours for approximately six months under this closure scenario due to the hauling of borrow soil to the Site, resulting in moderate traffic demands for a short period of time.	Off-Site impacts on nearby residents and EJ communities will be much greater under this closure scenario because it requires significantly more off-Site vehicle and equipment travel miles than the CIP scenario: 345,000 total off-Site travel miles are required for the CIP scenario, whereas 3,940,000 total off-Site travel miles are required for the CBR-Offsite scenario. In total, an estimated 0.045 fatalities and 1.4 injuries are expected to occur among community members due to off-Site activities. A haul truck is likely to pass a location near the Site every 3.4 minutes on average during working hours for approximately 30 months under this closure scenario due to the hauling of CCR from the Site and the hauling of borrow soil to the Site, resulting in considerable traffic demands for an extended period of time.
Impacts on Scenic, Historical, and Recreational Value	Due to (*e.g.*) noise and visual disturbances, construction activities may have short-term negative impacts on the recreational use of the Donnelley/DePue State Fish and Wildlife Areas complex and the Illinois River. Because the duration of construction activities is expected to be shorter under this closure scenario (approximately 10 months) compared to the CBR-Offsite scenario (approximately 33 months), short-term impacts on the scenic and recreational value of natural areas near the Site will be smaller under this closure scenario compared to CBR-Offsite scenario.	Due to (*e.g.*) noise and visual disturbances, construction activities may have short-term negative impacts on the recreational use of the Donnelley/DePue State Fish and Wildlife Areas complex and the Illinois River. Because the duration of construction activities is expected to be longer under this closure scenario compared to the CIP scenario, short-term impacts on the scenic and recreational value of natural areas near the Site will be greater under this closure scenario compared to CIP scenario.
Environmental Risks (Section 2.2.4.3, IAC Sections 845.710(b)(1)(D) and 845.710(b)(1)(F))		

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
Impacts on Greenhouse Gas Emissions and Energy Consumption	Total energy demands and GHG emissions are expected to be much smaller under this closure scenario than under the CBR-Offsite scenario, because the total equipment and vehicle mileages required under this closure scenario are an order of magnitude smaller than those required under the CBR-Offsite scenario: 398,000 total on-Site and off-Site travel miles are required for the CIP scenario, whereas 4,170,000 total on-Site and off-Site travel miles are required for the CBR-Offsite scenario. 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 will occur more rapidly under the CIP scenario than under the CBR-Offsite scenario.	Total energy demands and GHG emissions are expected to be much greater under this closure scenario than under the CIP scenario, because the total equipment and vehicle mileages required under this closure scenario are an order of magnitude greater than those required under the CIP scenario: 398,000 total on-Site and off-Site travel miles are required for the CIP scenario, whereas 4,170,000 total on-Site and off-Site travel miles are required for the CBR-Offsite scenario. 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 will occur more slowly under the CBR-Offsite scenario than under the CIP scenario.
Impacts on Natural Resources and Habitat	Construction may have short-term negative impacts on terrestrial species located near the EAP and the off-Site borrow soil location. Impacts on natural resources and habitat are expected to be smaller under the CIP scenario than under the CBR-Offsite scenario, because the overall duration of construction is shorter under the former scenario. Post-closure, we expect habitat on top of the EAP to improve since the cover system will be vegetated with grasses.	Construction may have short-term negative impacts on terrestrial species located near the EAP and the off-Site borrow soil location. Impacts on natural resources and habitat are expected to be greater under the CBR-Offsite scenario than under the CIP scenario, because the overall duration of construction is longer under the former scenario. Post-closure, we expect habitat on top of the EAP to improve.

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**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))	Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the EAP under each of the proposed closure alternatives (Ramboll, 2022). Because there are no known potential GWPS exceedances in groundwater associated with the EAP (Ramboll, 2021), modeling of closure alternatives evaluated whether groundwater quality would be maintained in compliance with the relevant GWPSs post-closure. The modeling concluded that groundwater quality near the EAP will maintain compliance with the GWPSs for a period of at least 30 years post-closure for both CIP and CBR-Offsite (Ramboll, 2022).	Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the EAP under each of the proposed closure alternatives (Ramboll, 2022). Because there are no known potential GWPS exceedances in groundwater associated with the EAP (Ramboll, 2021), modeling of closure alternatives evaluated whether groundwater quality would be maintained in compliance with the relevant GWPSs post-closure. The modeling concluded that groundwater quality near the EAP, will maintain compliance with the GWPSs for a period of at least 30 years post-closure for both CIP and CBR-Offsite (Ramboll, 2022).
Long-Term Reliability of the Engineering and Institutional Controls (Section 2.2.7; IAC Section 845.710(b)(1)(G))	CIP is expected to be a reliable closure alternative over the long term.	CBR-Offsite is 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 under either closure scenario.	Corrective action is not expected to be required at this Site under either closure scenario.
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 EAP under either closure scenario. During closure, there is minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Post-closure, the risks of overtopping and dike failure will 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 EAP under either closure scenario. During closure, there is minimal risk of dike failure occurring and minimal risk of dike overtopping during flood conditions. Following excavation, there is no risk of CCR releases due to dike failure.
Ease or Difficulty of Implementing the Alternative (Section 2.4, IAC Section 845.710(b)(3))		

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
Degree of Difficulty Associated with Construction	CIP is a reliable and standard method for managing and closing waste impoundments. Dewatering and excavating saturated CCR to construct a stabilized final cover system subgrade may present challenges during closure; however, these challenges are common to most CCR surface impoundment closures and are commonly addressed *via* surface water management and dewatering techniques.	Relative to CIP, CBR-Offsite will cause additional implementation difficulties due to significantly higher earthwork volumes and dewatering volumes, a longer construction schedule, and the need to remove and dispose of the existing bottom liner geomembrane. Hauling will also be more difficult to implement under the CBR-Offsite scenario, due to significantly greater earthwork volumes and increased haul traffic on public roadways. Because CCR will require hauling on public roads (*i.e.*, intrastate travel), it will need to be dewatered to a greater extent than will be necessary for the CIP scenario. Off-Site landfilling under the CBR-Offsite scenario will require the development of a disposal plan and may raise issues related to the co-disposal of CCR and other non-hazardous wastes. The off-Site landfill may also need to be expanded to receive all of the CCR generated during excavation.
Expected Operational Reliability	Operational reliability is expected under both closure scenarios.	Operational reliability is expected under both closure scenarios.
Need for Permits and Approvals	Permits required under both 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 EAP to be modified as part of closure; a construction stormwater permit through IEPA; and a joint water pollution control construction and operating permit (WPC permit).	Permits required under both 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 EAP to be modified as part of closure; a construction stormwater permit through IEPA; and a WPC permit. Relative to the CIP scenario, additional permits and approvals may be required under the CBR-Offsite scenario if the landfill must be expanded to receive all of the CCR from the EAP.

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
Availability of Equipment and Specialists	CIP and CBR-Offsite rely on common construction equipment and materials and typically do not require the use of specialists. 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 delays in construction under both scenarios if supply chain resilience does not improve by the time of construction. Due to smaller earthwork volumes and a lesser need for construction equipment under the CIP scenario than under the CBR-Offsite scenario, shortages may cause fewer challenges under the CIP scenario than under the CBR-Offsite scenario.	CIP and CBR-Offsite rely on common construction equipment and materials and typically do not require the use of specialists. 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 delays in construction under both scenarios if supply chain resilience does not improve by the time of construction. Due to significantly higher earthwork volumes and a greater need for construction equipment under the CBR-Offsite scenario than under the CIP scenario, shortages may cause greater challenges under the CBR-Offsite scenario than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due to the large volumes of borrow soil and CCR to be hauled to and from the Site.

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
Available Capacity and Location of Treatment, Storage, and Disposal Services	Under the CIP scenario, all of the CCR currently within the EAP will be stored within the footprint of the EAP. Treatment will consist of unwatering the EAP at the start of construction, performing limited dewatering to stabilize the CCR subgrade, and managing stormwater inflow. Water from unwatering and dewatering of the EAP will be discharged *via* the existing NPDES permit, utilizing the existing Leachate Pond and Polishing Pond as settling basins.	The capacity remaining at the chosen off-Site landfill in Ottawa, Illinois, is sufficient to receive all of the CCR in the EAP. However, closure of the EAP would increase the annual waste receipt rate at the off-Site landfill by approximately 50%. Due to 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 LandComp landfill were found to be impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. Water treatment will consist of unwatering/dewatering the EAP at the start of construction. Water from unwatering and dewatering of the EAP will be discharged *via* the existing NPDES permit, utilizing the existing Leachate Pond and Polishing Pond as settling basins. Under the CBR-Offsite scenario, a higher volume of water will be sent to the Leachate Pond/Polishing Pond compared to the CIP scenario, due to the longer construction schedule and the greater amount of dewatering that will need to occur for CCR to be transported on public roads to an off-Site disposal location.
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 are anticipated.	No current or future exceedances of any screening benchmarks for surface water are anticipated.
Potential Modes of Transportation Associated with CBR (Section 2.1; IAC Section 845.710(c)(1)	This factor is not relevant for CIP.	IAC Section 845.710(c)(1) requires CBR alternatives to consider multiple methods for transporting CCR off-Site, including rail, barge, and trucks. Geosyntec (2022a) 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. Truck transport has been identified as the preferred option for transport of CCR to the off-Site landfill.

Evaluation Factor (Report Section; IAC Part 845 Section)	**Closure Scenario**	
	CIP	**CBR-Offsite**
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 at the Site. Relative to CBR-Offsite, CIP also presents far less risks to nearby residents and potentially EJ communities in the form of accidents, traffic, noise, 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 8, 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, the CBR-Offsite scenario has several disadvantages with regard to potential community concerns. Relative to CIP, the CBR-Offsite scenario presents far greater risks to nearby residents and potentially EJ communities in the form of accidents, traffic, noise, and air pollution. Moreover, under the CBR-Offsite scenario, the Site could take longer to re-develop for use in utility-scale solar generation. A public meeting was held on December 8, 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 2.7, IAC Section 845.710(d)(1))	The CIP scenario can be implemented at a lower total cost (approximately \$5.79 million) than the CBR-Offsite scenario (approximately \$105 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 \$5.79 million) than the CBR-Offsite scenario (approximately \$105 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 Offsite CCR Disposal; CCR = Coal Combustion Residual; CIP = Closure-in-Place; EAP = East Ash Pond; EJ = Environmental Justice; GHG = Greenhouse Gas; IAC = Illinois Administrative Code; IDNR = Illinois Department of Natural Resources; 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

Dynegy Midwest Generation, LLC's (DMG) Hennepin Power Plant is an electric power generating facility with coal-fired units located approximately 4 miles northeast of the Village of Hennepin, Illinois, along the Illinois River. The facility began operating in the early 1950s and was retired in 2019 (Ramboll, 2021). The plant had two coal-fired units constructed in 1953 and 1959 with a capacity of 70 MW and 210 MW, respectively (Ramboll, 2021).

1.1.2 CCR Impoundment

The Hennepin Power Plant produced and stored coal combustion residuals (CCRs) as a part of its historical operations. The East Ash Pond (EAP; Vistra ID No. CCR Unit 803, Illinois Environmental Protection Agency [IEPA] ID No. W1550100002-05, and National Inventory of Dams [NID] ID No. IL50363) is the subject of this report.

The EAP (Figure 1.1) is a lined surface impoundment that underwent the first phase of construction in the mid-1990s, when the pond bottom and sidewalls were constructed (Ramboll, 2021). The sidewall liners were raised during the second phase of construction in 2003 (Ramboll, 2021). The pond was used to store and dispose of bottom ash, fly ash, and other non-CCR waste until the plant was retired in 2019 (Ramboll, 2021). Today, only stormwater flows to the EAP. Flows from the EAP are routed to the Leachate Pond and the Secondary (Polishing) Pond (Figure 1.1). The Secondary Pond flows to the Illinois River *via* a National Pollutant Discharge Elimination System (NPDES)-permitted outfall (Geosyntec, 2022a).

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

1.1.3 Surface Water Hydrology

The Illinois River is located approximately 0.1 miles north of the outer perimeter of the EAP. In the vicinity of the EAP, the river flows from east to west. As described below (Section 1.1.4, Hydrogeology), the Illinois River acts as a regional sink for surface water and groundwater in the vicinity of the Site.

The EAP is located within the DePue Lake-Illinois River Watershed (Ramboll, 2021). The IEPA classifies the River as a General Use Water: it is designated for aquatic life and use in primary contact recreation; however, it is not designated for use in food processing or as a public water supply. The segment of the Illinois River adjacent to the Site (Section D-16) is listed on the 2018 Illinois Section 303(d) List as being impaired for fish consumption, due to mercury and polychlorinated biphenyls. DePue Lake, which is located north of the Site along the north bank of the Illinois River, is listed as impaired for aquatic life due to cadmium, endrin, silver and zinc; it is also listed as impaired for fish consumption due to mercury and polychlorinated biphenyls (IEPA, 2016, 2019a).

Surface water samples were collected from 15 locations along the Illinois River adjacent to the Hennepin Power Plant in September 2020. The samples were taken along five transects, with three samples collected per transect (Geosyntec, 2021a). The results from the September 2020 surface water sampling campaign are summarized in Gradient's Human Health and Ecological Risk Assessment for the Site, which is provided as Appendix A of this report.

1.1.4 Hydrogeology

Two distinct hydrostratigraphic units have been identified in the area: the uppermost water-bearing unit, which consists of the clayey sands to sandy clays of the Cahokia Alluvium and the sand and gravels of the Henry Formation, and a confining shale bedrock unit. The Cahokia Alluvium consists of fine-grained sandy-silts and clay deposits of the Illinois River. The Henry Formation fills the valley under the Cahokia Alluvium and is composed of highly permeable glacial outwash deposits of sands and gravels. The total thickness of the uppermost water-bearing unit is approximately 80 feet (ft) beneath the EAP (Ramboll, 2021). The low-permeability bedrock aquitard underlying the Henry Formation acts as a barrier to the downward migration of groundwater (Ramboll, 2021). This aquitard consists of low-permeability shales and thin layers of limestone, sandstone, and coal beds of the Pennsylvanian Carbondale Formation (Ramboll, 2021). In the vicinity of the EAP, the estimated thickness of this layer is approximately 300-400 ft (Ramboll, 2021).

The highly permeable glacial outwash and re-worked glacial deposits of the Henry Formation are the primary conduit for groundwater flows beneath the EAP (Ramboll, 2021). Groundwater flows from south to north/northwest beneath the EAP towards the Illinois River, which serves as a large regional hydraulic boundary. Groundwater surrounding the EAP flows northwards and upwards into the River (Ramboll, 2021). During groundwater interaction with surface water, CCR-related constituents may partition between sediments and the surface water column. It should be noted that many CCR-related constituents occur naturally in sediments and surface water (and can also arise from other industrial sources). As a result, their presence in the sediments and/or surface water of the Illinois River does not signify contributions from the EAP.

Groundwater samples have been collected from monitoring wells at the Site since approximately 1983. The Hydrogeologic Site Characterization Report prepared by Ramboll as part of the Operating Permit for the EAP includes a summary of groundwater data collected from EAP monitoring wells between 1995 and 2021 at the Site (Ramboll, 2021).

1.1.5 Site Vicinity

The EAP is surrounded by the Illinois River to the north, industrial properties to the east (Tri-Con Materials) and south (Tri-Con Materials and Washington Mills), agricultural land to the southwest, and the Hennepin Power Station to the west (Figure 1.1). Tri-Con Materials produces various fill and washed sand, gravel, rock and boulder products (Ramboll, 2018-2020). Washington Mills produces abrasive grains and specialty electro-fused minerals (Ramboll, 2018-2020).

Notable natural areas and recreational areas in the vicinity of the EAP include the Illinois River and the Donnelley/DePue State Fish and Wildlife Areas complex, which is located opposite the EAP along the northern bank of the Illinois River. The Illinois River is popular for canoeing and other forms of water recreation (Illinois Dept. of Natural Resources, 2021). The nearby DePue Lake and Lyons Lake are popular spots for recreational boating and fishing (Illinois River Road National Scenic Byway, 2021; HookandBullet.com, 2021).

1.2 IAC 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 EAP pursuant to requirements under IAC Section 845.710. 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

2.1 Closure Alternative Descriptions (IAC Section 845.710(c))

This section of the report presents a CAA for the EAP pursuant to requirements under IAC Section 845.710 (IEPA, 2021a). The two closure scenarios evaluated in this CAA are Closure-in-Place (CIP) and Closure-by-Removal with Off-Site CCR Disposal (CBR-Offsite). Under the CIP scenario, the CCR will remain in place and the EAP will be capped with a new cover system. Under the CBR-Offsite scenario, all of the CCR will be excavated from the impoundment and hauled to an off-Site landfill. DMG will also continue to evaluate potential opportunities for beneficial re-use of CCR excavated from the EAP as an alternative to disposal.

IAC Section 845.710(c)(2) requires CAAs to, "[i]dentify whether the facility has an onsite landfill with remaining capacity that can legally accept CCR, and, if not, whether constructing an onsite landfill is possible" (IEPA, 2021a). There is an existing CCR landfill located adjacent to the EAP at the Hennepin site, the Hennepin Landfill (Figure 1.1). However, the single cell at the Hennepin Landfill is only 4.5 acres in size (Geosyntec, 2022a). This landfill does not currently have the capacity to contain all of the CCR that would be excavated from the EAP under the CBR-Offsite scenario (Geosyntec, 2022a). Due to the presence of other closed impoundments in the immediate vicinity of the landfill, the landfill also cannot be expanded in order to increase its capacity. Geosyntec has attempted to identify another area on the property that would be suitable for construction of a new on-Site landfill; however, none of the six areas that Geosyntec evaluated were found to be suitable for new landfill construction, due to either their location with respect to the floodplain or various engineering limitations (Geosyntec, 2022a). Construction of a new on-Site landfill would also interfere with existing plans to re-develop the property for use in utility-scale solar generation and battery storage; construction of the new on-Site landfill (and other closure activities) would need to occur concurrently with solar re-development activities, resulting in increased traffic on Site access roads and greater risks to workers due to on-Site accidents (Geosyntec, 2022a). In summary, neither expansion of the existing on-Site landfill nor construction of a new on-Site landfill is a viable alternative at this site.

While not addressed in this report, closure of the Hennepin Landfill may be performed concurrently with the planned closure of the EAP. The Hennepin Landfill was constructed with approximately 8,000 cubic yards (CY) of bottom ash used as a protection layer, which protects the landfill's secondary clay liner from damage during freezing and thawing cycles (Geosyntec, 2022a). Other than the bottom ash protective layer, the Hennepin Landfill never received CCR waste material prior to or post-retirement in 2019. As is described below (Section 2.1.1), the CIP scenario includes excavation of this bottom ash protection layer for use as contouring fill during closure of the EAP (Geosyntec, 2022a), consistent with the requirements in IAC Section 845.750(d) (IEPA, 2021a; Geosyntec, 2022a).

Sections 2.1.1 and 2.1.2 provide detailed descriptions of the CIP and CBR-Offsite closure scenarios. These scenarios are based on closure documents and analyses provided to Gradient by Geosyntec (Geosyntec, 2022a,b).

2.1.1 Closure-in-Place

Under the CIP scenario, the EAP will be capped in place with a final cover system. This scenario includes the following work elements (Geosyntec, 2022a):

- Elimination of free liquids by solidifying waste residues, as needed, or by removing liquid waste, including *via* pumping to the adjacent Secondary Pond or Leachate Pond.
- Contouring and grading to manage stormwater.
- Construction of an alternative cover system consisting of a 40-mil linear low-density polyethylene (LLDPE) geomembrane layer, a geotextile cushion if needed, and 24 inches of soil sourced from an off-Site location. The soil layer would include a 6-inch-thick topsoil layer and be revegetated with native grasses. The performance of this alternative cover system relative to a default cover is presented in Geosyntec (2022c).
- Long-term (post-closure) monitoring and maintenance, including at least 30 years of groundwater monitoring at the impoundment, or until such time as groundwater protection standards (GWPSs) are achieved. Additionally, 30 years of post-closure care will be undertaken for the final cover system, including annual cap inspections, mowing, and maintenance.

This CIP scenario meets all closure requirements of Part 845.750 (Geosyntec, 2022b). Key closure elements that address the Part 845 closure requirements are summarized below. Further details are provided in the Closure Plan (Geosyntec, 2022b).

- An alternative cover system will be installed over the CCR that remains in the EAP. The cover, consisting of a 40-mil LLDPE geomembrane low-permeability layer, a geotextile cushion if needed, and 24 inches of soil, will minimize vertical infiltration of precipitation into the basin [Part 845.750(a)(1)].
- All areas of the alternative cover system will be sloped in order to positively drain to the exterior of the EAP, thereby precluding any future impoundment of water [Part 845.750(a)(2)].
- Surface water will be removed from the top of the final cover *via* the construction of a free-draining stormwater management system, including channels and letdown structures [845.750(a)(2)].
- Free liquids in the CCR will be eliminated by solidifying waste residues, as needed, or by removing liquid waste. Liquids may be removed using a system of trenches and/or sumps; water will then be pumped to the Secondary Pond or the Leachate Pond [845.750(b)(1) and 845.750(b)(2)].

As an additional consideration, the proposed alternative cover and the existing bottom liner (consisting of 4 ft of compacted clay) and side liners (consisting of a 45-mil polypropylene geomembrane, 1 foot of compacted clay, and an 8-ounce geotextile) will be tied together, thereby encapsulating the CCR and minimizing any releases of CCR or leachate into groundwater or surface waters. Lateral infiltration of groundwater into the basin will also be controlled. Under normal conditions, the groundwater surface elevation is located approximately 12 ft below the lowest elevation of CCR in the EAP (*i.e.*, groundwater does not intersect ash in the basin; Geosyntec, 2022b); thus, there will be no post-closure infiltration of groundwater into the basin. Even during potential seasonal events that may cause transient groundwater elevations to temporarily rise, groundwater infiltration into the basin will be minimized due to the presence of the existing bottom and side liners (Geosyntec, 2022b).

In total, 45,200 CY of material are required for contouring and grading of the EAP (in-place volume after compaction). Geosyntec estimates that 37,200 CY of this material will be sourced from the CCR within the EAP. An additional 8,000 CY will be sourced from the bottom ash protection layer of the Hennepin Landfill. Contouring of this bottom ash material will be performed consistent with the requirements in IAC Section 845.750(d) (IEPA, 2021a; Geosyntec, 2022b). Construction of the final cover system will require an additional 70,100 CY of soil (hauled volume before compaction) to be hauled to the Site from a nearby borrow area (Geosyntec, 2022a). Borrow soil will be hauled to the Site using haul trucks with an assumed capacity of 16.5 CY (Geosyntec, 2022a).

DMG owns property near the Site that could potentially be used as a borrow site; however, this property is being reserved for use in utility-scale solar generation and battery storage. A borrow site will therefore need to be established off-Site. Because the EAP is located near the Site boundary and a Site access gate that leads to a county road, Geosyntec expects that it will be possible to identify a suitable borrow location within 2 miles of the Site. Under the CIP scenario, the overall duration of closure activities is expected to be approximately 10 months (Geosyntec, 2022b). Key parameters for the CIP scenario are shown in Table 2.1.

Table 2.1 Key Parameters for the Closure-in-Place Scenario

Parameter	
Surface Area of EAP	21 acres
Duration of Construction Activities	10 months
Distance to the Borrow Site	2 miles
Hauled Volume of Borrow Soil	70,100 CY
Labor Hours	
Total On-Site Labor	27,900 hours
Total Off-Site Labor	2,190 hours
Engineering Support and CQA During Construction	2,640 hours
30% Contingency	9,800 hours
Total Labor Hours:	42,600 hours
Vehicle and Equipment Travel Miles	
Vehicles On-Site	7,190 miles
Equipment On-Site	44,400 miles
On-Site Haul Trucks (Unloaded + Loaded)	850 miles
Labor Mobilization	258,000 miles
Equipment Mobilization (Unloaded + Loaded)	24,300 miles
Off-Site Haul Trucks (Unloaded + Loaded)	34,400 miles
Material Deliveries (Unloaded + Loaded)	28,100 miles
Total On-Site Vehicle and Equipment Travel Miles:	52,500 miles
Total Off-Site Vehicle and Equipment Travel Miles:	345,000 miles
Total Vehicle and Equipment Travel Miles:	398,000 miles

Notes:
CQA = Construction Quality Assurance; CY = Cubic Yards; EAP = East Ash Pond.
Sources: Geosyntec (2022a,b).

2.1.2 Closure-by-Removal with Off-Site CCR Disposal

Under the CBR-Offsite scenario, CCR will be excavated from the EAP and transported to an off-Site landfill for disposal. CCR will be sent to the LandComp Landfill in Ottawa, Illinois (2840 E. 13th Road), which is located approximately 32 miles from the Site (Geosyntec, 2022a). As is described below in

Section 2.4.5, it is possible that the LandComp Landfill will have to be expanded in order to accept all of the CCR from the EAP.

IAC Section 845.710(c)(1) requires CBR alternatives to consider multiple methods for transporting CCR off-Site, including rail, barge, and trucks. Geosyntec (2022a) 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. Transporting CCR by rail would require the construction of a new rail loading terminal on-Site and the construction of a new rail unloading terminal near the off-Site landfill. The construction of new rail terminals would require coordination with the railroad and additional permitting, which could negatively impact the project schedule. Trucks would still be needed to haul CCR to and from the terminals, and additional CCR exposures could occur during the loading and unloading of CCR into trucks and rail cars. Moreover, because there is no direct rail route from the Site to the off-Site landfill, the transport of CCR to the off-Site landfill would require 51 miles of rail transport on tracks owned by three separate rail lines.

Barge transport would similarly require the construction of a new loading terminal along the Illinois River, which would necessitate additional permitting and could negatively impact the project schedule. There are other loading terminals located within 5 miles of the Site; however, these terminals belong to other parties. Use of these terminals would therefore require negotiating agreements with the terminal owner and/or operator. Additionally, upgrades would likely be required at these terminals. Negotiations and terminal upgrades would also likely be required to secure the use of a terminal near the off-Site landfill. The terminal closest to the off-Site landfill is a loading terminal and would require upgrades to allow CCR to be unloaded. As with rail terminals, trucks would still be needed to haul CCR to and from the loading and unloading terminals, and additional CCR exposures could occur during the loading and unloading of CCR into trucks and onto barges. For all of these reasons, truck transport has been identified as the preferred option for transport of CCR to the off-Site landfill. Transportation *via* truck would not require the construction of additional loading or unloading infrastructure, and would not result in project delays due to permitting and coordination with other parties. The existing travel routes from the Site to the off-Site landfill are suitable for CCR transport *via* truck (Geosyntec, 2022a).

This scenario includes the following work elements (Geosyntec, 2022a):

- Removal of the existing free water from the EAP *via* pumping to the adjacent Secondary Pond or Leachate Pond, which drain to the Illinois River.
- Construction of stormwater control structures to convey runoff away from the impoundment and towards the Secondary Pond or Leachate Pond.
- Excavation of CCR, the existing geomembrane slide-slope liner, and an additional one foot of perimeter soils from the impoundment, and transport of these materials to the off-Site landfill.
- To allow stormwater to undergo gravity-driven flow into the Secondary Pond post-closure and prevent the impoundment of water, the excavated area will be backfilled with soil to an elevation of 480.4 ft near the riser structure.
- Site restoration, including the placement of six inches of topsoil along the side slopes and bottom of the EAP and revegetation with native grasses.
- Monitoring for 3 years post-closure or until such time as GWPSs are achieved, whichever is longer.

Material for backfilling the EAP post-closure will be hauled in from an offsite borrow area. In total, a hauled borrow soil volume of 410,000 CY will potentially be required under this closure scenario (Geosyntec, 2022a). As with the CIP scenario, a suitable borrow location is assumed to be located within

2 miles of the Site. A haul truck capacity of 16.5 CY is assumed for both the transport of borrow soil and CCR (Geosyntec, 2022a).

The overall duration of closure activities under this closure scenario is approximately 33 months (Geosyntec, 2022a). Key parameters for the CBR-Offsite scenario are shown in Table 2.2.

Table 2.2 Key Parameters for the Closure-by-Removal with Off-Site CCR Disposal Scenario

Parameter	Value
Surface Area of EAP	21 acres
Duration of Construction Activities	33 months
Distance to the Off-Site Landfill	32 miles
Hauled Volume of CCR and Liner	710,000 CY
Distance to the Borrow Site	2 miles
Hauled Volume of Borrow Soil	410,000 CY
Labor Hours	
Total On-Site Labor	21,500 hours
Total Off-Site Labor	81,100 hours
Engineering Support and CQA During Construction	8,340 hours
30% Contingency	33,300 hours
Total Labor Hours:	144,200 hours
Vehicle and Equipment Travel Miles	
Vehicles On-Site	32,400 miles
Equipment On-Site	199,000 miles
On-Site Haul Trucks (Unloaded + Loaded)	0 miles
Labor Mobilization	773,000 miles
Equipment Mobilization (Unloaded + Loaded)	158,000 miles
Off-Site Haul Trucks (Unloaded + Loaded)	2,950,000 miles
Material Deliveries (Unloaded + Loaded)	60,000 miles
Total On-Site Vehicle and Equipment Travel:	232,000 miles
Total Off-Site Vehicle and Equipment Travel:	3,940,000 miles
Total Vehicle and Equipment Travel:	4,170,000 miles

Notes:
CCR = Coal Combustion Residual; CQA = Construction Quality Assurance; CY = Cubic Yard; EAP = East Ash Pond.
Sources: Geosyntec (2022a).

2.2 Long- and Short-Term Effectiveness of the 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 (Appendix A), which provides a detailed evaluation of the magnitude of existing risks to human and ecological receptors associated with the EAP. This report concluded that there are no current unacceptable risks to any human or ecological receptors. Because there are no current risks to any human or ecological receptors, and dissolved constituent concentrations are expected to decline post-closure, no post-closure risks are expected under either closure scenario.

Thus, there is no current risk or future risk under either closure scenario, and the magnitude of reduction of existing risks is the same under both closure 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 releases of CCR that may occur during dike failure and storm-related events.

Storm-Related Releases and Dike Failure During Flood Conditions

Engineering analyses show that the EAP dikes are expected to remain stable under static, seismic, and flood conditions (Geosyntec, 2021b; AECOM, 2016). 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 risk of overtopping occurring during flood conditions is minimal under current conditions. Specifically, Geosyntec evaluated the risk of flood overtopping occurring at the EAP and found that the impoundment can adequately manage flow during peak discharge from even a 1,000-year storm event, thus preventing overtopping (Geosyntec, 2021b). Post-closure, the risks of overtopping and dike failure occurring due to floods or other storm-related events will be even smaller than they are currently. Under the CIP scenario, a new cover system will be installed, which will include 24 inches of soil and a geomembrane liner, as well as new stormwater control structures. Relative to current conditions, this cover system will provide increased protection against berm and surface erosion, groundwater infiltration, and other adverse effects that could potentially trigger a dike slope failure event. Geosyntec evaluated slope stability under post-closure conditions and determined that the factor of safety required to prevent dike failure will be well above minimum required values (Geosyntec, 2022b). Under the CBR-Offsite scenario, all of the CCR in the EAP will be excavated and relocated, eliminating the risk of a CCR release occurring post-closure. In summary, there is minimal current or future risk of sudden CCR releases occurring under either closure scenario either during or following closure.

Dike Failure Due to Seismicity

Four unnamed faults associated with the Troy Grove Dome are located approximately 11 miles northeast of the property (Ramboll, 2021). Additionally, the Sandwich Fault Zone and the Plum River Fault Zone are located approximately 35 miles northeast and 60 miles northwest of the property, respectively (Ramboll, 2021). While detailed information about the Sandwich Fault Zone is not readily available, United States Geological Survey (USGS) seismic hazard maps show no enhanced ground acceleration in the vicinity of the Plum River Fault Zone (Ramboll, 2021). Despite the presence of these faults, seismic analyses have revealed that the Site does not lie within a seismic impact area. Moreover, the EAP does not lie within 200 ft 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; Ramboll, 2021). For the CIP scenario, dikes, final cover, and stormwater control features have been designed to withstand earthquakes and storm events. The factor of safety in these design calculations are well above minimum regulatory requirements (Geosyntec, 2022b). Thus, the risk of dike failure occurring during or following closure activities due to seismic activity is low.

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 EAP under each closure scenario are described in Section 2.1 (Closure Alternatives Descriptions). In summary, under the CIP scenario, the EAP will undergo monitoring for 30 years post-closure, or until such time as GWPSs are achieved. Under the CBR-Offsite scenario, the EAP will undergo monitoring for 3 years post-closure, or until such time as GWPSs are achieved. The post-closure care plan for the CIP scenario additionally includes annual inspections, mowing, and maintenance of the final cover system.

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 the risk of accidents occurring 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/demobilization, material deliveries, and the hauling of borrow soil and CCR.

As shown in Tables 2.1 and 2.2, Geosyntec (2022a) estimates that the CIP scenario will require 27,900 on-Site labor hours (excluding labor hours related to engineering support and construction quality assurance [CQA] during construction and a 30% contingency). The CBR-Offsite scenario requires approximately 21,500 on-Site labor hours. The US Bureau of Labor Statistics (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 Bureau of Labor Statistics and the on-Site labor hours reported by Geosyntec, we estimate that approximately 0.32 worker injuries and 0.0021 worker fatalities will occur on-Site under the CIP scenario (Table 2.3). Under the CBR-Offsite scenario, approximately 0.25 worker injuries and 0.0016 worker fatalities are expected to occur on-Site (Table 2.3). The rate of on-Site worker accidents is therefore expected to be slightly higher under the CIP scenario than under the CBR-Offsite scenario.

Table 2.3 Expected Number of On-Site Worker Accidents Under Each Closure Scenario

Closure Scenario	Injuries	Fatalities
CIP	0.32	0.0021
CBR-Offsite	0.25	0.0016

Notes:
CIP = Closure-in-Place; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal.

A much greater number of off-Site haul truck miles, labor and equipment mobilization/demobilization miles, and material delivery miles are required under the CBR-Offsite scenario than are required under the CIP scenario (Tables 2.1 and 2.2). For example, under the CBR-Offsite scenario, 2,950,000 haul truck miles are required to haul CCR to the off-Site landfill and haul borrow soil to the Site; in contrast, under the CIP scenario, only 34,400 haul truck miles are required to haul borrow soil to the Site (Geosyntec, 2022a). Thus, in contrast to the trends observed for on-Site worker accidents, the expected number of off-Site worker accidents will be higher under the CBR-Offsite scenario than under the CIP scenario.

The United States Department of Transportation (US DOT, 2020) provides estimates of the expected number of fatalities and injuries "per vehicle mile driven" for drivers and passengers of large trucks and passenger vehicles. Table 2.4 shows the expected number of off-Site accidents under each closure scenario due to all categories of off-Site vehicle usage. For these calculations, it was assumed that labor mobilization/demobilization relied upon passenger vehicles (cars or light trucks, including pickups, vans, and sport utility vehicles) and that hauling, equipment mobilization/demobilization, and material deliveries relied upon large trucks. Based on US DOT's accident statistics and Geosyntec's mileage estimates, an estimated 0.17 injuries and 0.0023 fatalities are expected to occur among workers due to off-Site activities under the CIP scenario. Under the CBR-Offsite scenario, an estimated 0.88 injuries and 0.015 fatalities are expected to occur among workers due to off-Site activities.

Table 2.4 Expected Number of Off-Site Worker Accidents Under Each Closure Scenario

Off-Site Vehicle Use Category	CIP		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0.0044	0.0001	0.38	0.009
Labor Mobilization/Demobilization	0.16	0.0020	0.48	0.0061
Equipment Mobilization/Demobilization	0.0031	7.1×10^{-5}	0.020	0.00046
Material Deliveries	0.0036	8.2×10^{-5}	0.0077	0.00017
Total:	0.17	0.0023	0.88	0.015

Notes:
CIP = Closure-in-Place; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal.

Overall, taking into account accidents occurring both on- and off-Site, 0.49 worker injuries and 0.0044 worker fatalities are expected under the CIP scenario, whereas 1.1 worker injuries and 0.017 worker fatalities are expected under the CBR-Offsite scenario. Thus, overall risks to workers are higher under the CBR-Offsite scenario than under the CIP scenario.

Concurrently with closure activities, a utility-scale solar facility will be constructed on the Hennepin 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. Because the CIP scenario requires less hauling activity (and other forms of ingress and egress to and from the Site) than the CBR-Offsite scenario and will also be completed over a shorter time period, the CIP scenario is 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 under the CBR-Offsite scenario.

In summary, risks to workers due to accidents are expected to be greater under the CBR-Offsite scenario than under the CIP scenario. Differences in worker risks between the two scenarios are largely driven by off-Site activities.

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 reported by US DOT (2020) and the off-Site travel mileages required under the CBR-Offsite scenario (Geosyntec, 2022a), off-Site vehicle accidents could result in an estimated 1.4 injuries and 0.045 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 this closure scenario (Table 2.5). Off-Site activities are expected to result in a smaller number of expected community injuries (0.096 injuries) and fatalities (0.0020 fatalities) under the CIP scenario (Table 2.5).

Table 2.5 Expected Number of Community Accidents Under Each Closure Scenario

Off-Site Vehicle Use Category	CIP		CBR-Offsite	
	Injuries	Fatalities	Injuries	Fatalities
Hauling	0.013	0.00046	1.1	0.039
Labor Mobilization/Demobilization	0.064	0.00081	0.19	0.0024
Equipment Mobilization/Demobilization	0.0089	0.00032	0.058	0.0021
Material Deliveries	0.010	0.00037	0.022	0.0008
Total:	0.096	0.0020	1.4	0.045

Notes:
CIP = Closure-in-Place; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal.

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, the off-Site landfill, and the borrow site.

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 (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 due to CCR hauling (CBR-Offsite scenario only) and borrow soil hauling (CIP and CBR-Offsite scenarios). Under the CBR-Offsite scenario, hauling-related construction activities (*i.e.*, CCR excavation and backfilling of the EAP) are expected to take approximately 30 months and require approximately 67,900 truckloads (43,000 truckloads of CCR and 24,800 truckloads of borrow soil; Geosyntec, 2022a). Assuming 26 working days per month and 10-hour working days, a haul truck would need to pass a given location near the Site once every 3.4 minutes on average for 30 months under this closure scenario. The traffic demands of the CBR-Offsite scenario are therefore considerable. This level of traffic 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.

Traffic demands due to hauling are expected to be smaller under the CIP scenario. The CIP scenario requires approximately 4,250 truckloads to transport borrow soil to the Site, which corresponds with a haul truck passing a given location near the Site once every 11 minutes on average for the approximately 6-month duration of hauling-related construction activities (Geosyntec, 2022a,b).

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." There are no residences within 1,500 ft of planned construction areas at the Site; however, there are two industrial operations (Tri-Con Materials and Washington Mills). Employees at Tri-Con Materials and Washington Mills may be adversely impacted by noise pollution under both closure alternatives. Additionally, recreators and wildlife along the Illinois River, which lies within 1,500 ft of the EAP, could be temporarily impacted by construction noise under both scenarios. The duration of noise impacts in the vicinity of the EAP will be greater under the CBR-Offsite scenario than under the CIP scenario, because the expected duration of construction is longer under the former scenario (33 months *vs.* 10 months).

In addition to impacts in the immediate vicinity of the EAP, local roads near the Site, the off-Site landfill (CBR-Offsite scenario only), and the borrow site (CIP and CBR-Offsite scenarios) may also experience noise pollution due to high volumes of truck traffic. As described above (Traffic), the construction schedule for the CBR-Offsite scenario requires haul trucks to pass by a given location every 3.4 minutes on average for 10 hours each day for approximately 30 months. The construction schedule for the CIP scenario requires haul trucks to pass a given location every 11 minutes on average for 10 hours each day for approximately 6 months. 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 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. In summary, noise impacts are expected to be greater under the CBR-Offsite scenario than under the CIP scenario.

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 regard 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.

On-Site, emissions will be much higher under the CBR-Offsite scenario than under the CIP scenario, due to the greater amount of on-Site vehicle and equipment travel miles required under the former scenario relative to the latter (232,000 on-Site travel miles under the CBR-Offsite scenario *versus* 52,500 on-Site travel miles under the CIP scenario; Tables 2.1 and 2.2). Off-Site, emissions will similarly be much higher under the CBR-Offsite scenario than under the CIP scenario due to the greater amount of off-Site vehicle and equipment travel miles required under the former scenario relative to the latter (3,940,000 off-Site travel miles under the CBR-Offsite scenario *versus* 345,000 off-Site travel miles under the CIP scenario; *i.e*., over an order of magnitude difference).

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, 2019b). 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 (IEPA, 2019b), the nearest EJ community lies approximately 5.5 miles northeast of the Site near the City of Spring Valley (Figure 2.1). This community is unlikely to be directly impacted by on-Site air emissions, noise pollution, traffic, accidents, or other negative impacts arising at the Site. However, they may be impacted by off-Site impacts, including CCR hauling (CBR-Offsite scenario only), soil hauling (CIP and CBR-Offsite scenarios), labor and equipment mobilization/demobilization, and material deliveries. Off-Site impacts due to labor and equipment mobilization/demobilization and material deliveries are expected to be diffuse (*i.e.*, to span a wide range of transport routes originating over a wide area). Additionally, 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). Haul truck impacts, in contrast, will rely on a single transport route and will result in significant traffic impacts on local roads throughout the entire excavation period. Off-Site hauling is therefore more likely to have a significant impact on EJ communities than other types of off-Site vehicle use.

Two types of off-Site hauling are evaluated in this report: CCR hauling (CBR-Offsite scenario only) and borrow soil hauling (CIP and CBR-Offsite scenarios). Haul truck impacts on EJ communities due to soil hauling under the CIP and CBR-Offsite scenarios are expected to be small, because borrow soil will be sourced from within 2 miles of the Site, and there are no EJ communities within 2 miles of the Site. In contrast, under the CBR-Offsite scenario, EJ communities located along the haul route to the off-Site landfill or near the off-Site landfill itself may be negatively impacted throughout the excavation period by the air pollution, noise, traffic, and accidents generated by CCR-hauling activities. A review of the Illinois map of EJ communities reveals that the off-Site landfill is not located within the buffer zone of an EJ community. However, based on the three major haul routes suggested by Google Maps (Google, 2021), transport of CCR to the landfill may require hauling CCR through the buffer zone of the EJ community near Peru/La Salle (Figure 2.1).

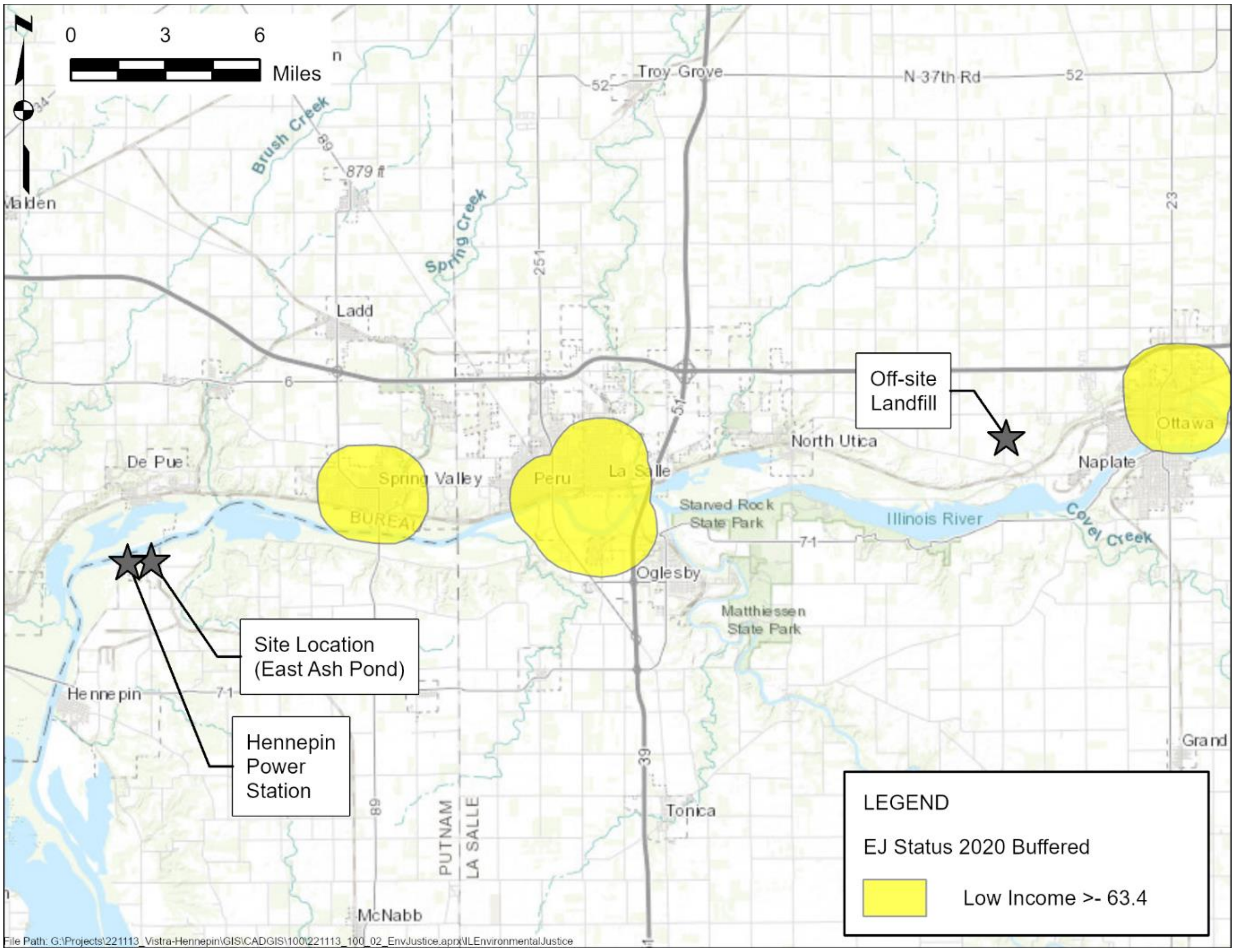

Figure 2.1 Environmental Justice Communities in the Vicinity of the Off-Site Landfill. Adapted from IEPA (2019b).

Scenic, Historical, and Recreational Value

During construction activities, negative impacts on scenic and recreational value may occur along the Illinois River and within the Donnelley/DePue State Fish and Wildlife Areas complex. The Donnelley/DePue State Fish and Wildlife Areas border the Hennepin Site to the north and west and include DePue Lake, Spring Lake, and Coleman Lake. Noise impacts were described above. In addition, construction activities at the EAP may be visible to recreators using the Illinois River, potentially interfering with enjoyment of the view. The duration of construction activities is expected to be longer under the CBR-Offsite scenario than under the CIP scenario (33 months *vs.* 10 months). It is therefore anticipated that short-term impacts on the scenic and recreational value of natural areas near the Site will be greater under the CBR-Offsite scenario than under the CIP scenario.

Based on a review of the Illinois Department of Natural Resources (IDNR) Historic Preservation Division database and the Illinois State Archaeological Survey database, there are no historic sites located within 1,000 meters of the EAP (Ramboll, 2021).

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 gases (GHGs), including carbon dioxide (CO_2) and possibly nitrous oxide (N_2O). The potential impact of each closure scenario on GHG emissions is proportional 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. In summary, GHG emissions from construction equipment and vehicles will be greater under the CBR-Offsite scenario than under the CIP scenario, because the total on-Site and off-Site vehicle and equipment travel miles required under the CBR-Offsite scenario (4,170,000 vehicles and equipment travel miles) are an order of magnitude greater than those required under the CIP scenario (398,000 vehicle and equipment travel miles; Tables 2.1 and 2.2).

We did not quantify the carbon footprint of the approximately 21 acres of 40-mil LLDPE geomembrane liner required for the final EAP cover system under the CIP scenario. The carbon footprint of this geomembrane (*i.e.*, the fossil fuel emissions required to manufacture it) is an additional source of GHG emissions at the Site under the CIP scenario. If expansion of the off-Site landfill becomes necessary in order to accept all of the CCR from the EAP, then the CBR-Offsite scenario may also have an additional, unquantified carbon footprint due to the manufacture of geomembranes used in the expanded landfill's liner.

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. Specifically, the energy demands of construction equipment and vehicles will be much greater under the CBR-Offsite scenario than under the CIP scenario. We did not quantify the energy demands of the geomembrane required for the construction of the final cover system under the CIP scenario or, potentially, the expansion of the off-Site landfill under the CBR-Offsite scenario.

The Hennepin 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. Because the CIP scenario requires less construction activity than the CBR-Offsite scenario and will be completed over a shorter time period, the CIP scenario is expected to result in fewer delays to re-development – and, hence, the more rapid realization of grid-scale energy benefits – than the CBR-Offsite scenario.

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 EAP and the off-Site borrow soil location. For example, excavation of the impoundment and the borrow soil location will result in the destruction of some habitat that may currently overlie these areas. Closure will also result in long-term shifts in the habitat overlying the EAP and the borrow soil location (*e.g.*, areas of the EAP that are not currently grassland will be converted to grassland). Use of the off-Site landfill under the CBR-Offsite scenario, in contrast, is not expected to result in significant habitat loss, because this landfill is already in use.

In addition to direct impacts to the existing habitat atop the EAP and the off-Site borrow soil location, construction activities may have indirect impacts by causing alarm and escape behavior in wildlife near these locations. The duration of time over which both direct and indirect habitat impacts occur during construction will be longer under the CBR-Offsite scenario than under the CIP scenario, due to the longer expected duration of construction activities under the former scenario (33 months *vs.* 10 months). Thus, negative short-term impacts to natural resources and habitat are expected to be greater under the CBR-Offsite scenario than under the CIP scenario.

The EAP is separated spatially from the Illinois River by a closed impoundment (AP2), the Hennepin Landfill, and the Leachate Pond (Figure 1.1). The EAP is also not located immediately adjacent to any wetlands (USFWS, 2021a). Construction activities in the vicinity of the impoundment are therefore 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, there are 9 state threatened species and 14 state endangered species within Putnam County (Ramboll, 2021). There is also a large area of critical habitat for the federally endangered Indiana Bat located immediately north of the Illinois River opposite the EAP. If protective action is found to be necessary at the Site, then efforts will be undertaken to minimize disturbances to critical bat habitat during construction activities (USFWS, 2021b).

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 highly permeable Henry Formation of the uppermost aquifer, consisting of sands and gravels, is the primary conduit for groundwater to discharge into the Illinois River (Ramboll, 2021). The downward groundwater migration from the uppermost aquifer to underlying units is significantly limited due to the presence of thick, low-permeability shale bedrock, which acts as a confining layer (Ramboll, 2021). No other potential groundwater transport pathways, other than discharges to the Illinois River, have been identified for the uppermost aquifer (Ramboll, 2021). Because the Illinois River is a large regional hydraulic boundary (*i.e.*, serves as a sink for groundwater discharges in the area), all shallow groundwater underlying the EAP is expected to discharge into the river. Similarly, based on measured groundwater elevations, lateral (*i.e.*, side-gradient or parallel to the Illinois River) groundwater flow is not expected. Under each closure scenario, constituents that are in groundwater near the EAP will continue to migrate toward the river.

Groundwater modeling was performed to evaluate future groundwater quality in the vicinity of the EAP under each of the proposed closure alternatives (Ramboll, 2022). Because there are no known potential GWPS exceedances in groundwater associated with the EAP (Ramboll, 2021), modeling of closure alternatives evaluated whether groundwater quality would be maintained in compliance with the relevant GWPSs post-closure. Boron was selected for groundwater transport modeling as a primary indicator of CCR impacts in groundwater. Boron is commonly used as a parameter for CCR contaminant transport modeling due to its presence in CCR and because it is relatively mobile and not very reactive in groundwater. The applicable GWPS for boron is 2 mg/L (IEPA, 2021a).

The modeling demonstrated that groundwater quality near the EAP will maintain compliance with the GWPSs for a period of at least 30 years post-closure for both CIP and CBR-Offsite (Ramboll, 2022).

Since the objective of model simulations for unit closure is to estimate long-term concentrations, steady-state, average river stage elevations were used to represent the river (Ramboll, 2022). However, periodic flooding of the river can create short-term reversals in the groundwater flow direction near the river, which has been documented in Site reports (Ramboll, 2021). The potential effects of river floods on groundwater flow and boron concentrations in Site groundwater have been previously evaluated at the Site using a transient model developed specifically to represent these conditions (Ramboll, 2022). As documented in the modeling report, saturation of ash at the EAP due to high river stages is unlikely to occur even during extreme flood events (Ramboll, 2022). Thus, while high river stages may cause short-term groundwater flow reversals, the use of a long-term steady-state model is appropriate for evaluating the fate and transport of constituents over a multi-year period subsequent to the implementation of each potential closure scenario.

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 leaching of CCR-associated constituents into groundwater during closure activities and following closure of the EAP. Section 2.2.2 evaluates the potential for CCR releases to occur due to dike failure or overtopping during floods or other storm-related events. In summary, there is no current or future risk to any human or ecological receptors associated with the EAP. Additionally, there is minimal current or future risk of overtopping occurring at the embankments due to flood conditions at the Site. 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 (Summary of Findings).

2.2.7 Long-Term Reliability of the Engineering and Institutional Controls (IAC Section 845.710(b)(1)(G))

Post-closure, there is minimal risk of engineering or institutional failures leading to sudden releases of CCR from the impoundment under the CIP scenario. There is no post-closure risk of engineering or institutional failures under the CBR scenario (see Section 2.2.2 above). Additionally, there are no current or future unacceptable risks to any human or ecological receptors under either closure scenario (see Section 2.2.1 above). Reliable engineering and institutional controls (*e.g.*, a bottom liner, a leachate management system, and groundwater monitoring) will be implemented at the off-Site landfill under the CBR-Offsite scenario. The CIP and CBR-Offsite scenarios are therefore both 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 this Site under either 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 CCR in the EAP 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 dissolved constituent concentrations are expected to decline post-closure, there will also be no unacceptable risks to human health or the environment following closure, regardless of the closure scenario.

Section 2.2.2 discussed the potential for dike failure or overtopping to occur during or following closure activities, resulting in a sudden release of CCR. That analysis showed that there is minimal risk of sudden CCR releases occurring during or following closure under either 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 and CBR-Offsite) at this Site under either 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

Closure-in-Place using a final cover system is a reliable and standard method for managing and closing impoundments that relies on common construction activities. Dewatering and excavating saturated CCR to construct a stabilized final cover system subgrade can present challenges during closure; however, these challenges are common to most CCR surface impoundment closures and are commonly addressed *via* surface water management and dewatering techniques.

Excavation of CCR *via* CBR-Offsite is also a reliable and well-standardized method for closing impoundments. However, relative to CIP, CBR-Offsite will have additional implementation difficulties due to:

- Significantly higher earthwork volumes;
- A longer construction schedule, resulting in the potential for additional weather delays over a multi-year period. A longer construction schedule for CBR-Offsite may also result in a commensurate increase in the amount of precipitation that comes in contact with CCR within the closure area, which could increase the volume of water discharged to the Illinois River *via* the facility's NPDES permit and could potentially require additional water quality controls (*e.g.*, treatment) to meet NPDES discharge requirements;
- Significantly higher dewatering volumes, due to the need to dewater all of the CCR within the EAP under the CBR-Offsite scenario to allow the material to be hauled offsite-in a non-saturated

condition. This will result in increased water discharge volumes to the Illinois River, relative to CIP, for which only the top 5 to 10 ft of the CCR will be dewatered; and

- Removal and disposal of the existing bottom liner geomembrane under the CBR-Offsite scenario, which may cause unique difficulties. Specifically, it may be difficult to remove and handle the geomembrane; additionally, the geomembrane may not be accepted for disposal at the landfill and it may need to be decontaminated prior to disposal.

Hauling will be easier to implement under the CIP scenario than under the CBR-Offsite scenario, due to significantly smaller earthwork volumes and less haul traffic on public roadways. Hauling under the CIP scenario would only require the importation of approximately 70,100 CY of soils and would not require the transportation of any CCR over public roadways. Additionally, because the CBR-Offsite scenario involves hauling ash 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 Impacts"), off-Site hauling may also have detrimental 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 DMG 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 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 CCR excavated from the impoundment.

2.4.2 Expected Operational Reliability of the Closure Alternative

The operational reliability of the CIP scenario and the CBR-Offsite scenario is expected to be similar. CIP will utilize a final cover system that includes a geomembrane, and the EAP currently includes a bottom liner system. Therefore, under the CIP scenario, the CCR will be surrounded by an engineered containment system on the top, sides, and bottom. The CBR-Offsite scenario similarly involves placing the CCR in an engineered landfill system that has a bottom liner, leachate collection system, and final cover system, resulting in the CCR being surrounded by an engineered containment system on the top, sides, and bottom. The operational reliability of both closure scenarios is therefore expected to be similar. Moreover, high reliability is expected under both scenarios due to the full containment of CCR. Operational reliability under the CIP scenario is further assured by the fact that the CCR within the EAP is located above normal groundwater levels (Ramboll, 2021), and groundwater impacts requiring corrective action have not been encountered at the EAP.

2.4.3 Need to Coordinate with and Obtain Necessary Approvals and Permits from Other Agencies

Permits and approvals will be needed under both closure scenarios. Components of both the CIP and CBR-Offsite 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 Illinois Department of Natural Resources, Office of Water Resources, Dam Safety Program to allow the embankment and spillways of the EAP 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).

Under the CBR-Offsite scenario, it may be necessary to construct additional, pre-approved cells at the off-Site landfill in order to accommodate the mass of waste to be received. 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.

2.4.4 Availability of Necessary Equipment and Specialists

CIP and CBR-Offsite are both reliable and standardized 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 both 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 significantly higher earthwork volumes and a greater need for construction equipment under the CBR-Offsite scenario than under the CIP scenario, shortages in construction equipment may cause greater challenges under the CBR-Offsite scenario than under the CIP scenario. The current shortage of truck drivers may be particularly impactful under the CBR-Offsite scenario, due primarily to the large volume of CCR to be hauled from the Site. If sufficient trucks and truck drivers are not available, the construction schedule 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, which are utilized for both scenarios, and geomembrane liner materials, which are required for the CIP scenario, 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, all of the CCR currently within the EAP and approximately 8,000 CY of bottom ash excavated from the Hennepin Landfill will be stored within the footprint of the EAP. Treatment will consist of unwatering the EAP at the start of construction, performing limited dewatering to stabilize the CCR subgrade, and managing stormwater inflow. Water from unwatering and dewatering of the EAP will be discharged *via* the existing NPDES permit, utilizing the existing Leachate Pond and Polishing Pond as settling basins. Under the CBR-Offsite scenario, water treatment will similarly consist of unwatering/dewatering the EAP at the start of construction and discharging water from unwatering/dewatering *via* the existing NPDES permit, utilizing the existing Leachate Pond and Polishing Pond as settling basins. Under the CBR-Offsite scenario, a higher volume of water will be sent to the Leachate Pond/Polishing Pond compared to the CIP scenario due to the longer construction schedule and the greater amount of dewatering that will need to occur for CCR to be transported on public roads to the off-Site disposal location.

For the CBR-Offsite scenario, 710,000 CY of CCR and liner materials will be excavated from the EAP and require disposal. 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 Republic Services LandComp Landfill in Ottawa, Illinois. This facility has 8,500,000 CY of remaining capacity in its current permitted footprint. It receives 450,000 CY of waste annually, and is located 32 miles from the Site by road. The LandComp Landfill therefore has sufficient capacity to receive CCR from the EAP. However, closure of the EAP would increase the annual waste receipt rate at the off-Site landfill by approximately 50%. Due to 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. 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 LandComp Landfill is impractical or infeasible, then an alternative landfill located farther from the Site would need to be identified. A likely alternative to the LandComp Landfill is the Eco Hill Landfill (aka Atkinson Landfill) in Atkinson, Illinois. It has 11,700,000 CY of remaining capacity in its current permitted footprint, receives 270,000 CY of waste annually, and is located 54 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), both modeled and measured surface water concentrations in the Illinois River are all below relevant human health and ecological screening benchmarks. Surface water concentrations of CCR-associated constituents are expected to 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 landfill that will receive the CCR excavated from the impoundment under the CBR-Offsite scenario will be managed to ensure that no surface water impacts occur in the vicinity of the landfill.

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). However, it is not the case that closing the EAP *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 EAP under either scenario. There is also minimal risk of future CCR releases occurring under either scenario. Furthermore, modeling concluded that groundwater quality near the EAP, based on simulations of boron in groundwater, will maintain compliance with the GWPSs for a period of at least 30 years post-closure for both CIP and CBR-Offsite (Ramboll, 2022). Both closure scenarios are therefore responsive to residents' concerns regarding impacts to groundwater and surface water quality.

The CIP scenario has several advantages over the CBR-Offsite scenario with regards to likely community concerns. Notably, the CIP scenario presents far fewer risks to workers, nearby residents, and potentially EJ communities during construction in the form of accidents, traffic, noise, and air pollution (Section 2.2.4 above). Closure will also be achieved more rapidly under the CIP scenario than under the CBR-Offsite scenario, due to the shorter duration of construction activities. Finally, the Site can be more rapidly re-developed for use in utility-scale solar generation under the CIP scenario than under the CBR-Offsite scenario. 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 8, 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 detailed cost estimate has been prepared for each of the closure scenarios (Geosyntec, 2022a). A summary of these estimates is provided in Table 2.6. The total expected cost of closure under the CIP scenario is $5,790,000. The total expected cost of closure under the CBR-Offsite scenario is $105,000,000. Costs under the CIP scenario are therefore considerably smaller than costs under the CBR-Offsite scenario.

Table 2.6 Expected Costs of Closure

Work Element	CIP	CBR-Offsite
Pre-Construction	$189,000	$570,000
Site Preparation	$455,000	$1,440,000
Dewatering, Unwatering, and Stormwater Management	$147,000	$770,000
East Ash Pond Closure	$2,940,000	$77,100,000
Site Restoration	$235,000	$243,000
Engineering and Construction Support	$480,000	$1,270,000
30% Contingency	$1,340,000	$24,000,000
Total:	**$5,790,000**	**$105,000,000**

Notes:
CIP = Closure-in-Place; CBR-Offsite = Closure-by-Removal with Off-Site CCR Disposal.
Costs are for comparative purposes only. Actual costs will be paid based on actual quantities and may vary from those calculated.
Source: Geosyntec (2022a).

Each closure scenario meets or exceeds 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 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 EAP. Key benefits of the CIP scenario relative to the CBR-Offsite scenario include more rapid re-development of the Site for use in utility-scale solar generation and greatly reduced impacts to workers, community members, and the environment due to construction activities (*e.g.*, fewer constructed-related accidents, lower energy demands, less air pollution and GHG emissions, less traffic, and potentially lower impacts to EJ communities). Furthermore we do not anticipate a need for any groundwater corrective measures other than source control (*i.e.*, CIP and CBR-Offsite) at this Site under either closure scenario.

References

AECOM. 2016. "CCR Rule Report: Initial Safety Factor Assessment for East Ash Pond at Hennepin Power Station (Draft)." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). October.

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."

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 (Geosyntec). 2021a. "Surface Water Sampling Locations, Hennepin Power Plant, Hennepin, Illinois." July.

Geosyntec Consultants (Geosyntec). 2021b. "2021 USEPA CCR Rule Periodic Certification Report (§257.73(a)(2), (c), (d), (e) and §257.82), East Ash Pond, Hennepin Power Plant, Hennepin, Illinois." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). October.

Geosyntec Consultants (Geosyntec). 2022a. "Closure Alternatives Analysis Supporting Information Report, Hennepin Power Plant East Ash Pond, Hennepin, Illinois (IEPA ID W1550100002-05)." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). January.

Geosyntec Consultants (Geosyntec). 2022b. "CCR Final Closure Plan, Hennepin Power Plant East Ash Pond, Hennepin, Illinois (IEPA ID W1550100002-05)." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). January.

Geosyntec Consultants (Geosyntec). 2022c. 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.

Google LLC. 2021. "Google Maps." Accessed on April 30, 2021 at https://www.google.com/maps.

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.

HookandBullet.com. 2021. "Lyons Lake fishing near DePue, Illinois." Accessed on October 6, 2021 at https://www.hookandbullet.com/fishing-lyons-lake-depue-il/.

Illinois Dept. of Natural Resources. 2021. "Illinois River." Division of Fisheries. Accessed on October 6, 2021 at https://www.ifishillinois.org/profiles/Illinois.php.

Illinois Environmental Protection Agency (IEPA). 2016. "Appendix A-5. 303(d) Listed Waters Maps." In Illinois Integrated Water Quality Report and Section 303(d) List - Volume I: Surface Water - 2016 (Final as submitted to US EPA Region V on July 11, 2016). Accessed on October 21, 2021 at https://www2.illinois.gov/epa/Documents/iepa/water-quality/watershed-management/tmdls/2016/303-d-list/appendix-a5.pdf.

Illinois Environmental Protection Agency (IEPA). 2019a. "Appendix A-1. Illinois' 2018 303(d) List and Prioritization." In Illinois Integrated Water Quality Report and Section 303(d) List, 2018 (Final as submitted to US EPA Region V on February 22, 2021). May 20. Accessed on October 21, 2021 at https://www2.illinois.gov/epa/topics/water-quality/watershed-management/tmdls/Documents/Appendix%20A-1_303d_by_priority_FINAL_5-20-19.pdf.

Illinois Environmental Protection Agency (IEPA). 2019b. "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 on October 4, 2021 at https://www.ilga.gov/commission/jcar/admincode/035/03500845sections.html.

Illinois Environmental Protection Agency (IEPA). 2021b. "Illinois Landfill Disposal Capacity Report." August. Accessed on October 4, 2021 at https://www2.illinois.gov/epa/topics/waste-management/landfills/landfill-capacity/Documents/landfill-capacity-report-2021.pdf.

Illinois River Road National Scenic Byway. 2021. "DePue Lake." Accessed on September 28, 2021 at https://www.illinoisriverroad.org/places/united-states/illinois/depue/nature-outdoor-recreation/depue-lake/.

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.

Ramboll. 2018-2020. "Final Closure and Post-Closure Plans for Hennepin East Ash Ponds No. 2 & No. 4." Report to Dynegy Midwest Generation, LLC.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Hennepin East Ash Pond, Hennepin Power Plant, 13498 E 800th Street, Hennepin, IL 61327." Report to Dynegy Midwest Generation, LLC.

Ramboll. 2022. "Groundwater Model Report, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois." Report to Dynegy Midwest Generation, LLC.

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

Sierra Club. 2014. "Dangerous Waters: America's Coal Ash Crisis."

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 on October 5, 2021 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 on October 5, 2021 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.

US EPA. 2016. "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis." June.

US Fish & Wildlife Service (USFWS). 2021a. "Wetlands Mapper." National Wetlands Inventory. May 3. Accessed on October 13, 2021 at https://www.fws.gov/wetlands/data/mapper.html.

US Fish & Wildlife Service (USFWS). 2021b. "FWS HQ ES Critical Habitat GIS Map Layer." October 13. Accessed on October 13, 2021 at https://fws.maps.arcgis.com/home/item.html?id=794de45b9d774d21aed3bf9b5313ee24.

Appendix A

Human Health and Ecological Risk Assessment

Human Health and Ecological Risk Assessment
East Ash Pond
Hennepin Power Plant
Hennepin, Illinois

January 28, 2022

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Abbreviations

ADI	Acceptable Daily Intake
BCF	Bioconcentration Factor
CAA	Closure Alternatives Assessment
CCR	Coal Combustion Residual
CEM	Conceptual Exposure Model
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
CWS	Community Water Supply Well
DMG	Dynegy Midwest Generation, LLC
DWW	Drinking Water Watch
EAP	East Ash Pond
ESV	Ecological Screening Value
GWPS	Groundwater Protection Standards
GWQS	Groundwater Quality Standards
HPP	Hennepin Power Plant
HTC	Human Threshold Criteria
IAC	Illinois Administrative Code
ID	Identification
IEPA	Illinois Environmental Protection Agency
ISGS	Illinois State Geological Survey
MCL	Maximum Contaminant Level
NID	National Inventory of Dams
NRWQC	National Recommended Water Quality Criteria
ORNL RAIS	Oak Ridge National Laboratory's Risk Assessment Information System
PWS	Public Water System
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SDWIS	Safe Drinking Water Information System
SWQS	Surface Water Quality Standards
TDS	Total Dissolved Solids
TEC	Threshold Effect Concentration
US DOE	United States Department of Energy's
US EPA	United States Environmental Protection Agency
USGS	US Geological Survey

1 Introduction

Dynegy Midwest Generation Company's Hennepin Power Plant (HPP, or "the Site") is an electric power-generating facility with coal-fired units located in Hennepin, Illinois. The facility began operations in the early 1950s and was retired in 2019 (Ramboll, 2021). The HPP produced and stored coal combustion residuals (CCRs) as a part of its historical operations in several CCR ash ponds located both east and west of the power plant (East Ash Pond No. 2, East Ash Pond No. 4, East Ash Pond [EAP], Leachate Pond, Polishing Pond; Old West Ash Pond [Pond No. 1 and Pond No. 3], and Old West Polishing Pond). The EAP (Vistra identification [ID] number [No.] 803, Illinois Environmental Protection Agency [IEPA] ID No. W1550100002-05, and National Inventory of Dams [NID] No. IL50363) is planned for closure and is the subject of this report.

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

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

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

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

Based on the evaluation presented in this report, no unacceptable risks to human and ecological receptors resulting from CCR exposures associated with the EAP were identified. Specific risk assessment results include the following:

- No unacceptable risks were identified for recreators swimming or boating in the Illinois River adjacent to the Site.
- No unacceptable risks were identified for recreators exposed to sediment in the Illinois River adjacent to the Site.
- No unacceptable risks were identified for anglers consuming locally caught fish.
- No unacceptable risks were identified for ecological receptors exposed to surface water or sediment.
- No bioaccumulative ecological risks were identified.

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

2 Site Overview

2.1 Site Description

The HPP is located four miles northeast of the Village of Hennepin in north central Illinois in Putnam County. The HPP property is bordered on the north by the Illinois River, on the south and east by industrial property, and on the west by agricultural land. The Illinois River flows past the facility from east to west. The CCR ash ponds located to the east of the power plant include East Ash Pond No. 2, East Ash Pond No. 4, and the EAP (Figure 2.1). East Ash Pond No. 2 and East Ash Pond No. 4 have been closed with IEPA approval. The EAP is a lined unit constructed from 1995 to 1996 to replace the East Ash Pond No. 2, which was removed from service (Ramboll, 2021). The EAP is planned for closure and is the subject of this report.

2.2 Geology/Hydrogeology

The geology underlying the Site in the vicinity of the EAP primarily consists of unlithified deposits of the Cahokia Alluvium and Henry Formation, underlain by a thick shale bedrock (Ramboll, 2021). Two distinct hydrostratigraphic units have been identified in the area: the uppermost water-bearing unit composed of the Cahokia Alluvium and Henry Formation, and a confining shale bedrock unit. The Illinois River, located less than 0.1 mile downgradient of the EAP, is the major surface water body in the area. The uppermost aquifer beneath the EAP is hydraulically connected to the Illinois River, while the low permeability bedrock aquitard acts as a barrier to downward migration of groundwater from the uppermost aquifer. These two major hydrostratigraphic units are discussed below.

The uppermost aquifer includes the Cahokia Alluvium and Henry Formation. The Cahokia Alluvium consists of fine-grained silt and clay deposits with an estimated thickness of about 20-40 feet (ft) at the EAP. The Henry Formation fills the valley under the Cahokia Alluvium and is composed of highly permeable sands and gravels (Ramboll, 2021). The thickness of the Henry Formation ranges from 21 to 45 ft within the EAP (Ramboll, 2021). The total thickness of the uppermost aquifer (*i.e.*, combined thickness of the Cahokia Alluvium and Henry Formation) directly beneath the EAP is approximately 80 ft; however, only the bottom 45 ft has been reported to be saturated (Ramboll, 2021).

Field measurements of horizontal hydraulic conductivities (K_x) of the Henry Formation ranged between 0.0016 and 3.2 cm/s, with a geometric mean of approximately 0.1 cm/s (Ramboll, 2021). The laboratory-measured vertical hydraulic conductivity values (K_z) for the uppermost aquifer ranged from 1.5×10^{-7} cm/s to 7.1×10^{-8} cm/s, with a geometric mean of about 6.4×10^{-8} cm/s (Ramboll, 2021).

Groundwater in the uppermost aquifer flows from south to north/northwest and discharges into the Illinois River under normal conditions (Ramboll, 2021). A flow reversal (*i.e.*, groundwater flows in a south to southwest direction) may occur during high river stages or flooding events when the Illinois River stage elevation is significantly higher than surrounding groundwater elevations. Under normal conditions (*i.e.*, no flow reversals), the average groundwater flow velocity from north to south across the Site is about 2.38 ft/day (Ramboll, 2021). The average horizontal hydraulic gradient near the EAP ranges from 0.0003 to 0.0035 ft/ft under normal conditions (Ramboll, 2021).

The bedrock aquitard consists of low-permeability shales and thin layers of limestone, sandstone, and coal beds of the Pennsylvanian Carbondale Formation (Ramboll, 2018-2020, 2021). The estimated thickness of the shale bedrock in the vicinity of the EAP is approximately 300-400 ft (Ramboll, 2018-2020, 2021). The horizontal hydraulic conductivities of the shale bedrock range between 5 × 10^{-6} and 5 × 10^{-10} cm/s. The vertical hydraulic conductivities range between 5 × 10^{-8} and 5 × 10^{-12} cm/s (Ramboll, 2021), indicating an anisotropy ratio (K_x/K_z) of 100 in the bedrock aquifer. The very low hydraulic conductivities of the aquitard significantly restrict horizontal and vertical migration of groundwater and do not yield usable quantities of water required for domestic water supply.

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

2.3 Conceptual Site Model

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

The highly permeable Henry Formation of the uppermost aquifer, consisting of sands and gravels, is the primary conduit for groundwater to discharge into the Illinois River (Ramboll, 2021). The downward groundwater migration from the uppermost aquifer to underlying units is significantly limited due to the presence of thick, low-permeability shale bedrock, which acts as a confining layer (Ramboll, 2021). No other potential groundwater transport pathways, other than discharges to the Illinois River, have been identified for the uppermost aquifer (Ramboll, 2021). Because the Illinois River is a large regional hydraulic boundary (*i.e.*, serves as a sink for groundwater discharges in the area), all shallow groundwater underlying the EAP is expected to discharge into the river. Similarly, based on measured groundwater elevations, lateral (*i.e.*, side-gradient or parallel to the Illinois River), groundwater flow is not expected.

At its discharge location, groundwater near the EAP mixes with surface water in the Illinois River. During groundwater discharge into the river, dissolved constituents in groundwater may partition between sediments and surface water.

2.4 Groundwater Monitoring

Thirteen wells have been used to monitor the groundwater quality near and downgradient of the EAP. Of these, 12 wells are screened in the uppermost aquifer, and 1 is screened in the bedrock unit (Table 2.1). The analyses presented in this report relied on all available data from the 13 wells collected between 2015 and 2021, which is the period subsequent to the promulgation of the Federal CCR Rule. Groundwater samples were analyzed for a suite of metals, both total and dissolved, specified in Illinois CCR Rule Part 845.600 (IEPA, 2021a).[1] A summary of the groundwater data used in this risk evaluation is presented in Table 2.2. The EAP well locations are shown in Figure 2.1. Note that there are additional wells in the vicinity of the EAP (shown on Figure 2.1) that were not used in this risk analysis, because these wells are downgradient of, and potentially affected by the presence of, other CCR disposal units including East Ash Pond No. 2, East Ash Pond No. 4, a landfill, and a leachate pond. The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with the EAP or that they have been identified as potential groundwater exceedances.

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

Table 2.1 Groundwater Monitoring Wells Related to Hennepin East Ash Pond

Well	Date Constructed	Screen Top Depth (ft BGS)	Screen Bottom Depth (ft BGS)	Well Depth from Ground Surface (ft BGS)	Hydrogeologic Unit
7	11/15/1984	67.5	77.5	78	UA
8	11/17/1984	51.5	61.5	62	UA
08D	4/17/2009	83	88	90	UA
12	3/28/1995	49.5	59.5	60	UA
13	3/1/1995	67	69	75	UA
16	3/30/1995	56	66	68	UA
17	3/30/1995	58.1	68.1	68	UA
46	8/11/2015	50	60	60	UA
47	8/11/2015	50	60	60	UA
52	2/11/2021	51	61	60.9	UA
53	1/13/2021	53.8	63.8	64.1	UA
54	2/9/2021	65	75	74.1	UA
55	2/10/2021	90	95	94.7	BR

Notes:
BGS = Below Ground Surface; BR: Bedrock Unit; UA = Uppermost Aquifer.

Table 2.2 Groundwater Data Summary

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Laboratory Detection Limit
Total Metals (mg/L)					
Antimony	0	146	-	-	0.002
Arsenic	8	165	0.001	0.0025	0.001
Barium	176	176	0.0351	0.23	0.004
Beryllium	0	146	-	-	0.001
Boron	186	186	0.0544	1.41	0.1
Cadmium	7	172	0.0011	0.0024	0.002
Chromium	11	165	0.001	0.019	0.005
Cobalt	64	160	0.001	0.147	0.001
Lead	9	165	0.0011	0.0036	0.001
Lithium	163	164	0.0051	0.0414	0.005
Mercury	0	161	-	-	0.0002
Molybdenum	129	176	0.001	0.0681	0.01
Selenium	53	175	0.001	0.0093	0.001
Thallium	0	146	-	-	0.002
Dissolved Metals (mg/L)					
Antimony	4	182	0.0011	0.0022	0.001
Arsenic	0	182	-	-	0.001
Barium	182	182	0.03	0.175	0.0025
Beryllium	0	182	-	-	0.001
Boron	182	182	0.05	1.32	0.025
Cadmium	1	182	0.0023	0.0023	0.002
Chromium	0	182	-	-	0.005
Cobalt	38	182	0.0039	0.124	0.005
Lead	4	182	0.0011	0.0013	0.001
Mercury	0	182	-	-	0.0002
Molybdenum	55	110	0.0055	0.04	0.01

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Laboratory Detection Limit
Selenium	58	182	0.001	0.009	0.001
Thallium	0	182	-	-	0.002
Radionuclides (pCi/L)					
Radium-226+228	86	159	0	3.21	2.0

Note:
- = Not applicable.

2.5 Surface Water Monitoring

Surface water samples were collected in September 2020 from 15 locations in the Illinois River adjacent to the HPP. The samples were collected along five transects, with three samples per transect collected from the two edges and the center of the river (Figure 2.2). Sample set IR-01 was collected approximately one mile upstream of the HPP. Sample sets IR-02 and IR-03 were located immediately upstream and downstream, respectively, of the EAP area. Sample sets IR-04 and IR-05 were located downstream of the EAP. It should be noted that many constituents occur naturally in the environment and/or could be associated with industrial activities unrelated to the EAP. The use of surface water data in this risk assessment does not imply that any constituents are associated with the EAP. A summary of the surface water data used in this risk evaluation is presented in Table 2.3.

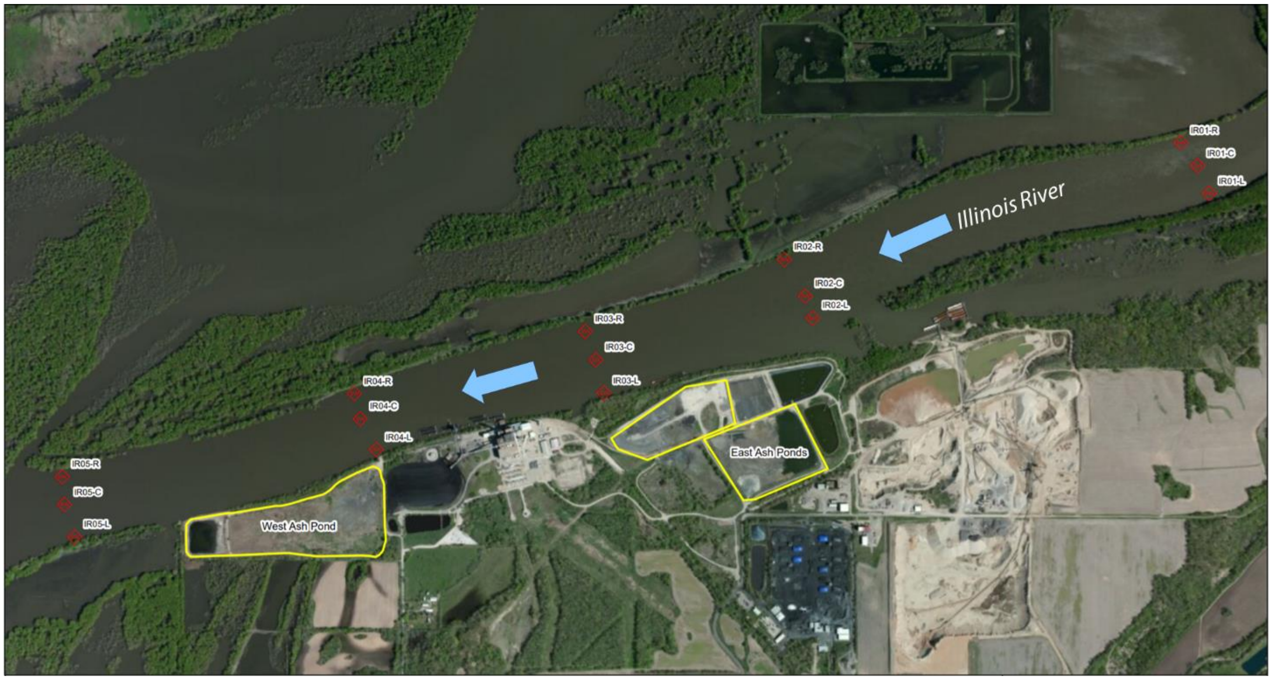

Figure 2.2 Surface Water Sampling Locations. Source: Geosyntec (2021a).

Table 2.3 Surface Water Data Summary

Constituent	Samples with Constituent Detected	Samples Analyzed	Minimum Detected Value	Maximum Detected Value	Maximum Detection Limit
Dissolved Metals (mg/L)					
Aluminum	1	15	0.641	0.641	0.025
Antimony	0	15	-	-	0.001
Arsenic	15	15	0.0026	0.0034	-
Barium	15	15	0.0351	0.0462	-
Beryllium	0	15	-	-	0.001
Boron	15	15	0.125	0.147	-
Cadmium	0	15	-	-	0.001
Chromium	1	15	0.015	0.015	0.015
Cobalt	0	15	-	-	0.001
Lead	1	15	0.002	0.002	0.001
Lithium	15	15	0.0071	0.0083	-
Molybdenum	15	15	0.0048	0.0063	-
Selenium	0	15	-	-	0.001
Thallium	0	15	-	-	0.002
Other (mg/L, unless otherwise noted)					
Chloride	15	15	97	103	-
pH (SU)	15	15	8.6	8.6	-
Sulfate	15	15	73	79	-
Total Dissolved Solids	10	10	368	416	-

Notes:

- = Not applicable; SU = Standard Unit.

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 EAP have the potential to pose adverse health effects to human and ecological receptors. The risk evaluation is consistent with the principles of risk assessment established by US EPA and has considered evaluation criteria detailed in Illinois guidance documents (*e.g.*, IEPA, 2013, 2019a).

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

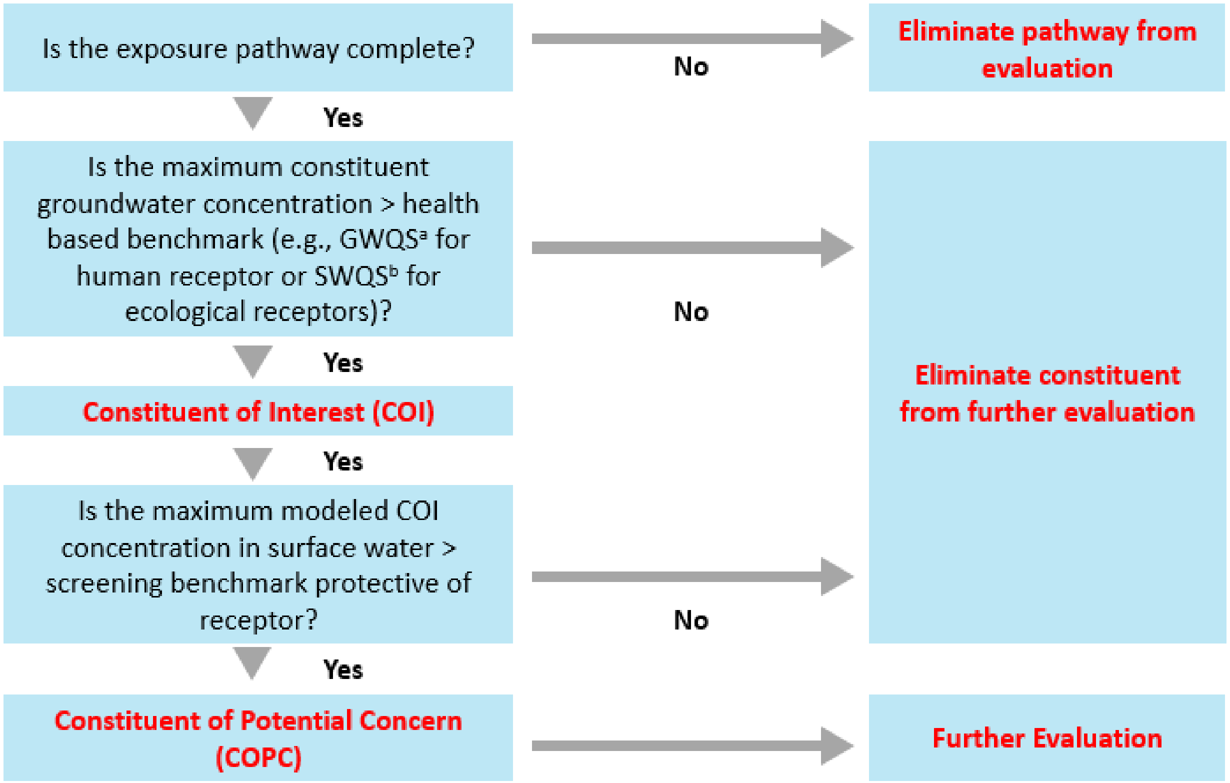

Figure 3.1 Overview of Risk Evaluation Methodology

IEPA = Illinois Environmental Protection Agency; GWQS = IEPA Groundwater Quality Standards; SWQS = IEPA Surface Water Quality Standards.

(a) The IEPA Part 845 groundwater protection standards were used to identify COIs.

(b) IEPA SWQS protective of chronic exposures to aquatic organisms were used to identify ecological COIs. In the absence of an SWQS, US EPA Region IV ecological screening values were used.

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

Groundwater data were used to identify COIs. COIs were identified as constituents with maximum concentrations in groundwater in excess of groundwater quality standards (GWQS)[2] for human receptors and surface water quality standards (SWQS) for ecological receptors. Based on the CSM (Section 2.2), groundwater underlying the EAP flows from south to north toward the Illinois River. Therefore, any potential EAP-related constituents in groundwater would flow toward and discharge into surface water.

Surface water samples have been collected from the Illinois River adjacent to the Site; however, sediment samples have not been collected from the river. Gradient modeled the potential migration of COIs from groundwater to surface water and sediment to evaluate potential risks to receptors (see Section 3.3.3). Gradient modeled the COI concentrations in surface water and sediment based on the groundwater data from the EAP-related wells. The measured and modeled COI concentrations in surface water, and the modeled sediment concentrations, were compared to conservative, generic risk-based screening benchmarks for human health and ecological receptors. These generic screening benchmarks rely on default assumptions with limited consideration of site-specific characteristics. Human health benchmarks are receptor-specific values calculated for each pathway and environmental medium that are designed to be protective of human health. Ecological benchmarks are medium-specific values designed to be protective of all potential ecological receptors exposed to surface water. Ecological and human health screening benchmarks are inherently conservative because they are intended to screen out chemicals that are of no concern with a high level of confidence. Therefore, a measured or modeled COI concentration exceeding a screening benchmark does not indicate an unacceptable risk, but only that further risk evaluation is warranted. COIs with maximum concentrations exceeding a conservative screening benchmark are identified as COPCs requiring further evaluation.

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

3.2 Human and Ecological Conceptual Exposure Models

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

3.2.1 Human Conceptual Exposure Model

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

- Residents – exposure to groundwater/surface water as drinking water;

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

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

All of these exposure pathways were considered complete except for residential exposure to groundwater or surface water used for drinking water or irrigation. Section 3.2.1.1 explains why the residential drinking water and irrigation pathways are incomplete, and Section 3.2.1.2 provides additional description of the recreational exposures.

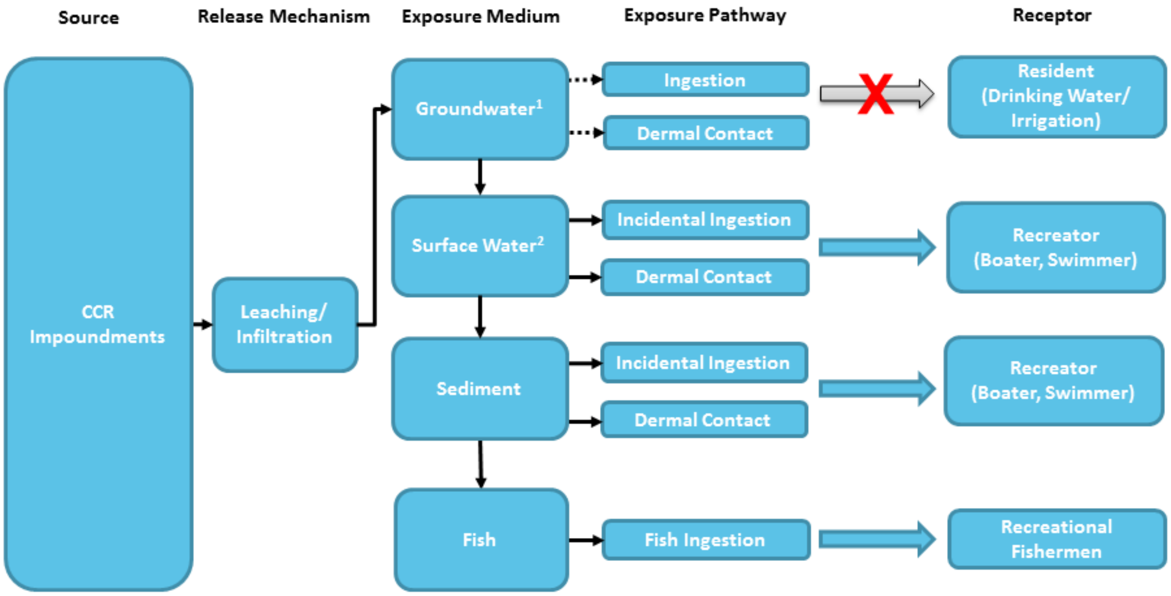

Figure 3.2 Human Conceptual Exposure Model. CCR = Coal Combustion Residual. Dashed line/Red X = Incomplete or insignificant exposure pathway. (1) Groundwater in the vicinity of the Site is not used as a drinking water or irrigation source. (2) Surface water is not used as a drinking water source.

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

Groundwater as a source of drinking water and/or irrigation water is not a complete exposure pathway for CCR-related constituents originating from the EAP. Specifically, shallow groundwater from the uppermost aquifer in the vicinity of the EAP is not used as a source of drinking water, and no public groundwater systems are downgradient of Hennepin. Further, the downward migration of groundwater from the uppermost aquifer is restricted due to the presence of a thick, shale bedrock (Ramboll, 2021). A summary of the evidence supporting the conclusion that there are no residential uses of the shallow groundwater and Illinois River surface water as a source of drinking water is presented below:

- **No potential groundwater receptors are in the vicinity of the EAP**. The public water systems (PWS) in the Putnam and Bureau Counties in the vicinity of the Hennepin EAP rely on groundwater as a source of potable water. A review of existing drinking water intakes within the US EPA Safe

Drinking Water Information System (SDWIS)[3] and IEPA Illinois Drinking Water Watch (DWW)[4] databases yielded no PWS wells within 1,000 meters of the Site (Ramboll, 2021).

  - A total of 10 wells were identified within a 1,000-meter radius of the EAP during a comprehensive search of the Illinois State Geological Survey's (ISGS) Illinois Water and Related Wells (ILWATER) Map[5] (Ramboll, 2021) (see Figure 3.3). Under normal groundwater flow conditions, 3 out of those 10 wells are located downgradient from the EAP (Well IDs 121552059800, 121552043500, and 121550012800), 2 wells are located side-gradient (Well IDs 121552045800, 121552059900), and the remaining 5 wells are located upgradient (Well IDs 121552029200, 121552049700, 121552025800, 121552051800, 121552068500) (Ramboll, 2021).
    - Because groundwater flow under the EAP is predominantly to the north/northwest towards the Illinois River, the CCR-impacted groundwater will not impact the seven wells that are located either upgradient or side-gradient of the EAP.
  - Further, the three downgradient wells and one of the side-gradient wells (Well ID 121552059900) are owned by the Dynegy Midwest Generation, LLC (DMG) and are non-potable and non-contact industrial wells (Ramboll, 2021). A 2009 water well survey conducted in the area by Kelron/Natural Resource Technology concluded that CCR-impacted groundwater at Hennepin is not likely to impact any existing potable or non-potable off-Site water wells that are located within 2,500 ft of the Hennepin Power Plant property boundary (Ramboll, 2018-2020).
  - In a letter to IEPA (Morris, 2021), DMG noted that 16 private wells were identified near the Site, with 1 well located potentially downgradient of the Site. However, DMG noted that this well is unlikely to be in use, based on the installation date (1884) and its remote floodplain location. DMG noted that three non-community water supply wells (CWS) were identified but that they are unlikely to be at risk because they are either inactive and/or not-located hydraulically downgradient of the EAP.

- **There is no off-Site migration of EAP-related constituents to nearby wells because all shallow groundwater flows into the Illinois River**. The Illinois River is the regional discharge point for groundwater in the uppermost aquifer. Groundwater hydraulic head measurements in wells screened within the uppermost aquifer near the EAP indicate that groundwater flows toward the river (Ramboll, 2021). Based on groundwater elevation data and because the Illinois River is a large regional hydraulic boundary (*i.e.*, serves as a sink for groundwater discharges in the area), any potential constituents present in groundwater underlying the EAP are not likely to migrate under or beyond the river.

- **The Illinois River adjacent to the Site is not used as a public water supply.** IEPA classified the Illinois River as a "General Use Water." IEPA fully supports the use of the Illinois River for aquatic life and primary contact recreation, but it is not designated for public and food processing water supplies. The segment of the Illinois River adjacent to the Site (Section D-16) is listed on the 2018 Illinois Section 303(d) List as being impaired for fish consumption, due to mercury and polychlorinated biphenyls (IEPA, 2016, 2018, 2019b). Therefore, surface water adjacent to the Site is not used as a source of drinking water, and this exposure pathway was not evaluated further.

- **The EAP has a limited hydraulic connection to underlying bedrock groundwater resources**. The bedrock aquitard is composed of a 300-400 ft thick shale unit of the Carbondale Formation

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[3] US EPA SDWIS (US EPA, 2021a): https://www.epa.gov/enviro/sdwis-search.

[4] IEPA Illinois DWW (IEPA, 2021b): http://water.epa.state.il.us/dww/index.jsp.

[5] ISGS ILWATER Map (ISGS, 2020): https://prairieresearch.maps.arcgis.com/apps/webappviewer/index.html?id=e06b64ae0c814ef3a4e43a191cb57f87.

(Ramboll, 2021). This thick, continuous shale bedrock forms a hydraulic barrier between the EAP and deeper groundwater resources. Very low hydraulic conductivities of the shale bedrock and the lack of a downward gradient restrict any downward migration of shallow groundwater originating from the EAP to the underlying aquifers (Ramboll, 2021). Vertical hydraulic gradients measured in well nests downgradient and adjacent to the north edge of the EAP (wells 12, 13, and 55) were reported to be either flat or upward (Ramboll, 2021). This further reduces the likelihood of EAP-related impacts to the deep groundwater resources in the area.

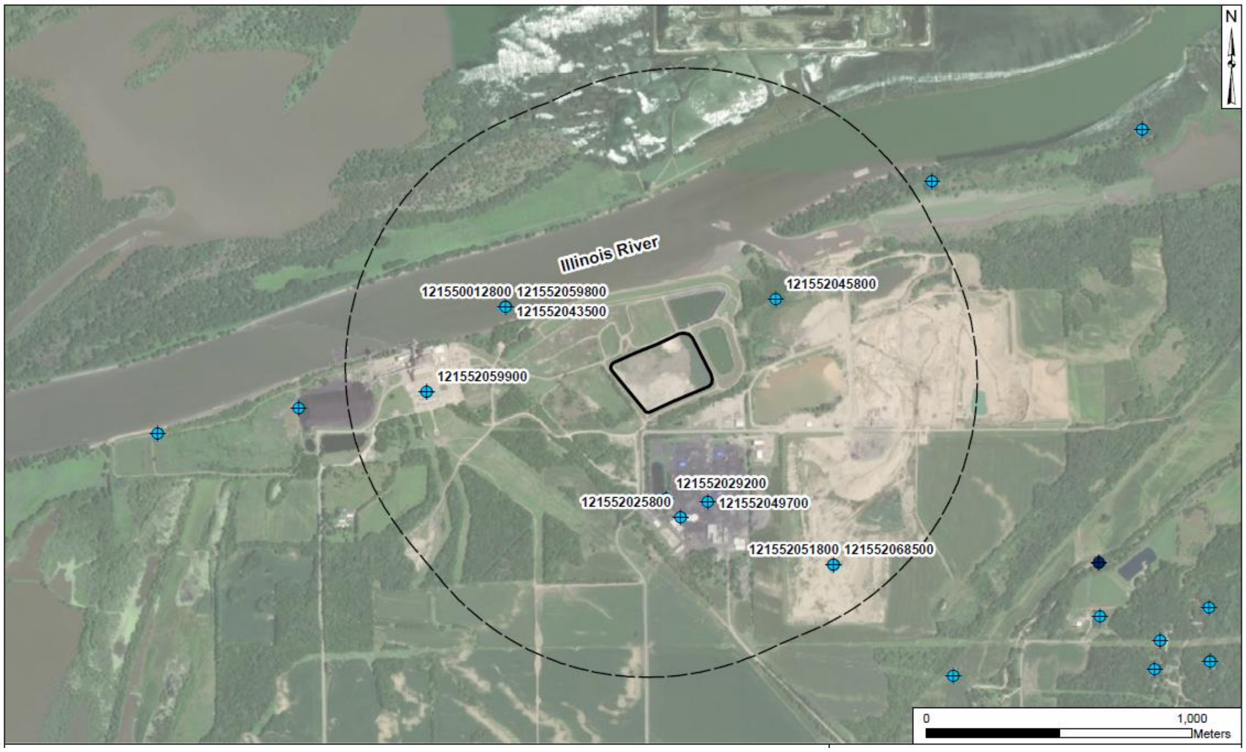

Figure 3.3 Water Wells Within 1,000 Meters of the East Ash Pond. Source: Geosyntec (2021b, Figure A-4).

3.2.1.2 Recreational Exposures

The Illinois River flows east to west past the Site. Recreational exposure to surface water and sediment may occur during activities such as swimming or boating in the river. Exposure estimates for swimmers provide a health-protective means to evaluate exposure during other recreational activities. Recreational anglers may also consume locally caught fish from the Illinois River.

3.2.2 Ecological Conceptual Exposure Model

The ecological CEM for the Site depicts the relationships between off-Site environmental media (surface water and sediment) potentially impacted by COIs in groundwater and ecological receptors that may be exposed to these media. The ecological risk evaluation considered both direct toxicity as well as secondary toxicity *via* bioaccumulation. Figure 3.4 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).
- **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).

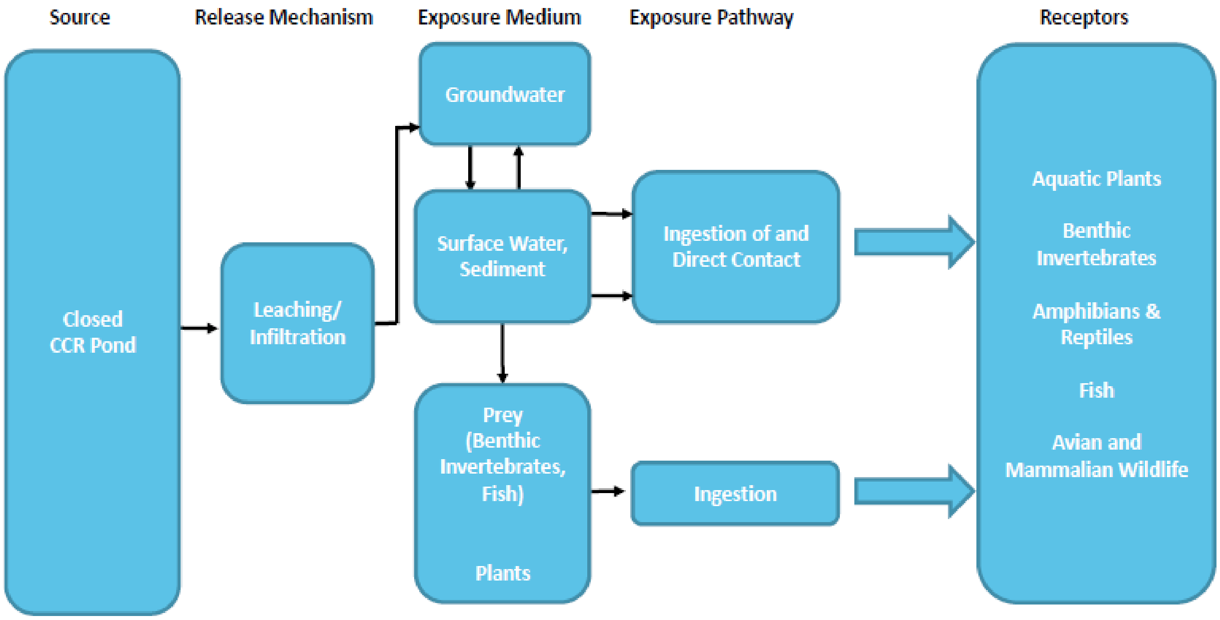

Figure 3.4 Ecological Conceptual Exposure Model. CCR = Coal Combustion Residual.

3.3 Identification of Constituents of Interest

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

3.3.1 Human Health Constituents of Interest

For the human health risk evaluation, COIs were conservatively identified as constituents with maximum concentrations in groundwater above the GWPSs listed in the Illinois CCR Rule Part 845.600 (IEPA, 2021a). The use of groundwater data in this risk evaluation does not imply that detected constituents are associated with the EAP or that they have been identified as potential groundwater exceedances. Using this approach, two COIs (cobalt and lithium) were identified for the human health risk evaluation *via* a surface water pathway (Table 3.1). The water quality parameters that exceeded the GWPS included chloride, sulfate, and total dissolved solids (TDS); however, these constituents were not included in the risk evaluation because the GWPS are likely based on aesthetic quality. US EPA set secondary maximum contaminant levels (MCLs) for chloride, sulfate, and TDS based on aesthetic quality. Chloride (200 mg/L) and sulfate (250 mg/L) MCLs are based on salty taste. The secondary MCL for TDS (500 mg/L) is based on hardness, colored water, staining, and salty taste (US EPA, 2021b). Given that these parameters are not likely to pose a human health risk concern in the event of exposure, they were not identified as COIs.

Table 3.1 Human Health Constituents of Interest

Analytes[a]	Maximum Groundwater Concentration	GWPS[b]	Human Health COI[c]
Dissolved Metals (mg/L)			
Antimony	0.0022	0.006	No
Barium	0.175	2	No
Boron	1.32	2	No
Cadmium	0.0023	0.005	No
Cobalt	0.124	0.006	Yes
Lead	0.0013	0.008	No
Molybdenum	0.04	0.1	No
Selenium	0.009	0.05	No
Total Metals (mg/L)			
Arsenic	0.0025	0.01	No
Barium	0.23	2	No
Boron	1.41	2	No
Cadmium	0.0024	0.005	No
Chromium	0.019	0.1	No
Cobalt	0.147	0.006	Yes
Lead	0.0036	0.0075	No
Lithium	0.041	0.04	Yes
Molybdenum	0.0681	0.1	No
Selenium	0.0093	0.05	No
Radionuclides (pCi/L)			
Radium-226 +228	3.21	5	No
Other Dissolved (mg/L)			
Chloride	325	200	No
Fluoride	0.34	4	No
Sulfate	479	400	No
Total Dissolved Solids	1,690	1,200	No
Other (mg/L, unless otherwise noted)			
Chloride	366	200	No
Fluoride	0.41	4	No
pH (SU)	7.9	9	No
Sulfate	278	400	No
Total Dissolved Solids	1,520	1,200	No

Notes:

COI = Constituent of Interest; GWPS = Groundwater Protection Standards; SU = Standard Unit.

Shaded = Compound identified as a COI.

(a) The constituents are those listed in the IL Part 845.600 GWPS (IEPA, 2021a).

(b) The IL Part 845.600 GWPS (IEPA, 2021a) were used to identify COIs.

(c) COIs are constituents for which the maximum concentration exceeds the groundwater standard.

3.3.2 Ecological Constituents of Interest

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

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

- IEPA (2019a) SWQS. IEPA SWQS are health-protective benchmarks for aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). The SWQS for several metals are hardness dependent (cadmium, chromium, copper, fluoride, lead, manganese, nickel, and zinc). Screening benchmarks for these constituents were calculated assuming US EPA's (2019a) default hardness of 100 mg/L.[6]
- 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's (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). Given that radium concentrations are expressed as total radium (radium-226+228, *i.e.*, the sum of radium-226 and radium-228), Gradient used the lower of the two benchmarks (3 pCi/L for radium-228) to evaluate total radium concentrations.

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

It should be noted that although cadmium and cobalt were screened in as ecological COIs based on the maximum groundwater concentration, neither constituent was detected in surface water (out of 15 samples) (Table 2.3), and the maximum detection limit (0.001 mg/L) was below the ecological benchmark for both constituents. In addition, no constituent was detected in surface water at a concentration exceeding its ecological benchmark (Table 3.3).

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[6] While hardness data are not available for the Illinois River adjacent to the Site, a US Geological Survey (USGS) station (05556200) located at Hennepin, Illinois, approximately five miles downstream from the Site, measured hardness concentrations ranging from 200 to 370 mg/L, with a mean hardness of 288 mg/L, from 106 samples collected between 1980 and 1997 (USGS, 2021a). These are older data and may not reflect current conditions; therefore, US EPA's default hardness of 100 mg/L was used. However, use of a higher hardness value (288 mg/L) would result in less stringent screening values, and thus, use of the US EPA default hardness is conservative.

Table 3.2 Ecological Constituents of Interest

Analyte[a]	Maximum Groundwater Concentration	Ecological Benchmark[b]	Basis	Ecological COI[c]
Dissolved Metals (mg/L)				
Antimony	0.0022	0.19	EPA R4 ESV	No
Barium	0.175	5	IEPA SWQC	No
Boron	1.32	7.6	IEPA SWQC	No
Cadmium	0.0023	0.00093	IEPA SWQC	Yes
Cobalt	0.12	0.019	EPA R4 ESV	Yes
Lead	0.0013	0.016	IEPA SWQC	No
Molybdenum	0.04	0.8	EPA R4 ESV	No
Selenium	0.009	1	IEPA SWQC	No
Total Metals (mg/L)				
Arsenic	0.0025	0.19	IEPA SWQC	No
Barium	0.23	5	IEPA SWQC	No
Boron	1.41	7.6	IEPA SWQC	No
Cadmium	0.0024	0.0011	IEPA SWQC	Yes
Chromium	0.019	0.21	IEPA SWQC	No
Cobalt	0.147	0.019	EPA R4 ESV	Yes
Lead	0.0036	0.020	IEPA SWQC	No
Lithium	0.041	0.44	EPA R4 ESV	No
Molybdenum	0.068	7.2	EPA R4 ESV	No
Selenium	0.0093	1	IEPA SWQC	No
Radionuclides (pCi/L)				
Radium-226 +228	3.21	3.0	US DOE	No[d]
Other Dissolved (mg/L)				
Chloride	325	500	IEPA SWQC	No
Fluoride	0.34	4	IEPA SWQC	No
Sulfate	479	NA	NA	No
Total Dissolved Solids	1690	NA	NA	No
Other (mg/L, unless otherwise noted)				
Chloride	366	500	IEPA SWQC	No
Fluoride	0.41	4	IEPA SWQC	No
pH (SU)	7.9	NA	NA	No
Sulfate	278	NA	NA	No
Total Dissolved Solids	1,520	NA	NA	No

Notes:

COI = Constituent of Interest; DOE = Department of Energy; EPA R4 ESV = US Environmental Protection Agency Region IV Ecological Screening Value; GWPS = Groundwater Protection Standards; IEPA SWQS = Illinois Environmental Protection Agency Surface Water Quality Standard; NA = Not Available; SU = Standard Unit.

Shaded = Compound identified as a COI.

(a) The constituents are those listed in the IL Part 845.600 GWPS (IEPA, 2021a) that were detected in at least one groundwater sample from the 13 wells related to the Hennepin EAP.

(b) Ecological benchmarks are from the hierarchy of sources discussed in Section 3.3.2: IEPA SWQS (IEPA, 2019a); US EPA R4 "Ecological Risk Assessment Supplemental Guidance" (US EPA Region IV, 2018); US DOE's guidance document "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (US DOE, 2019).

(c) Analytes with maximum detected concentrations exceeding a benchmark protective of surface water exposure are considered ecological COIs.

(d) Of the 159 groundwater samples analyzed for radium-226+228, only 1 sample was detected slightly 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.

Table 3.3 Measured Surface Water Data

Constituent	Maximum Detect (mg/L)	Maximum Detection Limit (mg/L)	Ecological Benchmark (mg/L)
Dissolved Metals			
Aluminum	0.641	0.025	
Antimony		0.001	0.19
Arsenic	0.0034		0.19
Barium	0.0462		5.0
Beryllium		0.001	0.064
Boron	0.147		7.6
Cadmium		0.001	0.0011
Chromium	0.015	0.015	0.21
Cobalt		0.001	0.019
Lead	0.002	0.001	0.020
Lithium	0.0083		0.44
Molybdenum	0.0063		7.2
Selenium		0.001	1.0
Thallium		0.002	0.0060

3.3.3 Surface Water and Sediment Modeling

Surface water sampling has been conducted in the Illinois River adjacent to the Site. To estimate the potential contribution to surface water (and sediment) from groundwater specifically associated with the EAP, Gradient modeled concentrations in the Illinois River surface water and sediment from groundwater discharge to the Illinois River for the detected COIs (cadmium, cobalt, and lithium). This is because the constituents detected in groundwater above a health-based benchmark are most likely to pose a risk concern in the adjacent surface water. Gradient modeled human health and ecological COI concentrations in the surface water and sediment using a mass balance calculation based on the surface water and groundwater mixing. The model assumes a well-mixed groundwater-surface water location.

The maximum detected concentrations in groundwater (regardless of well location) from 2015 to 2021 were conservatively used to model COI concentrations in surface water and sediment. For COIs that were measured as both total and dissolved fractions, we used the maximum of the total and dissolved COI concentrations for the modeling. In this case, the maximum concentration was from the total fraction for all three COIs. Use of the total metal concentration for these COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.

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

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 Illinois River and surface water concentrations are presented in Table 3.4. The COI concentrations in sediment were modeled using the COI-specific sediment-to-water partition coefficients and the sediment properties presented in Table 3.5. In the absence of Site-specific information for the Illinois River, we used default assumptions (*e.g.*, depth of the upper benthic layer and bed sediment porosity) to model sediment concentrations. The modeled surface water and sediment concentrations are presented in Table 3.6. These modeled concentrations reflect conservative contributions from groundwater discharge. A description of the modeling and the detailed results are presented in Appendix A.

Table 3.4 Groundwater and Surface Water Properties Used in Modeling

Parameter	Unit	Values	Notes/Source
Groundwater			
COI Concentration	mg/L	Constituent specific	Maximum detected dissolved concentration in groundwater
Cross Section Area for the Uppermost aquifer	m^2	800	Estimated assuming that the entire thickness of the uppermost aquifer (2.4 m) that intersects the Illinois River (Ramboll 2018-2020) is saturated. The discharge length was assumed to be equal to the length of the EAP (333 m)
Hydraulic Gradient	m/m	0.0038	Maximum hydraulic gradient measured between well 17 and well 19S in the vicinity of the EAP (Ramboll, 2021)
Hydraulic Conductivity of the Uppermost aquifer	cm/s	0.1	As reported in Ramboll (2021)
Surface Water			
Surface Water Flow Rate	L/yr	4.56×10^{12}	Representative low flow (10th percentile) discharge rate for the Illinois River (5,100 cfs), as derived from USGS station at Henry (USGS 05558300) (USGS, 2021b)
Total Suspended Solids (TSS)	mg/L	6	6 mg/L is the representative average river concentration (Hanson Professional Services Inc., 2019)
Depth of the Water Column	m	3.96	As indicated in cross-section (Ramboll 2018-2020)
Suspended Sediment to Water Partition Coefficient	mg/L	Constituent specific	Values based on US EPA (2014)

Notes:
cfs = Cubic Feet per Second; COI = Constituent of Interest; US EPA = United States Environmental Protection Agency.

Table 3.5 Sediment Properties Used in Modeling

Parameter	Unit	Value	Notes/Source
Sediment			
Depth of Upper Benthic Layer	m	0.03	Default (US EPA, 2014)
Depth of Water Body	m	3.99	Depth of water column (3.96 m, as indicated in Table 4.3 of Ramboll [2018-2020]) plus depth of upper benthic layer (0.03 m) (US EPA, 2014)
Bed Sediment Particle Concentration	g/cm^3	1	Default (US EPA, 2014)
Bed Sediment Porosity	-	0.6	Default (US EPA, 2014)
TSS Mass per Unit Area	kg/m^2	0.024	Depth of water column × TSS × conversion factors (10^{-6} kg/mg and 1,000 L/m^3)
Sediment Mass per Unit Area	kg/m^2	30	Depth of upper benthic layer × bed sediment particulate concentration × conversion factors (0.001 kg/g, 10^6 cm^3/m^3)
Sediment to Water Partition Coefficients	mg/L	Constituent specific	Values based on US EPA (2014)

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

Table 3.6 Surface Water and Sediment Modeling Results

Contaminant	Max Groundwater Concentration (mg/L)	Mass Discharge Rate (mg/year)	Modeled Surface Water Concentration (mg/L)	Modeled Sediment Concentration (mg/kg)
Cadmium	0.0024	2.30E+05	5.09E-08	6.88E-05
Cobalt	0.147	1.41E+07	3.12E-06	2.85E-03
Lithium	0.041	3.97E+06	8.78E-07	NA

Note:
NA: Lithium sediment concentration was not calculated because Lithium lacks a K_d value.

3.4 Human Health Risk Evaluation

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

3.4.1 Recreators Exposed to Surface Water

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

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

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

where:

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

Illinois defines the acceptable daily intake (ADI) as the "maximum amount of a substance which, if ingested daily for a lifetime, results in no adverse effects to humans" (IEPA, 2019a). US EPA defines its chronic reference dose (RfD) as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure for a chronic duration (up to a lifetime) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (US EPA, 2011a). Illinois lists methods to derive an ADI from the primary literature (IEPA, 2019a). In accordance with Illinois guidance, we derived an ADI by multiplying the MCL by the default water ingestion rate of 2 L/day (IEPA, 2019a). In the absence of an MCL, we used the RfD used by US EPA to derive its Regional Screening Levels (RSLs) (US EPA, 2020) as a conservative estimate of the ADI. The RfDs are given in mg/kg-day, while the ADIs are given in mg/day; thus, we multiplied the RfD by a standard body weight of 70 kg to obtain the ADI in mg/day. The calculation of the HTC values is shown in Appendix Table B.1.

We used bioconcentration factors (BCFs) from a hierarchy of sources. The primary BCFs were those that US EPA used to calculate the national recommended water quality criteria (NRWQC) for human health (US EPA, 2002, 2016). Other sources included BCFs used in the US EPA coal combustion ash risk assessment (US EPA, 2014) and BCFs reported by Oak Ridge National Laboratory's Risk Assessment Information System (ORNL RAIS).[7] Lithium did not have a BCF value available from any authoritative source. Therefore, the water quality criterion for lithium was calculated assuming a BCF of 1. This is a conservative assumption as lithium does not readily bioaccumulate in the aquatic environment (ECHA, 2020a,b; ATSDR, 2010).

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

Screening Risk Evaluation: The maximum modeled and measured COI concentrations in surface water were compared to the calculated Illinois HTC values (Table 3.7). All surface water concentrations were below their respective benchmarks. The HTC values are protective of recreational exposure *via* water and/or fish ingestion and do not account for dermal exposures to COIs in surface water while swimming. However, given that the modeled COI surface water concentrations are orders of magnitude below HTC

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

protective of water and/or fish ingestion, dermal exposures to COIs are not expected to be a risk concern. Moreover, the dermal uptake of metals is considered to be minimal and only a small proportion of ingestion exposures. Thus, none of the COIs evaluated would be expected to pose an unacceptable risk to recreators exposed to surface water while swimming and anglers consuming fish caught in the Illinois River.

Table 3.7 Risk Evaluation for Recreators (Swimmers and Anglers)

COI	Max Modeled SW Conc. (mg/L)	Max Measured SW Conc. (mg/L)	HTC for Water and Fish (mg/L)	HTC for Water Only (mg/L)	HTC for Fish Only (mg/L)	COPC Based on Modeled Conc.	COPC Based on Measured Conc.
Cobalt	3.1E-06	ND	0.0035	2.1	0.0035	No	No
Lithium	8.8E-07	0.0083[a]	4.7	14	7.0	No	No

Notes:

COI = Constituent of Interest; COPC = Constituent of Potential Concern; EAP = East Ash Pond; HTC = Human Threshold Criteria; ND = Not Detected; SW = Surface Water.

(a) Measured surface water concentrations may be different from modeled concentrations because measured data include the effects of background and other industrial sources. Modeled concentrations only represent the potential effect on surface water quality resulting from the measured groundwater concentrations.

3.4.2 Recreators Exposed to Sediment

Recreational exposure to sediment may occur during boating and swimming activity along the Illinois River; exposure to sediment may occur through incidental ingestion and dermal contact.

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

Screening Benchmarks: There are no established recreator RSLs that are protective of recreational exposures to sediment (US EPA, 2019c). Therefore, benchmarks that are protective of recreational exposures to sediment *via* incidental ingestion and dermal contact were calculated using US EPA's RSL guidance (US EPA, 2019c). These benchmarks were calculated using the recommended assumptions (*i.e.*, oral bioavailability, body weights, averaging time) and toxicity reference values (*i.e.*, RfD and cancer slope factor [CSF]), with the following changes: Recreators were assumed to be exposed to sediment while recreating 60 days a year (or two weekend days per week for 30 weeks a year, from April to October). The exposure duration was assumed for a child 6 years of age and an adult 20 years of age, per US EPA guidance (Stalcup, 2014). The daily recommended residential soil ingestion rates of 200 mg/day for a child and 100 mg/day for an adult are based on an all-day exposure to residential soils (Stalcup, 2014; US EPA, 2011b). Since recreational exposures to sediment are assumed to occur for less than four hours per day, one-third of the daily residential soil ingestion (67 mg/day for a child and 33 mg/day for an adult) was used as a conservative assumption. For dermal exposures, recreators were assumed to be exposed to sediment on their lower legs and feet (1,026 cm^2 for the child and 3,026 cm^2 for the adult, based on the age-weighted surface areas reported in US EPA, 2011b). While other body parts may be exposed to sediment, the contact time will likely be very short, as the sediment would wash off in the surface water. We used US EPA's recommended adherence factor of 0.2 mg/cm^2 based on child exposure to wet soil (US EPA, 2004; Stalcup, 2014), which was used in the US EPA RSL User's Guide for a child recreator exposed to soil or sediment (US EPA, 2019c). The sediment screening benchmarks for cadmium and cobalt were calculated based on a target hazard quotient of 1. Appendix Table B.2 presents the calculation of RSLs protective of recreational exposures to sediment.

Screening Risk Evaluation: The modeled sediment concentrations were well below the recreational sediment RSLs (Table 3.8). Therefore, exposure to sediment is not expected to pose an unacceptable risk to recreators while swimming or boating.

Table 3.8 Risk Evaluation for Recreators Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	Recreator RSL (mg/kg)	COPC
Cobalt	2.8E-03	411	No

Notes:
Lithium could not be modeled in sediment because it lacks a K_d value.
COI = Constituent of Interest; COPC = Constituent of Potential Concern.

3.5 Ecological Risk Evaluation

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

3.5.1 Ecological Receptors Exposed to Surface Water

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

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

- IEPA SWQS (IEPA, 2019a), regulatory standards that are intended to protect aquatic life exposed to surface water on a long-term basis (*i.e.*, chronic exposure). For cadmium, the surface water benchmark is hardness dependent and calculated using a default hardness of 100 mg/L[8];
- NRWQC – Aquatic Life Criteria Table (US EPA, 2019a); and
- US EPA Region IV (2018) surface water ESVs for hazardous waste sites.

Risk Evaluation: The maximum modeled COI concentrations in surface water were compared to the benchmarks protective of aquatic life (Table 3.9). The measured and 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 Illinois River.

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[8] While USGS hardness data are available, US EPA's (2019a) default hardness of 100 mg/L was conservatively used. Conservatisms associated with using a default hardness value are discussed in Section 3.4.

Table 3.9 Risk Evaluation of Ecological Receptors Exposed to Surface Water

COI	Maximum SW Conc., Modeled (mg/L)	Maximum Detected SW Conc. (mg/L)	Ecological Freshwater Benchmark (mg/L)	Basis	COPC Based on Modeled Conc.	COPC Based on Measured Conc.
Cadmium	5.1E-08	ND	0.00093	IEPA (2019a)	No	No
Cobalt	3.1E-06	ND	0.019	US EPA R4 (2018)	No	No

Notes:

COI = Constituent of Interest; COPC = Constituent of Potential Concern; IEPA = Illinois Environmental Protection Agency; ND = Not Detected; SW = Surface Water; US EPA R4 = United States Environmental Protection Agency Region IV.

(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 Illinois River can sorb to sediments *via* chemical partitioning. In the absence of sediment data, sediment concentrations were modeled using maximum detected groundwater concentrations. Therefore, the modeled COI sediment concentrations reflect the potential maximum Site-related sediment concentration from groundwater discharge.

Screening Benchmarks: Sediment screening benchmarks were obtained from US EPA Region IV (2018). The majority of the sediment ESVs are based on threshold effect concentrations (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. The benchmarks used in this evaluation are listed in Table 3.10.

Screening Risk Results: The maximum modeled COI sediment concentrations were below their respective sediment screening benchmarks (Table 3.10). The modeled sediment concentrations attributed to potential contributions from Site groundwater for all COIs were less than 1% 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 Illinois River adjacent to the Site.

Table 3.10 Risk Evaluation of Ecological Receptors Exposed to Sediment

COI	Modeled Sediment Concentration (mg/kg)	ESV[a] (mg/kg)	COPC	% of Benchmark
Cadmium	6.9E-05	0.99	No	0.007%
Cobalt	2.8E-03	50	No	0.006%

Notes:

COI = Constituent of Interest; COPC = Constituent of Potential Concern; ESV = Ecological Screening Value.

(a) ESV from US EPA Region IV (2018).

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's SWQS (IEPA, 2019a) guidance were used to identify analytes with potential bioaccumulative effects.

Risk Evaluation: The ecological COIs, cadmium and cobalt,[9] were not identified as having potential bioaccumulative effects. Therefore, these COIs are not considered to pose an ecological risk *via* bioaccumulation.

3.6 Uncertainties and Conservatisms

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

Exposure Estimates:

- The risk evaluation included the IL Part 845.600 constituents detected in groundwater samples collected from wells downgradient of the EAP. However, it is possible that not all of the detected constituents are related specifically to the EAP, since there are several sources in this area.
- The human health and ecological risk characterizations were based on the maximum modeled COI concentrations, rather than on averages. Thus, the variability in exposure concentrations was not considered. Assuming continuous exposure to the maximum concentration overestimates human and ecological exposures, given that receptors are mobile and concentrations change over time. For example, US EPA guidance states that risks should be estimated using average exposure concentrations as represented by the 95% upper confidence limit on the mean (US EPA, 1992). Given that exposure estimates based on the maximum concentrations did not exceed risk benchmarks, 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 EAP groundwater, the detection limits were below the IL Part 845 GWPS and thus do not require further evaluation.
- COI concentrations in surface water were modeled using the maximum detected total or dissolved COI concentrations. In this case, maximum detected concentrations for cadmium, cobalt, and lithium are based on total concentrations. Modeling surface water concentrations using total metal concentrations for these COIs may overestimate surface water concentrations because dissolved concentrations, which are lower than total concentrations, represent the mobile fractions of constituents that could likely flow into and mix with surface water.
- The COIs identified in this evaluation also occur naturally in the environment. Contributions to exposure from natural or other non-EAP-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 EAP-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-EAP-related sources.
- Screening benchmarks for human health were developed using exposure inputs based on US EPA's recommended values for reasonable maximum exposure (RME) assessments (Stalcup, 2014). RME is defined as "the highest exposure that is reasonably expected to occur at a site but that is

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[9] US EPA Region IV (2018) identifies only mercury (including methyl mercury) and selenium as having potential bioaccumulative effects. IEPA (2019a) identifies mercury as the only metal with bioaccumulative properties. Mercury was not detected in groundwater. Selenium was detected in groundwater but was not considered an ecological COI.

still within the range of possible exposures" (US EPA, 2004). US EPA states the "intent of the RME is to estimate a conservative exposure case (*i.e.*, well above the average case) that is still within the range of possible exposures" (US EPA, 1989). US EPA also notes that this high-end exposure "is the highest dose estimated to be experienced by some individuals, commonly stated as approximately equal to the 90th percentile exposure category for individuals" (US EPA, 2015b). Thus, most individuals will have lower exposures than those presented in this risk assessment.

- Although the maximum radium-226+228 concentration in groundwater exceeded the ecological screening benchmark, radium-226+228 was not considered an ecological COI because the maximum result, detected slightly above the benchmark, is considered an outlier at the 1% and 5% significance levels. While risks to ecological receptors exposed to radium-226+228 in surface water, sediment, and diet were not evaluated, the risks are expected to be *de minimis*.[10]

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. While a USGS station had available hardness data, we relied on US EPA's default hardness of 100 mg/L due to the limitations of the USGS data. USGS data from Hennepin, Illinois (five miles downstream of the Site), reported hardness ranging from 200 to 370 mg/L, with a mean hardness of 288 mg/L, based on samples collected in 1980-1997 (USGS, 2021a). Increasing the hardness from 100 to 288 mg/L would increase the cadmium SWQS because benchmarks become less stringent with higher levels of hardness. Regardless of the hardness, the maximum modeled cadmium concentration is orders of magnitude below the 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.
- In general, it is important to appreciate that the human health toxicity factors used in this risk evaluation are developed to account for uncertainties, such that safe exposure levels used as benchmarks are often many times lower (even orders of magnitude lower) than the levels that cause effects that have been observed in human or animal studies. For example, toxicity factors incorporate a 10-fold safety factor to protect sensitive subpopulations. This means that a risk exceedance does not necessarily equate to actual harm.

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[10] Radium was not analyzed in surface water. However, the surface water and sediment modeling for other ecological COIs demonstrate that the modeled concentrations are orders of magnitude lower than the measured COI concentration in surface water and sediment. Given that the maximum groundwater concentration slightly exceeds the surface water benchmark, the modeled surface water and sediment concentrations will be below their respective benchmarks. Furthermore, radium is not described in US EPA Region IV guidance, but it is identified as bioaccumulative by other entities (*e.g.*, ATSDR, 1990). However, the benchmark used to identify ecological COIs already considers bioaccumulative exposures. Given that the modeled concentrations are anticipated to be 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.

4 Summary and Conclusions

A screening-level risk evaluation was performed for Site-related constituents in groundwater at the Hennepin Power Plant in Hennepin, Illinois. The CSM developed for the Site indicates that groundwater beneath the EAP flows into the Illinois River adjacent to the Site and may potentially impact surface water and sediment.

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

Surface water data collected in 2020, and groundwater data collected from 2015 to 2021, were used to estimate exposures. The maximum detected concentrations in surface water were used for human and ecological receptors exposed to surface water. For analytes detected in groundwater, surface water concentrations were also modeled using the maximum detected groundwater concentration. In the absence of sediment data, modeled sediment concentrations based on the maximum detected groundwater concentrations were used as the exposure estimate for human and ecological receptors. Surface water and sediment exposure estimates were screened against benchmarks protective of human health and ecological receptors for this risk evaluation.

For recreators (boaters and swimmers) exposed to surface water, all COIs were below the conservative risk-based screening benchmarks. Therefore, none of the COIs evaluated in surface water are expected to pose an unacceptable risk to recreators swimming or boating in the Illinois River adjacent to the Site.

For recreators exposed to sediment *via* incidental ingestion and dermal contact, the modeled sediment concentration for cobalt was below the health protective sediment benchmark. Therefore, the modeled cobalt concentration in sediment is not expected to pose an unacceptable risk to recreators exposed to sediment in the Illinois River adjacent to the Site.

For anglers consuming locally caught fish, the maximum measured and modeled concentrations of all COIs in surface water were below conservative benchmarks protective of fish consumption. Therefore, none of the COIs evaluated are expected to pose an unacceptable risk to recreators consuming fish caught in the Illinois River.

Ecological receptors exposed to surface water include aquatic and marsh plants, amphibians, reptiles, and fish. The risk evaluation showed that none of the modeled or measured COIs in surface water exceeded protective screening benchmarks. Ecological receptors exposed to sediment include benthic invertebrates. The modeled sediment COIs did not exceed the conservative screening benchmarks; therefore, none of the COIs evaluated in sediment are expected to pose an unacceptable risk to ecological receptors. Ecological receptors were also evaluated for exposure to bioaccumulative COIs. This evaluation considered higher-trophic-level wildlife with direct exposure to surface water and sediment and secondary exposure through the consumption of dietary items (*e.g.*, plants, invertebrates, small mammals, fish). The ecological COIs (cadmium and cobalt) were not identified as having potential bioaccumulative effects. Therefore, these COIs are 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 EAP is closed. For all future closure scenarios, potential releases of CCR-related constituents will decline over time and, consequently, potential exposures to CCR-related constituents in the environment will also decline.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. "Toxicological Profile for Radium." December.

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. "Toxicological Profile for Boron." November. Accessed at http://www.atsdr.cdc.gov/ToxProfiles/tp26.pdf.

European Chemicals Agency (ECHA). 2020a. "REACH dossier for boron (CAS No. 7440-42-8)." Accessed at https://echa.europa.eu/registration-dossier/-/registered-dossier/14776.

European Chemicals Agency (ECHA). 2020b. "REACH dossier for lithium (CAS No. 7439-93-2)." Accessed on January 1, 2020 at https://echa.europa.eu/registration-dossier/-/registered-dossier/14178.

Geosyntec Consultants (Geosyntec). 2021a. "Surface Water Sampling Locations, Hennepin Power Plant, Hennepin, Illinois." July.

Geosyntec Consultants (Geosyntec). 2021b. "Illinois Administrative Code Part 845 Data Gap Analysis, Hennepin Power Plant East Ash Pond - Hennepin, Illinois 61327." Report to Dynegy Midwest Generation, LLC (Collinsville, IL). July 29.

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

Illinois Environmental Protection Agency (IEPA). 2016. "Appendix A-5. 303(d) Listed Waters Maps." In Illinois Integrated Water Quality Report and Section 303(d) List - Volume I: Surface Water - 2016 (Final as submitted to US EPA Region V on July 11, 2016). Accessed on October 21, 2021 at https://www2.illinois.gov/epa/Documents/iepa/water-quality/watershed-management/tmdls/2016/303-d-list/appendix-a5.pdf.

Illinois Environmental Protection Agency (IEPA). 2018. "Illinois Integrated Water Quality Report and Section 303(d) List, 2018 (Draft)." November 14.

Illinois Environmental Protection Agency (IEPA). 2019a. "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). 2019b. "Appendix A-1. Illinois' 2018 303(d) List and Prioritization." In Illinois Integrated Water Quality Report and Section 303(d) List, 2018 (Final as submitted to US EPA Region V on February 22, 2021) May 20. Accessed on October 21, 2021 at https://www2.illinois.gov/epa/topics/water-quality/watershed-management/tmdls/Documents/Appendix%20A-1_303d_by_priority_FINAL_5-20-19.pdf.

Illinois Environmental Protection Agency (IEPA). 2021a. "Standards for the disposal of coal combustion residuals in surface impoundments." Accessed on October 4, 2021 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 on September 28, 2021 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 on September 28, 2021 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.

Morris, P. [Dynegy Midwest Generation, LLC]. 2021. Letter to D. LeCrone (IEPA) re: CCR surface impoundment category designation and justification for Dynegy Midwest Generation, LLC. May 19.

Oak Ridge National Laboratory (ORNL). 2018. "Risk Assessment Information System (RAIS) Toxicity Values and Chemical Parameters: Chemical Toxicity Values." Accessed on July 17, 2018 at https://rais.ornl.gov/cgi-bin/tools/TOX_search?select=chem.

Ramboll. 2018-2020. "Final Closure and Post-Closure Plans for Hennepin East Ash Ponds No. 2 & No. 4." Report to Dynegy Midwest Generation, LLC.

Ramboll. 2021. "Hydrogeologic Site Characterization Report, Hennepin East Ash Pond, Hennepin Power Plant, 13498 E 800th Street, Hennepin, IL 61327." Report to Dynegy Midwest Generation, LLC.

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

US Dept. of Energy (US DOE). 2019. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota." DOE-STD-1153-2019. Accessed on July 16, 2019 at https://www.standards.doe.gov/standards-documents/1100/1153-astd-2019/@@images/file.

US EPA Region IV. 2018. "Region 4 Ecological Risk Assessment Supplemental Guidance (March 2018 Update)." Superfund Division, Scientific Support Section. March. Accessed on March 4, 2021 at https://www.epa.gov/sites/production/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf.

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) (Cincinnati, OH), EPA 600/R-98/137., December. Accessed at http://www.epa.gov/nceawww1/combust.htm.

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

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

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

US EPA. 2011b. "Exposure Factors Handbook: 2011 Edition." Office of Research and Development, US EPA, National Center for Environmental Assessment (NCEA) EPA/600/R-090/052F. September. Accessed on November 2, 2020 at https://www.epa.gov/expobox/about-exposure-factors-handbook.

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

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

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

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

US EPA. 2016. "National Recommended Water Quality Criteria - Aquatic Life Criteria Table." April 18. Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

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

US EPA. 2019c. "Regional Screening Levels (RSLs) - User's Guide." May. Accessed on October 1, 2019 at https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide.

US EPA. 2020. "Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1)." November. Accessed at https://semspub.epa.gov/work/HQ/400431.pdf.

US EPA. 2021a. "Safe Drinking Water Information System (SDWIS) Search." Accessed on September 28, 2021 at https://www.epa.gov/enviro/sdwis-search.

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

US Geological Survey (USGS). 2021a. "Streamgage data for Illinois River at Hennepin, IL [USGS 05556200] [Summary of all available data]." Accessed at https://waterdata.usgs.gov/il/nwis/inventory/?site_no=05556200&

US Geological Survey (USGS). 2021b. "Discharge data for Illinois River at Henry, IL (1981-2021) [USGS 05558300]."

Appendix A

Surface Water and Sediment Modeling

Gradient modeled concentrations in river surface water and sediment based on available groundwater data. First, we estimated the flow rate of constituents of interest (COIs) discharged to the Illinois River *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 Illinois River.

Model Overview

The groundwater flow into the river is represented by a one-dimensional steady-state model. In this model, the groundwater plume migrates horizontally in the uppermost aquifer, from south to north, in the direction of the Illinois River. The groundwater flow entering the river is the flow going through a cross-sectional area that has a length equal to the length of the river adjacent to the East Ash Pond (EAP) with potential coal combustion residual (CCR)-related impacts and a height equal to the saturated thickness of the uppermost aquifer (Table 3.4). It was assumed that all the groundwater flowing through the uppermost aquifer discharges to the Illinois River. The length of the river adjacent to the EAP was estimated using Google Earth Pro.

The groundwater flow into the river mixes with the surface water in the Illinois River. The COIs entering the river *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

We used conservative assumptions to evaluate the 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 river.

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 river 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)
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. 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 river gets diluted in the surface water flow. Constituents transported by groundwater into the surface water migrate into the water column and the bed sediments. The surface water model 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). These coefficients are presented in Table A.2.

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

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

where:

C_{wtot} = Total water body concentration of the constituent (mg/L)
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 Illinois River annual flow rate, we conservatively used the low flow (10th percentile) discharge rate of about 5,100 cubic feet per second (cfs) based on the daily mean discharge rates measured at Henry (USGS station #558300) between 1981 and 2021 (USGS, 2021b).

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 defined as (US EPA, 2014):

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

where:

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 river 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.3. Other water body parameters are presented in Table A.4.

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

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

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

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

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

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

where:

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

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

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

where:

C_{bstot} = Total concentration in bed sediment (mg/L or g/m^3)
C_{wtot} = Total water body concentration of the constituent (mg/L)
f_{benth} = Fraction of 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 was calculated from (US EPA, 1998):

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

where:

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

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

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

GW Unit	Parameter	Full Name	Value	Unit
Uppermost Aquifer	A	Cross-Sectional Area	800	m^2
Uppermost Aquifer	i	Hydraulic Gradient	0.0038	m/m
Uppermost Aquifer	K	Hydraulic Conductivity	0.10	cm/s

Notes:
GW = Groundwater.
Source: Hydraulic gradient and hydraulic conductivity values from Ramboll (2021).

Table A.2 Partition Coefficients

Constituent	Sediment-Water, Mean, Kdbs		Suspended Sediment-Water, Mean, Kdsw	
	Value ($\log_{10}$) (mL/g)	Value (mL/g)	Value ($\log_{10}$) (mL/g)	Value (mL/g)
Cadmium	3.3	2.00E+03	4.9	7.94E+04
Cobalt	3.1	1.26E+03	4.8	6.31E+04

Notes:
Lithium was not modeled because it lacks a Kd value in US EPA (2014).
Source: US EPA (2014).

Table A.3 Calculated Parameters

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 $f_{dissolved}$
Cadmium	0.0890	0.9110	0.6772
Cobalt	0.1263	0.8737	0.7254

Table A.4 Surface Water Parameters

Parameter	Full Name	Value	Unit
TSS	Total Suspended Solids	6	mg/L
V_{fx}	Surface Water Flow Rate	4.56E+12	L/yr
db	Depth of Upper Benthic Layer (default: 0.03)	0.03	m
dw	Depth of Water Column	3.96	m
dz	Depth of Water Body	3.99	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	0.024	kg/m^2
M_S	Sediment Mass per Unit Area	30	kg/m^2

Notes:
Source of default values: US EPA (2014).

Table A.5 Input Groundwater Concentrations and Output Surface Water and Sediment Concentrations

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)
Cadmium	2.40E-03	2.30E+05	5.09E-08	6.88E-05
Cobalt	1.47E-01	1.41E+07	3.12E-06	2.85E-03
Lithium	4.14E-02	3.97E+06	8.78E-07	Not Applicable

Note:
Lithium was not modeled due to lack of Kd value in US EPA (2014).

Appendix B

Screening Benchmarks

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

Analytes	Bioconcentration Factor (BCF)		Average Daily Intake (ADI)			Human Threshold Criteria (HTC)		
	BCF[a] (L/kg-tissue)	Basis	MCL (mg/L)	RfD (mg/kg-d)	ADI[b] (mg/day)	Water & Fish (mg/L)	Water Only (mg/L)	Fish Only (mg/L)
Cobalt	300	ORNL RAIS	NC	0.00030	0.021	0.0035	2.1	0.0035
Lithium	1	(d)	NC	0.002	0.14	4.7	14	7.0

Notes:

(a) BCFs from the following hierarchy of sources:

NRWQC (US EPA, 2016). National Recommended Water Quality Criteria.

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

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

ORNL RAIS (ORNL, 2018). Risk Assessment Information System (RAIS) Toxicity Values and Chemical Parameters.

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

(c) SWQC based on US EPA's action level.

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

Equations from IEPA (2019a):

Consumption of Water and Fish

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

Incidental Consumption of Water only

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

Consumption of Fish only

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

Where

Average Daily Intake (ADI)	=	Chem. Specific	mg/day
Fish Consumption Rate (F)	=	0.02	kg/day
Bioconcentration Factor (BCF)	=	Chem. Specific	L/kg-tissue
Water Consumption Rate (W)	=	0.01	L/day

Table B.2 Recreator Exposure to Sediment

Chemical COIs	Relative Bioavailability B (unitless)	Dermal Absorption Fraction ABS (unitless)	Cancer				Cancer SL (mg/kg)	Non-Cancer								Recreator RSL Sediment (mg/kg)	Basis
			TRV		Child + Adult			TRV		Child		Adult		Child	Adult		
			CSF $(mg/kg\text{-}d)^{-1}$	Derm. CSF $(mg/kg\text{-}d)^{-1}$	Incidental Ingestion SL_{ing} (mg/kg)	Dermal Contact SL_{derm} (mg/kg)		RfD (mg/kg-d)	Derm. RfD (mg/kg-d)	Incidental Ingestion SL_{ing} (mg/kg)	Dermal Contact SL_{derm} (mg/kg)	Incidental Ingestion SL_{ing} (mg/kg)	Dermal Contact SL_{derm} (mg/kg)	Non-Cancer SL (mg/kg)			
Cobalt	1	NA	NC	NC	NC	NC	NC	3.0E-04	3.0E-04	4.1E+02	NA	4.4E+03	NA	4.1E+02	4.4E+03	411	nc

Notes:

AL = EPA Action Level; COI = Constituent of Interest; CSF = Cancer Slope Factor; derm = Dermal Contact; ing = Ingestion; NC = No criterion available; RfD = Reference Dose; SL = Screening Level; TRV = Toxicity Reference Value.

Health Benchmark defined as the lower of the Screening Levels for cancer and non-cancer. The basis of the Health Benchmark presented as c = based on cancer endpoint or nc = based on non-cancer endpoint.

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

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

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

Target Cancer Risk (TR) = 1E-05
Target Hazard Quotient (THQ) = 1

Sediment – Ingestion (Chemical)

			Non-Cancer		Cancer		
Intake Factor (IF) =	$\frac{IR \times EF \times ED \times CF}{BW \times AT}$	=	7.3E-07	6.8E-08	6.3E-08	2.0E-08	Basis
			Child	Adult	Child	Adult	
IR	Ingestion Rate (mg/day)		67	33	67	33	One-third of US EPA residential soil ingestion rate (Prof. Judgment)
EF	Sediment Exposure Frequency (days/year)		60	60	60	60	2 days/week between April and Oct when air temp. > 70°F (Prof. Judgment)
ED	Exposure Duration (years)		6	20	6	20	Default value for Resident (US EPA, 2019c)
CF	Conversion Factor (kg/mg)		0.000001	0.000001	0.000001	0.000001	
BW	Body Weight (kg)		15	80	15	80	Default value for Resident (US EPA, 2019c)
AT	Averaging Time (d)		2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019c)

Sediment – Dermal Contact (Chemical)

			Non-Cancer		Cancer		
Intake Factor (IF) =	$\frac{SA \times AF \times EF \times ED \times CF}{BW \times AT}$	=	2.2E-06	1.2E-06	1.9E-07	3.6E-07	Basis
			Child	Adult	Child	Adult	
SA	Surface Area Exposed to Sediment (cm²/day)		1,026	3,026	1,026	3,026	Age weighted SA for lower legs and feet (US EPA, 2011b)
AF	Sediment Skin Adherence Factor (mg/cm²)		0.2	0.2	0.2	0.2	Age weighted AF for children exposed to sediment (US EPA, 2011b)
EF	Sediment Exposure Frequency (days/year)		60	60	60	60	2 days/week between April and Oct when air temp. > 70°F (Prof. Judgment)
ED	Exposure Duration (years)		6	20	6	20	Default value for Resident (US EPA, 2019c)
CF	Conversion Factor (kg/mg)		0.000001	0.000001	0.000001	0.000001	
BW	Body Weight (kg)		15	80	15	80	Default value for Resident (US EPA, 2019c)
AT	Averaging Time (d)		2,190	7,300	25,550	25,550	Default value for Resident (US EPA, 2019c)

ATTACHMENT B

Supporting Information for Closure Alternatives Analysis

Prepared for

Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

CLOSURE ALTERNATIVES ANALYSIS SUPPORTING INFORMATION REPORT

HENNEPIN POWER PLANT
EAST ASH POND
(IEPA ID W1550100002-05)
Hennepin, Illinois

Prepared by

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Revision 0

January 28, 2022

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TABLES

1. INTRODUCTION AND BACKGROUND

Dynegy Midwest Generation, LLC (Dynegy) is the owner of the coal-fired Hennepin Power Plant (HPP), also referred to as Hennepin Power Station, in Hennepin, Illinois. The HPP is currently inactive. Dynegy intends to complete closure of the East Ash Pond (EAP) at the HPP (IEPA ID No. W1550100005-05, Dynegy CCR Unit ID 803, and National Inventory of Dams Number IL50363). Closure of the EAP will be performed under the relevant Illinois Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (Part 845) [1] and the United States Environmental Protection Agency (USEPA) CCR Rule [2].

Part 845 requires a Closure Alternatives Analysis (CAA) to be completed, pursuant to the requirements of Section 854.710, to support the Closure Plan prepared pursuant to Section 845.720. The CAA for the HPP EAP will be performed by Gradient Corporation (Gradient). Geosyntec has prepared this Closure Alternatives Analysis Supporting Information Report (Report) to provide information requested by Gradient to support their preparation of the CAA.

1.1. Report Contents

The following information is contained within this report:

- **Section 1** includes the Introduction and Background;
- **Section 2** includes information related to closure-by-removal (CBR) including:
    - A feasibility evaluation of CBR using an onsite landfill (CBR-Onsite);
    - An evaluation of potential offsite landfills to receive the CCR for CBR-Offsite; and
    - A feasibility evaluation of CCR transportation for CBR-Offsite using over-the-road trucks, rail, and barging.
- **Section 3** includes an overview of the planned construction for both CIP and CBR-Offsite;
- **Section 4** includes a project schedule for both CIP and CBR-Offsite; and
- **Section 5** includes estimates for construction material quantities, cost, labor, vehicle miles, and equipment miles, for both CIP and CBR-Offsite.

2. CLOSURE-BY-REMOVAL INFORMATION

Section 845.710(c)(1) requires the evaluation of complete removal of CCR (e.g., CBR), and Section 845.710(d)(2) requires the CAA to identify if the Power Plant has a landfill that can accept the CCR, or if constructing an onsite landfill is feasible. Additionally, Section 845.710(c)(1) requires the evaluation of multiple modes of transportation of CCR, including rail, barge, and truck. This section includes evaluation of onsite landfill options, potential offsite landfills, and potential methods for transporting CCR to offsite landfills.

2.1. Evaluation of Onsite Landfill Options

2.1.1. Existing Hennepin CCR Landfill

An existing CCR landfill, the Hennepin Landfill, was constructed at the HPP in 2011 and was never used to store waste actively generated at the HPP, although approximately 7,000 cubic yards (CY) of bottom ash ballast were placed over the top of the leachate collection layer in 2011 to provide freeze protection for the underlying liner system. The existing landfill cell is approximately 4.5 acres in size [3].

The EAP contains approximately 680,000 CY of CCR [4]. Placing all CCR from the EAP within the landfill would require the landfill to be constructed to a height of approximately 330 feet with 1.2 horizontal (H) to one vertical (V) side-slopes. A landfill of this geometry is unlikely to be stable from a geotechnical perspective.

The landfill is adjacent on the west to East Ash Pond No. 2 (EAP#2), which has been closed-in-place [5], on the south by the EAP, and on the east by the non-CCR Leachate Pond. Any lateral expansions to the landfill would adversely impact the adjacent CCR and non-CCR surface impoundments.

Therefore, using the existing onsite landfill at the HPP is not feasible due to the limited capacity and inability of the landfill to be expanded.

2.1.2. Feasibility of New Onsite Landfill Construction

The HPP site boundary was evaluated for suitable areas for the construction of an onsite landfill. The site was divided into multiple areas, Area 1 through Area 6, as shown in **Figure 1**. The feasibility of constructing a new landfill in each area is described below:

- Area 1 is approximately 54 acres in size and is located immediately south of the closed Old West Ash Pond and Old West Polishing Pond.
    - Most of this area is located within the 100-year floodplain of the Illinois River and may contain wetlands.

  - This area is also adjacent to the Illinois Department of Natural Resources (IDNR) Donnelly Wildlife Management Area.
  - Therefore, there are no feasible locations for constructing a landfill within Area 1, due to impacts to the 100-year floodplain and potential impacts to adjacent protected areas.

- Area 2 is approximately 224 acres in size and is located south of the HPP.
  - Area 2 contains multiple utility service corridors, including five high-voltage electric lines leading to the switchyard at the HPP and one 10-inch natural gas line. These utilities are still active. Construction of a landfill in this area would likely require the utilities to be disturbed and potentially re-routed.
  - This area also includes County Road 875 East, which is an active roadway and provides access to adjacent industrial facilities. Construction of a landfill in this area may require the roadway to be relocated.
  - Most of Area 2 is planned for the development of a solar farm for generating electricity. Use of Area 2 for a landfill would impede solar development and potentially reduce the amount of low-carbon solar energy that could be developed at the site.
  - Some of Area 2 is within the 100-year floodplain of the Illinois River.
  - Therefore, there are no feasible locations for constructing a landfill within Area 2, due to existing utility corridors, existing public roadways, conflicts with proposed solar developments, and potential 100-year floodplain impacts.

- Area 3 is approximately 66 acres in size and is located immediately adjacent to and includes the HPP.
  - Approximately 10 acres of this area is the former HPP Coal Pile. Constructing a pyramid-shaped landfill to contain the approximately 680,000 CY of CCR from the EAP would require a total waste height of approximately 160 ft and 2.5H:1V side slopes, which may be geotechnically-challenging, considering the Coal Pile area is located at the top of a steep slope that leads to the Illinois River.
  - Outside of the Coal Pile, Area 3 has multiple conflicts related to existing site access roads and utilities and an electrical switchyard. The utilities and roads will need to be utilized as supporting infrastructure for future solar development at the stie.
  - Some of Area 3 is within the 100-year floodplain of the Illinois River.

  - Therefore, there are no feasible locations for constructing a landfill within Area 3, due to space limitations relative to the required capacity, existing utilities and roadways, and potential 100-year floodplain impacts.

- Area 4 is approximately 40 acres and Area 5 is approximately 39 acres in size. These areas consist of CCR surface impoundments that have been previously closed-in-placed and adjacent areas to the closed CCR surface impoundments.

  - Portions of Areas 4 and 5 that overlie closed CCR surface impoundments are unlikely to be suitable for constructing a landfill due to settlement induced by the overlying waste potentially damaging the final cover system of the closed CCR surface impoundment.

  - Portions of Areas 4 and 5 that do not overlie closed CCR surface impoundments are generally located on steep slopes leading to the Illinois River or the Illinois River floodplain.

  - Therefore, there are no feasible locations for constructing a landfill within Areas 4 or 5, due to the presence of existing CCR surface impoundments, steep slopes leading to the Illinois River, and potential 100-year floodplain impacts.

- Area 6 is approximately 21 acres in size and consists of existing non-CCR surface impoundments, including the Leachate Pond and Polishing Pond.

  - Both the Leachate Pond and Polishing Pond are currently used as settlement basins to manage discharge from the HPP to the Illinois River via National Pollutant Discharge Elimination System (NPDES) Outfall 003.

  - Both ponds will need to remain in-service during closure constructing to allow unwatering and dewatering flow from the EAP to be managed prior to discharge via NPDES Outfall 003. Without the use of these ponds, there would be not onsite facilities suitable for managing construction-generated water and stormwater prior to discharge.

  - Therefore, there are no feasible locations for constructing a landfill within Area 6, as the existing non-CCR surface impoundments in Area 6 will be used as settling basins during closure construction.

In summary, there are no feasible locations for constructing a landfill within the existing HPP site boundary. Each evaluated location has multiple conflicts related to future solar development, potential 100-year floodplain impacts, impacts to wetlands, existing closed CCR surface impoundments, existing utility corridors and site roadways, and steep slopes precluding landfill development.

2.2. Potential CBR-Offsite Receiving Landfills

Potential offsite landfills suitable for disposing of the approximately 680,000 CY of CCR within the EAP were evaluated using IEPA's online Illinois Disposal Capacity Report [6]. The closest landfills to the site, by road miles, were determined to be the Republic Services LandComp Landfill in Ottawa, Illinois and the Ecology Solutions Eco Hill Landfill (a.k.a. Atkinson Landfill) in Atkinson, Illinois.

The LandComp landfill is the preferred landfill due to its location being closer to the HPP (32 vs. 53 one-way miles, respectively), thereby resulting in reduced hauling mileage. Both landfills have sufficient remining permitted capacity to receive the approximately 680,000 CY of CCR, although the landfills have not yet been contacted, as of the date of this report, to confirm that they would be willing to accept the CCR. Information on both landfills is provided in **Table 1** and the location of each landfill relative to the HPP is provided in **Figure 2**.

2.3. Potential CBR-Offsite Transportation Methods

Section 845.710(c)(1) requires CBR to consider multiple methods for transporting removed CCR, including using rail, barge, and trucks. An evaluation of each method is included within this section.

2.3.1. Transportation by Rail

The HPP does not currently have an established rail terminal, although the HPP property does border a Norfolk Southern rail spur leading to the adjacent Washington Mills industrial facility. In order for CCR to be transported by rail, a new rail loading terminal would need to be constructed onsite, which would increase the project schedule due to the need to coordinate with the railroad, complete design and permitting, and construct the terminal. CCR would still need to be hauled by truck to the new onsite loading terminal and loaded into rail cars, resulting in additional CCR handing and exposure to the surrounding environment.

While both the Land Comp and Atkinson landfills are located within approximately one mile of existing rail lines, an existing terminal suitable for the unloading of CCR is not present near either landfill. A rail unloading terminal would need to be constructed which would increase the project schedule due to the need to coordinate with the railroad, complete design and permitting, and construct the terminal. CCR would still need to be hauled by truck from the new offsite unloading terminal to the landfill, resulting in additional CCR handling and exposure to the surrounding environment.

Furthermore, a direct rail route from the Hennepin Power Plant to either landfill does not exist. Hauling CCR to the Land Comp or Atkinson landfill would involve approximately 51 and 115 miles, respectively, of hauling by rail on tracks owned by three separate rail lines (Norfolk Southern, Illinois Railway, LLC, and Iowa Interstate Railroad, Ltd), as shown on **Figure 2**. The ability of CCR to be hauled over multiple lines and transferred from line to line is currently unknown.

Therefore, transporting CCR by rail is unlikely to be a viable option for the HPP EAP, due to the need to design, permit, and construct additional loading and unloading infrastructure, resulting in corresponding project schedule delays, and the distance and number of rail lines which the CCR would need to be transported over.

2.3.2. Transportation by Barge

The HPP is located along the Illinois River and formerly received coal shipments by barge, which were unloaded via an unloading terminal. The coal unloading terminal includes a clamshell unloading bucket that was utilized for removing coal from barges and placing the coal into a conveyor system that transported to the former coal pile at the HPP. This terminal is not currently suitable for the loading of CCR into barges as it was designed and constructed for unloading, rather than loading. The clamshell is unlikely to be sufficient to load CCR without potentially releasing of minor amounts of CCR dust from the clamshell into the surrounding environment. Additionally, the terminal was partially decommissioned by removing associated transformers and disconnecting the electrical supply after the HPP was closed in 2019. In order for CCR to be hauled by barge from the HPP a new loading terminal would need to be constructed, thereby increasing the project schedule due to the need to complete design, permitting, and construction.

Other barge terminals are located within five miles of the Hennepin Power Plant, but offsite, including a terminal at the adjacent Tri-Con Materials site, a terminal adjacent to the Marquis Energy facility, and the CBG grain terminal on the west bank of the Illinois River, as shown in **Figure 2**. However, use of these other terminals would require negotiating agreements with the terminal owner and/or operator. Additionally, it is unknown if these other terminals are suitable for the loading of CCR. If the terminals are not suitable, use of the terminals may require the design, permitting, and construction of improvements at each terminal, to allow CCR to be unloaded, thereby increasing the project schedule.

The Land Comp landfill is located approximately 3 miles from an existing barge loading terminal on the Illinois River, as shown in **Figure 2**. However, an agreement would need to be negotiated with the terminal owner. It is unknown if this terminal is suitable for the unloading of CCR. If the terminal is not suitable, us of the terminal may require the design, permitting, and construction of improvements to allow CCR to be unloaded. CCR would still need to be hauled by truck to the landfill and unloaded, resulting in additional CCR handling and exposure to the surrounding environment.

The Atkinson Landfill is not located near the Illinois River and, therefore, transportation of CCR to the Atkinson landfill by barge is not feasible.

Therefore, transporting CCR by barge is unlikely to be a viable option for the HPP East Ash Pond, due to the need to design, permit, and construct additional loading and potentially unloading infrastructure, resulting in corresponding schedule delays.

2.3.3. Transportation by Truck

The HPP is located approximately four miles from Interstate 180 (I-180) and Illinois Route 71 (IL-71), both of which are suitable for receiving truck hauling traffic. County Road 700E and 800E link the HPP to IL-71 and I-180 and routinely receive truck traffic associated with adjacent industrial facilities and the HPP. Potential travel routes between the HPP and LandComp and Atkinson Landfills are shown on **Figure 2**, although actual travel routes may vary.

Transporting CCR by truck will not require the construction of additional loading or unloading infrastructure at either the receiving landfill or the HPP. CCR would be loaded into truck using heavy equipment at the EAP. CCR will then be unloaded at the receiving landfill by the truck directly. Since no construction is required, project delays related to coordination with other entities, design, and permitting are unlikely to occur. Therefore, transporting CCR by truck is a viable option for the HPP EAP.

3. CLOSURE DESCRIPTION NARRATIVES

Section 845.720(a)(1)(A) requires narrative description of CCR impoundment closures to be prepared. Narrative descriptions have been prepared for both CIP and CBR-Offsite and are included within this section.

3.1. CIP

A narrative description of how the EAP will be closed in place is provided in Section 2.1 of the HPP Closure Plan [7].

3.2. CBR-Offsite

A narrative description of how CBR-Offsite of the EAP will be includes:

- The EAP will be unwatered by pumping free surface water to the adjacent non-CCR Leachate Pond or Polishing Pond (non-CCR surface impoundments) for ultimate discharge at NPDES Outfall 003.

- A temporary water management system will be constructed within the EAP, including ditches and sumps. The system will maintain the EAP in an unwatered state by collecting contact stormwater during closure construction. Unwatering flows will be pumped to the Leachate Pond or Polishing Pond for ultimate discharge at NDPES Outfall 003.

- CCR will be removed from the EAP using mass mechanical excavation techniques. Much of the CCR will be saturated or nearly saturated, so mass excavation will include the use of dewatering trenches or other forms of passive dewatering (i.e., rim ditching or windrowing) to moisture-condition the CCR prior to handling. Dewatering flows will be pumped to the Polishing Pond or Leachate Pond for ultimate discharge at NPDES Outfall 003.

- CCR will be loaded into over-the-road dump trucks and hauled to the offsite receiving landfill.

- Any accumulated CCR within the riser structure and culvert leading to the Polishing Pond will be removed and the riser structure and culvert will be decontaminated by pressure washing. Decontamination water will be routed to the Leachate Pond or Polishing Pond. The removed CCR will also be disposed of in the offsite receiving landfill.

- The existing EAP liner system, including the geomembrane side-slope liner and bottom soil liner, will be removed and disposed of in the offsite landfill. The EAP bottom and side-slopes will be decontaminated by removing approximately one foot of foundation soil beneath the side-slope and bottom liners. The liner system and foundation soils will be disposed of in the offsite receiving landfill.

- The decontaminated EAP will be backfilled to a minimum elevation of 480.4 ft and sloped to drain towards the existing riser structure, in order to allow post-closure, non-contact stormwater to gravity flow into the adjacent Polishing Pond through the existing spillway structure and preclude the impoundment of water within the EAP. Backfill materials would include clean soil material excavated from an offsite borrow source.

- The EAP will be restored by placing six inches of topsoil on the bottom and side slopes of the EAP and establishing vegetation. Stormwater best management practices (BMPs) such as erosion control blankets and straw wattles will be used, as needed to reduce erosion during vegetation establishment.

- After vegetation is established, BMPs will be removed, and closure construction will be considered completed.

4. CONSTRUCTION SCHEDULES

Section 845.720(a)(1)(F) requires a schedule including all activities necessary to complete closure to be prepared. Schedules have been prepared for both CIP and CBR-Offsite and are included within this section. Schedules were prepared using estimates of task durations based on Geosyntec's experience, typical weather conditions at the site, and expected construction rates relative to estimated construction quantities.

4.1. CIP

The proposed closure completion schedule for CIP is provided in Section 2.6 of the HPP Closure Plan [7].

4.2. CBR-Offsite

The proposed closure construction schedule for CBR-Offsite is provided in **Table 2**.

5. MATERIAL, QUANTITY, COST, LABOR, AND MILEAGE ESTIMATES

5.1. Quantity and Cost Estimates

Section 845.720(d)(1) requires a cost estimate to be prepared in accordance with the Class 4 standards of the Association for the Advancement of Cost Engineering (AACE) [8]. Cost estimates for both CIP and CBR-Offsite were prepared in accordance with the AACE Class 4 standards, utilizing the following approach:

- Major construction components and line-items were identified, in accordance with the narrative closure description (**Section 3**).
- Construction quantities were estimated based on volume estimates, area estimates, and proposed construction schedules (**Section 4**).
- Unit costs were estimated for each construction line-item utilizing RSMeans Heavy Construction Cost Data [9] (RS Means). For line-items where RSMeans data was not available, unit costs were estimated based on Geosyntec's experience.
    - RSMeans unit costs were developed assuming Union labor for LaSalle, Illinois (located approximately 21 miles from the HPP), for 2021.
- Soil fill was assumed to come from offsite borrow sources located within 2 miles of the site, as limited borrow soil is expected to be available at the HPP, due to the need to avoid disturbing large portions of the site and potentially precluding eventual solar development.
- A contingency of 30% was applied for the construction cost estimate total, based on the level of design and quantity estimate prepared as part of this Report.

5.2. Labor and Mileage Estimates

In addition to construction cost and quantity estimates, Gradient also utilized Geosyntec's estimates of construction labor hours, equipment usage, haul truck mileage, daily labor mobilization vehicle mileage, material delivery mileage, and onsite vehicle mobilization mileage. These estimates were prepared using the following approach:

- For line items where RSMeans [9] was utilized to develop the costs, the corresponding RSMeans crew size, equipment description, and daily output were utilized to estimate the total number of man-hours and equipment hours.
- For line items where RSMeans data was unavailable, the crew size, equipment description, and daily output were estimated based on Geosyntec's experience.

- Daily labor mobilization miles were estimating assuming an average one-way commute of 35 miles for each individual working onsite. The number of working days were estimated from the construction schedules (**Section 4**).

- Estimates of haul truck mileage were based on the assumed round-trip haul distance and dump truck size. All dump trucks were assumed to be filled to capacity.

- Estimates of material delivery miles were prepared based on Geosyntec's experience.

5.3. Results

The total cost estimate for CIP is $5,790,000, including contingency. The detailed cost estimate and labor and mileage estimates are provided in **Tables 3** and **4**, respectively.

The total cost estimate for CIP is $105,000,000 including contingency. The detailed cost estimate and labor and mileage estimates are provided in **Tables 5** and **6**, respectively

6. REFERENCES

[1] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[2] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[3] Geosyntec Consultants, "2021 USPEA CCR Rule Periodic Operating Record Run-on and Run-off Control Plan Review Report, §257.81, CCR Landfill, Hennepin Power Plant," Chesterfield, Missouri, October 11, 2021.

[4] Geosyntec Consultants, "Construction Permit Application, Hennepin Power Plant, East Ash Pond," Chesterfield, Missouri, January 28, 2022.

[5] D. Tickner, "Hennepin Power Station; Old West Ash Pond, Ash Pond No. 2, Notification of Completion of Closure," Luminant, Collinsville, Illinois, December 17, 2020.

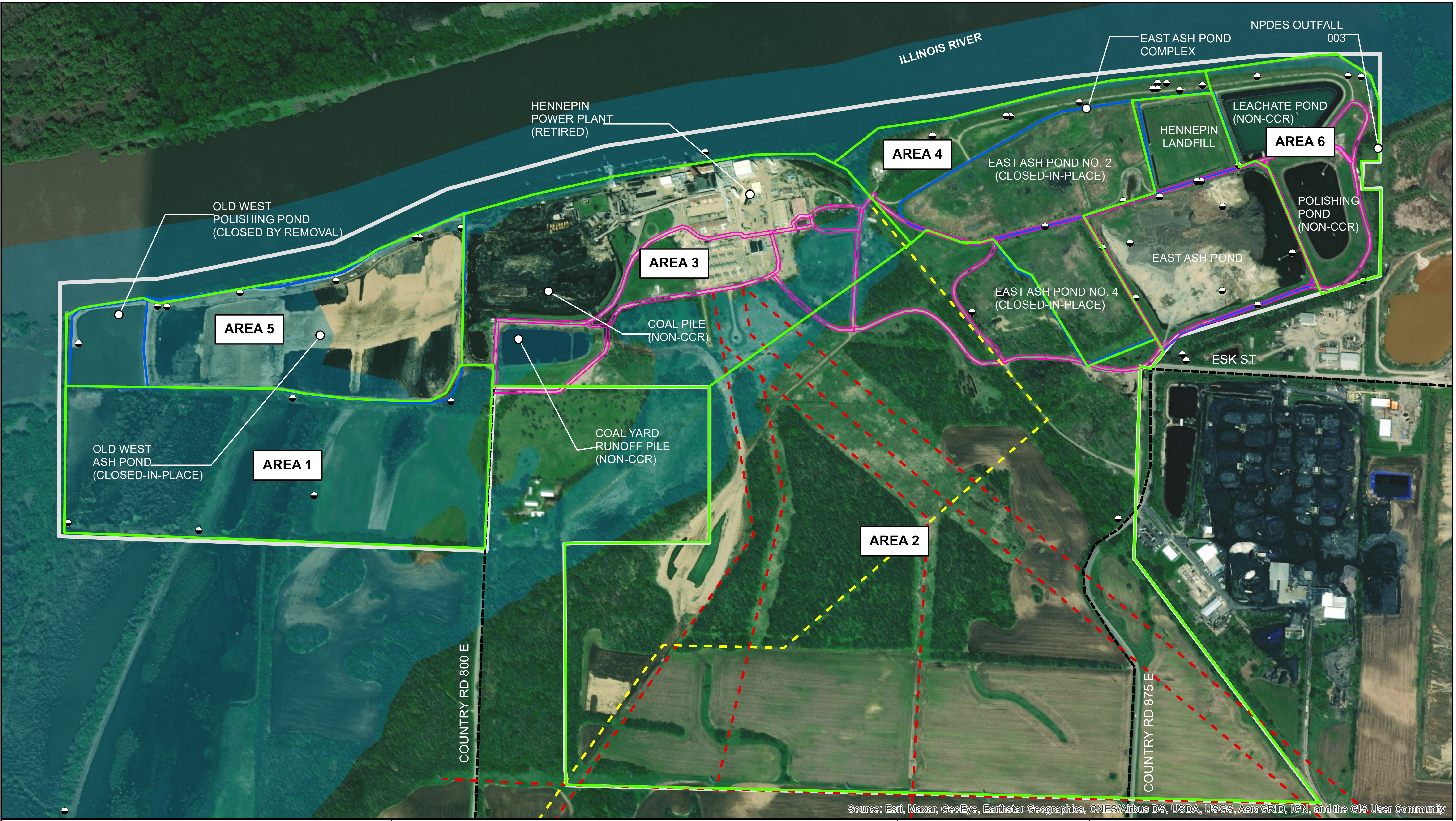
[6] Illinois Environmental Protection Agency, "Illinois Landfill Disposal Capacity Report," August 2021.

[7] Geosyntec Consultants, "CCR Final Closure Plan, Hennepin Power Plant, East Ash Pond," Chesterfield, Missouri, January 28, 2022.

[8] AACE International, "Recommended Practice 18R-97: Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Process Industries," 2020.

[9] RSMeans, "Heavy Construction Costs with RSMeans Data," Gordian, 2021.

FIGURES

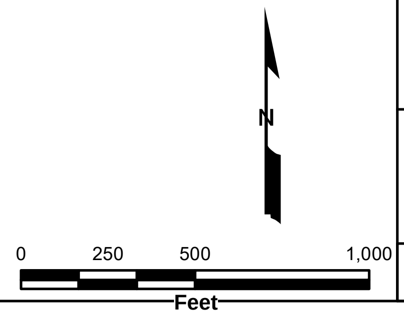


Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- 🟩 POTENTIAL LANDFILL AREAS
- ◒ MONITORING WELLS
- -- BURIED GAS LINE
- -- HIGH VOLTAGE OVERHEAD ELECTRIC
- ═ ONSITE TRANSPORTATION ROUTES FOR CLOSURE
- -- PUBLIC ROADWAY
- ☐ CCR UNIT LIMITS - APPROXIMATE
- ☐ APPROXIMATE SITE BOUNDARY
- ▨ FEMA 100-Year Flood Zone

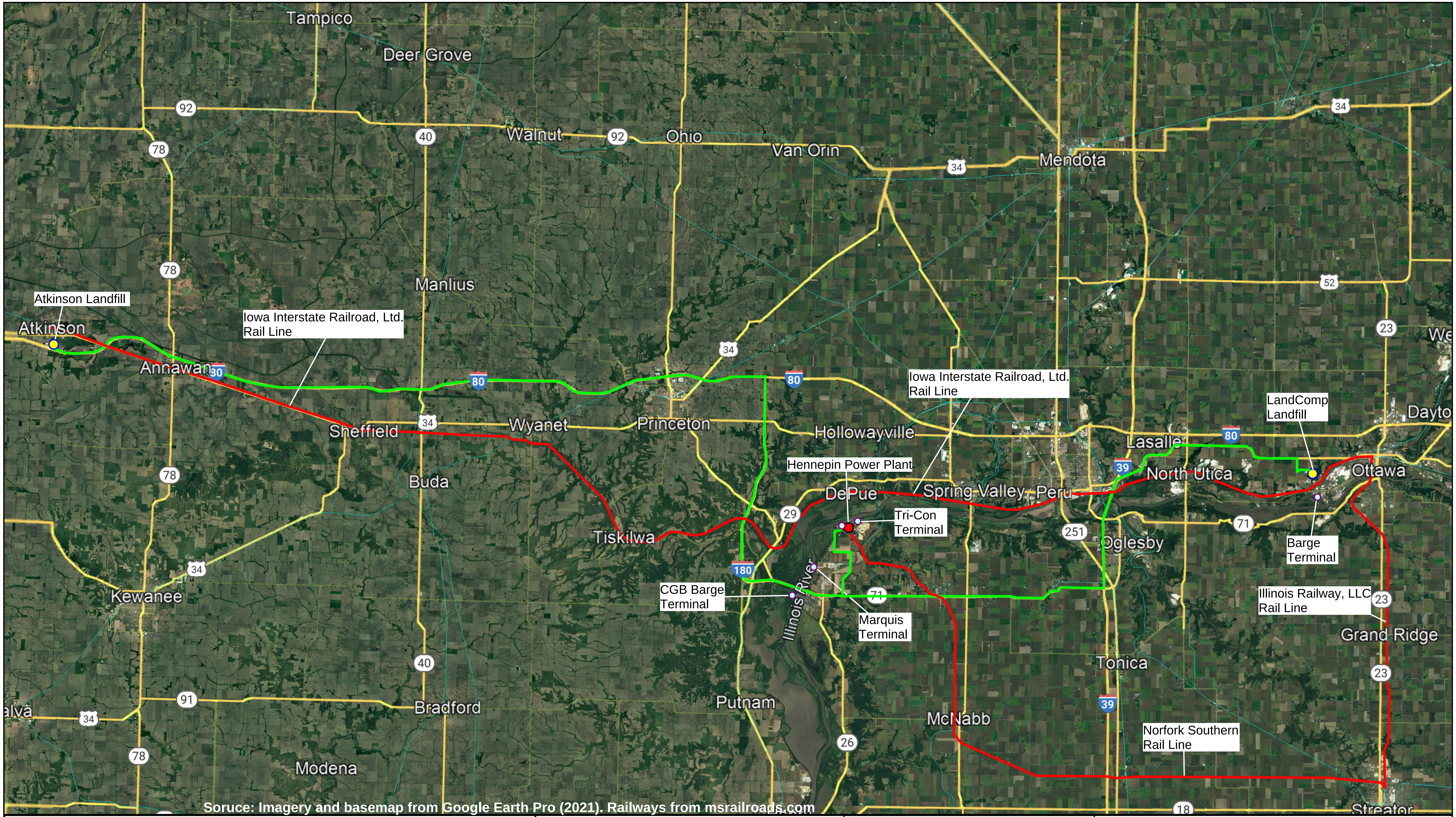
NOTE:
CCR unit limits and Site boundary locations are approximate. All high-voltage electric line alignments and gas line alignments were based off available aerial imagery data, should be considered approximate, may vary in the field, and should not be considered comprehensive. Local utilities including, but not limited to, service electric lines, gas lines, water and sewer lines, telecommunication lines, plant utilities, and/or private utilities are not shown on this figure and shall be verified in the field prior to any site work.



POTENITAL ONSITE LANDFILL LOCATIONS

Geosyntec consultants

GLP8027	NOVEMBER 2021	FIGURE 1

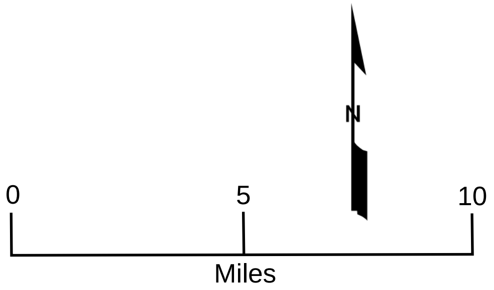


Soruce: Imagery and basemap from Google Earth Pro (2021). Railways from msrailroads.com

Legend

●	Hennepin Power Plant	🟩	Potential Truck Haul Route
●	Potential Offsite Landfill	🟥	Potential Rail Haul Route
○	Existing Barge Terminal	······	Potential Barge Haul Route
—	Railroad Right-of-Way		
—	Highway		

Note: Some railroad right-of-ways no longer contain tracks. The potential rail haul route was selected to include right-of-ways with existing tracks, based on an evaluation of Google Earth imagery.



OFFISTE LANDFILL LOCATIONS AND TRANSPORTATION ROUTES

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FIGURE 2

GLP8027

NOVEMBER 2021

TABLES

Table 1: Offsite Landfill Information

Landfill Name	**Owner**	**Location**	**One-Way Distance from Site by Road (Miles)**	**2020 Five-Year Average Disposal Volume (in-place CY)** [6]	**2020 Remaining Capacity Reported (in-place CY)** [6]
LandComp	Republic Services	Ottawa, IL	32	450,497	8,478,610
Eco Hill (a.k.a. Atkinson)	Ecology Solutions	Atkinson, IL	53	271,715	11,745,000

Table 2 – Construction Schedule – CBR-Offsite

Milestone	Timeframe (Preliminary Estimates)
Agency Coordination, Approvals, and Permitting • Obtain state permits, as needed, for dewatering, water discharge, land disturbance, and dam modifications	6 to 12 months after Final Closure Plan Approval
Final Design and Bid Process • Complete final design of the closure and select a construction contractor.	6 to 24 months after Agency Coordination, Approvals, and Permitting
Dewater and Excavate CCR, Decontaminate CCR Unit • Complete contractor mobilization, installation of stormwater BMPs, and unwatering of the EAP. • Complete mass excavation of CCR and decontamination of the EAP. • Winter weather delays are assumed between November and March of each construction year.	16 to 24 months after necessary permits are issues
Backfill with Clean Soil • Backfill the EAP to clean soil to El. 480.4 ft and slope to drain.	8 to 12 months after decontamination is complete
Site Restoration • Seed and stabilize the EAP. • Complete contractor demobilization.	2 to 5 months after backfill is complete
Timeframe to Complete Closure	38 to 77 months

Table 3 - Material Quantity and Cost Estimate - CIP (1 of 1)

AACE 18R-97 COST ESTIMATE CLASSIFICATION SYSTEM: CLASS 4 ESTIMATE
DYNEGY - HENNEPIN POWER STATION
CLOSURE-IN-PLACE OF EAST ASH POND

ITEM NO.	PRE-CONSTRUCTION	Units	Quantity	Percentage of Construction Costs	Total Cost	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
1	Mobilization and De-Mobilization	LS	1	5%	$189,000	-	-	-	-	Percentage based on experience
PRE-CONSTRUCTION ESTIMATED SUBTOTAL					**$ 189,000**					
ITEM NO.	**SITE PREPARATION**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
2	Mow Vegetation in East Ash Pond and Landfill	MSF	30	$48.06	$1,440	B84	22	11	11	320190191660: Mowing, mowing brush, light density, tractory with rotary mower
3	Construction Soil Erosion & Sediment Controls (Silt Fence)	LF	5,000	$3.20	$16,000	B62	650	185	62	312514161000: Synthetic erosion control, silt fence, install and remove, 3' high
4	Construction Facilities	MO - in use	10	$955.00	$9,550	-	-			
	Unit Costs									
	Office Trailer	MO - in use	10	$255.79	$2,560	-	-	-	-	015213200350: Office trailer, furnished, no hookups, 32' x 8', rent per month
	Storage Trailers (x2)	MO - in use	10	$283.56	$2,840	-	-	-	-	015213201350: Storage boxes, 40' x 8', rent per month
	Portable Toilet (x2)	MO - in use	10	$414.96	$4,150	-	-	-	-	015433406410: Rent toilet, portable chemical
5	Dust Control	DAY	163	$2,139.70	$349,000	B59	0.5	2,607	2,607	312323202510: Dust control, heavy; utlizing truck tractor and water tank trailer per RSMeans Crew B59. Quantity is assumed to be 3/4 of working days will need dust control = 1.25 days/week.
6	Haul Road Maintenance	DAY	43	$1,809.50	$78,600	B86A	1	348	348	312323202600: Haul road maintenance Quantity is assumed to be 1 day/week.
SITE PREPARATION ESTIMATED SUBTOTAL					**$ 455,000**			**3,150**	**3,030**	
ITEM NO.	**DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
7	Unwatering, Dewatering, and Stormwater Management for the East Ash Pond	DAY	87	$1,052.60	$91,500	Dewater	4	174	43	312319200650: Dewatering, pumping 8 hours, attended 2 hours per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose. Crew, Daily Output, and Unit Rate multiplied by 4 based on experience. Quantity is 5 days/week for 4 months.
8	Temporary Unwatering of the Polishing Pond	DAY	15	$1,052.60	$15,800	B10I	4	45	30	312319200650: Dewatering, pumping 8 hours, attended 2 hours per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose. Crew, Daily Output, and Unit Rate multiplied by 4 based on experience.
9	Dewatering Sumps Installation	EA - in place	4	$10,000.00	$40,000	Sump Install	4	16	8	Unit Rate, Crew, and Daily Output based on experience. Materials include 24" corrugated HDPE pipe with geotextile wrapping, and 1 C.Y. of gravel backfill.
DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT ESTIMATED SUBTOTAL					**$ 147,000**			**230**	**80**	
ITEM NO.	**EAST ASH POND CLOSURE**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
10	Removal and Abandonment of Outlet Structure	LS	-	-	$32,500	-	-	155	23	
	Unit Costs									
	Demolition of Steel Walkway	SF	800	$12.01	$9,610	B21C	500	90	13	024116330200: Bridge demolition, pedestrian, steel, 50' to 160' long, 8' to 10' wide
	Demolition of Outlet Structure	LF	20	$16.16	$320	B69	300	3	1	024113430100:Selective demolition, box culvert, precast, 8' x 6' x 3' to 8' x 8' x 8', excludes excavation
	Plugging of Outlet Pipe	CY	2	$1,946.93	$3,890	C14A	18	22	2	033053401040: Cast-in-place Concrete, including forms (4 uses), Grade 60 rebar, concrete (portland cement Type I), placement and finishing included; Columns, square (4000 psi), 36" x 36", up to 3% reinforcing by area
	Cleaning of Pipe Interior	LS	1	$3,000.00	$3,000	2 Clab	1	16	0	Unit rate, Crew, and Daily Output based on experience.
	Grouting of Pipe	CY	79	$200.00	$15,700	Grout/Concrete	80	24	8	Unit rate, Crew, and Daily Output based on experience.
11	Excavation and Placement of Ballast Material Contouring Fill from Hennepin Landfill	CY - in place	8,000	$24.63	$197,000	-	-	2,099	734	
	Unit Costs									
	Excavation of Ballast Material (Upper 8 inches)	CY - as excavated	5,628	$9.11	$51,270	B11C	150	600	300	312316130050: Excavating, Trench or continuous footing, common earth with no sheeting or dewatering included, 1' to 4' deep, 3/8 C.Y. excavator
	Fine/detailed Cleaning of Surface	MSF	220	$65.49	$14,410	1 Clab	7.5	235	0	320130104500: Site maintenance, lawn maintenance, rake leaves or lawn, by hand
	Excavate of Materials by Hand and Skidsteer (Lower 4 inches)	SY	24,200	$2.78	$67,280	B63	1000.0	968	194	311413231540: Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile onsite, by skid steer, 901-1100 S.Y., 6" deep, 200' haul
	Loading of Material	CY - as excavated	8,400	$1.45	$12,180	B14A	3230	31	21	312316435400: Excavating, large volume projects; excavation with truck loading; excavator, 4.5 C.Y. bucket, 95% fill factor (assume 5% shrinkage factor from ground to in-place)
	Hauling of Ballast Material	CY - as excavated	8,400	$3.02	$25,370	B34F	528	127	127	312323205000: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 22 C.Y. off-road, 15 min wait/ld/uld., 5 MPH, cycle 2000 feet
	Spreading of Material	CY - as excavated	8,400	$2.54	$21,340	B10B	1000	101	67	312323170020: Spread dumped material, no compaction, by dozer
	Compaction of Material	CY - in place	8,000	$0.59	$4,720	B10F	2600	37	25	312323235100: Compaction; Riding, vibrating roller, 12" lifts, 4 passes (RSMeans Crew is B10Y; altered to B10F based on experience)
12	Excavation and Placement of Contouring Fill within Construction Limits	CY - in place	37,200	$8.31	$309,000	-	-	1,435	1,163	
	Unit Costs									
	Excavation and Loading of Material	CY - as excavated	40,920	$1.45	$59,330	B14A	3230	152	101	312316435400: Excavating, large volume projects; excavation with truck loading; excavator, 4.5 C.Y. bucket, 95% fill factor (assume 5% shrinkage factor from ground to in-place)
	Hauling of Material	CY - as excavated	40,920	$3.02	$123,580	B34F	528	620	620	312323205000: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 22 C.Y. off-road, 15 min wait/ld/uld., 5 MPH, cycle 2000 feet
	Spreading of Material	CY - as excavated	40,920	$2.54	$103,940	B10B	1000	491	327	312323170020: Spread dumped material, no compaction, by dozer
	Compaction of Material	CY - in place	37,200	$0.59	$21,950	B10F	2600	172	114	312323235100: Compaction; Riding, vibrating roller, 12" lifts, 4 passes (RSMeans Crew is B10Y; altered to B10F based on experience)
13	Piezometer and Monitoring Well Extensions	EA	8	$5,500.00	$44,000	Grout/Concrete	4	48	16	Unit rate, Crew, and Daily Output based on experience. Includings extension and replacing surface completions (cover, cast-in-place reinforced concrete pad, and bollards)
14	Geomembrane	SF - in place	914,760	$1.17	$1,070,000	B63B	1600	18,295	4,574	310519531200: Pond and reservoir liners, membrane lining systems HDPE, 100,000 S.F. or more, 60 mil thick, per S.F. (mulipled unit rate by 0.5 based on experience)
15	Geotextile	SF - in place	914,760	$0.53	$488,000	2 Clab	22500	650	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength (multiplied unit rate by 4 to account for heavier geotextile based on experience)
16	Anchor Trench Installation	LF	2,700	$5.52	$14,900	-	-	181	121	
	Unit Costs									
	Excavation of Material	CY - as excavated	945	$9.11	$8,610	B11C	150	101	50	312316130050: Excavating, Trench or continuous footing, common earth with no sheeting or dewatering included, 1' to 4' deep, 3/8 C.Y. excavator
	Backfilling Material	CY - as excavated	945	$3.06	$2,890	B10R	400	28	19	312316133020: Backfill trench, F.E. Loader, wheel mtd., 1 C.Y. bucket, minimal haul
	Compacting Material	CY - in place	900	$3.74	$3,370	A1D	140	51	51	312323237040: Compaction, walk behind, vibrating plate 18" wide, 6" lifts, 4 passes
17	Placement of Imported Offsite Protective Cover Soil	CY - in place	49,830	$11.44	$570,000	-	-	2,380	2,083	
	Unit Costs									
	Excavation and Loading of Material	CY - as excavated	52,322	$0.94	$49,180	B14B	5000	126	84	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket,100% fill factor (assume 5% shrinkage factor from ground to in-place)
	Purchase of Material	CY - as excavated	52,322	$2.50	$130,800	-	-	-	-	Unit Rate based on experience.
	Hauling of Material	CY - as excavated	52,322	$4.48	$234,400	B34C	281	1,490	1,490	312323203032: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. truck, 15 min wait/ld/uld., 20 MPH, cycle 4 miles
	Spreading of Material	CY - as excavated	52,322	$2.54	$132,900	B10B	1000	628	419	312323170020: Spread dumped material, no compaction, by dozer
	Finish Grading of Material	SY	101,640	$0.26	$26,430	B10W	8900	137	91	312216103300: Fine grading, Finish grading slopes, gentle. Crew altered to reflect likely equipment to be used based on experience.
18	Placement of Imported Offsite Vegetative Soil	CY - in place	16,950	$12.39	$210,000	-	-	890	762	
	Unit Costs									
	Excavation and Loading of Material	CY - as excavated	17,798	$0.94	$16,730	B14B	5000	43	28	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket,100% fill factor (assume 5% shrinkage factor from ground to in-place)
	Purchase of Material	CY - as excavated	17,798	$2.50	$44,490	-	-	-	-	Unit Rate based on experience.
	Hauling of Material	CY - as excavated	17,798	$4.48	$79,730	B34C	281	507	507	312323203032: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. truck, 15 min wait/ld/uld., 20 MPH, cycle 4 miles
	Spreading of Material	CY - in place	16,950	$2.54	$43,050	B10B	1000	203	136	312323170020: Spread dumped material, no compaction, by dozer
	Finish Grading of Material	SY	101,640	$0.26	$26,430	B10W	8900	137	91	312216103300: Fine grading, Finish grading slopes, gentle. Crew altered to reflect likely equipment to be used based on experience.
EAST ASH POND ESTIMATED SUBTOTAL					**$ 2,940,000**			**26,130**	**9,480**	
ITEM NO.	**SITE RESTORATION**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
19	Establish Access Roads	LF	2,700	$19.41	$52,400	-	-	41	36	
	Unit Costs									
	Purchasing of Material	CY	800	$20.00	$16,000	-	-	-	-	Unit Rate based on experience.
	Hauling of Material	CY	800	$4.48	$3,580	B34C	281	23	23	312323203032: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. truck, 15 min wait/ld/uld., 20 MPH, cycle 4 miles
	Spreading and Compacting Material	SY	2,400	$13.67	$32,810	B32	4200	18	14	321123230400: Base course drainage layers, aggregate base course for roadways and large paved areas, bank run gravel, spread and compacted, 12" deep
20	Riprap Stormwater Chutes	SF - in place	2,400	$11.96	$28,700	-	-	283	40	
	Unit Costs									
	Geotextile	SF - in place	2,400	$0.53	$1,280	2 Clab	22500	2	0	313219161550: Geotextile soil stabilization; non-woven 120 lb. tensile strength (multiplied unit rate by 4 to account for heavier geotextile based on experience)
	RipRap	SF - in place	2,400	$11.43	$27,440	B13	477	282	40	313713100200: Riprap and rock lining, random, broken stone, machine placed for slope protection, 18" minimum thickness, not grouted
21	Erosion Control Blanket	SF - in place	26,880	$1.20	$32,300	ECB	22500	29	10	Unit rate and Crew based on experience. Daily Output based on 312314160100: Rolled erosion control mats and blankets, plastic netting, stapled, 2" x 1" mesh, 20 mil.
22	Straw Wattle Ditch Checks	LF - in place	2,500	$4.10	$10,300	A2	1000	60	20	312514160705: Sediment Log, Filter Sock, 9"
23	Seed, Mulch, and Maintain Vegetated Surfaces	AC	21	$5,285.71	$111,000	-	-	189	189	
	Unit Costs									
	Lime	MSF	915	$22.42	$20,510	B66	700	10	10	329113234250: Soil preparation, structural soil mixing, spread soil conditioners, ground limestone, 1#/S.Y., tractor spreader
	Fertilizer	MSF	915	$12.38	$11,320	B66	700	10	10	329113234150: Soil preparation, tructural soil mixing, spread soil conditioners, fertilizer, 0.2#/S.Y., tractor spreader
	Seed	MSF	915	$30.09	$27,530	B66	52	141	141	329219142300: Seeding athletic fields, seeding fescue, tall, 5.5 lb. per M.S.F., tractor spreader
	Mulch	MSF	915	$56.02	$51,240	B65	530	28	28	329113160350: Mulching, Hay, 1" deep, power mulcher, large
SITE RESTORATION ESTIMATED SUBTOTAL					**$ 235,000**			**600**	**300**	
ITEM NO.	**ENGINEERING AND CONSTRUCTION SUPPORT TASKS**	**Units**	**Quantity**	**Percentage of Construction Costs**	**Total Cost**	**Crew**	**Output**	**Labor Hours**	**Equipment Hours**	**Notes**
24	Final Closure Design and Bid Support	LS	1	5%	$198,000	-	-	-	-	Unit Rate based on experience.
25	Engineering Support and CQA During Construction	LS	1	7%	$278,000	Eng	60 hrs/week	2,640	880	Unit Rate, Crew, and Output based on experience.
ENGINEERING AND PERMITTING ESTIMATED SUBTOTAL					**$ 480,000**			**2,640**	**880**	
					Total Cost			**Total Labor Hours**	**Total Equipment Hours**	
CONSTRUCTION COSTS SUBTOTAL					**$3,970,000**			**30,100**	**12,900**	
PROJECT SUBTOTAL					**$4,450,000**			**32,800**	**13,800**	
30% CONTINGENCY					**$1,340,000**			**9,800**	**4,100**	
ENGINEER'S ESTIMATE OF TOTAL CONSTRUCTION AND ENGINEERING COST AND HOURS					**$5,790,000**			**42,600**	**17,900**	

NOTES:
1. LS = Lump Sum, AC = Acre, LF = Linear Foot, EA = Each, SY = Square Yard, MO = Month, YR = Year, CY = Cubic Yard, MSF = Thousand Sqaure Feet
2. RS Means refers to the 2021 online edition of RS Means Commercial New Construction. All unit rates refer to standard union labor in La Salle, IL.
3. Earthwork quantities assume that the "Excavation and Placement of Contouring Fill within Construction Limits" will be balanced so that no offsite soil fill will be needed to reach the final cover system subgrade. The final cover system subgrade elevations may need to be adjusted during final design to achieve balanced quantities.

Table 4 - Labor, Equipment, and Mileage Estimate - CIP (1 of 2)

					Project Total	
Crew	**Labor**	**Daily Labor Hours**	**Equipment**	**Daily Equipment Hours**	**Labor Hours**	**Equipment Hours**
B84	Operator x1	8	Rotary Mower/Tractor	8	11	11
B62	Laborer x2 Operator x 1	24	Loader, Skid Steer, 30 H.P.	8	185	62
B59	Truck Driver x1	8	Truck Tractor, 220 H.P. Water Tank Trailer, 5000 Gal	8	2,607	2,607
B86A	Operator x1	8	Grader, 30,000 lbs	8	348	348
B10I	Operator x1 Laborer x0.5	12	Diaphragm Water Pump, 4"	8	45	30
B14A	Operator x1 Laborer x0.5	12	Hyd. Excavator, 4.5 C.Y.	8	183	122
1 Clab	Laborer x1	8	None	0	235	0
B34F	Truck Driver x1	8	Dump Truck, Off Hwy., 35 ton	8	747	747
B10B	Operator x1 Laborer x0.5	12	Dozer, 200 H.P.	8	1,423	949
B10G	Operator x1 Laborer x0.5	12	Sheepsfoot Roller, 240 H.P.	8	Not Used	Not Used
B34B	Truck Driver x1	8	Dump Truck, 12 C.Y., 400 H.P.	8	Not Used	Not Used
B21C	Labor Foreman x1 Laborer x4 Operator (crane) x1 Operator (oiler) x1	56	Cutting Torches x2 Sets of Gasses x2 Lattice Boom Crane, 90 ton	8	90	13
B69	Labor Foreman x1 Laborer x3 Operator (crane) x1 Operator (oiler) x1	48	Hyd. Crane, 80 ton	8	3	1
C14A	Carpenter Foreman x1 Carpenters x16 Rodmen x4 Laborers x2 Cement Finisher x1 Operator (medium) x1	200	Gas Engine Vibrator Concrete Pump (small)	16	22	2
B63B	Labor Foreman x1 Laborer x2 Operator (light) x1	32	Loader, Skid Steer, 78 H.P.	8	18,295	4,574
B32	Laborer x1 Operator (med) x3	32	Grader, 30,000 lbs Tandem Roller, 10 ton Dozer, 200 H.P.	24	18	14
2 Clab	Laborer x2	16	None	0	668	0
B13	Laborer Foreman x1 Laborer x4 Operator (crane) x1 Operator (oiler) x1	56	Hyd. Crane, 25 ton	8	282	40
A2	Laborer x2 Truck Driver x1	24	Flatbed Truck, Gas, 1.5 ton	8	60	20
B66	Operator (light) x1	8	Loader-Backhoe, 40 H.P.	8	162	162
B65	Laborer x1 Truck Driver (light) x1	16	Power Mulcher (large) Flatbed Truck, Gas, 1.5 ton	16	28	28
B63	Laborer x4 Operator (light) x1	40	Loader, Skid Steer, 30 H.P.	8	968	194
B11C	Laborer x1 Operator (med) x1	16	Backhoe Loader, 48 H.P.	8	701	351
B32C	Laborer Foreman x1 Laborer x2 Operator (med) x3	48	Grader, 30,000 lbs Tandem Roller, 10 Ton Dozer, 200 H.P.	24	Not Used	Not Used
B10R	Operator (med) x1 Laborer x0.5	12	F.E. Loader, W.M., 1 C.Y.	8	28	19
ECB	Laborer x3	24	Tractor	8	29	10
Dewater	Laborer x1	8	8" Diesel Pump	2	174	43
Sump Install	Laborer x1 Operator x1	16	Hyd. Excavator, 4.5 C.Y.	8	16	8
Grout/Concrete	Laborer x2 Truck Driver x1	24	Concrete Truck	8	72	24
Eng	Engineering Staff x1.2	10	Side by Side x1	4	2,640	880
A1D	Laborer x1	8	Vibrating Plate, Gas, 18"	8	51	51
B10F	Operator (med) x1 Laborer x0.5	12	Tandem Roller, 10, Ton	8	1,723	1,149
B10Y	Operator (med) x1 Laborer x0.5	12	Vibr. Roller, Towed, 12 Ton	8	Not Used	Not Used
B34C	Truck Driver (heavy) x 1	8	Truck Tractor, 6x4, 380 H.P. Dump Trailer, 16.5 C.Y.	8	2,019	2,019
B14B	Operator (crane) x 1 Laborer x 0.5	12	Hyd. Excavator, 6 C.Y.	8	168	112
B11L	Operator (med.) x 1 Laborer x 1	16	Grader, 30,000 lbs	8	Not Used	Not Used
B10W	Operator (med.) x 1 Laborer x 0.5	12	Dozer, 105 H.P.	8	274	183
Note: Blue crew names were created by Geosyntec based on experience (not pulled from RSMeans).				**Totals**	34,300	14,800

Table 4 - Labor, Equipment, and Mileage Estimate - CIP (2 of 2)

Item	Quantity	Assumptions
Labor Total Hours	34,300	Per projected total in cost estimate
Duration of Onsite Construction in Days	284	Per Construction Schedule Revision A, dated 9/22/21
Average Daily Crew Size	13	10 hour days
Daily Labor Mobilization Miles	258,440	Average of 70 miles round trip per day
Vehicles Miles Onsite	7,185	1 mile round trip from gate to parking 5 miles per day for CQA tech and Construction Supervisor 10% Contingency for site visitors (client and engineering support)
Equipment Mobilization Miles - Unloaded	12,171	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Equipment Mobilization Miles - Loaded	12,171	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Daily Equipment Miles Onsite	44,447	Average of 10 of 15 crew members running equipment Assume 15 miles per piece of equipment (based on 15 minute round trip path across EAP) 10 miles per day used for water truck 5 miles per day used for grader
Onsite Haul Truck Miles - Unloaded	425	22 CY Haul Truck 2000 ft cycle
Onsite Haul Truck Miles - Loaded	425	22 CY Haul Truck 2000 ft cycle
Offsite Haul Truck Miles - Unloaded	17,192	16.5 CY Dump Truck 4 mi cycle
Offsite Haul Truck Miles - Loaded	17,192	16.5 CY Dump Truck 4 mi cycle
Material Delivery Miles - Unloaded	14,050	Same geosynthetic material source, trailer quantities, and roll sizes as HEN WAPS project assumed 30 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 1000 miles away average
Material Delivery Miles - Loaded	14,050	Same geosynthetic material source, trailer quantities, and roll sizes as HEN WAPS project assumed 30 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 1000 miles away average

Table 5 - Material Quantity and Cost Estimate - CBR-Offsite (1 of 1)

AACE 18R-97 COST ESTIMATE CLASSIFICATION SYSTEM: CLASS 4 ESTIMATE
DYNEGY - HENNEPIN POWER STATION
CLOSURE-BY-REMOVAL OF EAST ASH POND

ITEM NO.	PRE-CONSTRUCTION	Units	Quantity	Percentage of Construction Costs	Total Cost	Crew	Daily Output	Labor Hours	Equipment Hours	Notes
1	Mobilization and De-Mobilization	LS	1	3%	$570,000	-	-	-	-	Percentage based on experience
PRE-CONSTRUCTION ESTIMATED SUBTOTAL					**$ 570,000**					
ITEM NO.	**SITE PREPARATION**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
2	Mow Vegetation in East Ash Pond	MSF	30	$48.06	$1,440	B84	22	11	11	320190191660: Mowing, mowing brush, light density, tractory with rotary mower
3	Construction Soil Erosion & Sediment Controls (Silt Fence)	LF	10,000	$3.20	$32,000	B62	650	369	123	312514161000: Synthetic erosion control, silt fence, install and remove, 3' high
4	Construction Facilities	MO - in use	32	$953.13	$30,500	-	-			
	Unit Costs									
	Office Trailer	MO - in use	32	$255.79	$8,190	-	-	-	-	015213200350: Office trailer, furnished, no hookups, 32' x 8', rent per month
	Storage Trailers (x2)	MO - in use	32	$283.56	$9,070	-	-	-	-	015213201350: Storage boxes, 40' x 8', rent per month
	Portable Toilet (x2)	MO - in use	32	$414.96	$13,280	-	-	-	-	015433406410: Rent toilet, portable chemical
5	Dust Control	DAY	521	$2,139.70	$1,120,000	B59	0.5	8,342	8,342	312323202510: Dust control, heavy; utlizing truck tractor and water tank trailer per RSMeans Crew B59. Quantity is assumed to be 3/4 of working days will need dust control = 1.25 days/week.
6	Haul Road Maintenance	DAY	139	$1,809.50	$252,000	B86A	1	1,112	1,112	312323202600: Haul road maintenance Quantity is assumed to be 1 day/week.
SITE PREPARATION ESTIMATED SUBTOTAL					**$ 1,440,000**			**9,830**	**9,590**	
ITEM NO.	**DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
7	Unwatering, Dewatering, and Stormwater Management for the East Ash Pond	DAY	347	$1,052.60	$365,000	Dewater	4	694	174	312319200650: Dewatering, pumping 8 hours, attended 2 hours per day, 4" discharge pump used for 8 hours, includes 20 LF of suction hose and 100 LF of discharge hose. Crew, and Daily Output, and Unit Rate multiplied by 4 based on experience. Quantity is 5 days/week for 64 weeks (unwatering/dewatering and excavation duration) and 1 day/week for 27 weeks (backfill duration)
8	Dewatering Sumps Installation	EA - in place	40	$10,000.00	$400,000	Sump Install	4	160	80	Unit Rate, Crew, and Daily Output based on experience. Materials include 24" corrugated HDPE pipe with geotextile wrapping, and 1 C.Y. of gravel backfill.
DEWATERING, UNWATERING, AND STORMWATER MANAGEMENT ESTIMATED SUBTOTAL					**$ 770,000**			**850**	**250**	
ITEM NO.	**EAST ASH POND CLOSURE**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
9	Excavation of CCR and Liner	CY - in place	709,800	$102.14	$72,500,000	-	-	71,906	70,600	
	Unit Costs									
	Excavation and Loading of Material	CY - as excavated	709,800	$1.45	$1,029,210	B14A	3230	2,637	1,758	312316435400: Excavating, large volume projects; excavation with truck loading; excavator, 4.5 C.Y. bucket, 95% fill factor (assume 5% shrinkage factor from ground to in-place)
	Hauling of Material	CY - as excavated	709,800	$15.16	$10,760,570	B34C	83	68,414	68,414	312323203304: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y.truck, 20 min wait/ld/uld., 45 MPH, cycle 50 miles
	Finish Grading of Excavation Surface	SY	89,000	$1.29	$114,810	B32C	5000	854	427	312216101020: Fine grading, loam or topsoil fine grade for large area, 15,000 S.Y. or more
	Landfill Tipping Fee	Ton	766,584	$79.00	$60,560,140	-	-	-	-	Unit Rate based on actual tipping fee from Republic Services LandComp Landfill (nearest landfill to site). Unit Rate subject to increase upon Landfill's soil classification.
10	Abandonment of Piezometers and Monitoring Wells	EA	8	$850.00	$6,800	Grout/Concrete	4	48	16	Unit rate, Crew, and Daily Output based on experience.
11	Placement of Imported Offsite Backfill Soil	CY - in place	373,360	$11.65	$4,350,000	-	-	18,666	16,165	
	Unit Costs									
	Excavation and Loading of Material	CY - as excavated	392,028	$0.94	$368,510	B14B	5000	941	627	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket,100% fill factor (assume 5% shrinkage factor from ground to in-place)
	Purchase of Material	CY - as excavated	392,028	$2.50	$980,070	-	-	-	-	Unit Rate based on experience.
	Hauling of Material	CY - as excavated	392,028	$4.48	$1,756,290	B34C	281	11,161	11,161	312323203032: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. truck, 15 min wait/ld/uld., 20 MPH, cycle 4 miles
	Spreading of Material	CY - as excavated	392,028	$2.54	$995,750	B10B	1000	4,704	3,136	312323170020: Spread dumped material, no compaction, by dozer
	Finish Grading of Material	SY	101,640	$0.26	$26,430	B10W	8900	137	91	312216103300: Fine grading, Finish grading slopes, gentle. Crew altered to reflect likely equipment to be used based on experience.
	Compaction of Material	CY - in place	373,360	$0.59	$220,280	B10F	2600	1,723	1,149	312323235100: Compaction; Riding, vibrating roller, 12" lifts, 4 passes (RSMeans Crew is B10Y; altered to B10F based on experience)
12	Placement of Imported Offsite Vegetative Soil	CY - in place	16,950	$12.39	$210,000	-	-	890	762	
	Unit Costs									
	Excavation and Loading of Material	CY - as excavated	17,798	$0.94	$16,730	B14B	5000	43	28	312316435320: Excavating, large volume projects; excavation with truck loading; excavator, 6 C.Y. bucket,100% fill factor (assume 5% shrinkage factor from ground to in-place)
	Purchase of Material	CY - as excavated	17,798	$2.50	$44,490	-	-	-	-	Unit Rate based on experience.
	Hauling of Material	CY - as excavated	17,798	$4.48	$79,730	B34C	281	507	507	312323203032: Hauling; no loading equipment, including hauling, waiting, loading/dumping; 16.5 C.Y. truck, 15 min wait/ld/uld., 20 MPH, cycle 4 miles
	Spreading of Material	CY - in place	16,950	$2.54	$43,050	B10B	1000	203	136	312323170020: Spread dumped material, no compaction, by dozer
	Finish Grading of Material	SY	101,640	$0.26	$26,430	B10W	8900	137	91	312216103300: Fine grading, Finish grading slopes, gentle. Crew altered to reflect likely equipment to be used based on experience.
EAST ASH POND ESTIMATED SUBTOTAL					**$ 77,100,000**			**91,510**	**87,540**	
ITEM NO.	**SITE RESTORATION**	**Units**	**Quantity**	**Unit Rate**	**Total Cost**	**Crew**	**Daily Output**	**Labor Hours**	**Equipment Hours**	**Notes**
13	Erosion Control Blanket	SF - in place	101,720	$1.20	$122,000	ECB	22500	109	36	Unit rate and Crew based on experience. Daily Output based on 312514160100: Rolled erosion control mats and blankets, plastic netting, stapled, 2" x 1" mesh, 20 mil.
14	Straw Wattle Ditch Checks	LF - in place	2,500	$4.10	$10,300	A2	1000	60	20	312514160705: Sediment Log, Filter Sock, 9"
15	Seed, Mulch, and Maintain Vegetated Surfaces	AC	21	$5,285.71	$111,000	-	-	189	189	
	Unit Costs									
	Lime	MSF	915	$22.42	$20,510	B66	700	10	10	329113234250: Soil preparation, structural soil mixing, spread soil conditioners, ground limestone, 1#/S.Y., tractor spreader
	Fertilizer	MSF	915	$12.38	$11,320	B66	700	10	10	329113234150: Soil preparation, tructural soil mixing, spread soil conditioners, fertilizer, 0.2#/S.Y., tractor spreader
	Seed	MSF	915	$30.09	$27,530	B66	52	141	141	329219142300: Seeding athletic fields, seeding fescue, tall, 5.5 lb. per M.S.F., tractor spreader
	Mulch	MSF	915	$56.02	$51,240	B65	530	28	28	329113160350: Mulching, Hay, 1" deep, power mulcher, large
SITE RESTORATION ESTIMATED SUBTOTAL					**$ 243,000**			**360**	**250**	
ITEM NO.	**ENGINEERING AND CONSTRUCTION SUPPORT TASKS**	**Units**	**Quantity**	**Percentage of Construction Costs**	**Total Cost**	**Crew**	**Output**	**Labor Hours**	**Equipment Hours**	**Notes**
16	Final Closure Design and Bid Support	LS	1	1.5%	$293,000	-	-	-	-	Unit Rate based on experience.
17	Engineering Support and CQA During Construction	LS	1	5.0%	$980,000	Eng	60 hrs/week	8,340	2,780	Unit Rate, Crew, and Output based on experience.
ENGINEERING AND PERMITTING ESTIMATED SUBTOTAL					**$ 1,270,000**			**8,340**	**2,780**	
					Total Cost			**Total Labor Hours**	**Total Equipment Hours**	
CONSTRUCTION COSTS SUBTOTAL					**$80,000,000**			**102,600**	**97,600**	
PROJECT SUBTOTAL					**$81,000,000**			**110,900**	**100,400**	
30% CONTINGENCY					**$24,000,000**			**33,300**	**30,100**	
ENGINEER'S ESTIMATE OF TOTAL CONSTRUCTION AND ENGINEERING COST AND HOURS					**$105,000,000**			**144,200**	**130,500**	

NOTES:
1. LS = Lump Sum, AC = Acre, LF = Linear Foot, EA = Each, SY = Square Yard, MO = Month, YR = Year, CY = Cubic Yard, MSF = Thousand Sqaure Feet
2. RS Means refers to the 2021 online edition of RS Means Commercial New Construction. All unit rates refer to standard union labor in La Salle, IL.

Table 6 - Labor, Equipment, and Mileage Estimate - CBR-Offsite (1 of 2)

Geosyntec consultants

					Project Total	
Crew	**Labor**	**Daily Labor Hours**	**Equipment**	**Daily Equipment Hours**	**Labor Hours**	**Equipment Hours**
B84	Operator x1	8	Rotary Mower/Tractor	8	11	11
B62	Laborer x2 Operator x 1	24	Loader, Skid Steer, 30 H.P.	8	369	123
B59	Truck Driver x1	8	Truck Tractor, 220 H.P. Water Tank Trailer, 5000 Gal	8	8,342	8,342
B86A	Operator x1	8	Grader, 30,000 lbs	8	1,112	1,112
B10I	Operator x1 Laborer x0.5	12	Diaphragm Water Pump, 4"	8	Not Used	Not Used
B14A	Operator x1 Laborer x0.5	12	Hyd. Excavator, 4.5 C.Y.	8	2,637	1,758
1 Clab	Laborer x1	8	None	0	Not Used	Not Used
B34F	Truck Driver x1	8	Dump Truck, Off Hwy., 35 ton	8	Not Used	Not Used
B10B	Operator x1 Laborer x0.5	12	Dozer, 200 H.P.	8	4,908	3,272
B10G	Operator x1 Laborer x0.5	12	Sheepsfoot Roller, 240 H.P.	8	Not Used	Not Used
B34B	Truck Driver x1	8	Dump Truck, 12 C.Y., 400 H.P.	8	Not Used	Not Used
B21C	Labor Foreman x1 Laborer x4 Operator (crane) x1 Operator (oiler) x1	56	Cutting Torches x2 Sets of Gasses x2 Lattice Boom Crane, 90 ton	8	Not Used	Not Used
B69	Labor Foreman x1 Laborer x3 Operator (crane) x1 Operator (oiler) x1	48	Hyd. Crane, 80 ton	8	Not Used	Not Used
C14A	Carpenter Foreman x1 Carpenters x16 Rodmen x4 Laborers x2 Cement Finisher x1 Operator (medium) x1	200	Gas Engine Vibrator Concrete Pump (small)	16	Not Used	Not Used
B63B	Labor Foreman x1 Laborer x2 Operator (light) x1	32	Loader, Skid Steer, 78 H.P.	8	Not Used	Not Used
B32	Laborer x1 Operator (med) x3	32	Grader, 30,000 lbs Tandem Roller, 10 ton Dozer, 200 H.P.	24	Not Used	Not Used
2 Clab	Laborer x2	16	None	0	Not Used	Not Used
B13	Laborer Foreman x1 Laborer x4 Operator (crane) x1 Operator (oiler) x1	56	Hyd. Crane, 25 ton	8	Not Used	Not Used
A2	Laborer x2 Truck Driver x1	24	Flatbed Truck, Gas, 1.5 ton	8	60	20
B66	Operator (light) x1	8	Loader-Backhoe, 40 H.P.	8	162	162
B65	Laborer x1 Truck Driver (light) x1	16	Power Mulcher (large) Flatbed Truck, Gas, 1.5 ton	16	28	28
B63	Laborer x4 Operator (light) x1	40	Loader, Skid Steer, 30 H.P.	8	Not Used	Not Used
B11C	Laborer x1 Operator (med) x1	16	Backhoe Loader, 48 H.P.	8	Not Used	Not Used
B32C	Laborer Foreman x1 Laborer x2 Operator (med) x3	48	Grader (30,000 lbs) Tandem Roller, 10 Ton Dozer, 200 H.P.	24	Not Used	Not Used
B10R	Operator (med) x1 Laborer x0.5	12	F.E. Loader, W.M., 1 C.Y.	8	Not Used	Not Used
ECB	Laborer x3	24	Tractor	8	109	36
Dewater	Laborer x1	8	8" Diesel Pump	2	694	174
Sump Install	Laborer x1 Operator x1	16	Hyd. Excavator, 4.5 C.Y.	8	160	80
Grout/Concrete	Laborer x2 Truck Driver x1	24	Concrete Truck	8	48	16
Eng	Engineering Staff x1.2	10	Side by Side x1	4	8,340	2,780
B10F	Operator (med) x1 Laborer x0.5	12	Tandem Roller, 10, Ton	8	1,723	1,149
B10Y	Operator (med) x1 Laborer x0.5	12	Vibr. Roller, Towed, 12 Ton	8	Not Used	Not Used
B34C	Truck Driver (heavy) x 1	8	Truck Tractor, 6x4, 380 H.P. x 1 Dump Trailer, 16.5 CY x 1	8	80,082	80,082
B14B	Operator (crane) x 1 Laborer x 0.5	12	Hyd. Excavator, 6 C.Y.	8	984	656
B11L	Operator (med.) x 1 Laborer x 1	16	Grader, 30,000 lbs	8	Not Used	Not Used
B10W	Operator (med.) x 1 Laborer x 0.5	12	Dozer, 105 H.P.	8	274	183
Note: Blue crew names were created by Geosyntec based on experience (not pulled from RSMeans).				**Totals**	110,000	100,000

Table 6 - Labor, Equipment, and Mileage Estimate - CBR-Offsite (2 of 2)

Item	Quantity	Assumptions
Labor Total Hours	110,000	Per projected total in cost estimate
Duration of Onsite Construction in Days	1,841	Per Construction Schedule Revision A, dated 9/22/21
Average Daily Crew Size	6	10 hour days
Daily Labor Mobilization Miles	773,220	Average of 70 miles round trip per day
Vehicles Miles Onsite	32,402	1 mile round trip from gate to parking 5 miles per day for CQA tech and Construction Supervisor 10% Contingency for site visitors (client and engineering support)
Equipment Mobilization Miles - Unloaded	78,900	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Equipment Mobilization Miles - Loaded	78,900	Average of 300 miles one way for equipment hauling Average 1 load of equipment per working week
Daily Equipment Miles Onsite	199,214	Average of 7 of 9 crew members running equipment Assume 15 miles per piece of equipment (based on 15 minute round trip path across EAP) 10 miles per day used for water truck 5 miles per day used for grader
Onsite Haul Truck Miles - Unloaded	0	No onsite hauling included as CCR material is assumed to be disposed of at an offsite landfill and backfill will be imported from offsite.
Onsite Haul Truck Miles - Loaded	0	No onsite hauling included as CCR material is assumed to be disposed of at an offsite landfill and backfill will be imported from offsite.
Offsite Haul Truck Miles - Unloaded	1,475,933	16.5 CY Dump Truck 4 mi cycle for imported soil; 64 mi cycle for exported CCR
Offsite Haul Truck Miles - Loaded	1,475,933	16.5 CY Dump Truck 4 mi cycle for imported soil; 64 mi cycle for exported CCR
Material Delivery Miles - Unloaded	30,000	30 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 1000 miles away average
Material Delivery Miles - Loaded	30,000	30 extra trips for seed, fertilizer, lime, mulch, ECBs, straw wattles, and concrete - source 1000 miles away average

ATTACHMENT C

Alternative Final Protective Layer Equivalency Demonstration

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Technical Memorandum

Date:	January 25, 2022
To:	Victor Modeer, P.E., DGE
Copies to:	Phil Morris, Rhys Fuller
From:	John Seymour, P.E., Geosyntec Consultants (Geosyntec)
Subject:	Proposed Alternative Final Protective Layer Equivalency Demonstration Hennepin East Ash Pond and Duck Creek GMF Pond CCR Surface Impoundments Geosyntec Project: GLP8026

PROPOSAL

An alternative final protective layer is proposed by Dynegy Midwest Generation, LLC (DMG) for surface impoundments closed in place for the Hennepin Power Plant (HPP) East Ash Pond (EAP) and by Illinois Power Resources Generating, LLC (IPRG) for the Duck Creek Power Plant (DCPP) Gypsum Management Facility (GMF) Pond. The closure will be in accordance with IAC Part 845 Rule [1] (Part 845). Overall, the proposal will meet the requirements of Section 845.750 c) 2).

This Technical Memorandum presents a demonstration that a 2-foot-thick alternative final protective layer consisting of an 18-inch-thick soil layer and a 6-inch layer of topsoil provide equivalent or superior performance to the default protective layer set forth in Section 845.750 c) 2). The alternative final protective layer works in combination with an underlying low permeability (geomembrane) layer in place of the default three-foot thick, low permeability compacted earth layer. In addition, a cushion layer consisting of a geotextile (at HPP EAP) or a drainage layer consisting of a geocomposite (at DCPP GMF) are placed on top of the geomembrane prior to installation of the final protective layer. The combination of the above materials comprises the final “alternative final cover system”.

A discussion of how the closure, including the proposed alternative final cover system discussed herein, meets the performance standards is contained in the Closure Plan, which includes the Closure Alternatives Assessment required by Section 845.710.

REQUIREMENTS OF SECTION 845

Section 845.750 provides requirements for both the final protective layer and underlying low permeability layer. They work in tandem to provide protection of groundwater and surface exposure conditions. A principal intention of the low permeability layer is to reduce the infiltration of liquid through the final cover system and into the CCR waste mass during post-closure conditions, in accordance with Section 845.720 (a), which states in part:

> *The owner or operator of a CCR surface impoundment must ensure that, at a minimum, the CCR surface impoundment is closed in a manner that will*:
>
> 1) *Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate or contaminated run-off to the ground or surface waters or to the atmosphere;*

Specific default requirements for the final cover system are included in Section 845.750(c), which requires the final cover system to have either: 1) a three-foot thick soil low permeability compacted earth layer overlain by a three-foot-thick final protective layer (final protective layer), or 2) a geomembrane low permeability layer with a three-foot-thick final protective layer.

The specific Section 845.750 (c) (2) design requirements for the final protective layer are as follows (emphasis added):

> *Standards for the Final Protective Layer: The final protective layer must meet the following requirements,* ***unless the owner or operator demonstrates that another final protective layer construction technique or material provides equivalent or superior performance to the requirements of this subsection (c)(2)*** *and is approved by the Agency.*

Therefore, Section 845.750 (c) (2) specifically allows the use of an alternate final protective layer as long as it provides an equivalent or superior performance to the default standards set forth in Section 845.750(c)(2), which are as follows:

> A) *Cover the entire low permeability layer;*
>
> B) *Be at least three feet thick, be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer;*
>
> C) *Consist of soil material capable of supporting vegetation;*
>
> D) *Be placed as soon as possible after placement of the low permeability layer; and*

E) Be covered with vegetation to minimize wind and water erosion.

The alternate design is only requesting an alternate to Section 845.740(c)(2)(B) related to the thickness of the of the final protective layer.

PROPOSED FINAL COVER SYSTEM SUMMARY

The proposed final cover systems for each site will include:

- A low permeability layer consisting of a linear low-density polyethylene (LLDPE) geomembrane that is at least 40-mil in thickness, placed on a smooth CCR subgrade.
- A geosynthetic cushion layer, such as a needle-punched, nonwoven geotextile (HPP EAP), or a geocomposite drainage layer (DCPP GMF), on top of the geomembrane.
    - The geocomposite drainage layer is comprised of a high-density polyethylene (HDPE) geonet covered with a geotextile filter fabric (typically a needle-punched, non-woven geotextile fabric)
- A final protective layer consisting of 18 inches of protective cover soil with a 6-inch layer of topsoil capable of supporting vegetation.

The final protective layer will meet all Section 845.750(c)(2) criteria, will not need any supplemental engineering measures, and will be designed by a qualified professional engineer licensed in Illinois.

The concepts of the alternative cover system are illustrated on **Figure 1**.

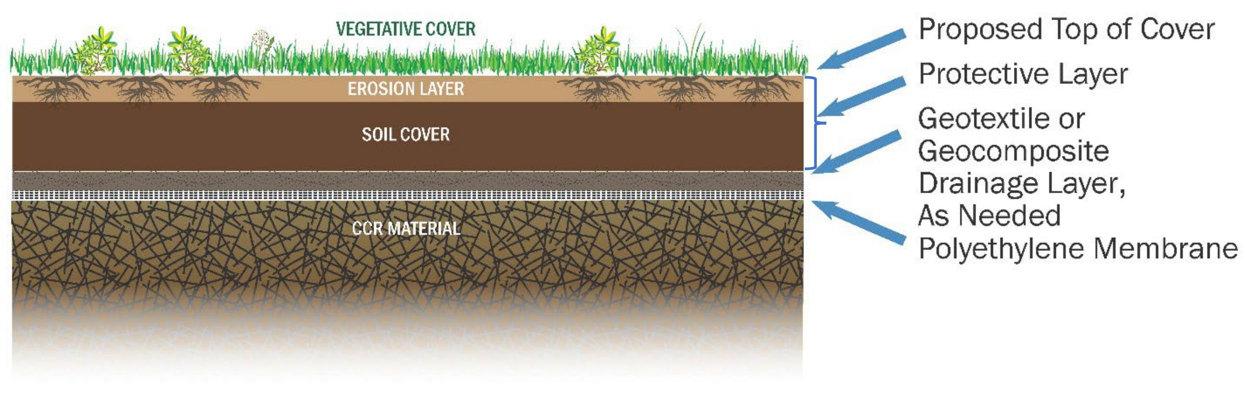

Figure 1: Proposed Alternative Final Cover System

DEMONSTRATION

The proposed alternate final protective layer will address the five requirements of Section 845.750 (c)(2)(A) to (E), as described in this section.

Section 845.750(c)(2)(A) Cover the entire low permeability layer

The final protective layer will horizontally cover the entire low-permeability layer, as indicated in the following drawings for each CCR surface impoundment:

- Duck Creek GMF Pond: Closure-in place drawings 4, 5, and 6 within Attachment 2 to the Closure Plan [2].
- Hennepin East Ash Pond: Drawings C-101, C-102, and C-103 within Attachment C to the Closure Plan [3].

Therefore, the use of the two-foot-thick final protective layer will meet the minimum requirements of Section 845 750(c)(2)(A) because it will completely cover the low-permeability layer.

Section 845.750(c)(2)(B) Be sufficient to protect the low permeability layer from freezing, and minimize root penetration of the low permeability layer

The existing Part 845, which has the same requirements as Part 814 (closure rule for landfills), requires a three-foot-thick final protective layer to protect the underlying low permeability layer from freeze-thaw effects and root penetration. However, when a geomembrane is used as the low permeability layer it does not need these protections since it is not subject to the same impacts (i.e., increase in hydraulic conductivity) as a compacted earth layer as discussed in more detail below.

Geomembrane low permeability layers will be used for both the HPP EAP and the DCPP GMF Pond. They have the following characteristics:

- Geomembranes do not have pores that can contain water and are therefore not susceptible to freeze-thaw damage that may reduce their performance as a low permeability layer and/or lead to degradation of the geomembrane.
    - In fact, geomembrane panel strength and stiffness both increase with decreasing temperatures ([4], [5]). In 1996, the United States Bureau of Reclamation [6] (USBR) performed testing of both geomembrane panels and seams subjected to up to 500 freeze-thaw cycles, in both constrained and unconstrained conditions, with temperature cycles as severe as +30º C to -20º C.

  - The testing showed no changes in the strength of the geomembrane panels or seams. The USBR concluded that *"...there is simply "no change" in tensile behavior of geomembrane sheets or their seams after freeze-thaw cycling"*.
  - In 2013, the Geosynthetic Institute, upon reviewing the results of the USBR and other studies, concluded that *"the essential question often raised in this regard, i.e., "will freeze-thaw conditions affect geomembrane sheets or their seam behavior," is answered with a resounding "NO""* [7].
- Geomembranes are not susceptible to grass plant root penetration because the geomembranes do not provide organic nutrients to plant roots and do not have pores or other areas where roots can enter the geomembrane.
  - Consequently, geomembranes are not a hospitable material that would either encourage root penetration or allow root penetration. Additionally, the geomembrane will be covered with a geotextile cushion or geocomposite drainage layer, which will provide an additional barrier to root penetration.

U.S. EPA research [8] states that "…a typical minimum thickness of the cover soil is 0.45 to 0.6 m…" (18 to 24 inches) thick "… for cover systems with hydraulic barriers" (low permeability layer). This is particularly appropriate when using a geomembrane low permeability which is not susceptible to any impact from freezing. U.S. EPA research also states that cover thickness design for root penetration into the low permeability layer is only a concern for compacted clay layers or geosynthetic clay barriers. This is when using an appropriate design of cover vegetation.

Therefore, the use of the two-foot-thick final protective layer will provide equivalent or superior performance to the requirements of Section 845.750 (c) (2) (B) when coupled with a geotextile cushion or geocomposite drainage layer, and a geomembrane low permeability layer, as geomembranes are not susceptible to freeze-thaw damage or root penetration as compared to a low permeability compacted earth layer.

Section 845.750(c)(2)(C) Consist of soil material capable of supporting vegetation.

The uppermost six inches of the final protective layer will consist of topsoil that is capable of supporting vegetation, which is the same requirement as the default (three-foot thick) final protective layer. This is also consistent with the Federal CCR Rule, which requires a six-inch-thick erosion (topsoil) layer. Research [8] and Geosyntec's experience indicate topsoil layers are designed to have shallow-rooted grasses and most shallow-rooted grasses do not typically penetrate more than six inches into the subsurface. Shallow-rooted grasses will be specified based on recommendations from specialists at nurseries in the location of HPP and DCPP and Illinois Department of Transportation guidelines. The topsoil layer will be fertilized and/or amended, as necessary, on a site-specific basis based on agronomical soil testing, to provide a growing medium for the vegetation that provides the required levels of nutrients and water storage during drought conditions.

Grass species will also be selected on a site-specific basis to minimize long-term vegetation maintenance, based on the climatic conditions at each site and the soil types. Vegetation will be established by applying seed and mulch and watering to establish the vegetation. Temporary erosion control measures will also be used during vegetation establishment to protect the topsoil layer from erosion. These measures may include erosion control blankets (ECBs), silt fences, hydroseeding, and/or other methods. The Post-Closure Care Plan includes the commitment to maintain the vegetation of the surface for the closed DCPP GMF Pond in the Construction Permit Application, Attachment J [2] and the HPP EAP in the Construction Permit Application Attachment J [3].

The 18-inches of the protective layer below the topsoil will consist of a soil type suitable for retaining moisture to provide additional support for vegetation during times of drought, and to support any grass species with roots that exceed six inches. Such soil types may include silts, silty clays, lean clays, sandy clays, and/or sandy silts. A silty granular layer will be used at HPP EAP and a silty clay layer will be used at DCPP GMF.

Therefore, the use of the two-foot-thick protective layer will meet the requirements of Section 845.750(c)(2)(C), as the final protective layer will utilize soil capable of supporting vegetation.

Section 845.750(c)(2)(D) Be placed as soon as possible after placement of the low permeability layer

The HPP EAP Closure Plan (Section 4.7.2 [3]) states that the geotextile and cover soil "…will be placed as soon as practical after the geomembrane has been deployed and both quality assurance and quality control testing has been performed on the geomembrane seams." The DCPP GMF Closure Plan (Section 4.7.2 [2]) states the protective layer will be placed "…as soon as possible after placement of the low-permeability layer and will be covered with vegetation to limit wind and water erosion."

The use of a two-foot-thick protective layer will allow the final protective layer to be placed on top of the low permeability layer and vegetation to be established on top of the final protective layer sooner than if a three-foot thick final protective layer is used. This is due to the 33% reduction in earthwork volumes associated with the thinner 2-ft-thick final protective layer.

Therefore, the use of the two-foot-thick final protective layer will exceed the minimum requirements of Section 845.750(c)(2)(D), by allowing the protective layer to be installed sooner than when using a three-foot-thick protective layer.

Section 845.750(c)(2)(E) Be covered with vegetation to minimize wind and water erosion.

Vegetation will be established to cover the final protective layer immediately after the protective layer is installed, as noted in the discussion regarding Section 845.750(c)(2)(C). Additionally, the following design and engineering features, construction techniques, and maintenance procedures will be used to reduce the potential for wind and water erosion under both long-term conditions and during vegetation establishment.

- Design and Engineering Features
    - Final cover system slopes will be installed at relatively flat grades (e.g., typically 2.5 to 4%, with steeper slopes used only in limited areas). The use of flat grades will reduce water runoff velocities and therefore reduce the potential for water erosion of the final cover soils.
    - The geotextile cushion and geocomposite drainage layer provide cushioning and help to facilitate lateral drainage of infiltration off the geomembrane, thereby reducing the amount of water available for infiltration through the geomembrane. This layer is not required by Section 845.750 but it enhances the final cover system performance.
    - A stormwater management system consisting of channels and letdown structures is included in each Construction Permit Application and will be designed to collect stormwater in a controlled manner and route it off the final cover system which will minimize infiltration into the CCR waste mass. The stormwater management system will minimize the overland flow distance between stormwater channels. Channels will be lined with an appropriate material, based on estimated stormwater velocities, to limit water erosion.
- Construction Techniques
    - The final protective layer is typically the most susceptible to wind and water erosion in the period between the placement of the protective layer and the establishment of vegetation. To reduce the potential for both wind and water

erosion during this time, the following approaches will be utilized:

    - Temporary erosion and sediment controls (ESCs) will be installed to reduce the potential for erosion, such as erosion control blankets (ECBs), silt socks, silt fences, and other methods. These ECSs will be regularly inspected and maintained until vegetation is established.
    - The entire surface of the final protective layer will be stabilized during seeding and until vegetation is established. Coverings may consist of straw mulch, hydroseeding binder, ECBs, or engineering growing media.
    - The final protective layer will be regularly inspected and maintained during vegetation establishment. Any areas that become eroded by wind and water will be repaired until vegetation is established to a suitable level over the surface of the final cover.

- Maintenance Procedures
  - During the post-closure care period, vegetation established on the final protective cover layer will be regularly maintained using a written and IEPA-approved maintenance program. The program will consist of regular mowing and inspections. Any bare areas or areas of erosion will be repaired by seeding and stabilizing the area, and observing the area until vegetation becomes re-established.
  - The final cover slopes will be relatively flat (<5%); these slopes experience less erosion in general, especially less than typical landfill covers sloped at 25 to 33%. Typically, after three to five years, it is Geosyntec's experience that the cover vegetation becomes fully stabilized and experiences less erosion.

Therefore, the use of the two-foot-thick final protective layer will exceed the minimum requirements of Section 845 750 c) 2) E), using a robust program to support the establishment of protective vegetation, prevent and address any erosion that may occur during vegetation establishment, and monitor and maintain the vegetation during post-closure conditions.

ADDITIONAL CONSIDERATIONS

Infiltration Analysis

The use of the proposed two-foot-thick final protective layer, when coupled with a geomembrane low permeability layer, will also meet the criteria contained within Section 845.750 (a) (1). Section 845.750 (a) (1) provides the following requirement:

> *Section 845.750(a)(1) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;*

Section 845.750(a)(1) is an important overall measure of the effectiveness of the final cover system because it requires control of post-closure infiltration of liquids through the final cover and into the waste and releases of CCR.

An infiltration analysis was performed to estimate post-closure liquid infiltration rates through both the default and the proposed alternate final cover systems. The following infiltration analysis discussion is provided for the proposed closure at the HPP EAP and DC GMF.

The cover systems for both the EAP and GMF have the same final cover system thickness configuration[1]. An infiltration analysis was performed by Ramboll in the HPP EAP Construction Permit Application [3] and in the DCPP GMF Construction Permit Application [2] using the Hydrologic Evaluation of Landfill Performance (HELP) software promulgated by the USEPA [9]. The HELP model estimates the infiltration rates from the top of the cover, through the final protective layer and through the low permeability layer (either a geomembrane or the three-foot thick compacted earth layer). The results are included in **Appendix A**. The resulting estimated infiltration rates are provided in **Table 1** for HPP EAP and in **Table 2** for DCPP GMF.

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[1] The EAP has a 40 mil LLDPE with an overlying geotextile cushion, 18-inches of silty granular soil, and 6-inches of topsoil. The GMF has a 40 mil LLDPE with an overlying geocomposite drainage layer, 18-inches of silty clay soil, and 6-inches of topsoil.

Table 1 – HPP Final Cover Systems for Infiltration Analysis

Description	Low Permeability Layer[2]	Final Protective Layer	Infiltration Rate[3]
Proposed Alternative Final Cover System	40-mil Linear Low-Density Polyethylene (LLDPE) Geomembrane	2 ft of cover material, including, from bottom to top, a protective geotextile cushion[4], 1.5 ft of sandy soil and 0.5 ft of silty, sandy clay topsoil	0.53 in/yr
Default Cover with Geomembrane Barrier	40-mil LLDPE Geomembrane	3 ft of cover material, including, from bottom to top, a protective geotextile cushion, 2.5 ft of silty sandy soil and 0.5 ft of silty, sandy clay topsoil	0.88 in/yr
Default Cover with Compacted Earth Layer	3-ft thick compacted earth layer (1×10^{-7} cm/sec)	3 ft of cover material, including, from bottom to top, 2.5 ft of silty sandy soil and 0.5 ft of silty, sandy clay topsoil	2.26 in/yr

The HPP analysis indicated that the proposed alternative final cover system with a geomembrane and a two-foot-thick final protective layer exceeds the performance offered by the default final cover system utilizing a geomembrane with the default three-foot-thick protective layer, with the infiltration rate reduced by a factor of 1.66.

Furthermore, the proposed alternative final cover system performance exceeds the performance of a final cover system using a three-foot-thick compacted earthen low permeability layer and a three-foot-thick final protective layer (a total cover thickness of six feet) by reducing infiltration by a factor of 4.26.

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[2] All HELP run versions used a pinhole density of 1 hole per acre, installation defects of 1 hole/acre, and construction quality as “good”.

[3] Infiltration is out the bottom of the low permeability layer.

[4] The geotextile cushion was not included in the HELP run as HELP does not include a default drainage value for geotextiles. If the geotextile were included, infiltration may reduce even further than indicated in Table 1, relative to the default cover.

Table 2 – DCPP GMF Final Cover Systems for Infiltration Analysis

Description	Low Permeability Layer[5]	Protective Layer	Infiltration Rate
Proposed Alternative Final Cover System	40-mil Linear Low-Density Polyethylene (LLDPE) Geomembrane	2 ft of cover soil, including, from bottom to top, a geocomposite drainage layer[6], a 1.5 ft of silty clay soil, and 0.5 ft of silty clay topsoil	0.00025 in/yr
Default Cover with Geomembrane Barrier	40-mil LLDPE Geomembrane	3 ft of cover soil, including, from bottom to top, a geocomposite drainage layer, a 2.5 ft of silty clay soil, and 0.5 ft of silty clay topsoil	0.00026 in/yr
Default Cover with Compacted Clay Barrier	3-ft thick Clay Liner (1×10^{-7} cm/sec)	3 ft of cover soil, including, from bottom to top, 2.5 ft of silty clay soil and 0.5 ft of silty clay topsoil	2.1 in/yr

The DCPP GMF Pond analysis indicated that the proposed alternative final cover system with a geomembrane and a two-foot-thick final protective layer is essentially equivalent to the performance offered by the geomembrane with the default three-foot-thick final protective layer.

Furthermore, the proposed alternative final cover system performance exceeds the performance of a final cover system using a three-foot-thick compacted earth low permeability layer and a three-foot-thick soil protective layer (a total cover thickness of six feet) by reducing infiltration by a factor of nearly four orders of magnitude.

Environmental and Societal Benefits

The use of the proposed two-foot-thick final protective layer will provide the following additional environmental and societal benefits, relative to the default three-foot-thick final protective layer:

- The final cover system earthwork quantities will be reduced by 33% for each CCR surface impoundment. This will result in a corresponding 33% reduction in the amount of locally available soil fill that needs to be excavated, hauled to the construction location, and placed. This provides multiple benefits, such as:
    - Reduced disruption to offsite areas caused by the excavation of fill materials and corresponding disturbance to the natural environment.

---

[5] All HELP run versions used a pinhole density of 1 hole per acre, installation defects of 1 hole/acre, and construction quality as “good”.

  - Reduced haul truck traffic on local roadways, thereby reducing traffic impacts, roadway damage, air pollution, and carbon emissions.
  - Reduced earthwork effort during installation of the final cover system, thereby reducing air pollution and carbon emissions.
- Construction of the alternate final cover system can be completed faster than the default final cover, providing multiple benefits, such as:
  - Initiation of the reduction of infiltration at a sooner date than with the default final cover system.
  - Ceasing construction-related impacts to offsite residents (e.g., haul truck traffic, congestion) at a sooner date than otherwise possible.

SUMMARY

The proposed alternate final protective layer will:

- Provide equivalent or superior performance to the requirements of Section 845.750 (c)(2).
- Have a geotextile cushion or a geocomposite drainage layer, which are not required by Section 845.750, over the geomembrane that add both physical protection and a lateral drainage layer to reduce the amount of water available for infiltration through the geomembrane.
- Have a lower infiltration rate than the infiltration through the default final cover system.
- Meet or exceed the same criteria for long term performance and all other requirements of Section 845.750(c)(2).
- Provide other benefits by reducing the amount of final cover earthwork by 33% at each site.

REFERENCES

[1] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[2] Golder Associates, "Final Closure Plan for the Gypsum Management Facility Pond, Duck Creek Power Plant," Canton, Illinois, 2022.

[3] Geosyntec Consultants, "Construction Permit Application Hennepin Power Plant East Ash Pond," Geosyntec Consultants, St. Louis, 2022.

[4] A. L. Rollin, J. Lafleur, M. Marcotte, O. Dascal and Z. Akber, "Selection Criteria for the Use of Geomembranes in Dams and Dykes in Northern Climate," in *Proceedings of the International Conference on Geomembranes*, Denver, Colorado, 1945.

[5] D. E. Thorton and P. Blackall, "Report EPA-3-76-13: Field Evaluation of Plastic Film Liners for Petroleum Storage Areas in the Mackenzie Delta," Canadian Environmental Protection Service, 1976.

[6] A. I. Comer and Y. G. Hsuan, "Report R-96-03: Freeze-Thaw Cycling and Cold Temperature Effects on Geomembrane Sheets and Seams," U.S. Bureau of Reclamation, 1996.

[7] Y. G. Hsuan, R. M. Koerner and A. I. Comer, "GSI White Paper #28: Cold Temperature and Freeze-Thaw Cycling Behavior of Geomembranes and their Seams," Geosynthetic Institute, Folsom, Pennsylvania, 2013.

[8] United States Environmental Protection Agency, "(Draft) Technical Guidance For RCRA/CERCLA Final Covers," Office of Solid Waste and Emergency Response, Washington D.C., 2004.

[9] T. Tolaymat and M. Krause, "Hydrologic Evaluation of Landfill Performance: HELP 4.0 User Manual," United States Environmental Protection Agency, Washington, DC, 2020.

APPENDIX A: HELP MODEL OUTPUT

A-1: HPP EAP- 2-FT FINAL PROTECTIVE COVER SOIL

A-2: HPP EAP-3-FT FINAL PROTECTIVE COVER SOIL

A-3: HPP EAP-3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL

A-4: DCPP GMF Pond- 2-FT FINAL PROTECTIVE COVER SOIL

A-5: A-4: DCPP GMF Pond- 3-FT FINAL PROTECTIVE COVER SOIL

A-6: A-4: DCPP GMF Pond- 3-FT COMPACTED EARTH LAYER, 3-FT FINAL PROTECTIVE COVER SOIL

APPENDIX A-1
HENNEPIN POWER PLANT EAST ASH POND HELP RESULTS: 2-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP CIP (2 ft cover) **Simulated On:** 10/28/2021 14:14

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	6	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.3947	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness	=	18	inches
Porosity	=	0.417	vol/vol
Field Capacity	=	0.045	vol/vol
Wilting Point	=	0.018	vol/vol
Initial Soil Water Content	=	0.4166	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-02	cm/sec

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	3	Good

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 372 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.1873 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness = 48 inches
Porosity = 0.451 vol/vol
Field Capacity = 0.419 vol/vol
Wilting Point = 0.332 vol/vol
Initial Soil Water Content = 0.4207 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.0649 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 156 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 80.6
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 510 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 3.196 inches
Upper Limit of Evaporative Storage = 3.222 inches
Lower Limit of Evaporative Storage = 0.852 inches
Initial Snow Water = 0.274951 inches
Initial Water in Layer Materials = 107.552 inches
Total Initial Water = 107.827 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829
3.29051	4.017539	3.401471	3.029886	2.510213	1.863762

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Average Annual Totals Summary

Title: HEN EAP CIP (2 ft cover)
Simulated or 10/28/2021 14:16

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	8.075	[3.311]	14,948,903.1	22.69
Evapotranspiration	27.017	[3.834]	50,016,380.0	75.92
Subprofile1				
Percolation/leakage through Layer 3	**0.529518**	[0.021507]	980,296.3	1.49
Average Head on Top of Layer 3	18.5065	[0.739]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**0.319267**	[0.207637]	591,059.7	0.90
Water storage				
Change in water storage	0.1740	[0.9142]	322,172.8	0.49

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-2
HENNEPIN POWER PLANT EAST ASH POND HELP RESULTS: 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure-in-Place **Simulated On:** 1/14/2022 8:20

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness = 6 inches
Porosity = 0.398 vol/vol
Field Capacity = 0.244 vol/vol
Wilting Point = 0.136 vol/vol
Initial Soil Water Content = 0.2488 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-04 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness = 30 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.3063 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-02 cm/sec

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 372 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.1873 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness = 48 inches
Porosity = 0.451 vol/vol
Field Capacity = 0.419 vol/vol
Wilting Point = 0.332 vol/vol
Initial Soil Water Content = 0.4205 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.0646 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 156 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 80.6
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 510 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 1.697 inches
Upper Limit of Evaporative Storage = 3.222 inches
Lower Limit of Evaporative Storage = 0.852 inches
Initial Snow Water = 0.27495054 inches
Initial Water in Layer Materials = 108.323 inches
Total Initial Water = 108.598 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 41.3 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 70 %
Average 2nd Quarter Relative Humidity = 66 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 77 %

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829018
3.29051	4.017539	3.401471	3.029886	2.510213	1.86376189

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.30303/-89.31435

Average Annual Totals Summary

Title: HEN EAP - CURRENT CONDITIONS
Simulated on: 1/14/2022 8:23

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	7.713	[3.344]	14,279,113.1	21.67
Evapotranspiration	26.948	[3.837]	49,888,594.9	75.73
Subprofile1				
Percolation/leakage through Layer 3	**0.880978**	[0.027359]	1,630,955.3	2.48
Average Head on Top of Layer 3	30.2516	[0.8802]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**0.544600**	[0.386956]	1,008,217.1	1.53
Water storage				
Change in water storage	0.3795	[1.1939]	702,590.4	1.07

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-3
HENNEPIN POWER PLANT EAST ASH POND HELP RESULTS: 3-FT OF COMPACTED EARTH LAYER, 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: HEN EAP - Closure-in-Place **Simulated On:** 10/13/2021 20:45

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness = 6 inches
Porosity = 0.398 vol/vol
Field Capacity = 0.244 vol/vol
Wilting Point = 0.136 vol/vol
Initial Soil Water Content = 0.2488 vol/vol
Effective Sat. Hyd. Conductivity = 1.20E-04 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
CoS - Coarse Sand
Material Texture Number 1

Thickness = 30 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.275 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-02 cm/sec

Layer 3

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness = 36 inches
Porosity = 0.427 vol/vol
Field Capacity = 0.418 vol/vol
Wilting Point = 0.367 vol/vol
Initial Soil Water Content = 0.427 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 4

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 372 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.19 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer
Clay - moderate
Material Texture Number 43

Thickness = 48 inches
Porosity = 0.451 vol/vol
Field Capacity = 0.419 vol/vol
Wilting Point = 0.332 vol/vol
Initial Soil Water Content = 0.419 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer
S - Sand
Material Texture Number 2

Thickness = 12 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.062 vol/vol
Wilting Point = 0.024 vol/vol
Initial Soil Water Content = 0.0641 vol/vol
Effective Sat. Hyd. Conductivity = 5.80E-03 cm/sec

Layer 7

Type 1 - Vertical Percolation Layer
Glacial Outwash
Material Texture Number 44

Thickness = 156 inches
Porosity = 0.417 vol/vol
Field Capacity = 0.045 vol/vol
Wilting Point = 0.018 vol/vol
Initial Soil Water Content = 0.045 vol/vol
Effective Sat. Hyd. Conductivity = 1.80E-01 cm/sec

Note: Initial moisture content of the layers and snow water were
computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	80.6	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	510	acres
Evaporative Zone Depth	=	8	inches
Initial Water in Evaporative Zone	=	1.696	inches
Upper Limit of Evaporative Storage	=	3.222	inches
Lower Limit of Evaporative Storage	=	0.852	inches
Initial Snow Water	=	0.27495054	inches
Initial Water in Layer Materials	=	123.7	inches
Total Initial Water	=	123.975	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	41.3	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	120	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	9	mph
Average 1st Quarter Relative Humidity	=	70	%
Average 2nd Quarter Relative Humidity	=	66	%
Average 3rd Quarter Relative Humidity	=	74	%
Average 4th Quarter Relative Humidity	=	77	%

Note: Evapotranspiration data was obtained for , Illinois

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
1.665246	1.874612	2.254818	3.099339	4.449317	4.12829018
3.29051	4.017539	3.401471	3.029886	2.510213	1.86376189

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
27.4	35	40.3	50	69.5	78.4
83	79.7	71.5	56.9	46.3	33.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 41.3/-89.31

Average Annual Totals Summary

Title: HEN EAP - Closure-in-Place (CLAY)
Simulated on: 10/13/2021 20:48

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.59	[5.14]	65,878,515.6	100.00
Runoff	6.701	[3.161]	12,404,742.9	18.83
Evapotranspiration	26.571	[4.002]	49,190,796.8	74.67
Subprofile1				
Percolation/leakage through Layer 3	**2.261741**	[0.038582]	4,187,161.3	6.36
Average Head on Top of Layer 3	29.5380	[1.1069]	---	---
Subprofile2				
Percolation/leakage through Layer 7	**1.697246**	[0.951224]	3,142,112.4	4.77
Water storage				
Change in water storage	0.6162	[1.663]	1,140,863.6	1.73

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-4
DUCK CREEK POWER PLANT GYPSUM MANAGEMET FACILITY POND
HELP RESULTS: 2-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/12/2022 9:32

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness = 6 inches
Porosity = 0.461 vol/vol
Field Capacity = 0.36 vol/vol
Wilting Point = 0.203 vol/vol
Initial Soil Water Content = 0.4073 vol/vol
Effective Sat. Hyd. Conductivity = 9.00E-06 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness = 18 inches
Porosity = 0.461 vol/vol
Field Capacity = 0.36 vol/vol
Wilting Point = 0.203 vol/vol
Initial Soil Water Content = 0.3829 vol/vol
Effective Sat. Hyd. Conductivity = 9.00E-06 cm/sec

Layer 3
Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness = 0.2 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.0338 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E+01 cm/sec
Slope = 4 %
Drainage Length = 450 ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 5

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness = 240 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.105 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.105 vol/vol
Effective Sat. Hyd. Conductivity = 6.70E-04 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 90.1
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 15 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 3.294 inches
Upper Limit of Evaporative Storage = 3.688 inches
Lower Limit of Evaporative Storage = 1.624 inches
Initial Snow Water = 0 inches
Initial Water in Layer Materials = 34.543 inches
Total Initial Water = 34.543 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 40.5 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days

End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 72 %
Average 2nd Quarter Relative Humidity = 67 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 75 %

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/12/2022 9:36

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	12.581	[3.246]	685,044.7	34.24
Evapotranspiration	23.227	[2.957]	1,264,727.0	63.21
Subprofile1				
Lateral drainage collected from Layer 3	0.9541	[0.7929]	51,952.6	2.60
Percolation/leakage through Layer 4	0.000247	[0.00019]	13.5	0.00
Average Head on Top of Layer 4	0.0005	[0.0004]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000248	[0.00019]	13.5	0.00
Water storage				
Change in water storage	-0.0142	[1.0912]	-772.6	-0.04

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-5
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND
HELP RESULTS: 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/13/2022 15:36

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness = 6 inches
Porosity = 0.461 vol/vol
Field Capacity = 0.36 vol/vol
Wilting Point = 0.203 vol/vol
Initial Soil Water Content = 0.4073 vol/vol
Effective Sat. Hyd. Conductivity = 9.00E-06 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness = 30 inches
Porosity = 0.461 vol/vol
Field Capacity = 0.36 vol/vol
Wilting Point = 0.203 vol/vol
Initial Soil Water Content = 0.3834 vol/vol
Effective Sat. Hyd. Conductivity = 9.00E-06 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness = 0.2 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.0156 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E+01 cm/sec
Slope = 4 %
Drainage Length = 450 ft

Layer 4

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness = 0.04 inches
Effective Sat. Hyd. Conductivity = 4.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 1 Holes/Acre
FML Placement Quality = 3 Good

Layer 5

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness = 240 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.105 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.105 vol/vol
Effective Sat. Hyd. Conductivity = 6.70E-04 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 90.1
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 15 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 3.294 inches
Upper Limit of Evaporative Storage = 3.688 inches
Lower Limit of Evaporative Storage = 1.624 inches
Initial Snow Water = 0 inches
Initial Water in Layer Materials = 39.149 inches
Total Initial Water = 39.149 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 40.5 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days

End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 72 %
Average 2nd Quarter Relative Humidity = 67 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 75 %

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/13/2022 15:40

	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	12.581	[3.246]	685,044.7	34.24
Evapotranspiration	23.227	[2.957]	1,264,727.0	63.21
Subprofile1				
Lateral drainage collected from Layer 3	0.9570	[0.8034]	52,108.0	2.60
Percolation/leakage through Layer 4	0.000258	[0.0002]	14.1	0.00
Average Head on Top of Layer 4	0.0005	[0.0004]	---	---
Subprofile2				
Percolation/leakage through Layer 5	0.000258	[0.0002]	14.1	0.00
Water storage				
Change in water storage	-0.0171	[1.1899]	-928.6	-0.05

* Note: Average inches are converted to volume based on the user-specified area.

APPENDIX A-6
DUCK CREEK POWER PLANT GYPSUM MANAGEMENT FACILITY POND HELP RESULTS: 3-FT OF COMPACTED EARTH LAYER, 3-FT OF FINAL PROTECTIVE COVER SOIL

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Duck Creek Coversystem CIP **Simulated On:** 1/13/2022 15:07

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness = 6 inches
Porosity = 0.461 vol/vol
Field Capacity = 0.36 vol/vol
Wilting Point = 0.203 vol/vol
Initial Soil Water Content = 0.461 vol/vol
Effective Sat. Hyd. Conductivity = 9.00E-06 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
SiL - Silty Loam(Moderate)
Material Texture Number 23

Thickness = 30 inches
Porosity = 0.461 vol/vol
Field Capacity = 0.36 vol/vol
Wilting Point = 0.203 vol/vol
Initial Soil Water Content = 0.461 vol/vol
Effective Sat. Hyd. Conductivity = 9.00E-06 cm/sec

Layer 3

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness = 36 inches
Porosity = 0.427 vol/vol
Field Capacity = 0.418 vol/vol
Wilting Point = 0.367 vol/vol
Initial Soil Water Content = 0.427 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Layer 4

Type 1 - Vertical Percolation Layer
Gypsum waste material (Sandy Loam)
Material Texture Number 43

Thickness = 240 inches
Porosity = 0.437 vol/vol
Field Capacity = 0.105 vol/vol

Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.1135 vol/vol
Effective Sat. Hyd. Conductivity = 6.70E-04 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 90.1
Fraction of Area Allowing Runoff = 100 %
Area projected on a horizontal plane = 15 acres
Evaporative Zone Depth = 8 inches
Initial Water in Evaporative Zone = 3.688 inches
Upper Limit of Evaporative Storage = 3.688 inches
Lower Limit of Evaporative Storage = 1.624 inches
Initial Snow Water = 0 inches
Initial Water in Layer Materials = 59.2 inches
Total Initial Water = 59.2 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 40.5 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 120 days
End of Growing Season (Julian Date) = 300 days
Average Wind Speed = 9 mph
Average 1st Quarter Relative Humidity = 72 %
Average 2nd Quarter Relative Humidity = 67 %
Average 3rd Quarter Relative Humidity = 74 %
Average 4th Quarter Relative Humidity = 75 %

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.01298	1.895696	2.373253	3.597322	4.095479	4.395065
3.769391	3.145982	3.272523	2.912689	2.788342	2.489949

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
32.4	34.2	41.9	56.4	69.6	79
83.5	81	72.5	61.4	45.9	35.6

\---

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 40.5/-89.98

Average Annual Totals Summary

Title: Duck Creek Coversystem CIP
Simulated on: 1/13/2022 15:10

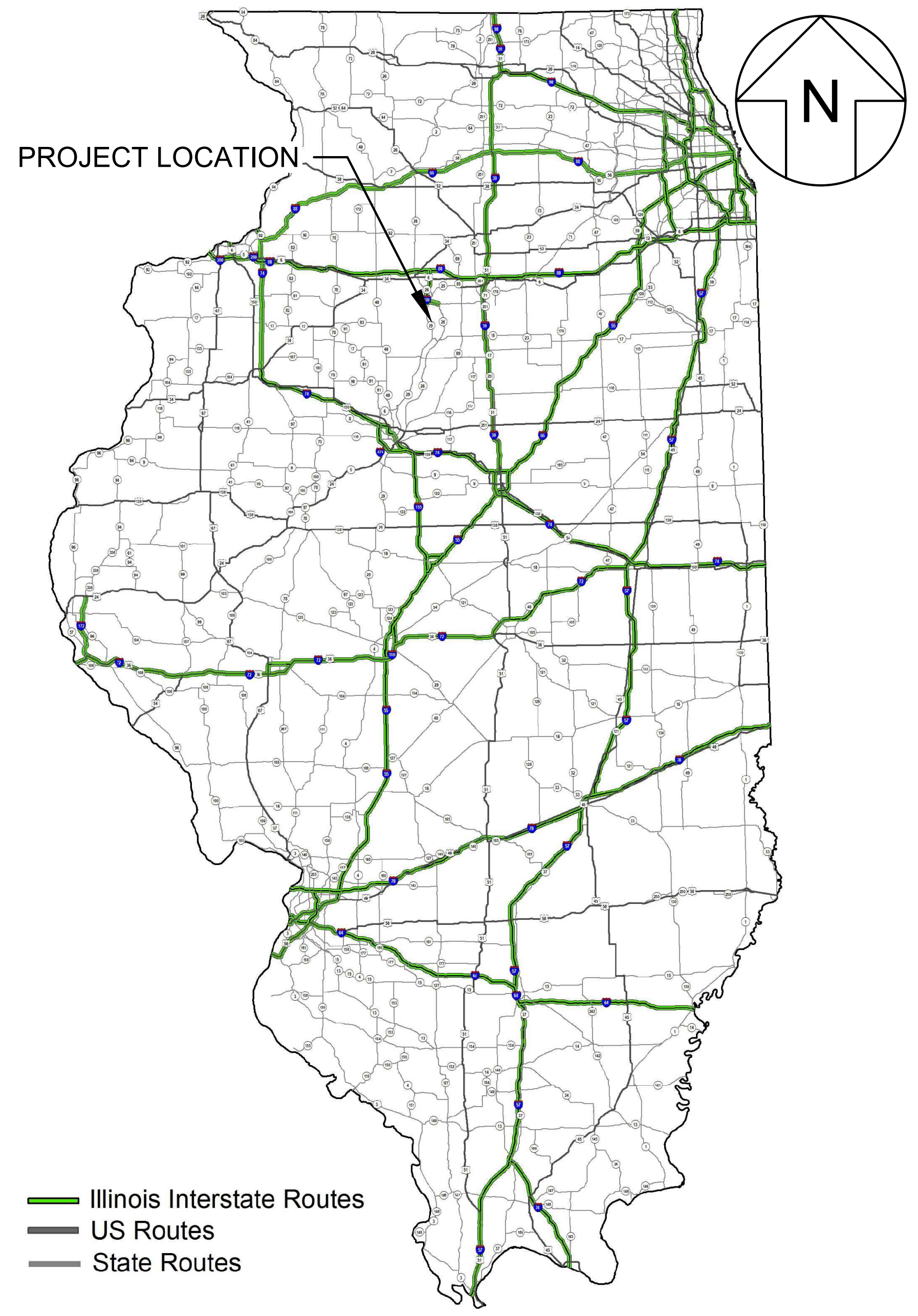
	Average Annual Totals for Years 1 - 100*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.75	[5.46]	2,000,965.1	100.00
Runoff	6.844	[2.987]	372,642.1	18.62
Evapotranspiration	27.772	[3.713]	1,512,183.1	75.57
Subprofile1				
Percolation/leakage through Layer 3	2.147626	[0.073824]	116,938.2	5.84
Average Head on Top of Layer 3	26.2293	[2.126]	---	---
Subprofile2				
Percolation/leakage through Layer 4	1.973425	[0.573329]	107,453.0	5.37
Water storage				
Change in water storage	0.1595	[1.2078]	8,686.9	0.43

* Note: Average inches are converted to volume based on the user-specified area.

ATTACHMENT D

Final Closure Plans and Material Specifications

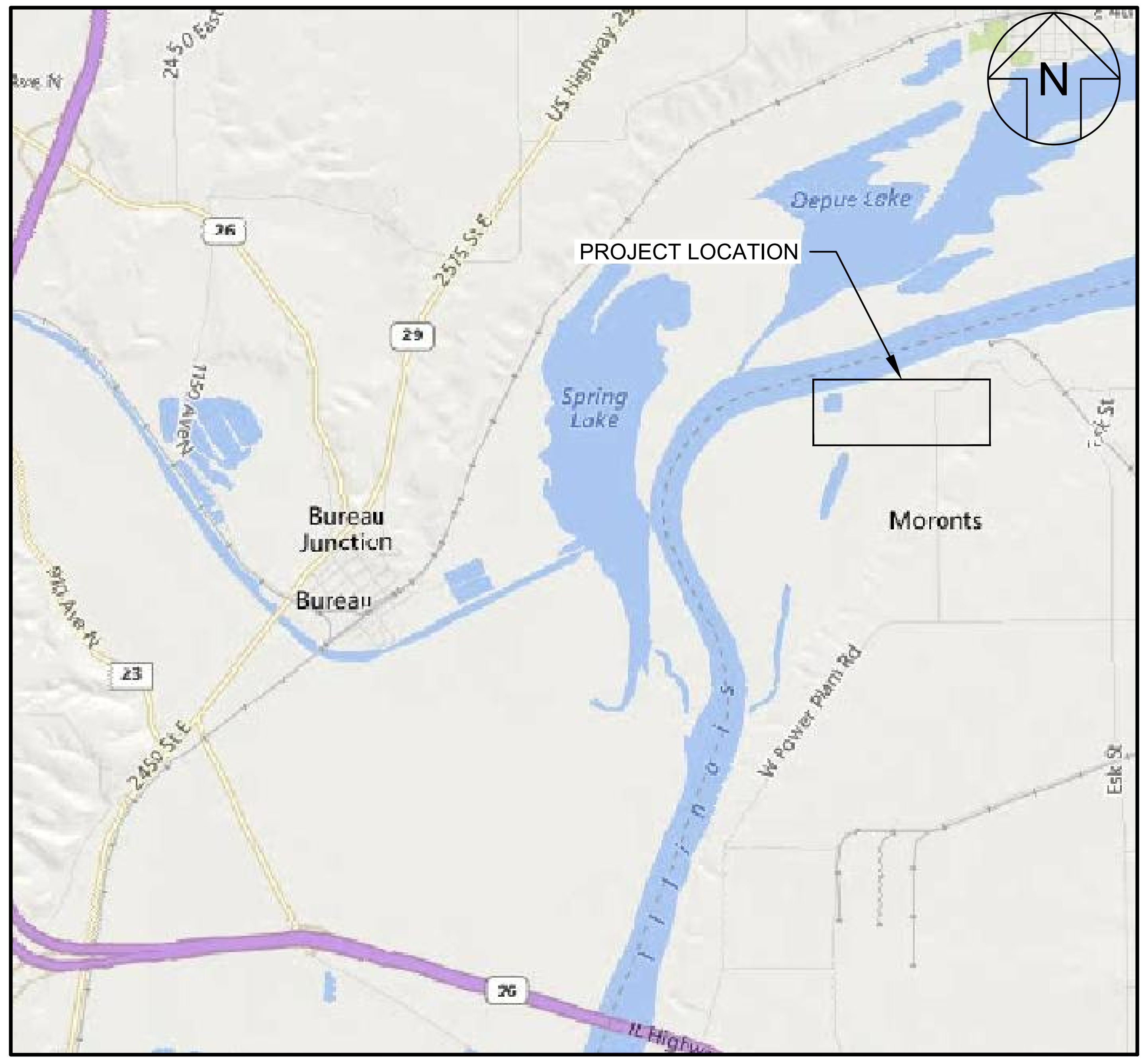
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS
EAST ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS



SOURCE: IDOT

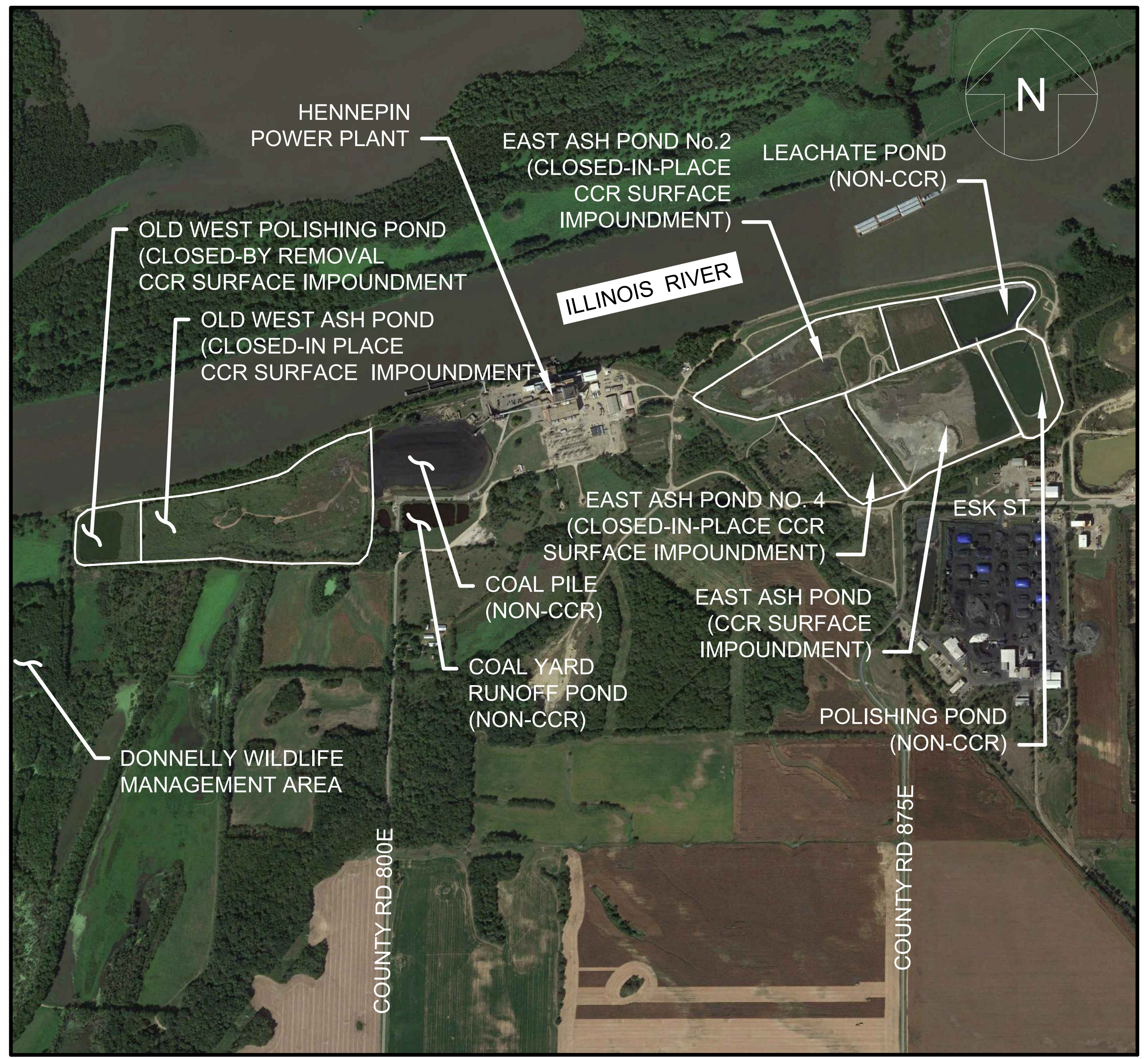
STATE MAP

NOT TO SCALE



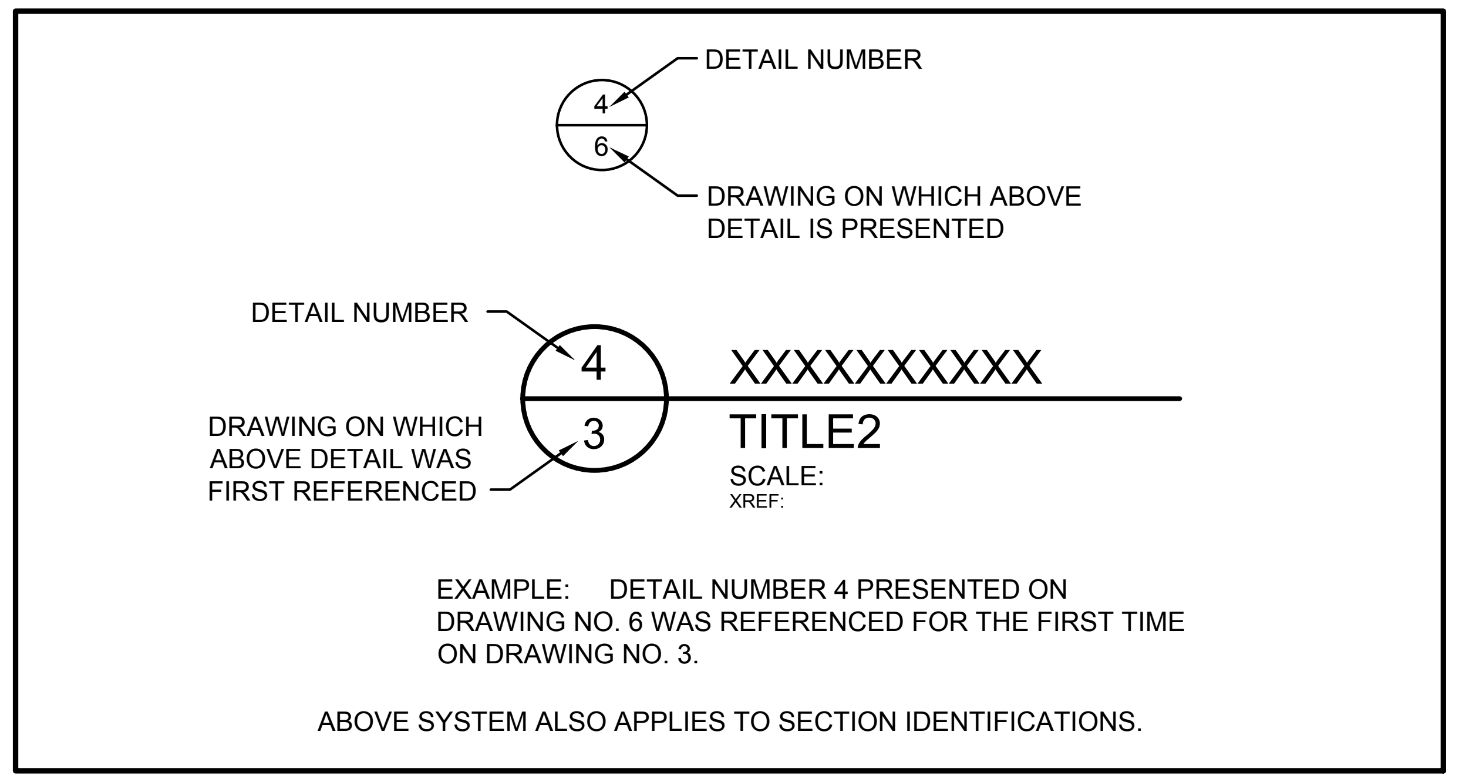
SOURCE: BING MAPS

LOCATION MAP



SOURCE: GOOGLE EARTH PRO

SITE MAP



EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 6 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 3.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

DRAWINGS LIST

SHEET NO.	SHEET TITLE
G-100	COVER SHEET AND LOCATION MAP
G-101	EXISTING CONDITIONS
C-100	OUTFALL AND PIEZOMETER ABANDONMENT PLAN
C-101	OVERALL GRADING PLAN
C-102	SECTIONS
C-103	DETAILS AND MATERIAL SPECIFICATIONS

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NOT FOR CONSTRUCTION

0	11/5/2021	DRAFT CLOSURE PLAN ISSUE	MGK	LPC
REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DR, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636.812.0800

DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: COVER SHEET AND LOCATION MAP

PROJECT: EAST ASH POND CONSTRUCTION PERMIT
APPLICATION CLOSURE DRAWINGS

SITE: HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY: LPC
DRAWN BY: IJV/MGK
CHECKED BY: TWW
REVIEWED BY: JPS
APPROVED BY: LPC

DATE: NOVEMBER 2021
PROJECT NO.: GLP8026
FILE:
DRAWING NO.: G-100

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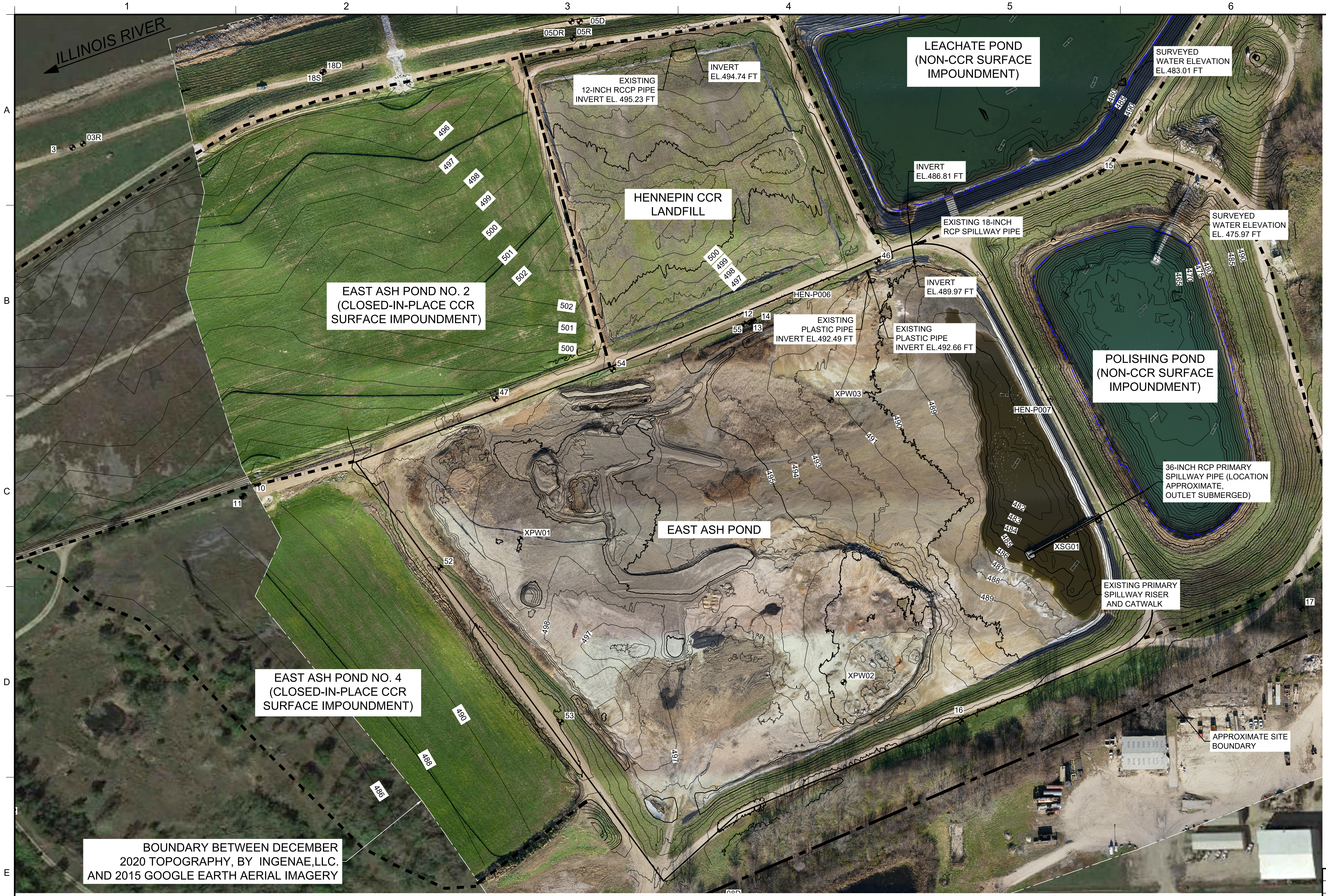
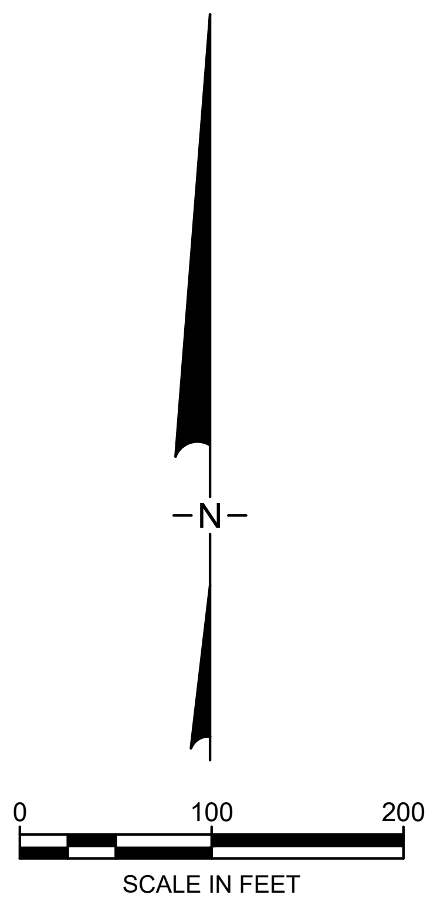


LEGEND

―	EXISTING GROUND SURFACE ELEVATION (MAJOR) (5-FT INTERVAL)
―	EXISTING GROUND SURFACE ELEVATION (MAJOR) (1-FT INTERVAL)
— — —	2020 SURVEYED IMPOUNDMENT WATER LEVEL
■ ■ ■	APPROXIMATE LIMITS OF CCR UNITS AND NON-CCR SURFACE IMPOUNDMENT
—·—	APPROXIMATE SITE BOUNDARY
―	BOUNDARY BETWEEN DECEMBER 2020 TOPOGRAPHY, BY INGENAE,LLC. AND 2015 GOOGLE EARTH AERIAL IMAGERY
◈	EXISTING MONITORING WELL
⊕	EXISTING PIEZOMETERS



NOTES:

1. COORDINATES AND DIRECTIONS SHOWN IN THESE DRAWINGS WERE BASED ON THE ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83, IN US FEET). ELEVATIONS WERE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).
2. EXISTING CONTOURS, AERIAL IMAGERY AND WATER SURFACE ELEVATIONS FOR THE EAP, POLISHING POND, LEACHATE POND, AND HENNEPIN LANDFILL WERE TAKEN FROM "DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER STATION - DECEMBER 2020 TOPOGRAPHY, 3/10/2021", BY INGENAE, LLC.
3. EXISTING CONTOURS AND AERIAL IMAGERY FOR EAST ASH POND NO. 2 AND EAST ASH POND NO. 4 WERE TAKEN FROM "HENNEPIN POWER STATION, EAST ASH PONDS #2 & #4, DYNEGY MIDWEST GENERATION, LLC", 11/17/2020, BY INGENAE, LLC
4. AERIAL IMAGERY FOR AREAS OUTSIDE OF THE LIMITS OF THE INGENAE IMAGERY IS DATED SEPTEMBER 20, 2015 AND WAS OBTAINED FROM GOOGLE EARTH PRO ON SEPTEMBER 12, 2017.

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

0	11/5/2021	DRAFT CLOSURE PLAN ISSUE	MGK	LPC
REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1 MCBRIDE AND SON CENTER DR, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636.812.0800

DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
COLLINSVILLE, IL 62234 USA

TITLE:
EXISTING CONDITIONS

PROJECT:
EAST ASH POND CONSTRUCTION PERMIT
APPLICATION CLOSURE DRAWINGS

SITE:
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY: LPC		DATE: NOVEMBER 2021	
DRAWN BY: IJV/MGK		PROJECT NO.: GLP8026	
CHECKED BY: TWW		FILE:	
REVIEWED BY: JPS		DRAWING NO.: G-101	
APPROVED BY: LPC			

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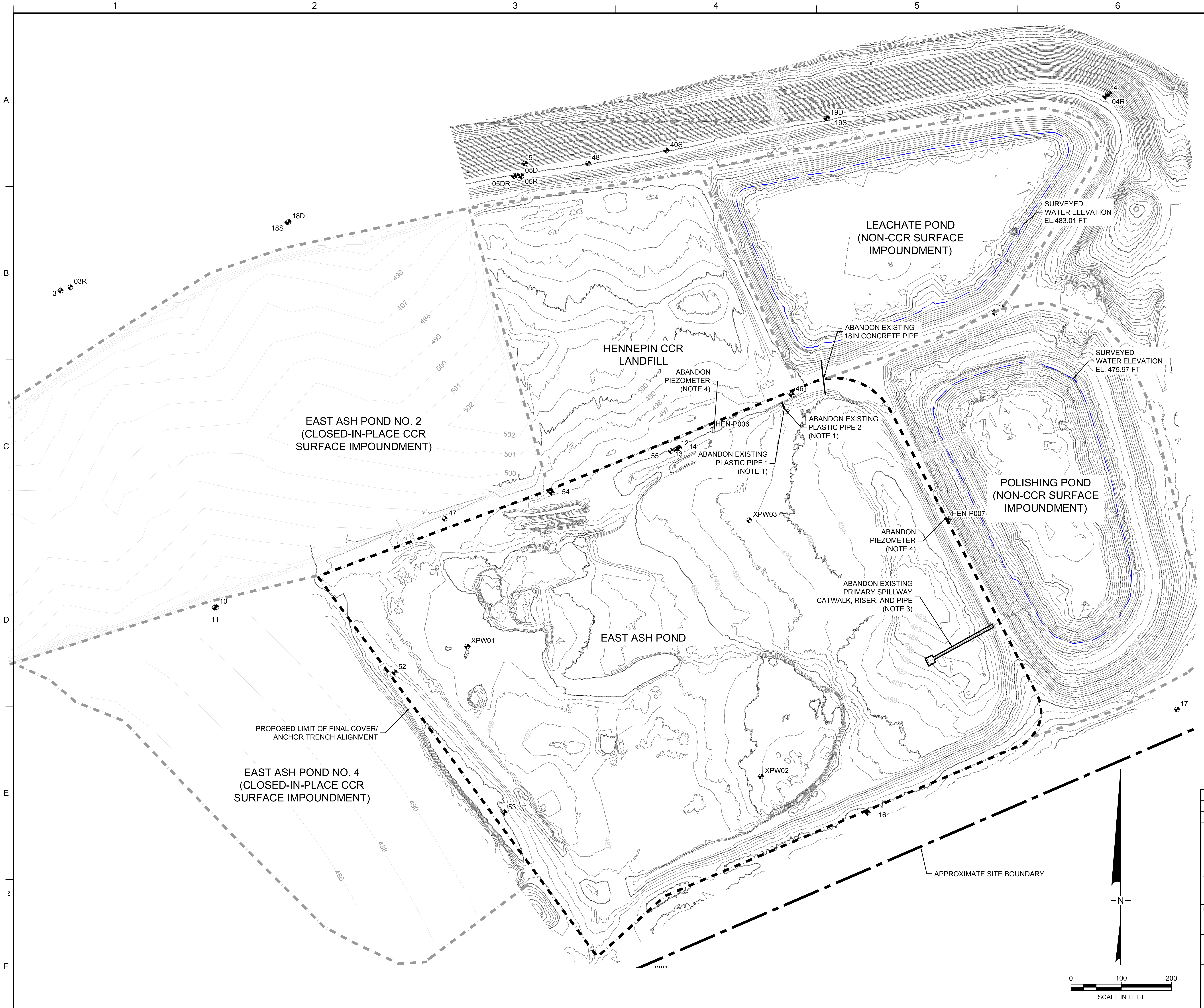

LEGEND

—480—	EXISTING GROUND SURFACE ELEVATION (MAJOR) (5-FT INTERVAL)
——	EXISTING GROUND SURFACE ELEVATION (MAJOR) (1-FT INTERVAL)
— — —	2020 SURVEYED IMPOUNDMENT WATER LEVEL
▪ ▪ ▪	APPROXIMATE LIMITS OF CCR UNITS AND NON-CCR SURFACE IMPOUNDMENT
■ ■ ■	PROPOSED LIMIT OF FINAL COVER/ ANCHOR TRENCH ALIGNMENT
— · —	APPROXIMATE SITE BOUNDARY
⊗	EXISTING MONITORING WELL
⊕	EXISTING PIEZOMETERS

NOTES:

1. EXISTING PLASTIC PIPES 1 AND 2 TO BE ABANDONED BY CUTTING THE LINER SYSTEM AND PIPE BOOT AROUND THE PIPE PENETRATION, CUTTING THE PIPE OFF FLUSH AT LEAST 1 FT BEHIND THE LINER, AND INSTALLING A GLUED PIPE CAP OF THE SAME MATERIAL AS THE PIPE. THE PIPE AREA IS TO BE BACKFILLED WITH CLEAN SOIL AND THE LINER IS TO BE PATCHED USING THE SAME LINER MATERIAL AND EXTRUSION WELDING TECHNIQUES.
2. THE EXISTING 18" RCP SPILLWAY PIPE IS TO BE ABANDONED BY THOROUGHLY CLEANING THE INSIDE OF THE PIPE WITH PRESSURIZED WATER, CONSTRUCTING A BULKHEAD SEAL AT THE DOWNSTREAM END OF THE PIPE, INSIDE OF THE LEACHATE POND, AND THEN FILLING THE ANNULUS OF THE PIPE COMPLETELY WITH CEMENT-BENTONITE GROUT.
3. THE EXISTING PRIMARY SPILLWAY PIPE IS TO BE ABANDONED BY DEMOLISHING THE CATWALK AND RISER ABOVE THE LEVEL OF CCR IMPOUNDED ADJACENT TO THE STRUCTURE. DEMOLITION DEBRIS ARE TO BE DISPOSED OF WITHIN CCR RETAINED IN THE EAP. THE INSIDE OF THE REMAINING RISER STRUCTURE AND PIPE ARE TO BE THOROUGHLY CLEANED USING PRESSURIZED WATER. A BULKHEAD OR INFLATABLE PIPE BLADDER IS TO BE CONSTRUCTED AT THE DOWNSTREAM END OF THE PIPE, INSIDE THE POLISHING POND, AND THE REMAINING ANNULUS OF THE PIPE AND RISER STRUCTURE AT TO BE FILLED COMPLETELY WITH CEMENT-BENTONITE GROUT.
4. PIEZOMETERS HEN-P006 AND HEN-P007 ARE TO BE ABANDONED BY REMOVING THE SURFACE CASING AND CASTING TO 1 FT BELOW GRADE AND FILLING THE ANNULUS OF THE WELLS WITH GRANULATED BENTONITE. WELL ABANDONMENT FORMS ARE TO BE SUBMITTED TO THE PUTNAM COUNTY HEALTH DEPARTMENT.
5. ALL OTHER PIEZOMETERS AND MONITORING WELLS ARE TO BE MAINTAINED AND ARE NOT BE DAMAGED DURING CLOSURE CONSTRUCTION.
6. COORDINATES AND DIRECTIONS SHOWN IN THESE DRAWINGS WERE BASED ON THE ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83, IN US FEET). ELEVATIONS WERE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).
7. EXISTING CONTOURS AND WATER SURFACE ELEVATIONS FOR THE EAP, POLISHING POND, LEACHATE POND, AND HENNEPIN LANDFILL WERE TAKEN FROM "DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER STATION - DECEMBER 2020 TOPOGRAPHY, 3/10/2021", BY INGENAE, LLC.
8. EXISTING CONTOURS FOR EAST ASH POND NO. 2 AND EAST ASH POND NO. 4 WERE TAKEN FROM "HENNEPIN POWER STATION, EAST ASH PONDS #2 & #4, DYNEGY MIDWEST GENERATION, LLC", 11/17/2020, BY INGENAE, LLC

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

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0	11/5/2021	DRAFT CLOSURE PLAN ISSUE	MGK	LPC

Geosyntec consultants
1 MCBRIDE AND SON CENTER DR, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636.812.0800

DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
COLLINSVILLE, IL 62234 USA

TITLE:
OUTFALL AND PIEZOMETER ABANDONMENT PLAN

PROJECT:
EAST ASH POND CONSTRUCTION PERMIT
APPLICATION CLOSURE DRAWINGS

SITE:
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

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SIGNATURE

DATE

DESIGN BY:	LPC	DATE:	NOVEMBER 2021
DRAWN BY:	IJV/MGK	PROJECT NO.:	GLP8026
CHECKED BY:	TWW	FILE:	
REVIEWED BY:	JPS	DRAWING NO.:	C-100
APPROVED BY:	LPC		

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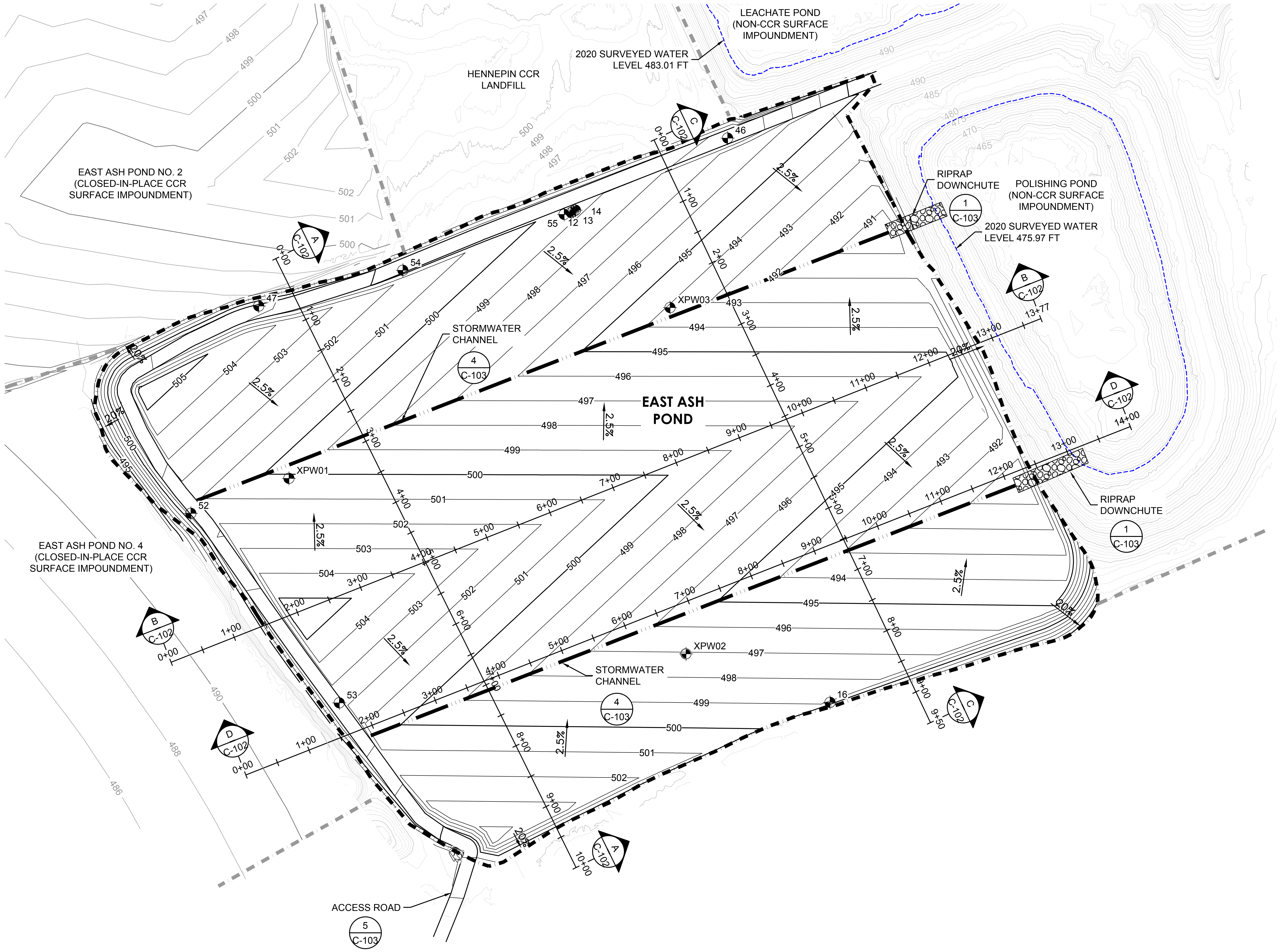
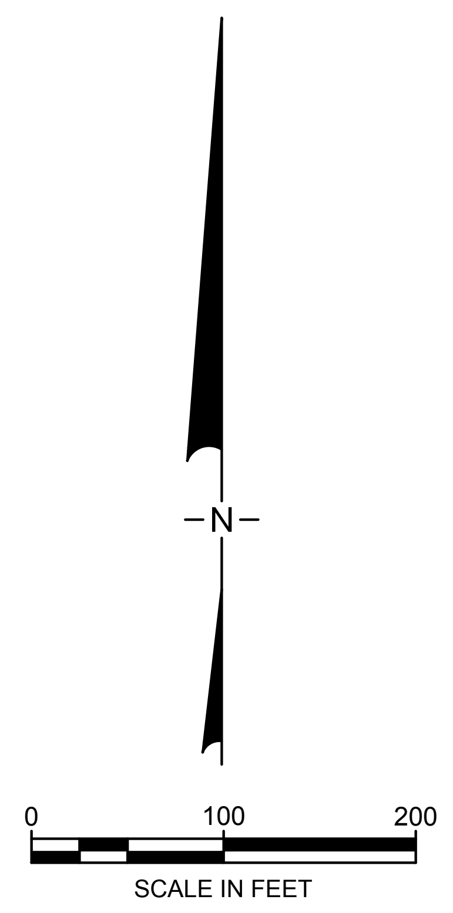


LEGEND

480	EXISTING GROUND SURFACE ELEVATION (2-FT INTERVAL)	
505	PROPOSED TOP OF FINAL COVER GRADE ELEVATION	
	2020 SURVEYED IMPOUNDMENT WATER LEVEL	
	PROPOSED STORMWATER CHANNEL	4 103
	APPROXIMATE LIMITS OF CCR UNITS AND NON-CCR SURFACE IMPOUNDMENT	
	PROPOSED LIMIT OF FINAL COVER/ ANCHOR TRENCH ALIGNMENT	3 103
◆	EAP MONITORING WELL-TO BE RETAINED	2 103



NOTES:

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3. EXISTING CONTOURS FOR EAST ASH POND NO. 2 AND EAST ASH POND NO. 4 WERE TAKEN FROM "HENNEPIN POWER STATION, EAST ASH PONDS #2 & #4, DYNEGY MIDWEST GENERATION, LLC", 11/17/2020, BY INGENAE, LLC

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0	11/5/2021	DRAFT CLOSURE PLAN ISSUE	MGK	LPC

Geosyntec consultants
1 MCBRIDE AND SON CENTER DR, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636.812.0800

DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
COLLINSVILLE, IL 62234 USA

TITLE:
OVERALL GRADING PLAN

PROJECT:
EAST ASH POND CONSTRUCTION PERMIT
APPLICATION CLOSURE DRAWINGS

SITE:
HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

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SIGNATURE

DATE

DESIGN BY:	LPC	DATE:	NOVEMBER 2021
DRAWN BY:	IJV/MGK	PROJECT NO.:	GLP8026
CHECKED BY:	TWW	FILE:	
REVIEWED BY:	JPS	DRAWING NO.:	C-101
APPROVED BY:	LPC		

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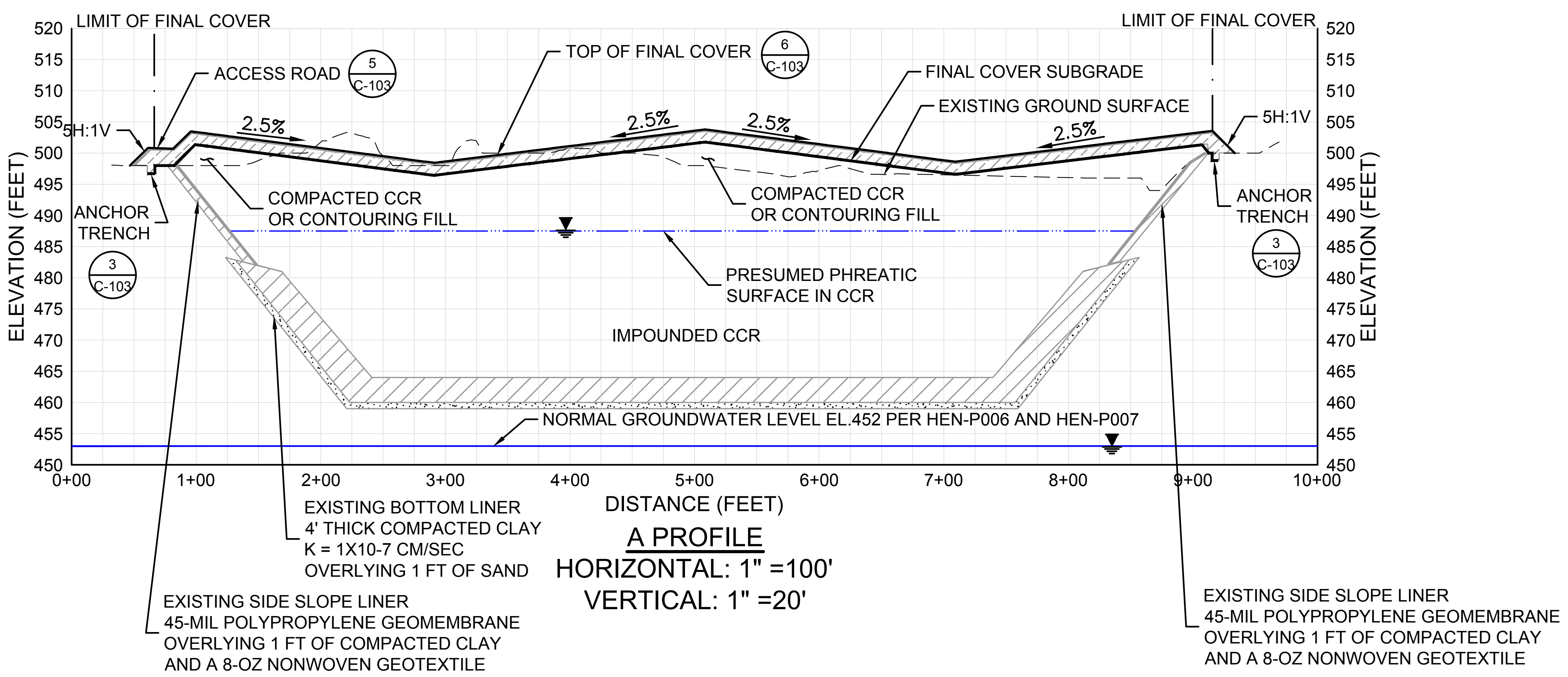
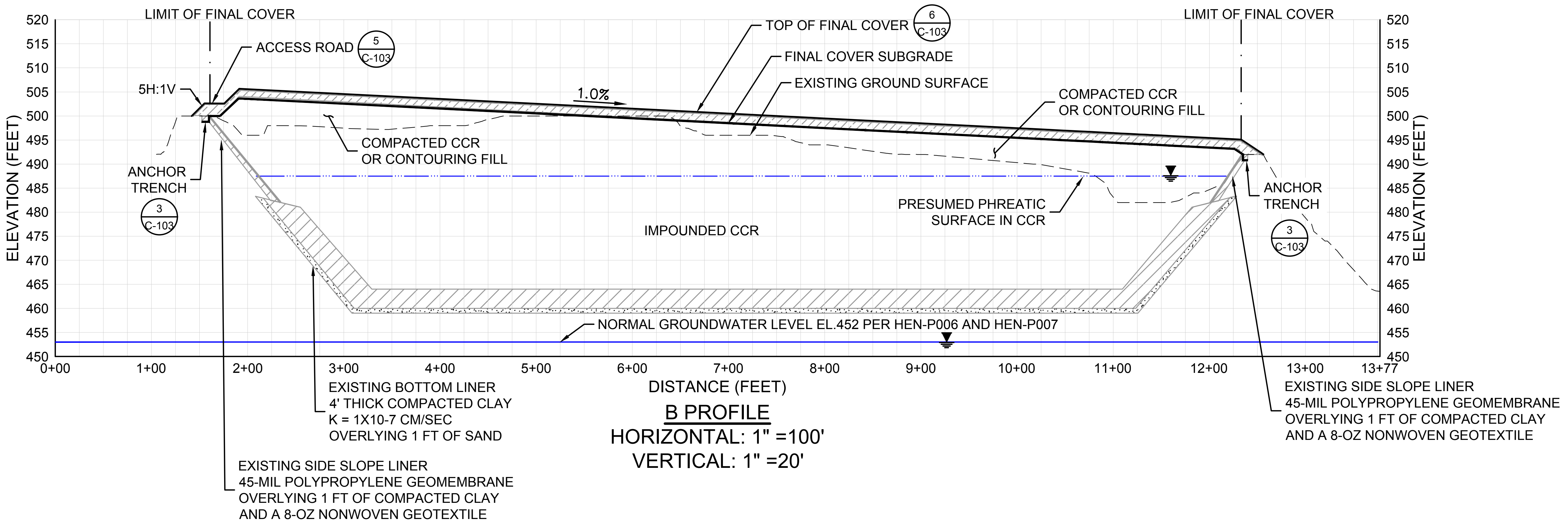
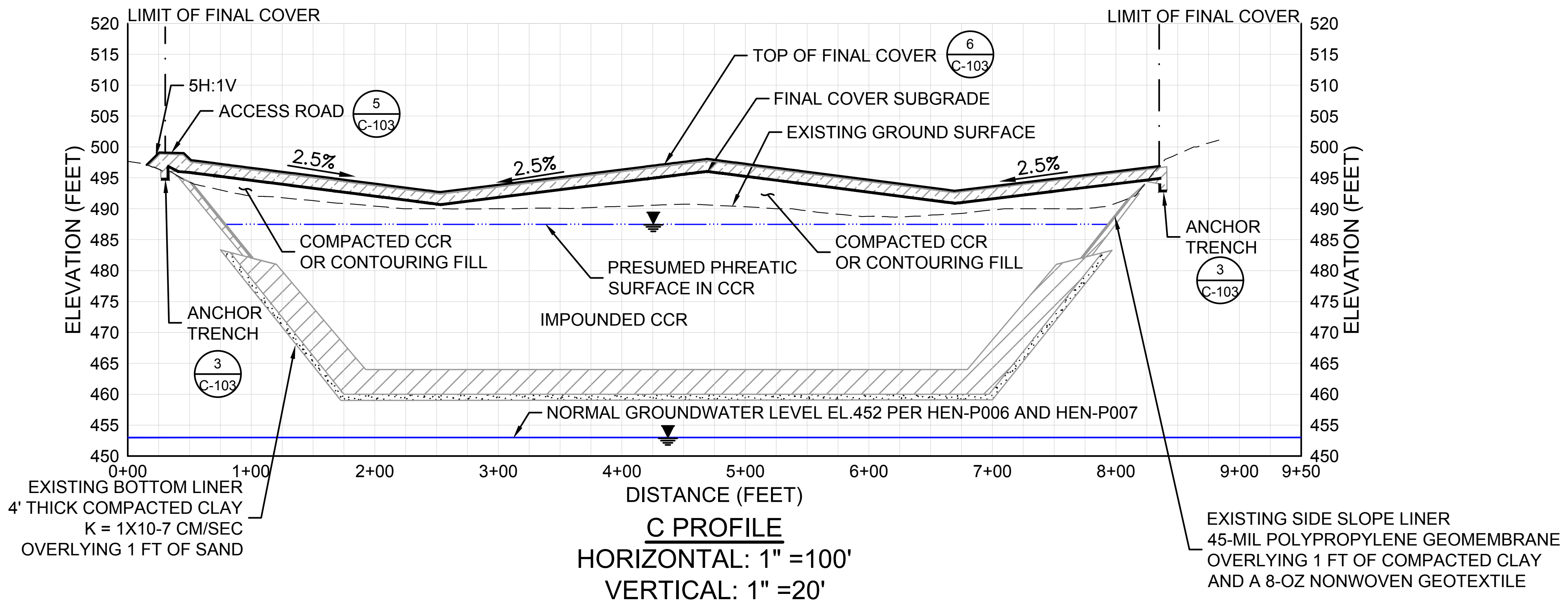


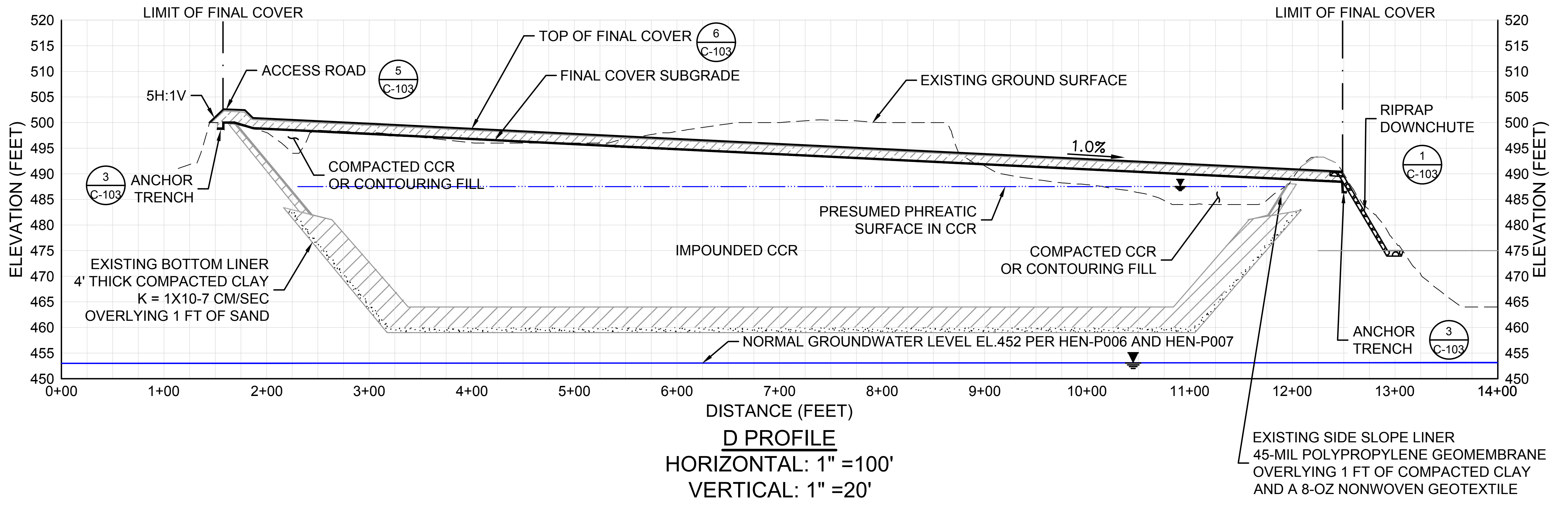
A PROFILE
HORIZONTAL: 1" =100'
VERTICAL: 1" =20'



B PROFILE
HORIZONTAL: 1" =100'
VERTICAL: 1" =20'



C PROFILE
HORIZONTAL: 1" =100'
VERTICAL: 1" =20'



D PROFILE
HORIZONTAL: 1" =100'
VERTICAL: 1" =20'

NOTES:

1. COORDINATES AND DIRECTIONS SHOWN IN THESE DRAWINGS WERE BASED ON THE ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83, IN US FEET). ELEVATIONS WERE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).
2. EXISTING CONTOURS AND WATER SURFACE ELEVATIONS TAKEN FROM "DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER STATION - DECEMBER 2020 TOPOGRAPHY", 3/10/2021, BY INGENAE, LLC.
3. EXISTING CONTOURS FOR EAST ASH POND NO. 2 AND EAST ASH POND NO. 4 WERE TAKEN FROM "HENNEPIN POWER STATION, EAST ASH PONDS #2 & #4, DYNEGY MIDWEST GENERATION, LLC", 11/17/2020, BY INGENAE, LLC
4. INFORMATION ON THE EXISTING SIDE SLOPE AND BOTTOM LINERS WAS TAKEN FROM "HISTORY OF CONSTRUCTION, USEPA FINAL CCR RULE, 40 CFR §257.73(C), HENNEPIN POWER STATION, HENNEPIN, ILLINOIS", OCTOBER 2016, BY AECOM.

LEGEND

━━━	TOP OF FINAL COVER
– – –	EXISTING GROUND SURFACE
–·–·–	PRESUMED PHREATIC SURFACE IN CCR
───	NORMAL GROUNDWATER LEVEL
━━━	GEOMEMBRANE
▨	PROTECTIVE COVER SOIL
▨	COMPACTED CLAY LAYER
⁘	SAND LAYER
▩	RIPRAP

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP
0	11/5/2021	DRAFT CLOSURE PLAN ISSUE	MGK	LPC

Geosyntec consultants
1 MCBRIDE AND SON CENTER DR, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636.812.0800

DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: SECTIONS

PROJECT: EAST ASH POND CONSTRUCTION PERMIT APPLICATION CLOSURE DRAWINGS

SITE: HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	LPC	DATE:	NOVEMBER 2021
DRAWN BY:	IJV/MGK	PROJECT NO.:	GLP8026
CHECKED BY:	TWW	FILE:	
REVIEWED BY:	JPS	DRAWING NO.:	C-102
APPROVED BY:	LPC		

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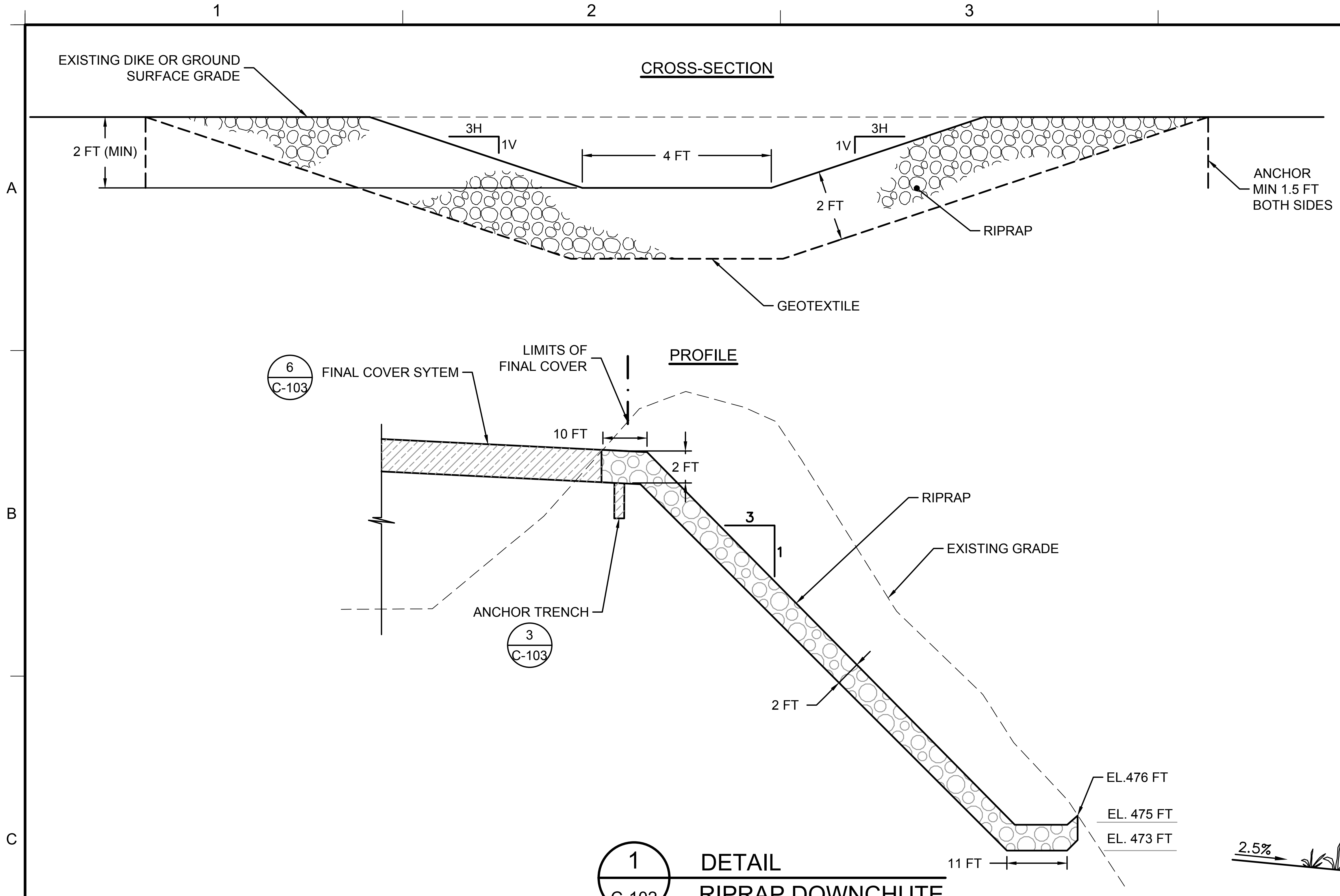
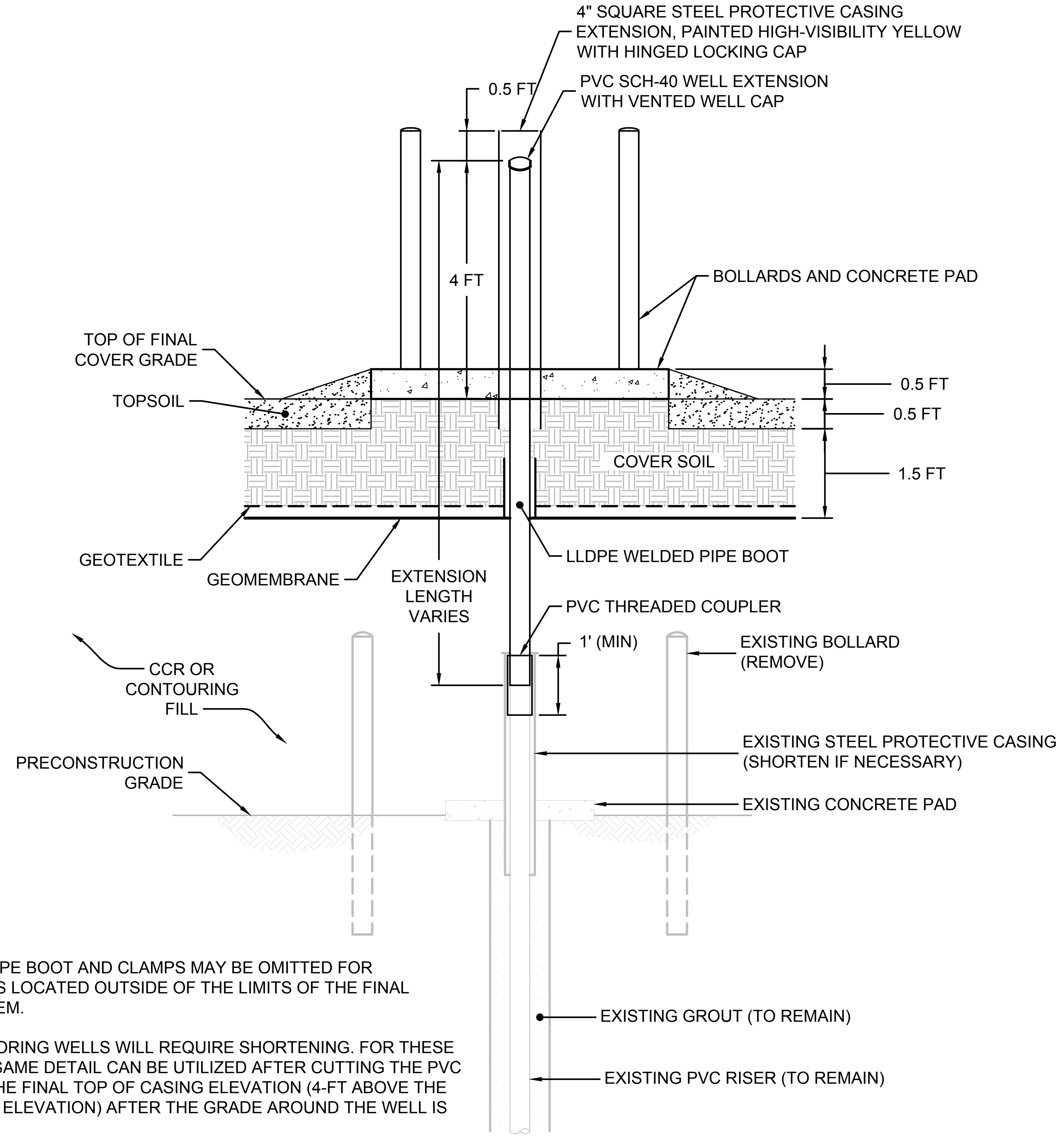


1 C-102 DETAIL
RIPRAP DOWNCHUTE
N.T.S



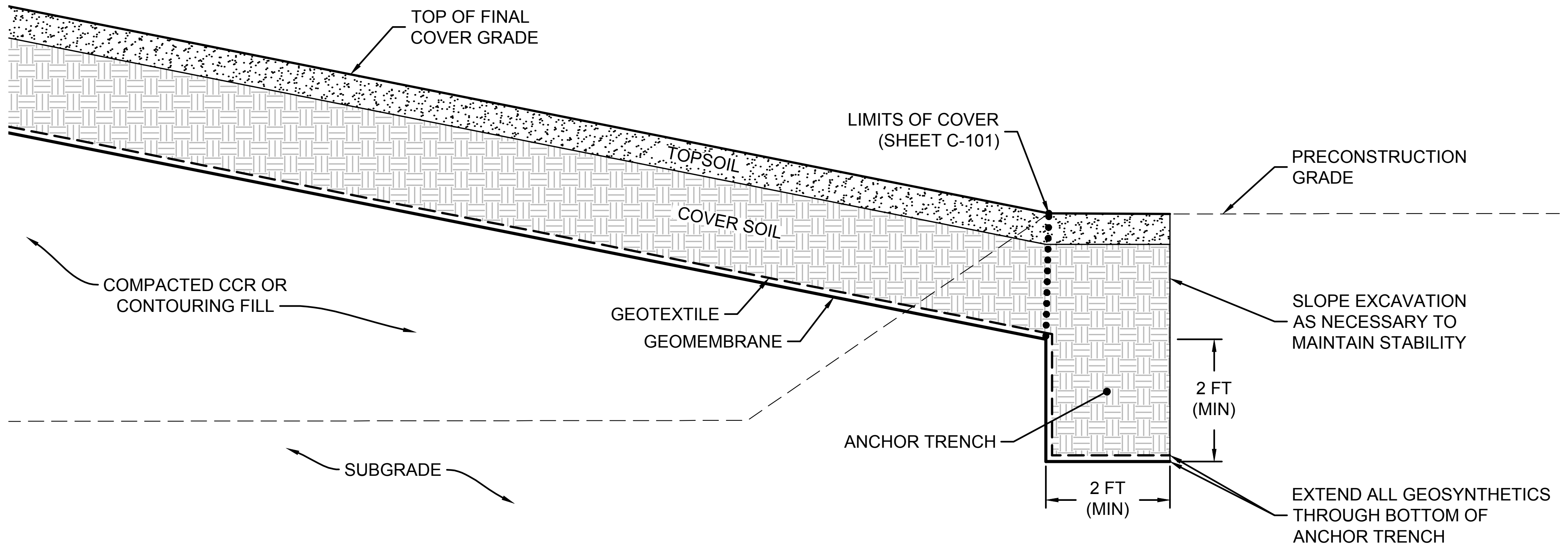
NOTES:

1. THE LLDPE PIPE BOOT AND CLAMPS MAY BE OMITTED FOR PIEZOMETERS LOCATED OUTSIDE OF THE LIMITS OF THE FINAL COVER SYSTEM.

2. SOME MONITORING WELLS WILL REQUIRE SHORTENING. FOR THESE WELLS, THE SAME DETAIL CAN BE UTILIZED AFTER CUTTING THE PVC CASING TO THE FINAL TOP OF CASING ELEVATION (4-FT ABOVE THE FINAL COVER ELEVATION) AFTER THE GRADE AROUND THE WELL IS LOWERED.

3. FOR MONITORING WELLS LOCATED IN AN ACTIVE SITE ROADWAY,THE ABOVE-GRADE PROTECTIVE CASING, BOLLARDS, AND CONCRETE PAD MAY BE SUBSTITUTED WITH A FLUSH MOUNT CASING AND A CONCRETE PAD AT LEAST 3 FT IN DIAMETER AND 4 INCHES IN THICKNESS. ALL OTHER DETAILS ARE TO REMAIN THE SAME.

2 C-102 DETAIL
MONITORING WELL EXTENSION
N.T.S



3 C-102 DETAIL
ANCHOR TRENCH
N.T.S

MATERIAL SPECIFICATIONS

1. RIPRAP
RIPRAP IS TO CONSIST OF A CRUSHED NATURAL LIMESTONE OR DOLOMITE MATERIAL WITH A D50 OF AT LEAST 11 INCHES, AND CONFORMING TO THE ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION SECTION 281 REQUIREMENTS, CLASS A OR CLASS B QUALITY.

2. EROSION CONTROL BLANKET
EROSION CONTROL BLANKETS ARE TO BE A ROLLED EROSION CONTROL PRODUCT WITH NETTING CAPABLE OF STORMWATER FLOW VELOCITIES OF UP TO 2.1 FEET PER SECOND.

3. CRUSHED STONE
CRUSHED STONE IS TO CONSIST OF A SCREENED GRAVEL MATERIAL CONFORMING TO THE IDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION SECTION 1004 REQUIREMENTS, GRADATION CA 6.

4. TOPSOIL
TOPSOIL IS TO CONSIST OF A NATURAL SOIL MATERIAL THAT IS RELATIVELY HOMOGENOUS, FREE OF DEBRIS, FOREIGN OBJECTS, AND LARGE ROCK FRAGMENTS. THE TOPSOIL IS TO:
    - BE CLASSIFIED AS SC, CL, ML, OR OL (PER ASTM D2487), AND
    - BE FERTILIZED, AS NECESSARY BASED ON AGRONOMIC TESTING, TO SUPPORT VEGETATION GROWTH AT THE SITE.

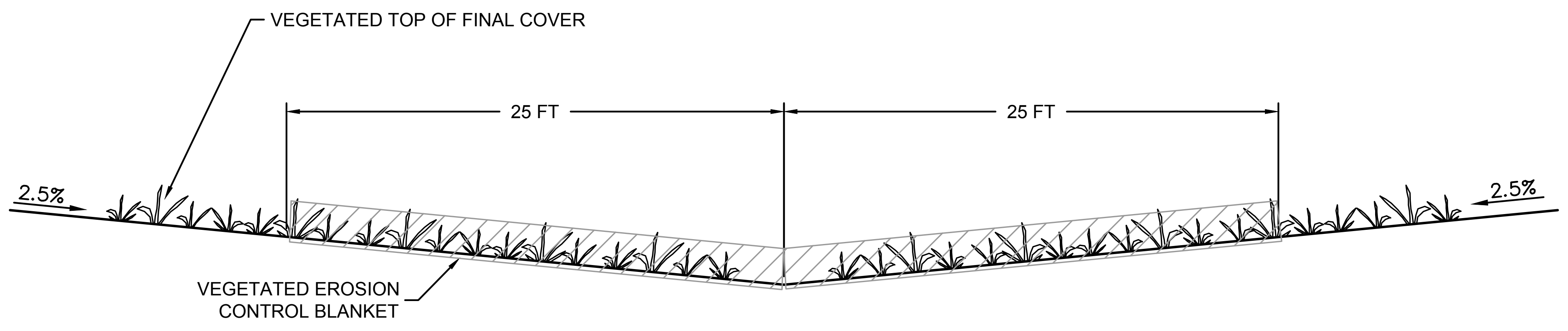
5. COVER SOIL
COVER SOIL IS TO CONSIST OF A NATURAL SOIL MATERIAL THAT IS RELATIVELY HOMOGENOUS, FREE OF DEBRIS, FOREIGN OBJECTS, AND LARGE ROCK FRAGMENTS. THE COVER SOIL IS TO:
    - BE CLASSIFIED AS A CL, CH, CL-CH, CL-ML, SC, OR SM (PER ASTH D2487), AND
    - HAVE A MAXIMUM PARTICLE SIZE OF 1.5 INCHES (PER ASTM D422 OR D6943).

6. GEOTEXTILE
THE GEOTEXTILE IS TO CONSIST OF A NONWOVEN POLYPROPYLENE MATERIAL MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC INSTITUTE GRI-GT12(A) STANDARD SPECIFICATION, AND WITH THE FOLLOWING REQUIREMENTS:
    - MINIMUM MASS PER UNIT ARE OF 16 OZ/YD2 (PER ASTM D5261),
    - MINIMUM GRAB STRENGTH OF 270 LB (PER ASTM D4632),
    - MINIMUM TEAR STRENGTH OF 105 LB (PER ASTM D4533), AND
    - MINIMUM PUNCTURE STRENGTH OF 725 LB (PER ASTM D6241).

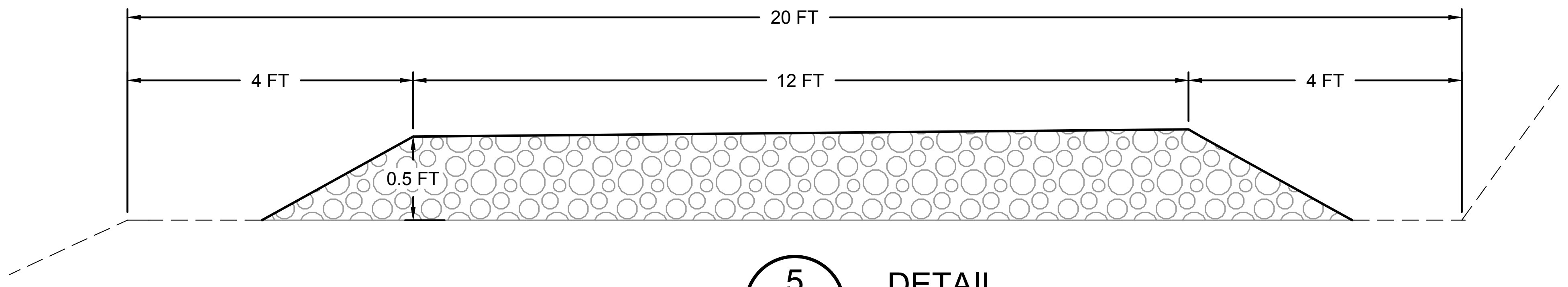
    GEOTEXTILE SEAMS ARE TO OVERLAPPED BY 1 FT DURING PLACEMENT AND EITHER MACHINE-SEWN OR THERMALLY BONDED TO ONE ANOTHER.

7. GEOMEMBRANE
THE GEOMEMBRANE IS TO CONSIST OF A LINEAR, LOW-DENSITY POLYETHYLENE (LLDPE) MATERIAL, TEXTURED ON BOTH SIDES, MANUFACTURED IN ACCORDANCE WITH THE LATEST VERSION OF GEOSYNTHETIC INSTITUTE GM17 STANDARD SPECIFICATION, AND WITH THE FOLLOWING REQUIREMENTS:
    - MINIMUM NOMINAL HEIGHT OF 40 MIL (PER ASTM D5994),
    - MINIMUM ASPERITY HEIGHT OF 16 MIL (PER ASTM D7466),
    - MAXIMUM DENSITY OF 0.939 G/ML (PER ASTM D792, OR ASTM D1505),
    - MINIMUM TENSILE STRENGTH AT BREAK OF 60 LB/IN (PER ASTM D6693),
    - MINIMUM ELONGATION AT BREAK OF 250% (PER ASTM D6693),
    - MINIMUM TEAR RESISTANCE OF 22 LB (PER ASTM D1004), AND
    - MINIMUM PUNCTURE RESISTANCE OF 44 LB (PER ASTM D3895).

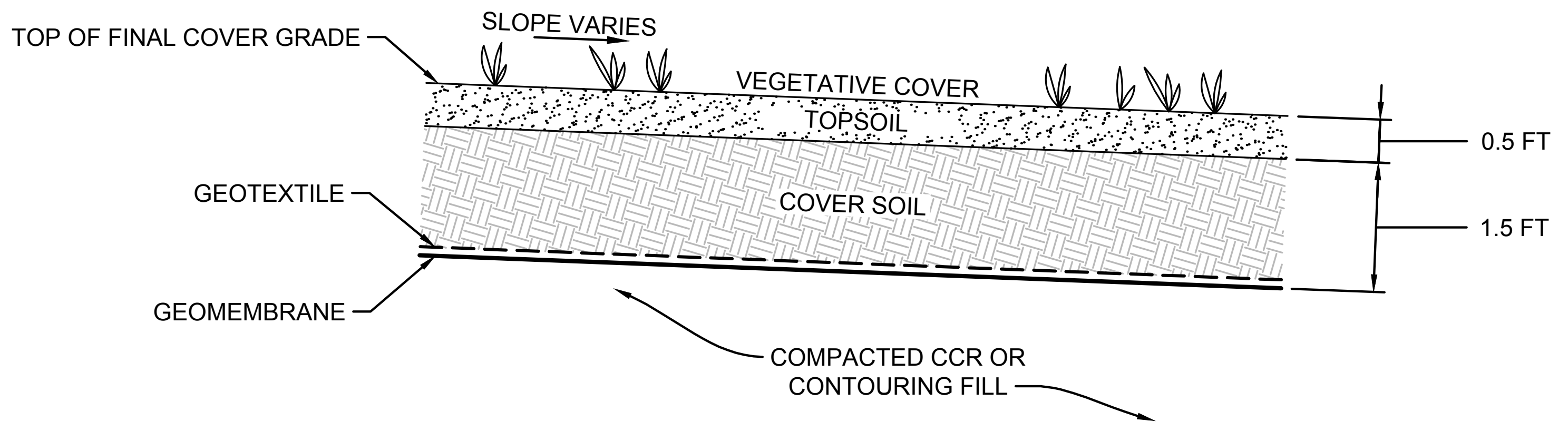
    GEOMEMBRANE SEAMS ARE TO BE FUSION-WELDED; REPAIRS AND PENETRATIONS FOR PIPE BOOTS ARE TO BE EXTRUSION WELDED.



4 C-102 DETAIL
STORMWATER CHANNEL
N.T.S



5 C-102 DETAIL
ACCESS ROAD
N.T.S



6 C-102 DETAIL
FINAL COVER
N.T.S

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP
0	11/5/2021	DRAFT CLOSURE PLAN ISSUE	MGK	LPC

Geosyntec consultants
1 MCBRIDE AND SON CENTER DR, SUITE 202
CHESTERFIELD, MO 63005 USA
TELEPHONE: 636.812.0800

DYNERGY MIDWEST GENERATION, LLC
1500 EASTPORT PLAZE DRIVE
COLLINSVILLE, IL 62234 USA

TITLE: DETAILS AND MATERIAL SPECIFICATIONS

PROJECT: EAST ASH POND CONSTRUCTION PERMIT
APPLICATION CLOSURE DRAWINGS

SITE: HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	LPC	DATE:	NOVEMBER 2021
DRAWN BY:	IJV/MGK	PROJECT NO.:	GLP8026
CHECKED BY:	TWW	FILE:	
REVIEWED BY:	JPS	DRAWING NO.:	C-103
APPROVED BY:	LPC		

ATTACHMENT E

Hydrologic and Hydraulic Design of Stormwater Management System

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: **Dynegy** Project: **Hennepin Closure Plan** Project/ Proposal No.: **CHE8356**
Task No. **A/03**

Title of Computations **Hennepin West Cover Stormwater Calculation Package**

Computations by:
Signature
Date 9-22-2021
Printed Name Lee Hauser
Title Professional

Assumptions and Procedures Checked by: (peer reviewer)
Signature
Date 10-05-2021
Printed Name Patrick VanDeWiele
Title Project Engineer

Computations Checked by:
Signature
Date 10-05-2021
Printed Name Patrick VanDeWiele
Title Project Engineer

Computations backchecked by: (originator)
Signature
Date 10-06-2021
Printed Name Lee Hauser
Title Professional

Approved by: (pm or designate)
Signature
Date 10-06-2021
Printed Name Lucas Carr, P.E.
Title Senior Engineer

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by: **LH** Date: **09/22/21** Reviewed by: **PVW** Date: **9/23/21**

DD MM YY DD MM YY

Client: **Dynegy** Project: **Hennepin Closure Plan** Project No.: **GLP8026** Task No.: **A/03**

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Written by: **LH** Date: **09/22/21** DD MM YY Reviewed by: **PVW** Date: **9/23/21** DD MM YY

Client: **Dynegy** Project: **Hennepin Closure Plan** Project No.: **GLP8026** Task No.: **A/03**

LIST OF APPENDICES

Written by: **LH** Date: **09/22/21** (DD MM YY) Reviewed by: **PVW** Date: **9/23/21** (DD MM YY)

Client: **Dynegy** Project: **Hennepin Closure Plan** Project No.: **GLP8026** Task No.: **A/03**

1. Purpose

The purpose of this calculation package is to provide documentation of the hydrologic and hydraulic calculations of the cover design for the final closure of the 21-acre Hennepin Power Plant East Ash Pond. In particular, the analysis evaluates the performance of the cover's proposed drainage features and outlet chutes for the 25-year and 100-year, 24-hour Soil Conservation Service (SCS) Type II storm event in accordance with the CCR Rule (USEPA, 2015). HEC-HMS 4.2.1 (USACE, 2016) was used for the Hydrologic analysis to estimate the peak runoff rate from each subcatchment for the identified storm events. A Manning's spreadsheet calculation was performed for the hydraulic analysis of the cover swales and down chutes.

2. Design Basis

The proposed drainage swales and rock chutes were designed to meet the following:

1. Designed for the 25-year storm event to satisfy IL Part 845.510; and
2. Safely convey the 100-year storm event to satisfy IL Part 845.510.

For design purposes, the SCS Type-II rainfall distribution was applied to both storm events listed above. The SCS Type-II distribution is a conservative temporal distribution for a 24-hour duration storm event in context of this closure design due to its peak rainfall intensity, which is greater than the other acceptable standardized distributions that were considered; such as Huff 3rd Quartile (for areas less than 10 square miles) as published in the Illinois State Water Survey (ISWS) Circular 173 (ISWS, 1990).

3. Assumptions and Data Input

The following section presents a summary of the assumptions and inputs associated with the hydrologic and hydraulic analysis and design.

Written by: **LH** Date: **09/22/21** (DD MM YY) Reviewed by: **PVW** Date: **9/23/21** (DD MM YY)

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Summary of Survey Data and Site Improvement Data

Site topographic surveys of existing conditions (e.g., pre-closure conditions) were performed by IngenAE, LLC in December 2020, which were prepared and provided to Dynegy as a drawing set (IngenAE, March 2021). Site improvements are based on the preliminary closure design for the EAP prepared by Geosyntec Consultants.

Hydrology Inputs

The following design assumptions and hydrologic parameters were used to perform the hydrologic analysis.

Rainfall Depth and Distribution

Rainfall depths were based on NOAA Atlas 14 (NOAA, 2006) Point Precipitation Frequency Estimates, as shown in Appendix 1. The Type II SCS storm distribution was used to evaluate the imbedded high rainfall intensity portion of the storm as a critical flood risk analysis. The SCS was preferred over the huff distribution as it is more conservative and will reduce the long-term structural maintenance of channels/letdown structures. This storm temporal distribution is considered conservative for a 24-hour duration event and therefore adequate for design purposes (see Section 2 for detailed explanation). The following storm events were used to size the proposed stormwater features:

- Type II SCS 25-year, 24-hour event is 5.08 inches (Design)
- Type II SCS 100-year, 24-hour event is 6.58 inches (Safely Convey)

Curve Number (CN)

Curve numbers (CN) were estimated using Table 2-2 in the TR-55 manual (USDA, 1986) and assumed soil conditions based on soil maps and knowledge of the site. A single curve number was used to represent the final cover. The final cover will include, from bottom to top, a geomembrane, geotextile, 2.5 ft of cover soil, 0.5 ft of topsoil, and established vegetation. The following assumed conditions were used in determining the curve numbers based on those conditions:

- Post-development Areas (CN=78)
- Cover Type – Meadow
- Hydrologic Condition – Fair
- Hydrologic Soil Group – D

Subcatchments

The total 21-acre cover was subdivided into north and south drainage areas and are approximately 10.99 and 9.83 acres respectively. The areas were subdivided based on the grading plan and drainage feature tributaries. The drainage map and associated subcatchment parameters are shown in the Appendix 2, Figure 1.

Hydraulic Inputs

The following section summarizes the design assumptions and hydraulic parameters used to perform the hydraulic analysis.

Cover Swales

The location and longitudinal slope of the cover swales were based the 30% grading plans. The swales were designed as V-ditches with side slopes of 40:1 to match the grading plan (2.5% side-slopes), a maximum flow depth of 2 feet, and longitudinal slope of one percent. The channels were oversized to accommodate mowing equipment and allow for any additional maintenance needs. According to Manning's n for Channels (Chow, 1959), a manning's roughness coefficient of 0.03 was used for excavated earthen channels with short grass and few weeds.

Rock Chutes

The hydraulic performance of the rock chutes were designed to have a maximum longitudinal slope of 3H:1V with a 4-ft bottom width and 3H:1V side slopes. Manning's n was derived from the Design of Rock Chutes Spreadsheet calculator (Robinson et al., 1998) based on the size of the rock used to line the channel.

4. Results

Cover Swale Design

Cover swales were designed to convey the 25-year, 24-hour event. The cover has two (2) swales, however, there was only one (1) swale design that was based on the critical drainage area – i.e., highest peak discharge from a drainage area. Peak discharge outputs were taken from the HEC-HMS model to determine the critical drainage area. Table 1 displays critical swale results for the north drainage area while all of the HEC-HMS peak flow outputs are shown in Appendix 3. The peak flows are 18.0 cfs and 26.5 cfs for the 25-year, and 100-year events respectively. Additionally, swale velocities and depths were calculated from a Manning's spreadsheet calculation based on the peak discharges and the typical swale cross-section. Swales were designed to have side slopes of 40:1 to, a maximum flow depth of 2 feet, and a graded longitudinal slope of 1 percent. This resulted in velocities of 1.9 ft/s and 2.1 ft/s and depths of 0.49 feet and 0.56 feet for the 25-year and 100-year events, respectively (shown in Table 1). The spreadsheet calculation sheets for both storm events are shown in Appendix 4.

Table 1 - Peak Swale Parameters

Storm Event	Peak Flow (CFS)	Max Velocity (ft/s)	Max Flow Depth (ft)
25-year	18.0	1.9	0.49
100-year	26.5	2.1	0.56

Using guidance from Chapter 8 of the Natural Resources Conservation Services (NRCS) Engineering Handbook (NRCS, 2007), temporary erosion control blanket and grass cover provide enough protection to prevent erosion. Using the max velocities of 2.1 ft/s for the 100-year storm event and Table 8-11 from Chapter 8, table shown below in Figure 1, the swales can use "Jute net" or "Straw with net" as a temporary erosion control product. To be conservative, it is recommended the swales be lined with "straw with net" as an erosion control product as it has an allowable velocity of 3 ft/s compared to an allowable velocity of 2.5 ft/s that is indicated for "jute net". Grass vegetation is expected to establish through the temporary erosion control product within the swales and has a recommended allowable velocity of 5 to 8 ft/s dependent on grass type – e.g., bermudagrass versus Kentucky bluegrass per Table 8-11 for Chapter 8.

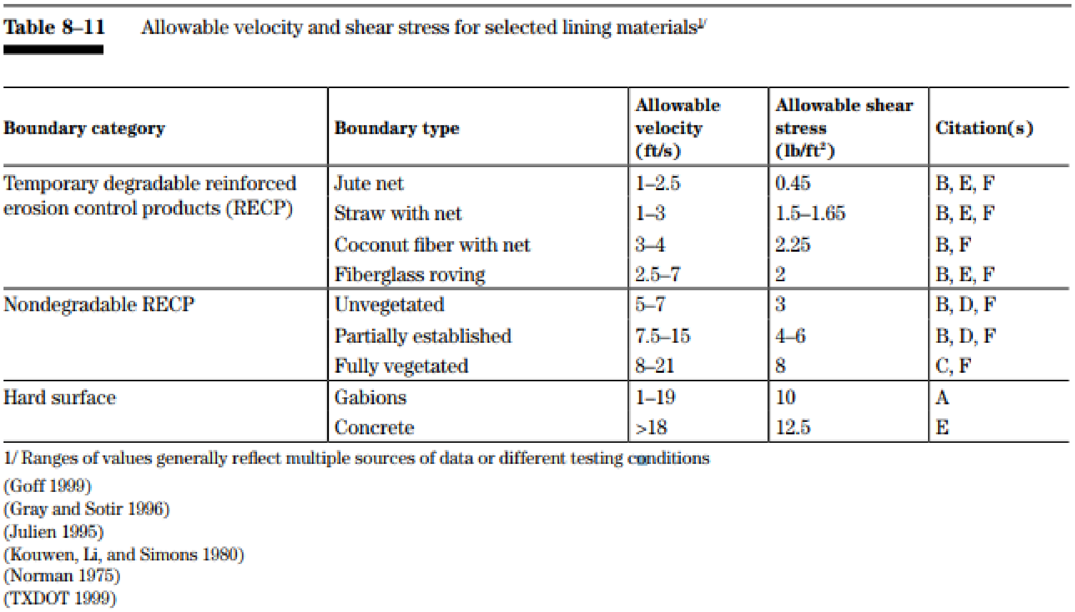

Table 8–11 Allowable velocity and shear stress for selected lining materials[1/]

Boundary category	**Boundary type**	**Allowable velocity (ft/s)**	**Allowable shear stress (lb/ft²)**	**Citation(s)**
Temporary degradable reinforced erosion control products (RECP)	Jute net	1–2.5	0.45	B, E, F
	Straw with net	1–3	1.5–1.65	B, E, F
	Coconut fiber with net	3–4	2.25	B, F
	Fiberglass roving	2.5–7	2	B, E, F
Nondegradable RECP	Unvegetated	5–7	3	B, D, F
	Partially established	7.5–15	4–6	B, D, F
	Fully vegetated	8–21	8	C, F
Hard surface	Gabions	1–19	10	A
	Concrete	>18	12.5	E

1/ Ranges of values generally reflect multiple sources of data or different testing conditions

(Goff 1999)
(Gray and Sotir 1996)
(Julien 1995)
(Kouwen, Li, and Simons 1980)
(Norman 1975)
(TXDOT 1999)

Figure 1: Excerpt Table 8-11 from Chapter 8 of the NRCS Engineering Handbook

Rock Chute Design

The rock chutes were designed using the Design of Rock Chutes spreadsheet developed by the NRCS (Robinson et al., 1998). The peak flows presented in Table 1 were used to design the channel geometry and rock-armor sizing applied to both rock chutes. Based on the calculations presented in Appendix 5, the rock chutes shall consist of an outlet apron no less than 13-feet long, an inlet apron no less than 9-feet long, have a D50 rock size of 10.8 inches or larger, and a bed thickness of 21.6 inches. Appendix 5 presents a plan sheet of the rock chute design.

Written by: **LH** Date: **09/22/21** Reviewed by: **PVW** Date: **9/23/21**
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5. Conclusions

The three design features are summarized as follows:

1. A V-ditch swale with a longitudinal slope of 1% and side slopes of 40H to 1V to match the proposed grading plan is expected to safely convey the 25-year, and 100-year events at flow depths of 0.49 feet and 0.56 feet for respectively.
2. According to Table 8-11 in Chapter 8 of the Natural Resources Conservation Services Engineering Handbook, the max velocities of 2.1 ft/s for the 100-year storm event in the swales are low enough to be supported by temporary erosion control blanket and grass cover.
3. The rock chute should be constructed with rock of minimum D50 of 10.8 inches and minimum bed thickness of 21.6 inches. The rock chutes will include inlet and outlet aprons with minimum lengths of 9 feet and 13 feet, respectively. Plan detail is shown in Attachment 3.

6. References

Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill, 680 p.

F.A. Huff and J.R. Angel, "Time Distributions of Heavy Rainstorms in Illinois," State Water Survey Division, Department of Energy and Natural Resources, State of Illinois, Champaign, Illinois, 1990.

IngenAE, 2021. "Luminant Dynegy Midwest Generation, LLC, Hennepin Power Station, December 2020 Topography". Earth City, Missouri, March 10, 2021.

National Oceanic and Atmospheric Administration (NOAA), 2006. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 4. Available online at http://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume2.pdf.

National Resource Conservation Service (NRCS), 1997. Part 630 Hydrology, National Engineering Handbook.

Robinson, K.M., Rice, C.E., and Kadavy, K.C. 1988. Design of Rock Chutes. American Society of Agricultural Engineers, Vol. 41(3):621-626.

United States Army Corps of Engineers, HEC-HMS User's Manual Version 4.2. August 2016.

United States Department of Agriculture, Natural Resources Conservation Service, 2007 (NRCS, 2007), Threshold Channel Design, Part 654 Stream Restoration Design National Engineering Handbook.

United States Department of Agriculture, Natural Resources Conservation Service, Technical Release 55, June 1986.

United States Geological Survey Central Midwest Water Science Center (USGS, 2008). Discharge time-series data for Station Number 0558300 (Illinois River at Henry, IL). Provided via email from John Latour (USGS) to Lee Hauser (Geosyntec).

United States Environmental Protection Agency (USEPA, 2015). Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities.

Written by: **LH** Date: **09/22/21** Reviewed by: **PVW** Date: **9/23/21**
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Weaver Consultants (2015). Hennepin 2015 Aerial Topography Existing Site Conditions, Hennepin Power Station, 01 December 2015.

APPENDIX 1

NOAA Atlas 14, Volume 2, Version 3

NOAA Atlas 14, Volume 2, Version 3
Location name: Hennepin, Illinois, USA*
Latitude: 41.302°, Longitude: -89.3152°
Elevation: 463.74 ft**
* source: ESRI Maps
** source: USGS

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	**0.394** (0.357-0.435)	**0.463** (0.420-0.510)	**0.546** (0.495-0.601)	**0.625** (0.564-0.687)	**0.716** (0.644-0.786)	**0.794** (0.710-0.873)	**0.866** (0.769-0.955)	**0.942** (0.829-1.04)	**1.04** (0.906-1.16)	**1.13** (0.968-1.26)
10-min	**0.613** (0.554-0.676)	**0.723** (0.656-0.797)	**0.848** (0.769-0.933)	**0.964** (0.871-1.06)	**1.10** (0.984-1.20)	**1.20** (1.08-1.32)	**1.30** (1.16-1.44)	**1.41** (1.24-1.56)	**1.53** (1.33-1.70)	**1.64** (1.41-1.84)
15-min	**0.751** (0.680-0.829)	**0.884** (0.803-0.974)	**1.04** (0.944-1.15)	**1.19** (1.07-1.31)	**1.35** (1.22-1.49)	**1.49** (1.33-1.64)	**1.62** (1.44-1.79)	**1.75** (1.54-1.94)	**1.91** (1.66-2.13)	**2.05** (1.76-2.30)
30-min	**0.993** (0.899-1.10)	**1.18** (1.07-1.30)	**1.43** (1.29-1.57)	**1.65** (1.49-1.81)	**1.91** (1.72-2.10)	**2.13** (1.90-2.34)	**2.34** (2.08-2.58)	**2.55** (2.25-2.83)	**2.83** (2.46-3.15)	**3.08** (2.64-3.45)
60-min	**1.21** (1.10-1.34)	**1.45** (1.32-1.60)	**1.79** (1.62-1.97)	**2.10** (1.89-2.31)	**2.48** (2.23-2.72)	**2.81** (2.51-3.09)	**3.13** (2.78-3.45)	**3.47** (3.05-3.83)	**3.92** (3.41-4.36)	**4.32** (3.71-4.84)
2-hr	**1.46** (1.31-1.61)	**1.75** (1.58-1.92)	**2.16** (1.95-2.37)	**2.55** (2.29-2.80)	**3.04** (2.72-3.33)	**3.47** (3.09-3.81)	**3.92** (3.46-4.31)	**4.40** (3.85-4.86)	**5.07** (4.37-5.63)	**5.68** (4.84-6.36)
3-hr	**1.55** (1.41-1.71)	**1.86** (1.69-2.05)	**2.31** (2.10-2.54)	**2.73** (2.47-3.00)	**3.27** (2.94-3.59)	**3.75** (3.35-4.12)	**4.24** (3.75-4.66)	**4.77** (4.18-5.26)	**5.51** (4.76-6.11)	**6.19** (5.28-6.92)
6-hr	**1.85** (1.68-2.04)	**2.21** (2.01-2.43)	**2.74** (2.49-3.02)	**3.25** (2.94-3.58)	**3.92** (3.52-4.31)	**4.54** (4.04-4.99)	**5.19** (4.57-5.72)	**5.90** (5.13-6.53)	**6.92** (5.91-7.70)	**7.89** (6.62-8.85)
12-hr	**2.13** (1.94-2.34)	**2.53** (2.31-2.79)	**3.12** (2.84-3.43)	**3.68** (3.34-4.03)	**4.41** (3.98-4.83)	**5.08** (4.54-5.56)	**5.77** (5.11-6.34)	**6.53** (5.72-7.21)	**7.60** (6.55-8.44)	**8.63** (7.31-9.66)
24-hr	**2.41** (2.23-2.62)	**2.90** (2.68-3.15)	**3.62** (3.34-3.93)	**4.22** (3.88-4.58)	**5.08** (4.64-5.53)	**5.80** (5.26-6.34)	**6.58** (5.91-7.22)	**7.43** (6.59-8.19)	**8.66** (7.56-9.63)	**9.68** (8.32-10.9)
2-day	**2.81** (2.61-3.03)	**3.37** (3.14-3.65)	**4.17** (3.88-4.50)	**4.82** (4.47-5.20)	**5.73** (5.28-6.19)	**6.48** (5.94-7.02)	**7.26** (6.60-7.91)	**8.10** (7.30-8.86)	**9.28** (8.24-10.3)	**10.2** (8.97-11.4)
3-day	**2.98** (2.77-3.21)	**3.57** (3.33-3.85)	**4.39** (4.09-4.74)	**5.06** (4.70-5.46)	**5.99** (5.54-6.48)	**6.76** (6.21-7.33)	**7.56** (6.89-8.23)	**8.40** (7.60-9.20)	**9.60** (8.55-10.6)	**10.6** (9.29-11.8)
4-day	**3.14** (2.93-3.39)	**3.76** (3.51-4.06)	**4.61** (4.30-4.97)	**5.30** (4.93-5.72)	**6.26** (5.79-6.76)	**7.04** (6.48-7.64)	**7.86** (7.17-8.55)	**8.71** (7.90-9.53)	**9.91** (8.87-11.0)	**10.9** (9.61-12.1)
7-day	**3.65** (3.41-3.93)	**4.35** (4.07-4.69)	**5.25** (4.91-5.66)	**5.96** (5.56-6.43)	**6.93** (6.43-7.49)	**7.69** (7.10-8.35)	**8.47** (7.76-9.24)	**9.27** (8.43-10.2)	**10.4** (9.31-11.5)	**11.2** (9.96-12.5)
10-day	**4.15** (3.89-4.45)	**4.94** (4.62-5.30)	**5.89** (5.51-6.32)	**6.62** (6.19-7.12)	**7.59** (7.07-8.17)	**8.35** (7.73-9.01)	**9.10** (8.38-9.86)	**9.85** (9.02-10.7)	**10.9** (9.84-11.9)	**11.6** (10.4-12.8)
20-day	**5.57** (5.22-5.94)	**6.61** (6.21-7.07)	**7.87** (7.39-8.41)	**8.80** (8.25-9.42)	**10.0** (9.37-10.7)	**11.0** (10.2-11.8)	**11.9** (11.0-12.8)	**12.8** (11.8-13.8)	**14.0** (12.8-15.2)	**14.9** (13.5-16.3)
30-day	**6.87** (6.48-7.28)	**8.14** (7.68-8.65)	**9.54** (8.98-10.1)	**10.6** (9.94-11.2)	**11.8** (11.1-12.6)	**12.8** (11.9-13.6)	**13.7** (12.7-14.6)	**14.5** (13.5-15.5)	**15.6** (14.4-16.8)	**16.4** (15.0-17.7)
45-day	**8.62** (8.15-9.11)	**10.2** (9.64-10.8)	**11.9** (11.2-12.6)	**13.1** (12.4-13.8)	**14.6** (13.8-15.5)	**15.8** (14.8-16.7)	**16.8** (15.8-17.9)	**17.9** (16.7-19.1)	**19.2** (17.8-20.6)	**20.1** (18.6-21.8)
60-day	**10.3** (9.72-10.9)	**12.1** (11.5-12.8)	**14.0** (13.3-14.8)	**15.4** (14.5-16.3)	**17.1** (16.1-18.1)	**18.3** (17.2-19.4)	**19.4** (18.2-20.6)	**20.5** (19.2-21.8)	**21.8** (20.3-23.3)	**22.7** (21.1-24.5)

[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.

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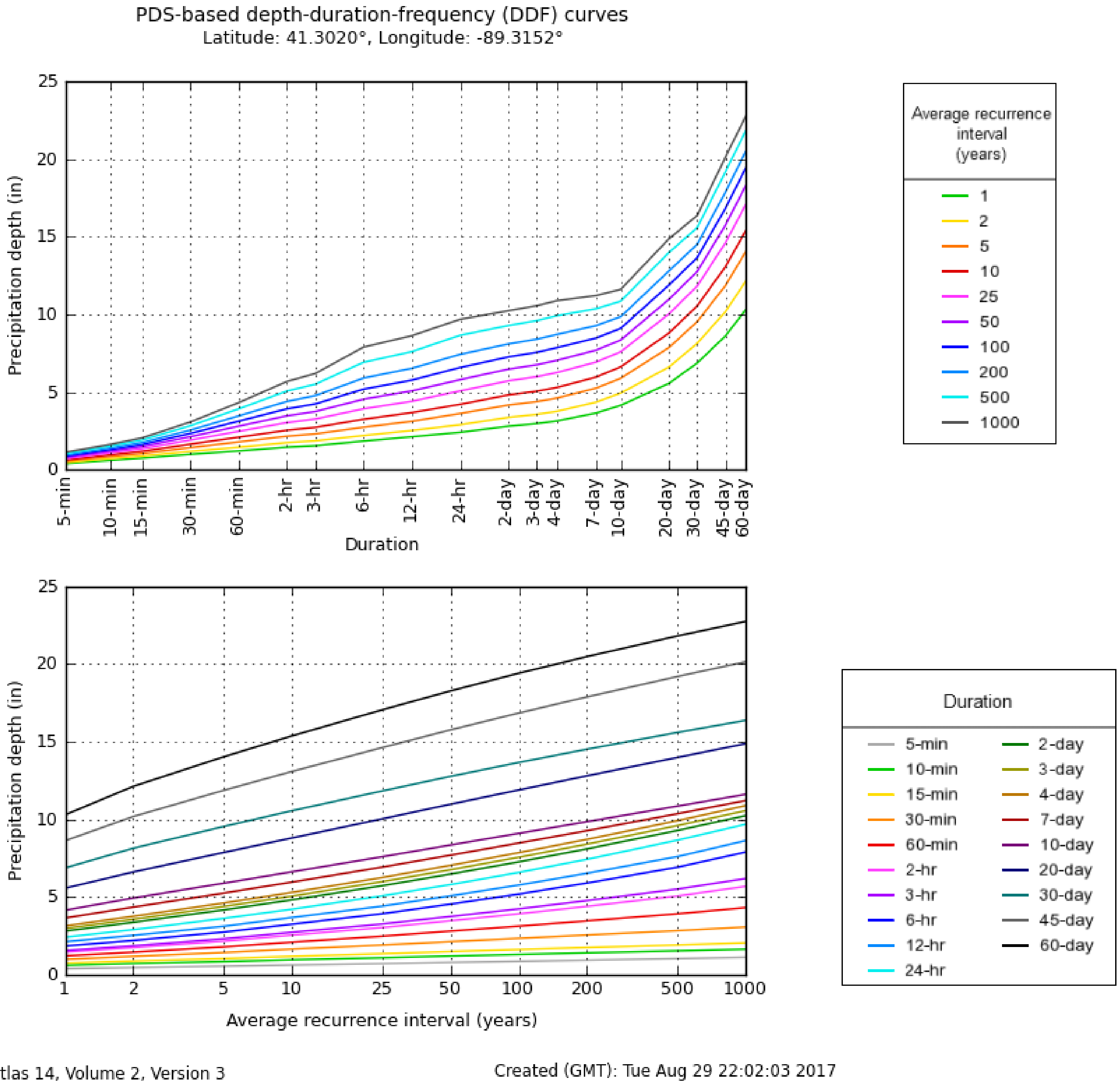
PF graphical



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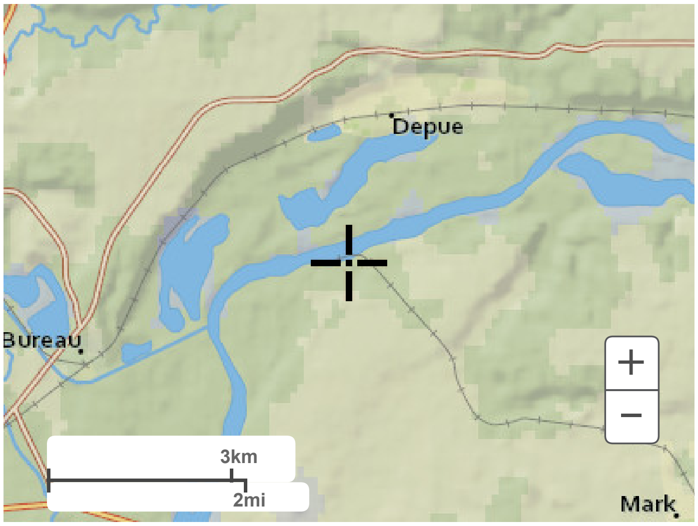
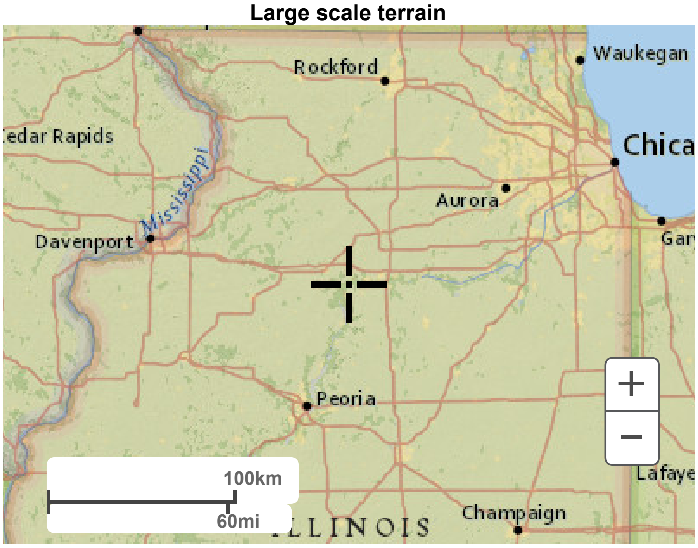
Maps & aerials

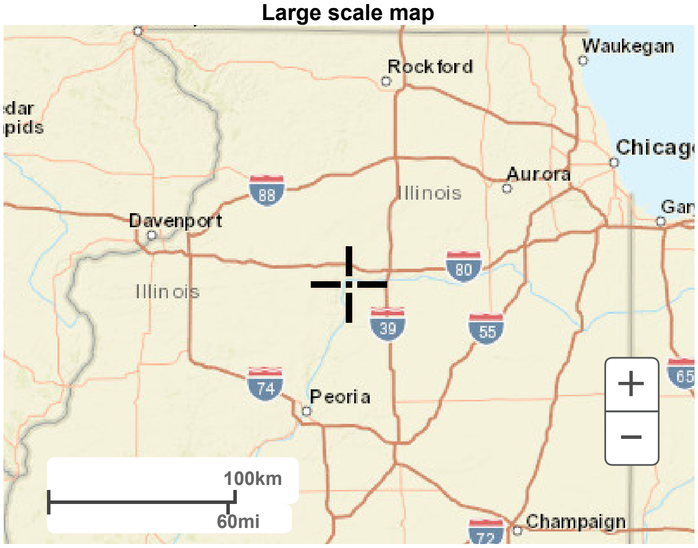
Small scale terrain



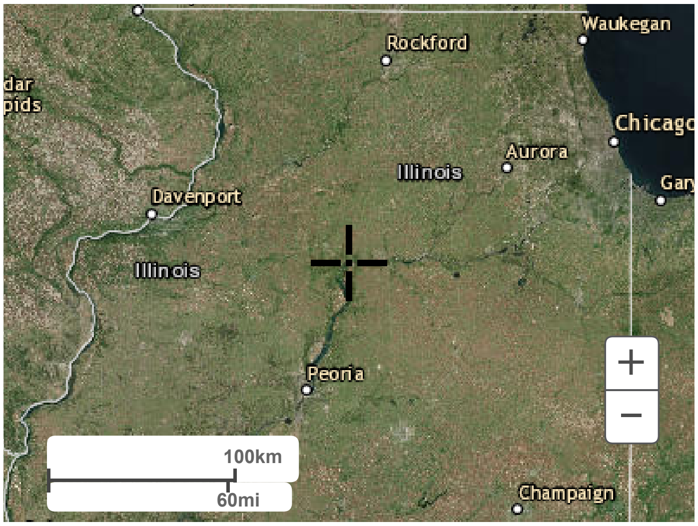
Large scale terrain



Large scale map



Large scale aerial



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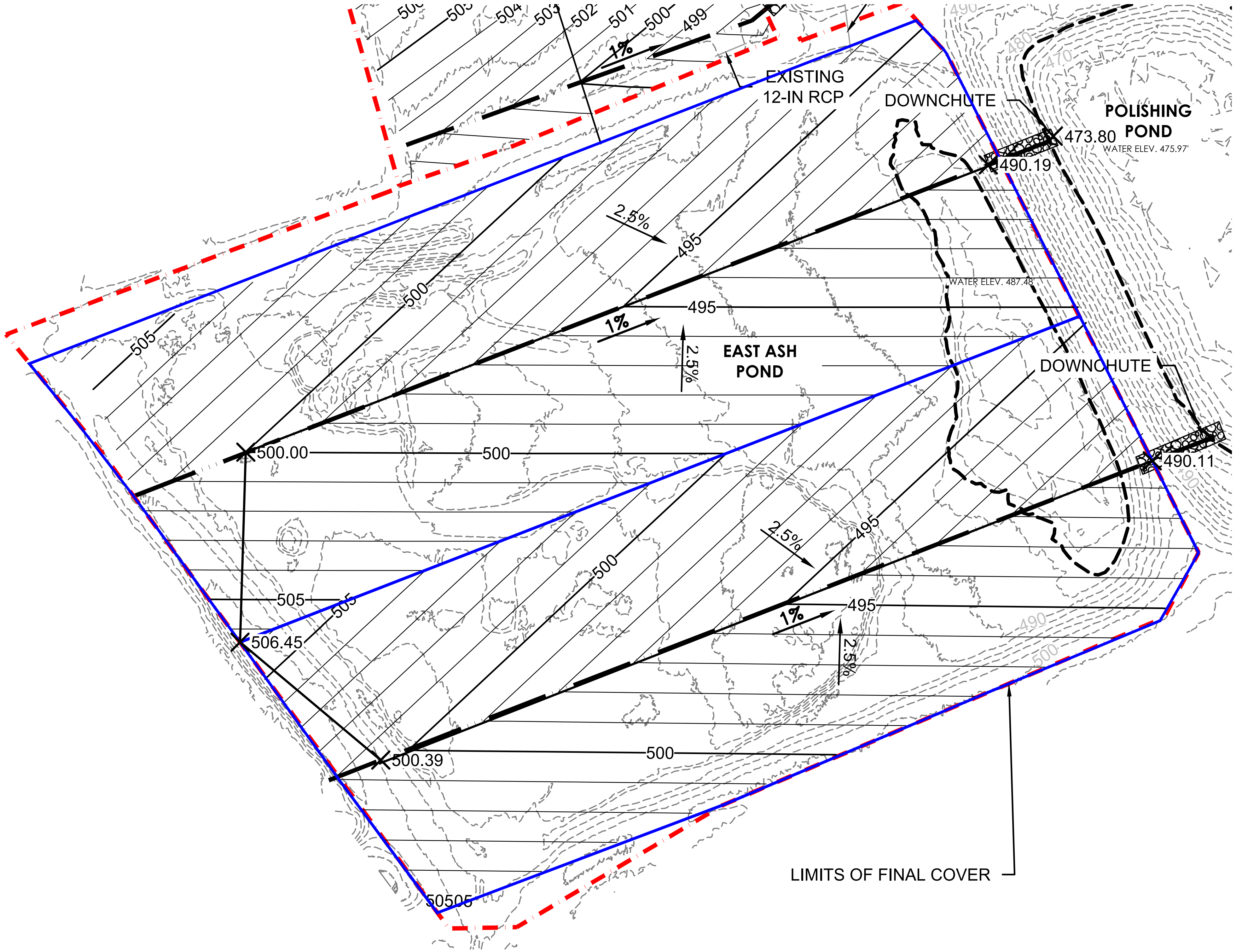
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

APPENDIX 2

Cover Grading Plan and Drainage Map



LEGEND

480 EXISTING GROUND SURFACE ELEVATION (2 FT INTERVAL)

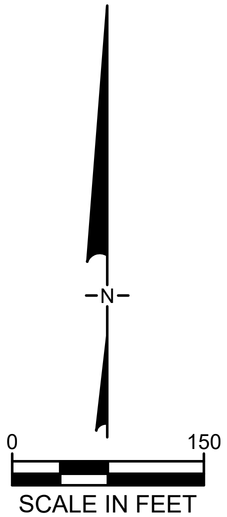
505 TOP OF FINAL COVER GRADE ELEVATION

EXISTING RCP PIPE

STORMWATER CHANNEL

LIMIT OF FINAL COVER

DRAINAGE AREA BOUNDARY



NOTES:

1. COORDINATES AND DIRECTIONS SHOWN IN THESE DRAWINGS WERE BASED ON THE ILLINOIS STATE PLANE COORDINATE SYSTEM (NAD83, IN US FEET). ELEVATIONS WERE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, IN US FEET).
2. EXISTING CONTOURS AND WATER SURFACE ELEVATIONS TAKEN FROM DYNEGY MIDWEST GENERATION, LLC - HENNEPIN POWER STATION - DECEMBER 2020 TOPOGRAPHY, 3/10/2021, BY INGENAE, LLC.

CONCEPTUAL - NOT FOR CONSTRUCTION

COVER GRADING PLAN AND
DRAINAGE MAP
EAST ASH POND
DYNEGY MIDWEST GENERATION, LLC
HENNEPIN POWER STATION

Geosyntec
consultants

DRAWING
1

PROJECT NO: GLP8026
SEPTEMBER 2021

S:\COMPANY\PROJECTS_POST_2014\GLP8026_HEN_845_CONST_PERMIT\500_TECHNICAL\530_CAD\GLP8026-001-EAST POND_COVER_DRAINAGE MAP - Last Saved by: mlauser on 9/20/21

APPENDIX 3

Hydrologic Summary

Geosyntec consultants

engineers | scientists | innovators

1420 Kensington Road, Suite 103

Oak Brook, IL
TELEPHONE (630)
FAX (630) 203 3341

JOB GLP8026 Hennepin East Ash Pond Closure
SHEET NO. OF
CALCULATED BY LH DATE 9/22/2021
CHECKED BY PV DATE 9/23/2021
SCALE
DESCRIPTION Subcatchment Peak Flow Summary

Subcatchment Summary

Catchment	Area (acres)	25-yr Peak Flows (CFS)	100-yr Peak Flows (CFS)
North Drainage Area	11.0	18.0	26.5
South Drainage Area	9.8	16.0	23.5

🟨 Indicates Flows used for swale and chute design

Written by: **LH** Date: **09/22/21** Reviewed by: **PVW** Date: **9/23/21**
DD MM YY DD MM YY
Client: **Dynegy** Project: **Hennepin Closure Plan** Project No.: **GLP8026** Task No.: **A/03**

APPENDIX 4

Cover Swale Hydraulic Analysis

Geosyntec consultants
engineers | scientists | innovators

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TELEPHONE (630)
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JOB GLP8026 Hennepin East Ash Pond Closure
SHEET NO. OF
CALCULATED BY LH DATE 9/20/2021
CHECKED BY PV DATE 9/23/2021
SCALE
DESCRIPTION 2021 Cover Updates
25-year, 24 hr SCS Type II

Peak Discharge, Q_{max}= 18.00 cfs
Bottom Width, B = 0.00 ft
Left Side Slope, Z_1 = 40.00 horizontal :1 vertical
Right Side Slope, Z_2 = 40.00 horizontal :1 vertical
Manning's Roughness Coeff., n = 0.030
Longitudinal Channel Slope, S_o = 0.0100 ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Channel Slope ft/ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.80	0.00	0.010	0.14	0.00	0.00	
0.18	1.24	14.07	0.09	0.010	0.98	1.21	0.05	
0.34	4.67	27.34	0.17	0.010	1.53	7.13	0.11	
0.51	10.30	40.61	0.25	0.010	1.99	20.49	0.16	
0.67	18.14	53.88	0.34	0.010	2.40	43.56	0.21	
0.84	28.17	67.15	0.42	0.010	2.78	78.37	0.26	
1.01	40.40	80.43	0.50	0.010	3.14	126.77	0.31	
1.17	54.83	93.70	0.59	0.010	3.47	190.51	0.37	
1.34	71.47	106.97	0.67	0.010	3.80	271.24	0.42	
1.50	90.30	120.24	0.75	0.010	4.10	370.52	0.47	
1.67	111.33	133.51	0.83	0.010	4.40	489.86	0.52	
1.83	134.57	146.78	0.92	0.010	4.69	630.72	0.57	
2.00	160.00	160.05	1.00	0.010	4.97	794.50	0.62	
0.49	9.60	39.21	0.24	0.01	1.94	18.66	0.15	DESIGN Q

Geosyntec consultants
engineers | scientists | innovators

1420 Kensington Road, Suite 103
Oak Brook, IL
TELEPHONE (630)
FAX (630) 203 3341

JOB GLP8026 Hennepin East Ash Pond Closure
SHEET NO. OF
CALCULATED BY LH DATE 9/20/2021
CHECKED BY PV DATE 9/23/2021
SCALE
DESCRIPTION 2021 Cover Updates
100-year, 24 hr SCS Type II

Peak Discharge, Q_{max}= 26.50 cfs
Bottom Width, B = 0.00 ft
Left Side Slope, Z_1 = 40.00 horizontal :1 vertical
Right Side Slope, Z_2 = 40.00 horizontal :1 vertical
Manning's Roughness Coeff., n = 0.030
Longitudinal Channel Slope, S_o = 0.0100 ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Channel Slope ft/ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.80	0.00	0.010	0.14	0.00	0.00	
0.18	1.24	14.07	0.09	0.010	0.98	1.21	0.05	
0.34	4.67	27.34	0.17	0.010	1.53	7.13	0.11	
0.51	10.30	40.61	0.25	0.010	1.99	20.49	0.16	
0.67	18.14	53.88	0.34	0.010	2.40	43.56	0.21	
0.84	28.17	67.15	0.42	0.010	2.78	78.37	0.26	
1.01	40.40	80.43	0.50	0.010	3.14	126.77	0.31	
1.17	54.83	93.70	0.59	0.010	3.47	190.51	0.37	
1.34	71.47	106.97	0.67	0.010	3.80	271.24	0.42	
1.50	90.30	120.24	0.75	0.010	4.10	370.52	0.47	
1.67	111.33	133.51	0.83	0.010	4.40	489.86	0.52	
1.83	134.57	146.78	0.92	0.010	4.69	630.72	0.57	
2.00	160.00	160.05	1.00	0.010	4.97	794.50	0.62	
0.56	12.54	44.81	0.28	0.01	2.12	26.65	0.17	DESIGN Q

APPENDIX 5

Rock Chute Analysis

Rock_Chute.xls
for construction plan

Rock Chute Design - Cut/Paste Plan

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Hennepin East Pond Closure **County:** Putnam
Designer: LWH
Date: 10/6/2021

Design Values

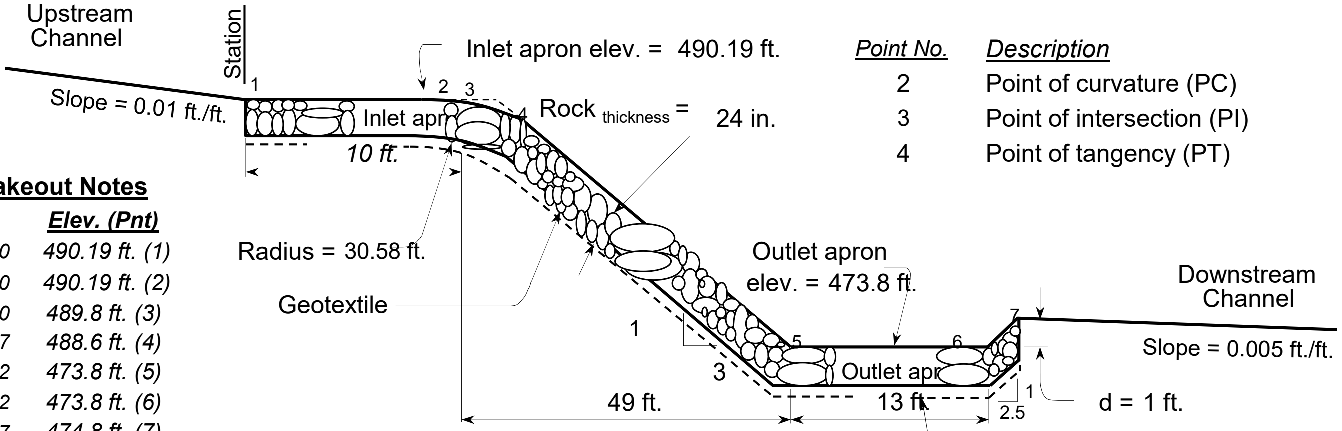
D_{50} dia. = 11.0in.
$Rock_{chute}$ thickness = 24.0in
Inlet apron length = 10 ft.
Outlet apron length = 13 ft.
Radius = 31 ft
Will bedding be used? No

Rock Gradation Envelope

% Passing	*Diameter, in. (weight, lbs.)*
D_{100}--------	17 - 22 (318 - 754)
D_{85}---------	14 - 20 (207 - 549)
D_{50}---------	11 - 17 (94 - 318)
D_{10}---------	9 - 14 (48 - 207)

Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$

Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

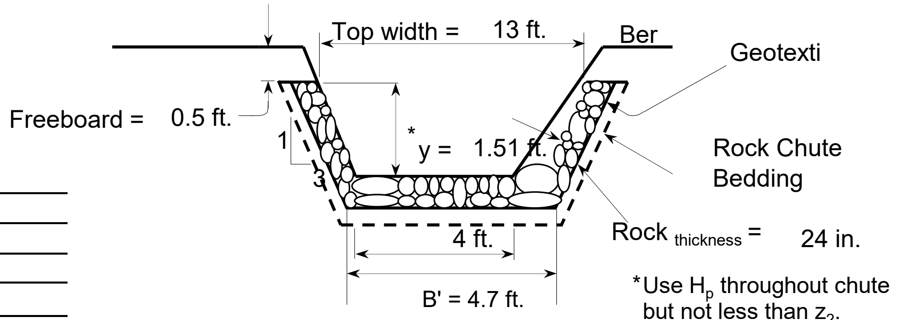


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	***Elev. (Pnt)***
0+00.0	*490.19 ft. (1)*
0+05.0	*490.19 ft. (2)*
0+10.0	*489.8 ft. (3)*
0+14.7	*488.6 ft. (4)*
0+59.2	*473.8 ft. (5)*
0+72.2	*473.8 ft. (6)*
0+74.7	*474.8 ft. (7)*

Profile Along Centerline of Rock Chute



Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
DOT Extra Heavy riprap Gradation

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Hennepin East Pond Closure

Putnam County

		Date
Designe	LWH	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

ATTACHMENT F

Geotechnical Design of Slopes and Final Cover System

COMPUTATION COVER SHEET

Client: **Dynegy** Project: **Hennepin EAP Closure Plan** Project No.: **GLP8026**
Task No.: **B/02**

Title of Computations **Geotechnical Calculations for Closure Design**

Computations by:
Signature
Printed Name Isaiah Vaught, EIT
& Lucas P. Carr, P.E.
Title Staff Professional
& Senior Engineer
Date 10-27-2021

Assumptions and Procedures Checked by:
(peer reviewer)
Signature
Printed Name John P. Seymour. P.E.
Title Senior Principal
Date 11-01-2021

Computations Checked by:
Signature
Printed Name Zachary J. Fallert, P.E.
Title Engineer
Date 11-01-2021

Computations backchecked by:
(originator)
Signature
Printed Name Isaiah Vaught, EIT
& Lucas P. Carr, P.E.
Title Staff Professional
& Senior Engineer
Date 11-01-2021

Approved by:
(pm or designate)
Signature
Printed Name Lucas P. Carr, P.E.
Title Senior Professional
Date 11-01-2021

Approval notes: Closure Plan Submittal

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1. PURPOSE

This calculation package presents geotechnical calculations performed to support the development of the closure design for the East Ash Pond (EAP) at the Hennepin Power Plant (HPP) in Hennepin, Illinois. The analyses provided in this calculation package include:

(i) A summary of past geotechnical investigations completed at and around the EAP;

(ii) A summary of subsurface conditions, selected geotechnical design parameters, and seismic inputs developed by others;

(iii) The results of liquefaction screening analyses performed by others;

(iv) Global slope stability analyses considering post-closure conditions for static and seismic conditions;

(v) Cover system veneer stability analyses, and

(vi) A discussion of the potential for closure-induced settlements.

2. SUMMARY OF SUBSURFACE INVESTIGATIONS

2015 AECOM Investigation

A subsurface investigation program was performed by AECOM at the EAP and adjacent CCR surface impoundments in September and October of 2015 [1]. The investigation program provided information to complete the initial geotechnical analyses for the EAP. Boring locations are shown on **Figure 1**.

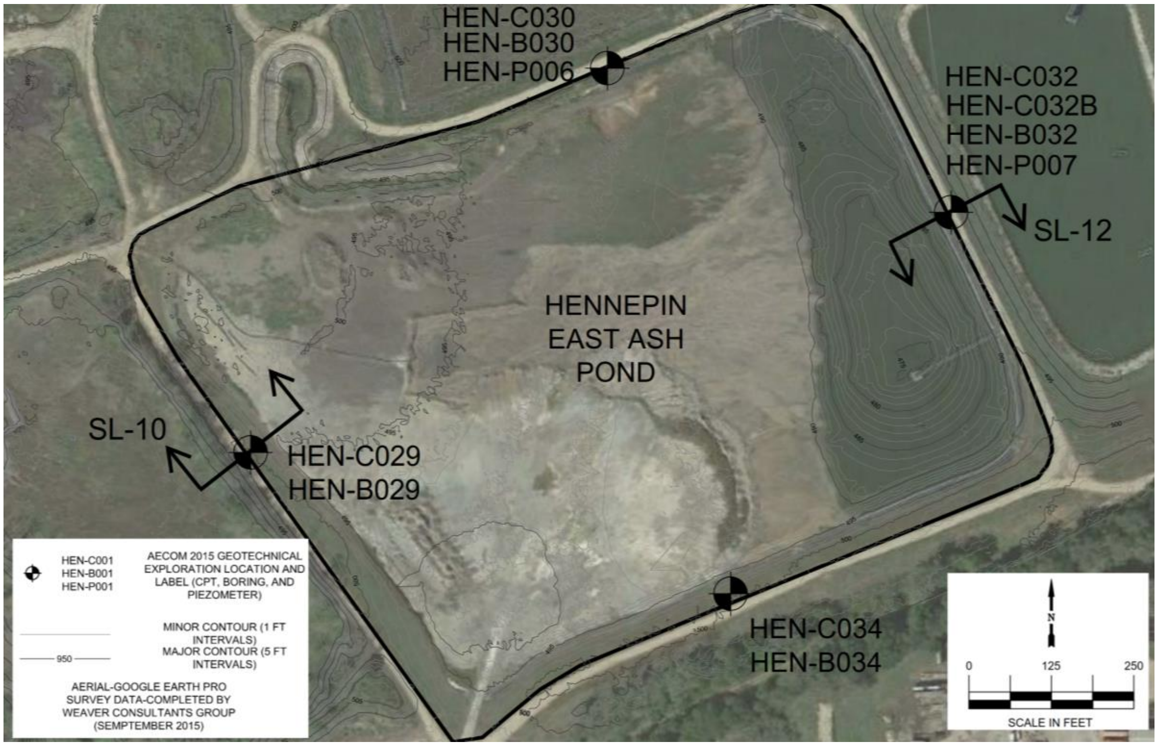


Figure 1 – 2015 AECOM Subsurface Investigation Locations

AECOM's geotechnical report is provided in **Attachment A**.

2021 Geosyntec Investigation

A supplemental investigation of the CCR contained within the East Ash Pond was completed by Geosyntec in 2021 [2]. The investigation program included advancing three hollow-stem auger borings within the interior of the EAP and four monitoring well borings using sonic drilling techniques, as shown in **Figure 2**. Borings in the EAP were terminated above the liner system.

The hollow-stem auger borings were advanced to between 17 and 20 ft below grade and the sonic borings were advanced to between 64 and 98 ft below grade. Laboratory testing was only performed on samples of CCR collected from the hollow-stem auger borings, and the following laboratory tests were performed:

<u>Index Tests</u>:

- Moisture content (ASTM D2216): 7 tests
- Atterberg limits (ASTM D4318): 4 tests
- Grain size analyses (ASTM D422): 7 tests
- Dry unit weight (ASTM D7263): 5 tests
- Specific Gravity (ASTM D854): 7 tests

Hydraulic Tests:

- Flexible Wall Hydraulic Conductivity (ASTM D5084): 3 tests

Each of the borings were converted into monitoring wells after completion. Excerpts from Geosyntec's report, including boring location information, boring logs, and laboratory testing data, is provided in **Attachment B**.

Figure 2 – 2021 Geosyntec Subsurface Investigation Locations[1]

3. SUMMARY OF SUBSURFACE CONDITIONS

AECOM [1] and Geosyntec [2] identified the following subsurface materials within, beneath, and around the EAP:

(i) Roadway fill;
(ii) Embankment fill;
(iii) Alluvial foundation materials;
(iv) CCR;
(v) Liner System;

---

[1] The 2021 Geosyntec investigation also included monitoring wells installed around the perimeter of the EAP. These monitoring wells were advanced using sonic drilling techniques and did not include conducting in-situ geotechnical tests or laboratory tests and are therefore not discussed further in this report.

(vi) Bedrock.

Each material is discussed below:

Roadway Fill

Roadway fill consisting of silty sand comprised an access road located around the perimeter of the EAP. The fill was considered very dense, based on SPT blow counts [1].

Embankment Fill

Embankment fill consists of the materials used to construct the north, south, east, and west embankments. Reportedly, the original dikes were constructed to El. 483 ft and then raised to El. 494 to 500 ft in the early 2000s. The dike soils were considered to be stiff to hard clayey silt and clay, with some zones of sand and gravel, based on CPT logs and SPT N-values [1].

Alluvial Foundations

Native alluvial foundations materials were encountered below the embankments. The material included medium dense to dense sand and gravel with isolated zones and lenses of silt and clay ([1], [2]).

CCR

CCR consists of ash materials that were sluiced into the EAP for disposal. The CCR materials included well-graded sand to silt with trace slag and coal fragments, generally consisting of fly ash, bottom ash, and fly ash/bottom ash mixtures. The CCR was typically saturated and loose to very loose (for bottom ash) and soft to very soft (for fly ash) [2].

Liner System

The EAP contains a 4-ft thick compacted clay liner on the bottom and side-slopes, with a sand filter layer on the side and bottom slopes of the pond (6 and 12 inches thick, respectively). When the dikes were raised in the early 2000s, the liner was extended using an 8-ounce geotextile, 1 ft of compacted clay, and a 45-mil geomembrane. Laboratory or other test data were not collected on the liner system to avoid damage [1].

Bedrock

Shale bedrock was encountered beneath the alluvial foundation material in MW-55. The rock was grey-green in color and noted to be silty [2]. Bedrock was not considered in geotechnical analyses for the site due to its depth (approximately 86 ft below grade) and the thickness of relatively high-strength alluvial foundation material above the bedrock (approximately 67 ft).

4. DESIGN GEOTECHNICAL STRENGTH AND UNIT WEIGHT PARAMETERS

Design geotechnical strength and unit weight parameters for each subsurface soil material were selected by AECOM using available laboratory data, CPT sounding information, published correlations, and engineering judgment [1]. Geosyntec reviewed AECOM's design parameters for soil materials and generally agreed with selected values. Design geotechnical parameters for CCR were selected by Geosyntec based on available laboratory test data [2] and Geosyntec's experience. Design geotechnical materials for the final covers were also selected based on Geosyntec's experience. Design geotechnical parameters are summarized in **Table 1**.

Table 1. Design Geotechnical Parameters

Material	Total Unit Weight (γ_t, pcf)	Drained Shear Strength		Undrained Shear Strength (Su, psf)
		Friction Angle (ϕ', deg)	Cohesion (c', psf)	
Road Fill	130	38	0	Assumed drained under each evaluated loading condition
Embankment Fill	105	32	30	2,500
Alluvial Foundation	135	38	0	Assumed drained under each evaluated loading condition
CCR	80	30	0	
Liner System	120	30	60	2,500
Final Cover System	110	27	0	Assumed drained under each evaluated loading condition

5. GROUNDWATER CONDITIONS

Available groundwater data for the two piezometers at the EAP (HEN-P005 and HEN-P006) was provided by the HPP, with the data collected between October 27, 2015 and April 23, 2021. Both piezometers are screened in alluvial soils beneath the embankments. This data was plotted, as shown in **Figure 3**.

The data indicates that groundwater levels in the foundation soil typically vary between El. 446 ft and El. 452 ft. This is similar to the water level in the adjacent Illinois River, and observed spikes to El. 456 ft in June of 2019 and El. 457 ft in June of 2020 are coincident with observed flooding events. The data also indicates that groundwater levels are well below the normal pool level in the EAP (approximately El. 490 ft), which is to be expected as the EAP has a liner system. For geotechnical analyses, a groundwater level of EL. 452 ft was selected for the foundation soils, as this is consistent with conditions observed from HEN-P006 and normal water levels in the Illinois River.

For the CCR retained within the EAP, a water level of El. 490 ft was conservatively selected to represent the pre-closure normal pool level. Actual water levels within the EAP are expected decrease during closure due to dewatering and due to a reduction in infiltration caused by installation of the final cover system.

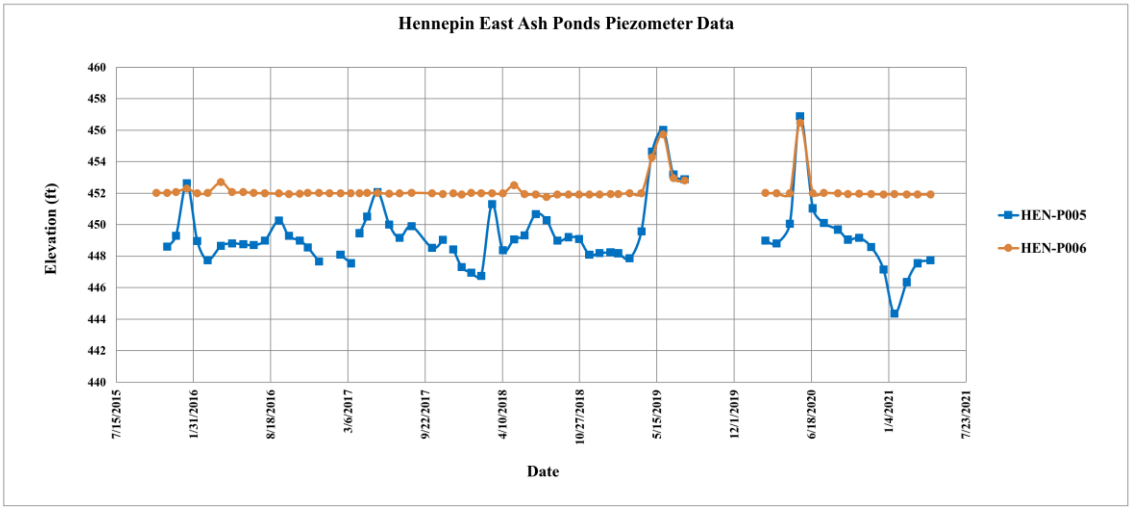


Figure 3 – EAP Piezometer Data

6. SEISMIC ASSESSMENTS

Site Seismic Hazard Assessment

AECOM evaluated seismic hazards at the site using published United States Geological Survey (USGS) data for the 2% probability of exceedance in 50-years (2,500-yr return period) seismic event. The bedrock acceleration, 0.073g, was then used in conjunction with the seismic site classification of D to estimate a site-class amplified ground surface acceleration of 0.119 g. AECOM then estimated a peak transverse acceleration at the crest of the dike of 0.35 g and a pseudostatic seismic coefficient of 0.119g. Geosyntec reviewed AECOM's seismic hazard assessment and generally agreed with the approach. Additional details regarding AECOM's seismic hazard assessment [1] is provided in **Attachment A**.

Liquefaction Triggering Analysis – Dike and Foundation Soils

AECOM noted that saturated, cohesionless soils were not encountered within the dikes of the EAP, and therefore the dikes were not susceptible to liquefaction. AECOM also evaluated the potential for liquefaction in the foundation soils by comparing ranges in SPT blow counts (17 to 85 blows per foot and 53 as a mean), comparing them to liquefaction case histories published by Idriss and Boulanger [3], and finding that SPT blow counts were well above any case history where liquefaction was identified. AECOM then concluded that liquefaction of the foundation soils was unlikely to occur at the EAP [1]. Geosyntec reviewed AECOM's liquefaction triggering analysis and generally agreed with the approach. Additional data on the liquefaction triggering analysis is provided in **Attachment A**.

Liquefaction Triggering Analysis – Retained CCR

The potential for the liquefaction of retained CCR within the EAP was not evaluated by AECOM, as the material was not present within the dikes or foundation soils of the EAP and evaluation was therefore not required by the CCR Rule [4]. However, the potential for liquefaction of the retained CCR should be considered for closure, as the CCR will be supporting the final cover system and the dikes will be retaining CCR.

Geosyntec conservatively assumed that saturated CCR will be susceptible to liquefaction under post-closure conditions. A lower-bound post-liquefaction residual strength ratio (S_r/σ'_{vo}) of 0.05 was assigned for the CCR, based on Geosyntec's experience.

7. GLOBAL SLOPE STABILITY

Global slope stability analyses for the post-closure EAP were performed using limit-equilibrium SLOPE/W software [5], to calculate the factor of safety (FoS) of the perimeter dikes of the EAP against global instability. Slope stability analyses utilized the Spencer's method [6] and evaluated circular slip surface defined using the entry-exist method, with each critical slip surface being optimized into a non-circular slip surface. Factors of safety were calculated for the following loading conditions:

> <u>End-of-Construction Static Conditions</u>: This loading condition corresponds to the stability of the post-closure EAP dikes immediately after construction of the closure is completed. Peak undrained material properties are used for all cohesive materials, as pore pressures induced by construction may not yet have dissipated. Peak drained material properties are used for all free-draining materials, as these materials are assumed to dissipate pore pressures concurrently with loading. The minimum acceptable FoS for this loading condition is 1.30, per the USEPA CCR Rule [4] and the Illinois Part 845 Rule [7].

Long-Term Static Conditions: This loading condition corresponds to the stability of the post-closure EAP dikes under long-term, normal operating conditions with estimated static groundwater levels. Drained material properties, representing effective stress conditions, are used for all materials, as this condition corresponds to static conditions without the application of pore-pressure inducing loads. The minimum acceptable FoS for this loading condition is 1.50, per the USEPA CCR Rule [4] and the Illinois Part 845 Rule [7].

Pseudostatic Seismic Conditions: This loading condition corresponds to the stability of the EAP dikes under short-term seismic shaking conditions. This loading condition assumed peak drained strengths in all free-draining materials (CCR, road fill, and alluvial foundation) and was checked with both peak drained and peak undrained strengths in the embankment fill and liner materials, in order to evaluate the sensitivity of the analysis to two separate material parameter assumptions. The seismic loads are modeled as an outward-acting horizontal force of 0.119 g, as discussed in **Section 6**. The minimum acceptable FoS for this loading condition is 1.00, per the USEPA CCR Rule [4] and the Illinois Part 845 Rule [7].

Post-Earthquake Conditions: This loading condition corresponds to the stability of the EAP dikes and final cover surface immediately following a seismic event. This loading condition assumed peak drained strengths in all non-liquified free-draining materials (unsaturated CCR, road fill, and alluvial foundation), residual liquefied shear strengths in saturated CCR (below El. 490 ft) and was checked with both peak drained and peak undrained strengths in the embankment fill and liner materials, in order to evaluate the sensitivity of the analysis to two separate material parameter assumptions. It should be noted that this loading condition is not expressly required by the USEPA CCR Rule [4] and the Illinois Part 845 Rule [7], as liquefaction-susceptible materials are not present within the dikes or foundations of the EAP. However, this condition was checked to evaluate the mass stability of the EAP dikes and final cover system, as saturated CCR may remain beneath the final cover system and retained by the dikes of the EAP under post-closure conditions, and liquefaction could potentially occur in this material. A minimum acceptable FoS of 1.20 was assumed. This is equal to the USEPA CCR Rule [4] and the Illinois Part 845 Rule [7] loading condition where liquefaction-susceptible materials are present within the dike of a CCR surface impoundment.

It should be noted that flood loading conditions (e.g., maximum storage pool [4], [7]) were not evaluated as closure of the EAP will remove the ability of the EAP to retain water. Therefore, this loading condition will not be appliable.

All slope stability analyses include proposed post-closure grades within the EAP and the estimated long-term groundwater levels of El. 490 ft in the CCR and El. 452 ft in foundation soils (see **Section 5**). The static water level in the Polishing Pond was conservatively assumed as empty, thereby resulting in no stabilizing water force on the downstream embankment of the EAP. This assumption as made because the water level in the pond may vary during and after construction, based on site precipitation and other factors.

Subsurface material interfaces at each cross-section were developed using available boring data (**Section 3**), including interpolations between borings using available historic data [1] and engineering judgment.

Selected Cross-sections

Geosyntec reviewed the cross-sections previously selected for the Initial SFA and generally agreed with AECOM's findings [8]. AECOM selected two cross-sections for analysis of the EAP (SL-10 and SL-12), with cross-section SL-10 located along the west dike of the EAP and cross-section SL-12 located along the east dike, as shown in **Figure 1**. The cross-sections were selected based on critical subsurface geometry and subsurface conditions and were considered the critical cross-sections for the EAP. Cross-sections were not evaluated along the north and south dikes and grades were essentially flat or sloped inward into the EAP. Geosyntec utilized the AECOM cross-sections, including subsurface stratigraphy and material layering developed by AECOM based on AECOM's borings completed at the site [1]. Cross-sections were modified by Geosyntec to include critical post-closure grades (consisting of highest cover system slopes along each side of the EAP), the final cover materials, and assumed post-closure groundwater conditions.

Results

The results of each of the design scenarios is presented in **Table 2**. Each calculated factor of safety exceeds minimum acceptable values. The output from SLOPE/W is provided in **Attachment C** for each of the design scenarios and Sections.

Table 2. Results of Stability Analyses

<table>
<tr><th rowspan="2">Loading Condition</th><th rowspan="2">Minimum Factor of Safety</th><th colspan="2">Results</th><th rowspan="2">Pass/ Fail</th></tr>
<tr><th>SL-10</th><th>SL-12</th></tr>
<tr><td>End-of-Construction</td><td>1.30</td><td>8.94</td><td>3.65</td><td>PASS</td></tr>
<tr><td>Long-Term Static</td><td>1.50</td><td>2.35</td><td>2.74</td><td>PASS</td></tr>
<tr><td>Pseudostatic Seismic – Drained Embankment and Liner</td><td>1.00</td><td>1.76</td><td>1.90</td><td>PASS</td></tr>
<tr><td>Pseudostatic Seismic – Undrained Embankment and Liner</td><td>1.00</td><td>5.04</td><td>2.35</td><td>PASS</td></tr>
<tr><td>Post-Earthquake – Drained Embankment and Liner</td><td>1.20</td><td>2.35</td><td>2.74</td><td>PASS</td></tr>
<tr><td>Post-Earthquake – Undrained Embankment and Liner</td><td>1.20</td><td>8.93</td><td>3.65</td><td>PASS</td></tr>
</table>

8. VENEER COVER STABILITY

Veneer stability refers to the shallow, translational stability of the cover system and each material interface within the cover system. The cover system will include, from bottom to top, a CCR subgrade, a geomembrane low permeability layer, 1.5 ft of cover soil, and 0.5 ft of topsoil capable of sustaining vegetation. Veneer stability calculations were performed to evaluate the factor of safety against sliding between each of the material interfaces within the final cover system. Material interfaces within the cover system include, from top to bottom:

- Geotextile against the cover soil;
- Geotextile against the 40-mil geomembrane low-permeability layer; and
- CCR subgrade against the geomembrane low-permeability layer.

Veneer stability for static loading conditions was evaluated following published methodology [9]. Two final cover system slopes were evaluated at the site and represent critical veneer stability sections, based on the maximum height of 2.5% slope (Slope A) and maximum height of 20% slope (Slope B). The evaluated slopes are listed in **Table 3** and shown in plan in **Figure 4**.

Table 3 – Slopes Evaluated for Veneer Stability

Slope	Grade	Height (ft)	Length (ft)	Crest Elevation (ft)
Slope 1	2.5% (40H:1V)	6	233	505.5
Slope 2	20% (5H:1V)	10	48	503.0

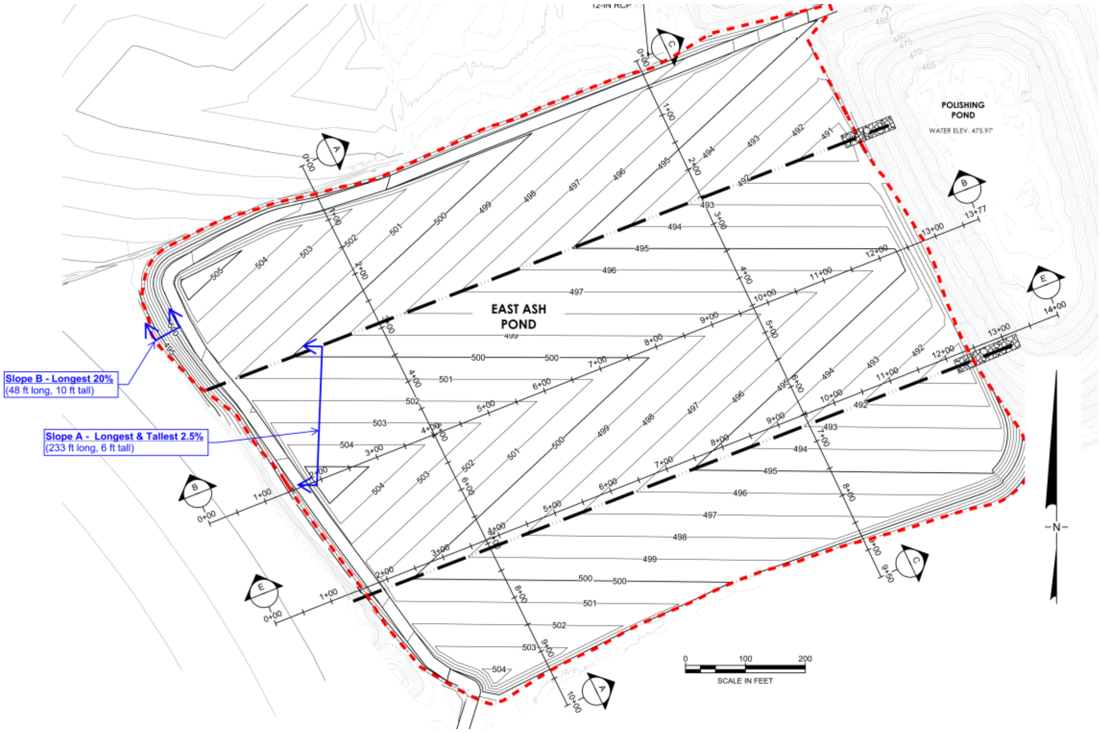


Figure 4 – Veneer Stability Slope Locations

Interface friction angles and adhesion values were taken from results of site-specific laboratory interface friction testing data (ASTM D5321) performed by Geosyntec for the closure of the Old West Ash Pond (OWAP) at the Hennepin Power Plant. Materials tested by Geosyntec included granular cover soil to a 16-ounce nonwoven geotextile, the 16-ounce nonwoven geotextile to a 40-mil textured liner low density polyethylene (LLDPE) geomembrane, and the 40-mil textured LLDPE geomembrane to the CCR subgrade soils and granular soil [10]. Similar materials will be utilized for the final cover system at the EAP; therefore, it is appropriate to use this data for the veneer stability assessment. The resulting interface friction data is provided in **Table 4** and interface testing data is provided in **Attachment D**.

Table 4 – Interface Friction Data

Material (Top to Bottom)	Peak		Large Displacement	
	Friction Angle (degrees)	Interface Adhesion (psf)	Friction Angle (degrees)	Interface Adhesion (psf)
Clay Cover Soil	27.8	81	17.1	0
Skaps Nonwoven Geotextile GE116				
Skaps 40 mil LLDPE Textured Geomembrane				
CCR				
Sand and Gravel Cover Soil	26.9	102	27.5	77
Skaps Nonwoven Geotextile GE116				
Sand and Gravel Cover Soil	25.3	51	18.9	0
Skaps 40 mil LLDPE Textured Geomembrane				
Design Parameters for EAP	**25.3**	**51**	**17.1**	**0**

Analyses were performed for the lower interfaces (one single analysis considering sliding along the subgrade against geomembrane liner, geomembrane liner against geotextile, and geotextile against cover soil), as the effective stresses would be the same for all three interfaces. Each analyzed loading condition is described below:

> <u>Normal Static Conditions</u>: This analysis considers the stability of the cover system under normal, static, steady-state operating conditions. The cover system soil is assumed to be unsaturated, and 0.25 inches of water is present within the geotextile, which corresponds to a full thickness of water within a geotextile. The minimum acceptable FoS for this condition is 1.5, as recommended by Koerner and Soong [11]. Peak interface shear strength data was used for this condition.
>
> <u>Saturated Conditions</u>: This analysis considers the stability of the cover system under static, saturated operating conditions that could potentially occur after a rainfall event that results in the entire cover system becoming fully saturated with two feet of water present (full cover soil thickness). Because this is a temporary condition and is expected to only occur after a significant rainfall event, a minimum acceptable FoS for this condition of 1.2 was selected for design. No regulatory guidance in Part 845 or the CCR Rule is available for this loading condition. Peak interface shear strength data was used for this condition.

Seismic Conditions: Veneer stability for seismic conditions was calculated following Matasovic (1991), for the same slope orientations as the static veneer analyses. Saturated conditions were not considered for the seismic analyses as the likelihood of a significant rainfall event occurring at the same time as a seismic event is low. A pseudostatic seismic coefficient of 0.078 g was selected for analysis, which is 65% of the site-class amplified peak ground acceleration of 0.119 g, as recommended by Matasovic [12]. The minimum acceptable factor of safety for this condition is 1.0, also as recommended by Matasovic. Peak interface shear strength data was used for this condition.

Post-Earthquake Conditions: This analysis considers the stability of the final cover condition under conditions immediately after a seismic event, when seismic shaking has stopped. Saturated conditions were not considered for the seismic analyses as the likelihood of a significant rainfall event occurring at the same time as a seismic event is low. The minimum factor of safety for this condition was assumed to be 1.2, which corresponds to the USEPA CCR Rule [4] and Illinois Part 845 [7] regulatory guidance for global dike stability. The residual, large-displacement friction angle was used for this condition, to account for reduced post-peak shear strengths that may be induced by seismic shaking.

Resulting veneer stability factors of safety are provided in **Table 5.** Each calculated factor of safety exceeds minimum acceptable values. Calculation output data is provided in **Attachment E**.

Table 5 – Veneer Stability Analysis Results

Loading Condition	Minimum Factor of Safety	Results		Pass/ Fail
		Slope A	Slope B	
Normal	1.5	32	3.8	PASS
Saturated	1.2	19	2.4	PASS
Seismic	1.0	6.8	2.5	PASS
Post-Earthquake	1.2	16	1.8	PASS

9. SETTLEMENT ANALYSES

The EAP is underlain by highly permeability sand and gravel materials (see **Section 3**). Settlement in these materials is expected to occur elastically and essentially immediately after stresses increased induced by fill placement or dewatering occur. CCR within the EAP may also be susceptible to settlement. However, based on Geosyntec's experience, CCR also rapidly settles, and settlement is expected to occur concurrently with fill placement and dewatering. Therefore, there is expected to be a negligible amount of post-closure settlement at the EAP. While settlements will occur in the CCR and alluvial foundation soils, they are expected to occur concurrently with construction and will be mitigated by placing additional fill, as needed to reach design grades. Consequently, a formal settlement analysis for closure of the EAP was not performed as post-construction settlements are expected to be negligible.

10. CONCLUSIONS

The calculations presented in this report demonstrate that the proposed closure plan for the East Ash Pond at the Hennepin Power Plant provides sufficient geotechnical dike stability, exceeding minimum acceptable factors of safety, for end-of-construction, long-term static, seismic, and post-earthquake loading conditions. Additionally, the cover system veneer stability exceeds minimum acceptable factors of safety for static, saturated, seismic, and post-earthquake conditions. Lastly, closure-induced settlements are expected to occur during construction and negligible post-closure settlements are expected.

11. REFERENCES

[1] AECOM, "Geotechnical Report, Hennepin Power Station, East Ash Pond," St. Louis, Missouri, October 7, 2016.

[2] Geosyntec Consultants, "Illinois Administrative Code, Part 845 Data Gap Analysis, Hennepin Power Plant, East Ash Pond - CCR Unit 8-3," Chesterfield, Missouri, July 29, 2021.

[3] I. Idriss and R. Boulanger, "Soil Liquefaction During Earthquakes," Earthquake Engineering Reserach Institute, Oakland, California, 2008.

[4] United Stated Environmental Protection Agency, "40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 2015," 2015.

[5] GeoSlope International, "GeoSudio 2012, August 2015 Release, Version 8.15.6.13446," Calgary, Alberta, Canada, 2015.

[6] E. Spencer, "A Method fo Analysis of The Stability of Embankments Assuming Parallel Interslice Forces," *Geotechnique,* vol. 17, pp. 11-26, 1967.

[7] Illinois Environmental Protection Agency, "35 Ill. Adm. Code Part 845, Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments," Springfield, IL, 2021.

[8] Geosyntec Consultants, "2021 USEPA CCR Rule Periodic Certification Report, §257.73(a)(2), (c), (d), (e), and §257.82, East Ash Pond, Hennepin Power Plant, Hennepin, Illinois," Chesterfield, Missouri, October 11, 2021.

[9] Giroud and B. R. B. R. J.P., "Influence of Water Flow on the Stability of Geosynthetic-Soil Layered Systems on Slopes," *Geosynthetics International*, vol. 2, no. 6, pp. 1149-1180, 1995.

[10] Geosyntec Consultants, "Draft Construction Certification Report, Closure of the Old West Ash Pond and Old West Polishing Pond, Hennepin Power Station, Hennepin, Illinois," Chesterfield, MIssouri, March 25, 2021.

[11] R. S. T. Koerner, "Analysis and Design of Veneer Cover Soils," in *Proceedings: Sixth International Conference on Geosynthetics, Industrial Fabrics Association International*, St. Paul, Minnesota, 1998.

[12] N. Matasovic, "Selection of Method for Seismic Slope Stability Analysis," in *Proceedings: Second International Conference on Recent Advances in Geotechnical Engineering and Soil Dynamics*, St. Louis, Missouri, 1991.

APPENDIX A

2016 AECOM Geotechnical Report

AECOM

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October 7, 2016

Mr. Matt Ballance, PE
Senior Project Engineer
Dynegy Inc.
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

RE: Geotechnical Report
Hennepin Power Station
East Ash Pond

Dear Mr. Ballance:

AECOM is pleased to provide this Geotechnical Report for the Dynegy Midwest Generation, LLC (DMG) East Ash Pond Coal Combustion Residuals (CCR) unit at the Hennepin Power Station located in Hennepin, Illinois. This Geotechnical Report has been prepared to document the analysis performed to check that the facility meets the geotechnical slope stability requirements including Factors of Safety required by 40 CFR § 257.73.

AECOM looks forward to providing continued support to DMG 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 or comments on this Geotechnical Report.

Sincerely,

AECOM

Ronald H. Hager

Jeremy Thomas, PE
Site Manager
jeremy.thomas@aecom.com

Ronald Hager
Program Manager
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cc: Mark Rokoff, PE – AECOM

Attachments:

A. Figures
B. Boring Logs
C. Piezometer Logs
D. CPT Data Report
E. Laboratory Test Data
F. Material Characterization Calculations
G. Slope Stability Analysis

1. INTRODUCTION

1.1. *Purpose of This Report*

This report presents the results of the geotechnical analyses prepared by AECOM for the Dynegy Midwest Generation, LLC (DMG[1]) East Ash Pond Coal Combustion Residuals (CCR) unit at the Hennepin Power Station in Hennepin, Illinois (see **Figure 1, Attachment A** for Location Map). The purpose of the geotechnical investigation and analyses performed is to evaluate the design, performance, and condition of the impoundment and associated structures using the data collected from surface and subsurface investigations, available design drawings, construction records, inspection reports, previous engineering investigations, and other pertinent historical documents provided to AECOM by DMG. This information was then used to evaluate the design and operation of the surface impoundment against the regulatory standards set in 40 CFR § 257.73.

The geotechnical field exploration was conducted between September 1 and October 21, 2015. The field program consisted of conventional hollow-stem auger and mud rotary borings, Standard Penetration Testing (SPT), Cone Penetration testing (CPT), and piezometer installation. Laboratory testing was conducted on the materials obtained through various sampling techniques to assist in characterization of the subsurface conditions, especially with respect to defining material parameters for use in stability analyses. Stability analyses were performed by AECOM to evaluate the potential for slope instabilities, in accordance with the Environmental Protection Agency (EPA) regulation 40 CFR § 257.73(d) and (e).

A summary or the geotechnical field program, laboratory testing program, and stability evaluations are presented herein. Detailed interpretations, calculations, and presentation of analysis results are provided in the Attachments to this report.

1.2. *Description of Impoundment*

The Hennepin Station has one active CCR surface impoundment, the East Ash Pond, which receives sluiced bottom ash, fly ash, boiler slag, and plant process water. The East Ash Pond is approximately 21 acres in size and is contained by an earthen perimeter embankment that forms the exterior of the CCR unit on all but the south side, where the East Ash Pond is bordered by high natural ground.

A site specific aerial and bathymetric survey of the East Ash Pond was completed by Weaver Consultants Group in September of 2015. The survey is spatially referenced to the Illinois NAD 1983 State Plane West, Zone 12020. Elevations are in feet and referenced to the North American Vertical Datum 1988 (NAVD88). Coordinates and elevations in this report are referenced to NAD83 and NAVD88, respectively, unless otherwise stated.

The north side of the East Ash Pond is bordered by the inactive Ash Pond No. 2 and the Hennepin Landfill. The crest of the Hennepin Landfill is at an elevation slightly higher than the East Ash Pond embankment. To the northeast and east of the East Ash Pond are the East Leachate Pond and the East Polishing Pond, respectively, both of which are non-CCR impoundments and are located at lower elevations than the East Ash Pond. The plant operations sluice bottom ash into the East Ash Pond for particle settling before being discharged downstream to the East Leachate Pond.

---

[1] Although the Hennepin Power Station and the East Ash Pond are owned and operated by DMG, Dynegy Administrative Services Company (*Dynegy*) contracted AECOM to develop this geotechnical report on behalf of DMG. Therefore, "Dynegy" is referenced in materials attached to this geotechnical report.

The East Ash Pond also utilizes a secondary outflow to the East Polishing Pond. The south side of the East Ash Pond is bordered by natural high ground. The west side is bordered by the former East Ash Pond No. 4.

According to the “Modification to Primary Ash Pond” design drawings, the perimeter embankment was raised from an elevation of 483 feet to the current elevations from 494 to 500 feet in the early 2000’s. The original East Ash Pond included an interior liner system consisting of a 4-foot thick compacted clay layer (design permeability of $1.0x10^{-7}$ centimeters per second) overlying a 1-foot thick sand drainage layer under the pond footprint. During the perimeter embankment raise, the liner system was extended from El. 480 feet (top of the original liner) to El. 494.0 feet using, from bottom to top, an 8-ounce polypropylene geotextile, 1-foot of compacted clay, and a double-layer of 45-mil polypropylene geomembrane. The raised East Ash Pond embankment is composed primarily of compacted clay fill materials with a gravel crest access road (described further in **Section 3.1**).

Embankment height on the west and east sides range from approximately 16 to 36 feet, as referenced to the downstream toe. The downstream embankment slope between the East Ash Pond and East Ash Pond No. 4 is approximately 3.5H:1V. The slope between the East Ash Pond and the East Polishing Pond is approximately 4H:1V. Embankment crest widths range from approximately 18 feet to 19 feet along the west and east sides of the East Ash Pond..

The site location and vicinity map are included in **Attachment A**.

2. SUMMARY OF FIELD INVESTIGATIONS

A subsurface exploration was performed at the Hennepin East Ash Pond, including 4 soil borings, installation of 2 piezometers, and 6 cone penetration test (CPT) soundings with shear wave velocity measurements and pore pressure dissipation (PPD) testing. Two of the CPT soundings were performed within the adjacent inactive East Ash Pond No. 2 to characterize behavior of the impounded CCR materials. The borings were drilled by AECOM's subcontractor Strata Earth Services, LLC of Palatine, IL, under the full-time supervision of AECOM geotechnical personnel. Strata Earth Services used a truck-mounted Mobile B-57 drill rig in conjunction with 3¼-inch inner diameter hollow stem augers with mud rotary methods as needed to drill the borings. CPT soundings were performed by AECOM's subcontractor ConeTec, Inc. of Charles City, Virginia, again with full-time oversight by AECOM personnel.

Borings extended to a predetermined depth of 41.5 feet, within alluvial sand and gravel present beneath the East Ash Pond and CPT depths varied based on refusal from approximately 11 to 29.5 feet below existing grades. Piezometers were installed in un-sampled boreholes, with drilling bottom-of-boring depths of 50 and 55 feet, in order to gather phreatic data in the alluvial sand and gravel layer. Approximate boring, piezometer, and CPT sounding locations are depicted on **Figure 2** in **Attachment A**. Logs of the borings are presented in **Attachment B**. Logs of the CPT soundings are presented in **Attachment D**, and piezometer logs are presented in **Attachment C**. Locations of borings and CPTs, as surveyed by Weaver Consultants in 2015, are summarized in **Table 1**.

Representative soil samples were collected from each of the borings for classification and/or testing. The soil samples were obtained by SPT with a split-spoon sampler, in accordance with ASTM D 1586. Undisturbed samples of fine-grained soils were obtained using 3-inch outside diameter steel (Shelby) tubes conventionally pushed in accordance with ASTM D 1587. Results of the laboratory testing are presented in **Attachment E**.

Table 1
Boring and CPT Exploration Location Data

Exploration ID	Easting (ft NAD83)	Northing (ft NAD83)	Elevation (ft NAVD88)
Auger Borings			
HEN-B029	2533022	1689436	499.7
HEN-B030	2533585	1690015	495.4
HEN-B032	2534055	1689837	494.3
HEN-B034	2533831	1689246	499.3
CPT Soundings			
HEN-C029	2533022	1689436	499.6
HEN-C030	2533582	1690014	495.3
HEN-C032	2534055	1689837	494.3
HEN-C032B[1]	2534056	1689838	494.0
HEN-C034	2533831	1689245	499.4

1. Location of HEN-CO32B was not surveyed as the CPT could not be located in the field. Locations are approximated based on handheld GPS measurements taken during investigation. The elevation for this boring is based on site topographic survey data from Weaver Consultants Group in September of 2015. The accuracy of this measurement is assumed to be approximately ±5 feet horizontal and ±1 foot vertical.

3. SUMMARY OF SITE-SPECIFIC SUBSURFACE CONDITIONS

3.1. Site Stratigraphy

Road Fill Materials: An access road surrounds the perimeter of the East Ash Pond. The material is primarily comprised of silty sand. The relative density of the road fill measured by the standard penetration test was very dense.

Embankment Fill: The perimeter embankment of the East Ash Pond was constructed in two stages, with an original embankment and a later raise constructed on top of the original. According to the “Modification to Primary Ash Pond” design drawings, this raise was completed in the early 2000s, raising the dike crest from an original elevation around 483 feet to the current elevations ranging from 494 to 500 feet. As indicated by the CPT logs, the new dike section was constructed primarily with clayey silt and clay, although some zones of sand and gravel were also noted, as well as limited amounts of CCRs. The consistency of the fill, as measured by uncorrected SPT N-values and pocket penetrometer tests, ranged from stiff to hard. Per construction drawings, the fill material was to be compacted to 95 percent (minimum) ASTM D698. Historical compaction records for the fill material were not available, but current field data were generally indicative of well-compacted materials.

Alluvial Foundation: Alluvial foundation materials, consisting primarily of sand and gravel with varying amounts of silt and clay were encountered in the borings drilled around the perimeter of the Hennepin East Ash Pond. The relative density of the alluvial foundation as measured by the standard penetration test ranged from medium dense to very dense.

Fly Ash (Impounded CCR Materials): Borings and CPTs were not performed within the footprint of the East Ash Pond to minimize any risk of compromising the existing liner system. Material properties for the CCRs in the East Ash Pond (assumed to be fly ash and bottom ash) were estimated based on data obtained from CPT soundings in CCR materials encountered in East Ash Pond No. 2. CPT correlations indicated soil behavior types corresponding to silt and sand with some gravel and clay.

Liner System: Per the "Modification to Primary Ash Pond" record drawings, the East Ash Pond has a 4-foot thick compacted clay liner on the bottom and side slopes of the pond. Under the clay liner is a 6-inch thick sand filter layer on the bottom of the pond and 12-inch thick sand layer on the side slopes of the pond. The liner was extended during the dike raise using, from top to bottom, a 8-ounce polypropylene geotextile, 1 foot of compacted clay, and a 45-mil polypropylene geomembrane. CPTs and borings were not performed within the lined area, to avoid puncturing the liner and construction documentation data was not available, therefore material properties for the liner system were estimated based on typical published values and AECOM's experience.

Bedrock: Bedrock was not encountered in the soil borings. It was estimated that bedrock is greater than 100 feet below the ground surface based on AECOM borings completed within the vicinity in 2015.

Specific information used to assess and develop the design site stratigraphy can be found in **Attachment B** – Boring Logs, **Attachment D** – CPT Data Report, and **Attachment E** – Laboratory Test Data.

3.2. Phreatic Water Conditions

AECOM evaluated piezometer data from five measurement events (10/27/15, 11/24/15, 12/17/15, 1/14/16, and 2/10/16) and borehole phreatic water depths measured immediately after drilling. Piezometer readings were judged to be the most representative of in-situ, steady state phreatic conditions. Saturated conditions did not appear to be encountered during CPT soundings surrounding the Hennepin East Ash Pond or in any of the other soil borings, other than a saturated pocket in boring HEN-B030 at 33 feet.

A total of two standpipe piezometers were installed for the Hennepin East Ash Pond. The two piezometers were installed through the perimeter embankment with the screened elevations located within the alluvial foundation soils.

Refer to **Table 2** for the piezometer locations and phreatic data.

Table 2
Piezometer Location and Water Level Data

PZ No.	Embankment	Northing[1] (NAD83 feet)	Easting[1] (NAD83 feet)	Ground Surface Elevation[1] (NAVD88 feet)	Location	PZ Type[2]	Total Depth[3] (ft)	Phreatic Surface Elevation (NAVD88 feet)				
								10/27/2015	11/24/2015	12/17/2015	1/14/2016	2/10/2016
HEN-P006	North	1690015	2533585	495.4	Crest	OSP_{stick}	43.7	452.1	452.1	452.2	452.4	452.1
HEN-P007	East	1689837	2534055	494.3	Crest	OSP_{flush}	47.4	450.7	449.4	449.7	452.8	449.3

Notes:

1. Piezometer locations based on adjacent surveyed SPT boring locations. Actual piezometer locations were not surveyed. Accuracy is assumed to be +/- 5 feet horizontal and +/- 1 foot vertical.
2. OSP = open standpipe piezometer.
3. Total Depth = Approx. bottom of screen for standpipe piezometers.

4. SUMMARY OF LABORATORY TESTING

4.1. *Summary of Laboratory Testing Scope*

Soil samples collected from the subsurface exploration were sealed at the site and transported to AECOM's laboratory testing subcontractor, Terracon of Vernon Hills, Illinois, where an AECOM geotechnical engineer reviewed and selected samples for laboratory testing. The laboratory testing program performed for the East Ash Pond was intended to obtain information on index properties and shear strength parameters of the subsurface materials at the site. The laboratory testing program for characterization of the materials at the East Ash Pond is summarized in **Table 3**.

Table 3
Summary of Laboratory Testing Program for Hennepin East Ash Pond

ASTM Designation	Test Type	Number of Tests				
		Total	Road Fill	Embankment Fill	Alluvial Foundation	Other Materials
D2216	Moisture Content	45	5	16	22	2
D4318	Atterberg Limits	3	-	3	-	-
T311[1], D1140, D422	Gradation / Hydrometer	6	1	-	5	-
D854	Specific Gravity	3	-	2	1	-
D5084	Hydraulic Conductivity	0	-	-	-	-
D2435	Consolidation	1	-	1	-	-
D 2166	Unconfined Compression	1	-	1	-	-
D4767	Consolidated Undrained Triaxial (CIU)	1	-	1	-	-
D6528	Direct Shear (DS)	1	-	1	-	-

[1] American Association of State Highway and Transportation Officials (AASHTO) test designation

4.2. *Summary of Laboratory Testing Results*

A summary of laboratory test results for the identified material horizons with the exception of the impounded CCR materials at the Hennepin East Ash Pond are presented in **Tables 4, 5** and **6**, respectively. Laboratory test data is included in **Attachment E**. Graphical displays of the shear strength characterization for the stratigraphic materials are included in the Material Characterization Calculation Package in **Attachment F**.

Table 4
Summary of Laboratory Test Results – Road Fill

Boring Number	Sample Number	Depth (feet)	USCS[1]	WC%[2]	% Gravel	% Sand	% Silt	% Clay
HEN-B029	S-1	0.0-1.5		4.7				
HEN-B030	S-1A	0.0-1.5		7				
HEN-B030	S-2	2.5-4.0	SM	6.4	34	45.7	11	9.3
HEN-B032	S-1A	0.0-1.0		2.7				
HEN-B034	S-1A	0.0-0.5		4.2				

Table 5
Summary of Laboratory Test Results –Embankment Fill

Boring Number	Sample Number	Depth (feet)	USCS[1]	WC%[2]	LL[3]	PL[4]	PI[5]	Specific Gravity	Direct Shear	
									c' (psf)[6]	phi' (deg)[7]
HEN-B029	S-2	2.5-4.0		14.7						
HEN-B029	S-3	5.0-7.0	CL	10.8	22	15	7			
HEN-B029	S-4	7.0-8.5		14.8						
HEN-B029	S-5	10.0-12.0	CL	16.7	31	17	14		62.2	31.8
HEN-B029	S-6	15.0-16.5		21.7						
HEN-B030	S-3	5.0-6.5		11.5				2.746		
HEN-B030	S-4	7.5-9.0		17.1						
HEN-B030	S-5	10.0-11.0		18.1						
HEN-B030	S-7	21.5		23.9						
HEN-B032	S-1B	1.0-1.5		7.9						
HEN-B032	S-2	2.5-4.0		9.7						
HEN-B032	S-3	5.0-7.0	CL	14	35	18	17			
HEN-B032	S-4	7.5-9.0		16.7						
HEN-B032	S-5	10.0-11.5		16.2						
HEN-B032	S-9	30.0-31.5		10.6						
HEN-B034	S-1B	0.5-1.5		9.1						
HEN-B034	S-2	2.5-4.0		14.2				2.704		
HEN-B034	S-3A	5.0-5.5		15.9						

Table 6
Summary of Laboratory Test Results – Alluvial Foundation

Boring Number	Sample Number	Depth (feet)	USCS[1]	WC%[2]	% Gravel	% Sand	% Silt	% Clay	Specific Gravity
HEN-B029	S-7	20.0-21.5		11.5					
HEN-B029	S-8	25.0-26.5		8.8					
HEN-B029	S-9	30.0-30.9		12.7					
HEN-B029	S-10	35.0-36.5	GP-GC	13.8	61	26			
HEN-B029	S-11	40.0-41.5		4.6					
HEN-B030	S-6	15.0-16.5	GW	17.6	81.4	14.8			
HEN-B030	S-8	25.0-26.5		11.2					
HEN-B030	S-10	35.0-36.5		8.9					
HEN-B030	S-11	40.0-41.5		9					
HEN-B032	S-6	15.0-16.5		8.2					
HEN-B032	S-7	20.0-21.5	SM	11.1	30.5	43.6	13.4	12.5	
HEN-B032	S-8	25.0-26.5		9.1					
HEN-B032	S-10	35.0-36.5		5.5					
HEN-B032	S-11	40.0-41.3		10.9					
HEN-B034	S-3B	5.5-6.5		1.4					
HEN-B034	S-4	7.5-9.0		2.5					
HEN-B034	S-5	10.0-11.5	GP-GM	11.2	60.1	27	7.7	5.2	
HEN-B034	S-6	15.0-16.5		9.1					2.808
HEN-B034	S-7	20.0-21.5		12.5					
HEN-B034	S-9	30.0-31.5		13.6					
HEN-B034	S-10	35.0-36.5	GP-GM	10.9	82.8	11.3			
HEN-B034	S-11	40.0-41.5		1.5					

Notes:
[1] USCS = Unified Soil Classification System
[2] WC% = Water Content (percent)
[3] LL = Liquid Limit
[4] PL = Plastic Limit
[5] PI = Plasticity Index
[6] C’ = Cohesion
[7] Phi’ = Friction Angle

5. SLOPE STABILITY ANALYSES

Slope stability analyses were performed for varying loading conditions at selected cross-sections, as described in the following sub-sections. Analysis section development, soil material properties, and seismic analyses related to the slope stability analysis are also discussed in the following sub-sections.

5.1. Cross-Sections for Analysis

Two cross sections were identified as representative cross sections for the stability evaluation of the East Ash Pond perimeter embankments. As the geometry and the foundation conditions underneath the East Ash Pond embankments were fairly uniform, sections were selected based primarily on the critical subsurface conditions and slope geometry (embankment height and slopes) along east and west sides of the East Ash Pond. Cross-sections were not analyzed along the north side of the East Ash Pond, as the grade is essentially flat beyond the East Ash Pond Dike, and therefore a slope is not present. Along the south side of the East Ash Pond, a dike is not present as the adjacent ground is sloping into the East Ash Pond, and an analysis was not performed. The location of each analysis section is listed in **Table 7** and shown on **Figure 2 (Attachment A)**.

Table 7
Cross-section Locations for Slope Stability Analyses

Cross-Section	Boring/CPT Numbers
SL-10	HEN-B029, HEN-C029
SL-12	HEN-B032, HEN-C032, HEN-C032B

The section geometry for each analysis cross-section was determined based on the site topographic survey data from Weaver Consultants Group in September of 2015, shown on **Figure 2 (Attachment A)**, and subsurface information from the borings and CPT soundings. Additionally, design drawings from the “1995 Ash Facility Hennepin Power Station” by Illinois Power Company (1993) and “Modification to Primary Ash Pond Hennepin Power Station” by Sargent & Lundy (2003) were used to supplement the subsurface investigation in developing the subsurface embankment geometry. The piezometric surfaces for each analysis section were determined based on the normal pool elevation of approximately 490.4 feet within the East Ash Pond and phreatic water level readings from the piezometers. The development of the analysis sections is discussed further in **Attachment G**.

5.2. Stability Analysis Conditions Considered

Consistent with the criteria provided in the USEPA CRR Rule § 257.73(e), the stability of the ash pond embankments was evaluated for four load cases:

Static, Steady-State, Normal Pool Condition*:* This case models the embankment under static, long-term conditions, at normal water level within the impoundment of El. 490.4 feet based on AECOM’s *Hydrologic and Hydraulic Summary Report* for the Hennepin East Ash Pond (AECOM, 2016). Drained (effective stress) shear strength parameters were used for all materials, and phreatic conditions were estimated based on available piezometer data. ***Target Factor of Safety of 1.50.***

Static, Maximum Surcharge Pool Condition: This case models the conditions under short-term surcharge pool conditions, at a surcharge pool level within the impoundment of EL. 492.2 feet, based on AECOM’s *Hydrologic and Hydraulic Summary Report* for the Hennepin East Ash Pond

(AECOM, 2016). Drained (effective stress) shear strength parameters were used for all materials, as the change in pool elevation is temporary and fairly small, and is unlikely to initiate total stress mechanisms of failure. It was assumed that the temporary surcharge load did not alter the phreatic surface in the embankment or foundation, due to the presence of a liner system. Therefore, the phreatic surface was modeled equivalent to the steady state case. ***Target Factor of Safety of 1.40.***

Seismic Slope Stability Analysis: These analyses incorporate a horizontal seismic coefficient k_h selected to be representative of expected loading during the design earthquake event (i.e., a “pseudostatic” analysis). The analyses utilized peak undrained strengths for all materials. The pool elevation and phreatic conditions corresponding to the steady state pool from the static analyses were utilized for this analysis. ***Target Factor of Safety of 1.00***.

Post-Liquefaction Slope Stability Analyses: Soils susceptible to liquefaction were not identified in the embankment or foundation soils at the East Ash Pond. Therefore, post-liquefaction conditions were not evaluated.

5.3. Material Properties

Material properties for slope stability analyses were developed using laboratory testing data (index and strength testing) and strength correlations from CPT and SPT data. The material characterization and development of strength parameters is described further in **Attachment F**.

Unit weight for the embankment fill was evaluated using laboratory test results from relatively undisturbed samples. All other materials were conservatively assigned unit weights based on typical published values and previous experience with similar materials.

Effective (drained) shear strengths for the embankment fill layers were evaluated using results from the consolidated undrained triaxial (CIU) and direct shear (DS) tests, as well as correlations with SPT data. In general, when assigning lab tests, direct shear tests were assigned for deeper samples and CIU tests were assigned to shallower samples to match the assumed orientation of the slope stability slip surface.

Total (undrained) shear strengths were developed using CIU and unconfined compression (UC) tests for the embankment fill and fly ash, as well and published correlations for SPT data.

The material properties developed for use in the slope stability analyses are listed in **Table 8**.

Table 8
Material Properties for Slope Stability Analyses

Material	Unit Weight Above and Below WT (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c’ (psf)	Φ’ (°)	c (psf)	Φ (°)
Road Fill	130	0	38	0	38
Embankment Fill	105	30	32	2500	0
Alluvial Foundation	135	0	38	0	38
Fly Ash	105	100	27	600	0
Liner System	120	60	30	2500	0

5.4. Methodology of Analyses

Limit equilibrium stability analysis was completed using the two-dimensional SLOPE/W 2012 (v. 8.15.4.11512 by GeoStudio) computer program. Factors of safety were calculated using Spencer's method utilizing circular search routines with optimization to develop non-circular sliding planes through lower-strength layers which may represent a lower factor of safety. Pore pressures were assigned as hydrostatic pressure under the piezometric line.

A brief summary of the analyses is presented in the following sections. A more detailed discussion is provided in **Attachment G**.

5.4.1. Static Analysis Conditions

Static stability was evaluated for steady-state phreatic conditions using both the normal pool elevation and the maximum flood surcharge pool elevation. Phreatic surfaces for impounded CCR materials in the stability models were developed utilizing a normal pool elevation of 490.4 feet and a maximum flood surcharge pool elevation of 492.2 feet. Phreatic surfaces for all non-impounded fill and native materials were modeled at elevations of 450 feet in cross section SL-12 and 452 feet in cross section SL-10, based on data form piezometers installed by AECOM.

5.4.2. Earthquake Analysis Conditions

Earthquake ground motions at the site were developed using simplified procedures, as described in the following sub-sections.

5.4.3. Determination of Ground Motion Parameters

Seismic ground motions were estimated using the United States Geological Survey (USGS) 2008 Interactive Deaggregation tool (http:earthquake.usgs.gov/hazards/apps/). This application generates acceleration values, including peak ground acceleration (PGA) for top of rock, and mean and modal moment magnitudes based on user entered values of location, exceedance probability, and spectral period. Results are computed based on the 2008 National Seismic Hazard Mapping Project (NSHMP) Probabilistic Seismic Hazard Analysis (PSHA) Seismic Hazard Maps.

For the Hennepin Power Station, the calculated PGA for an event with a probability of exceedance of 2% in 50 years (approximately a 2,500 year event) was 0.073g for top of hard rock. To estimate the free-field, ground surface horizontal acceleration, the site was classified according to the site classes defined in the International Building Code (2003) and amplified using the site amplification factors found in NEHRP (2009). The site class was determined based on the weighted average of the shear wave velocities of the upper 100 feet of the stratigraphic profile and found to be Site Class D (600 ≤ Vs ≤ 1,200 ft/sec). This corresponds to a NEHRP amplification factor of 1.6, resulting in a ground surface acceleration of 0.119g. The Peak Transverse Acceleration at the dike crest was estimated using the ground surface acceleration and the procedure proposed by Idriss (2015), resulting in a peak crest acceleration of 0.35g. Details of the estimation of ground motion parameters are included in **Attachment G**.

5.4.4. Seismic Coefficient

The seismic coefficient was calculated for use in the pseudo-static slope stability analysis based on the simplified procedure developed by Makdisi and Seed (1978). For the estimated peak crest acceleration value of 0.34g and full-height slip surfaces that were identified in the stability analyses (presented in **Attachment G**), a seismic coefficient of 0.119g was estimated for the pseudo-static analyses.

5.4.5. Liquefaction Triggering Analysis

Liquefaction is used to describe the contraction of coarse-grained (i.e. cohesionless) sand and gravel soils under cyclic loading imposed by earthquake shaking. The result is a reduction in the effective confining stress within the soil and an associated loss of strength (Idriss and Boulanger 2008). Liquefaction only occurs in saturated soils. Liquefaction susceptibility also largely depends on compositional characteristics such as particle size, shape, and gradation; however, laboratory and field observations also indicate that plasticity characteristics influence liquefaction susceptibility (Kramer 1996). Idriss and Boulanger (2008) suggested that soils with a plasticity index (PI) greater than about 7 are not susceptible to liquefaction.

AECOM's field exploration did not encounter saturated cohesionless soils in the embankment or foundation of the East Ash Pond. All cohesive soils encountered by AECOM were also unsaturated, and had PI's equal to or greater than 7, which means that neither the cohesive or cohesionless soils encountered in AECOM's field exploration are susceptible to liquefaction. However, AECOM's piezometers did indicate that the alluvial sand and gravel is typically saturated below El. 450 to 452 feet beneath the embankments, while the deepest SPT data collected by AECOM was at El. 452.8 feet. SPT blowcounts collected by AECOM in the alluvial sand and gravel between El. 470 and 452.8 feet ranges from 17 to 85 blows per foot, with a mean value of 53 blows per foot. Based on correlations provided in Idriss and Boulanger (2008), these blow counts are generally well above any case history where liquefaction was identified, meaning that the risk of liquefaction is low given the relatively low seismicity at the Hennepin Power Station and high observed blowcounts. Two SPT blowcounts, of 17 and 21, represent the lower-bound data for the alluvial sand, while most of the data is above 30 blows per foot. Consequently, a formal liquefaction analysis was determined unnecessary as the embankment and foundation soils at the site are not susceptible to liquefaction based on their composition, consistency, index properties, and observed saturation.

Due to the typically stiff nature of the compacted clay embankment fill, and relatively low seismicity at the site, the materials are also not susceptible to cyclic softening.

6. RESULTS

6.1. Results of Static Stability Analyses

The results of the limit equilibrium slope stability analyses for the static load cases are summarized in **Table 9**. The SLOPE/W output figures showing the critical slip surfaces and details of the analyses are included in **Attachment G.1**.

Table 9
Summary of Minimum Slope Stability Factors of Safety for Static Load Cases

Load Case	Program Criteria	Cross-Section	
		SL-10	SL-12
Steady State (Normal Pool)	FS≥1.50	2.14	2.81
Surcharge Pool (Flood Pool)	FS≥1.40	2.14	2.81

6.2. Results of Earthquake Stability Analyses

6.2.1. Slope Stability Analysis

The results of the slope stability analyses for the seismic load cases are summarized in **Table 10**. The SLOPE/W output figures showing the critical slip surfaces and details of the analyses are included in **Attachment G.1**.

Table 10
Summary of Minimum Slope Stability Factors of Safety for Earthquake Load Cases

Load Case	Program Criteria	Cross Section	
		SL-10	SL-12
Seismic (Pseudostatic)	FS ≥ 1.00	4.23	2.53

7. CONCLUSIONS

The calculated factors of safety from the limit equilibrium slope stability analysis satisfy the USEPA CCR Rule § 257.73(e) requirements for each loading condition at all of the analysis sections that represent the embankments of East Ash Pond at the Hennepin Power Station. Load cases analyzed for this study included static (steady-state) normal pool, maximum flood surcharge pool and seismic (pseudo-static).

8. LIMITATIONS

Background information, design basis, and other data have been furnished to AECOM by DMG. AECOM has used this data in preparing this report. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information.

Borings have been spaced as closely as economically feasible, but variations in soil properties between borings, that may become evident at a later date, are possible. The conclusions developed in this report are based on the assumption that the subsurface soil, rock, and phreatic water conditions do not deviate appreciably from those encountered in the site-specific exploratory borings. If any variations or undesirable conditions are encountered in any future exploration, we should be notified so that additional analyses can be made, if necessary.

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 DMG. 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 geotechnical investigation 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 geological and geotechnical 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.

9. REFERENCES

AECOM (2016). Hydrologic and Hydraulic Summary Report for Hennepin Power Station, Primary Ash Pond CCR Unit.

Illinois Power Company (1993) “1995 Ash Facility Hennepin Power Station”.

Sargent & Lundy (2003) “Modification to Primary Ash Pond Hennepin Power Station”.

GEO-SLOPE International Ltd. (2015). “GeoStudio 2012 (SLOPE/W and SEEP/W).” Calgary,Alberta, Canada.

Idriss, I. M., and Boulanger, R. W. (2008). *Soil Liquefaction During Earthquakes*. Earthquake Engineering Research Institute, Oakland, California, USA.

Weaver Consultants Group. (September 2015). Survey data.

International Code Council, (2003), 2003 International Building Code.

Kramer, S. L. (1996). *Geotechnical Earthquake Engineering*. *Engineering*, Prentice-Hall, Inc., Upper Saddle River, NJ.

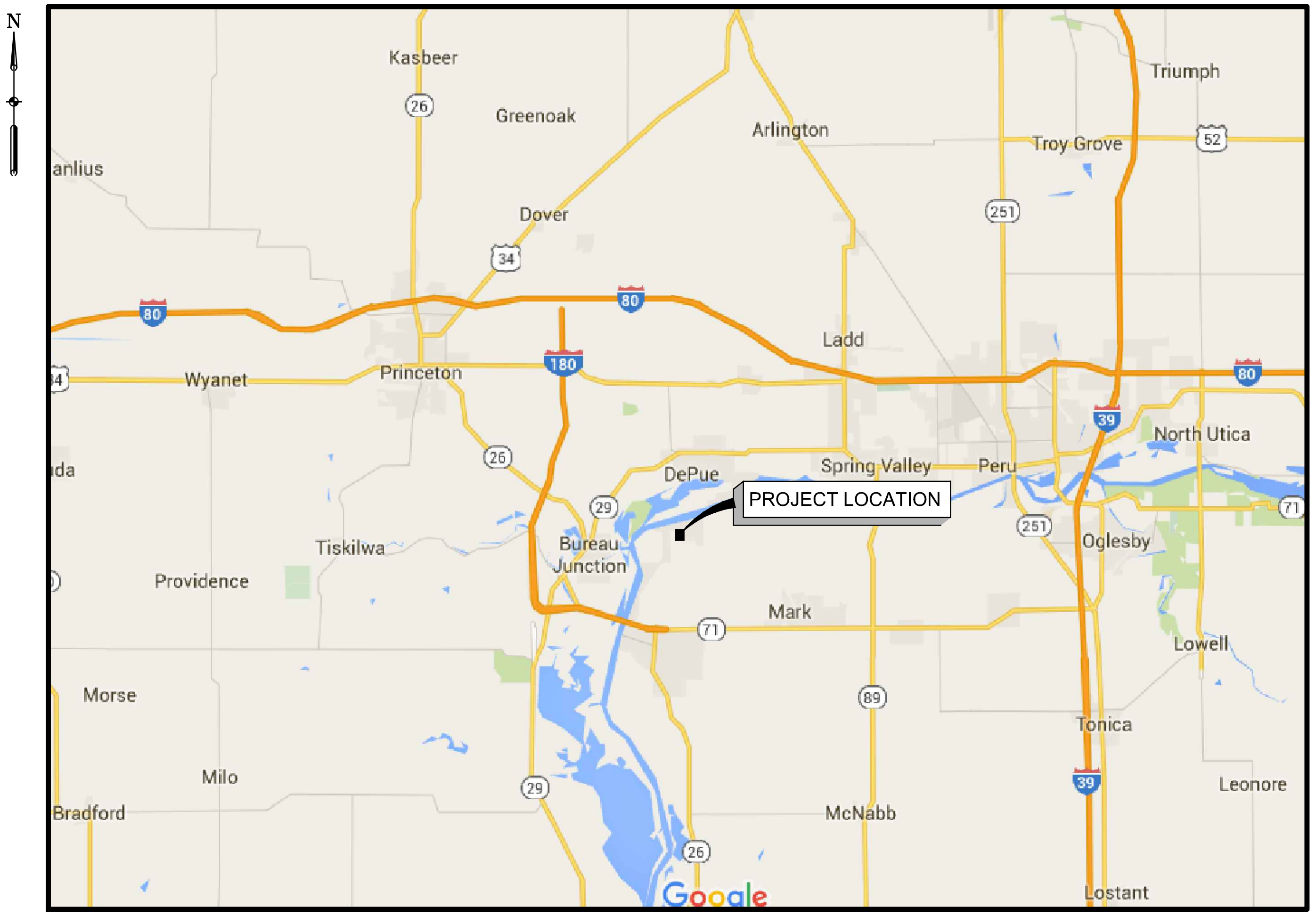
Makdisi, F. I., and Seed, H. B. (1978). “A Simplified Procedure for Estimating Dam and Embankment Earthquake-Induced Deformations.” *Journal of the Geotechnical Engineering Division*, 104(7), 849–867.

NEHRP (National Earthquake Hazards Reduction Program), (2009) Recommended Seismic Provisions for New and Other Structures, (FEMA P-750), 2009 Edition.

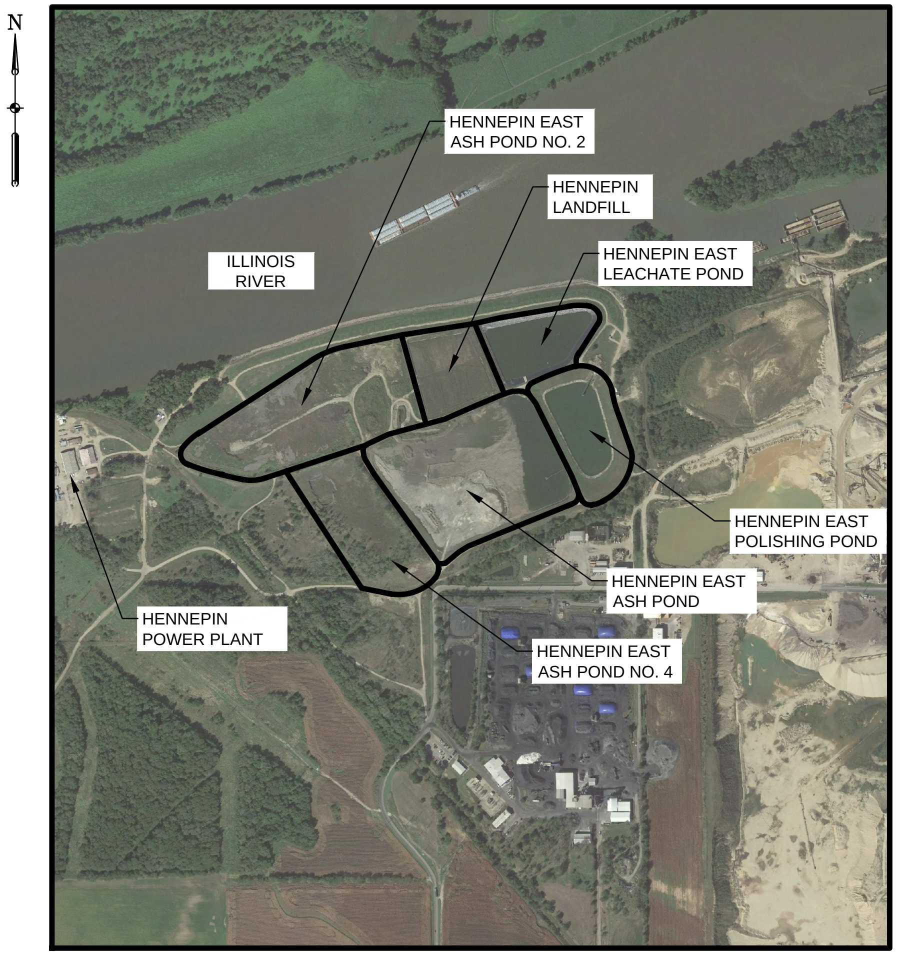
U.S. Environmental Protection Agency [USEPA]. (2015). *Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments*. 40 CFR §257. Federal Register 80, Subpart D, April 17, 2015.

Attachment A. Figures

AECOM DRAWING PATH: K:\Projects\60427894-Dynegy\900-WORKING DOCS-CAD\902-SHEETS\30% Design Sheets_East\Draft Geotechnical Report for Dynegy Hennepin Ash Pond CCR Unit\HEN 1-1 LOCATION PLAN.dwg
ALLEN, SHANNON (OSHKOSH), 3/2/2016 9:21 AM



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

AERIAL FROM GOOGLE EARTH PRO
MAP FROM GOOGLE

AECOM
558 N Main Street
Oshkosh, Wisconsin
920 235-0270 (phone)
920 235-0321 (fax)

DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

CCR RULE ASSESSMENT OF PLANTS

HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

GEOTECHNICAL REPORT
EAST ASH POND

ISSUED FOR BIDDING
DATE BY

ISSUED FOR CONSTRUCTION
DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
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△		
△		
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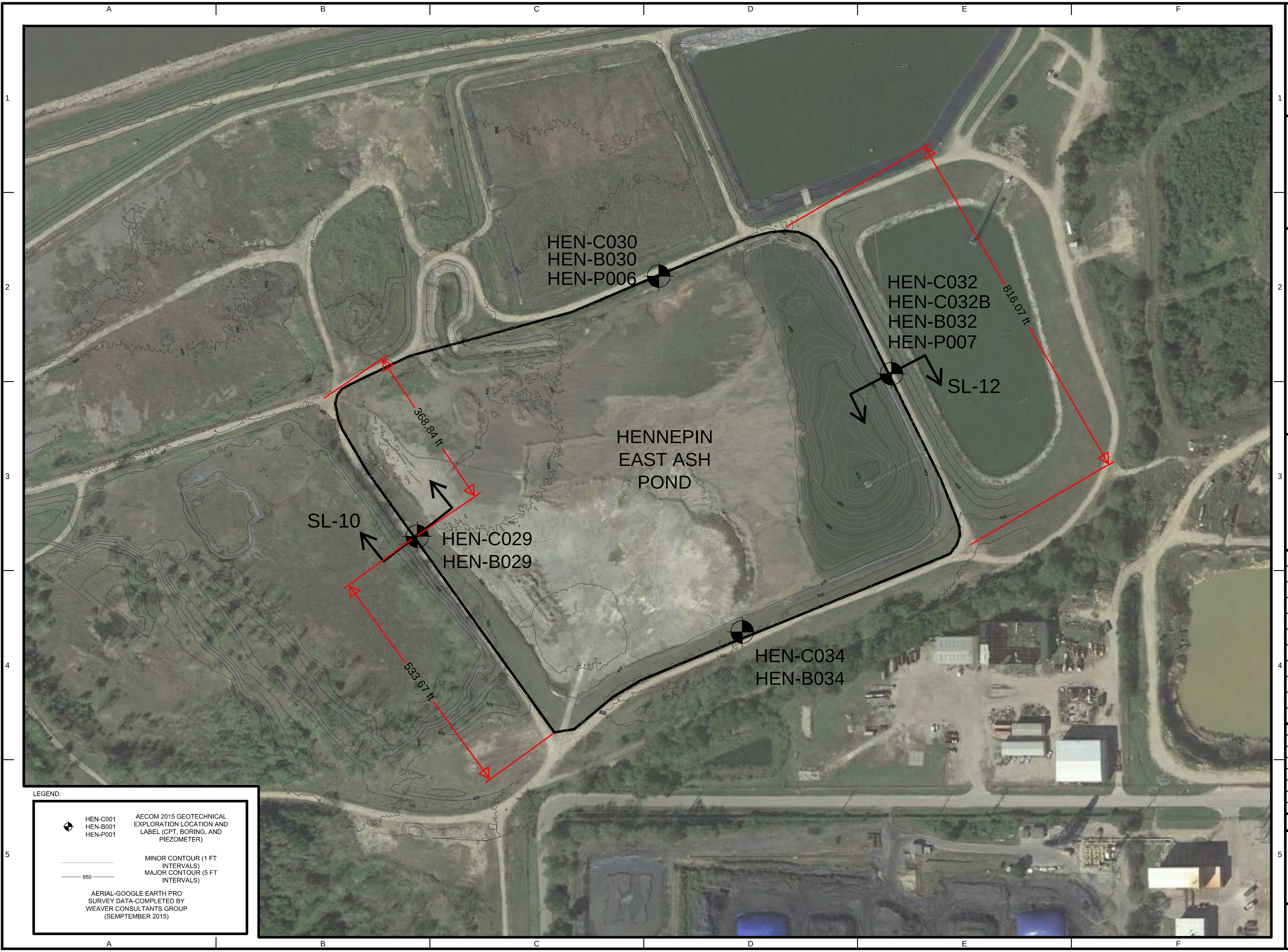
AECOM PROJECT NO:	60439752
DRAWN BY:	TPB
DESIGNED BY:	TPB
CHECKED BY:	SRA
DATE CREATED:	2/25/2016
PLOT DATE:	2/26/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

LOCATION MAP AND
SITE VICINITY MAP

FIGURE 1



LEGEND:

⌖	HEN-C001 HEN-B001 HEN-P001	AECOM 2015 GEOTECHNICAL EXPLORATION LOCATION AND LABEL (CPT, BORING, AND PIEZOMETER)
———		MINOR CONTOUR (1 FT INTERVALS)
—— 950 ——		MAJOR CONTOUR (5 FT INTERVALS)

AERIAL-GOOGLE EARTH PRO
SURVEY DATA-COMPLETED BY
WEAVER CONSULTANTS GROUP
(SEMPTEMBER 2015)

AECOM DRAWING PATH: K:\Projects\60427894–Dynegy\900–WORKING DOCS–CAD\902–SHEETS\30% Design Sheets_East\Draft Geotechnical Report for Dynegy Hennepin Ash Pond CCR Unit\HEN 2–1 OVERALL GEOTECHNICAL SITE PLAN.dwg

BRAND, TRAVIS, 2/26/2016 8:40 AM

AECOM
558 N Main Street
Oshkosh, Wisconsin
920 235-0270 (phone)
920 235-0321 (fax)

DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

HENNEPIN POWER PLANT
HENNEPIN, ILLINOIS

N

250.52 ft
0 125 250
SCALE IN FEET

ISSUED FOR BIDDING ________ DATE BY

ISSUED FOR CONSTRUCTION ________ DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
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△		

AECOM PROJECT NO:	60439752
DRAWN BY:	TPB
DESIGNED BY:	TPB
CHECKED BY:	SRA
DATE CREATED:	2/25/2016
PLOT DATE:	2/26/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

OVERALL
GEOTECHNICAL
SITE PLAN

FIGURE 2

Attachment B. Boring Logs

Project:	HENNEPIN POWER STATION
Project Location:	HENNEPIN, ILLINOIS
Project Number:	60439752

Key to Soil Boring Logs

Sheet 1 of 1

	Graphic Symbol	Description	USCS Classification
SAND AND GRAVEL	⁘	SAND poorly graded	SP
	⁙	SAND well graded	SW
	▥	Silty SAND	SM
	▨	Clayey SAND	SC
	●	GRAVEL poorly graded	GP
LOW PLASTIC SILTS AND CLAYS	▥	Inorganic low plastic SILT	ML
	▨	Inorganic low plastic CLAY	CL
	▥	Inorganic low plastic SILTY-CLAY	CL-ML
HIGH PLASTIC SILT AND CLAYS	▨	Inorganic high plastic CLAY	CH
	▨	Sandy Inorganic high plastic CLAY	CH
	▨	Inorganic elastic SILT	MH
SURFACE MATERIALS	■	Asphalt, Pavement	
	⁘	Topsoil	
	▩	Gravel Limestone	
	◪	Fly Ash	
	◪	Bottom Ash	
	◪	Fill	

TERMS DESCRIBING DENSITY OR CONSISTENCY

Coarse grained soils (major portion retained on No. 200 sieve) include gravels and sands. Density is based on the Standard Penetration Test (SPT).

Density	SPT blows per foot
Very loose	0 - 5
Loose	5 - 10
Medium dense	10 - 30
Dense	30 - 50
Very dense	Greater than 50

Fine grained soils (major portion passing No. 200 sieve) include clays and silts. Consistency is rated according to shearing strength, as indicated by uncorrected SPT blows per foot.

Descriptive Term	SPT blows per foot	Estimated undrained shear strength (ksf)	Hand Test
Very soft	0-2	< 0.25	Extrudes between fingers
Soft	2-4	0.25-0.5	Molded by slight pressure
Medium stiff	4-8	0.5-1.0	Molded by strong pressure
Stiff	8-15	1.0-2.0	Indented by thumb
Very stiff	15-30	2.0-4.0	Indented by thumbnail
Hard	> 30	> 4.0	Difficult to indent

LEGEND AND NOMENCLATURE

⧄	Standard penetration split spoon test sample
▥	Undisturbed shelby tube sample
PP qu	Pocket penetrometer unconfined compressive strength
NMC	Natural Moisture Content, %
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
NP	Non-plastic
▽	Depth Groundwater enters at time of drilling.
▼	Groundwater Level at some specified time after drilling
Su	Undrained Shear Strength
TXUU	Triaxial Unconsolidated Undrained
DTW	Depth to water
N/A	Not Applicable

SAMPLING RESISTANCE

P	Sample pushed by hydraulic rig action.
3 6 9	Numbers indicate blows per 6 in. of sampler penetration. Standard penetration test sampler, (2-in O.D.) and oversize penetration sample (3-in O.D.) are driven by a 140 lb hammer falling freely 30-in
50/2	Number of blows (50) used to drive a penetration sampler a certain number of inches (2)
WOH	Weight of hammer
WOR	Weight of rods

ABBREVIATIONS USED UNDER "REMARKS"

HSA	Hollow Stem Auger	No.	Number
ATD	At Time of Drilling	CIU	Isotropically Consolidated Undrained
AD	After Drilling	ST	Shelby Tube
ID	Inside Diameter	SS	Split Spoon
OD	Outside Diameter		
RQD	Rock Quality Designation		
-#200	(% Pass #200 Sieve)		
Sa (%)	Sieve Analysis (% Passing #200)		

AECOM

File: P:\RESOURCES\GINTDATA\GINT\GEOTECHNICAL\BORING KEY LOGS\DYNEGY GEO KEY.DWG Last edited: DEC. 16, 15 @ 09:38 a.m. by: david_deguire

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B029

Sheet 1 of 2

Date(s) Drilled	12:00AM 10/01/2015 to 12:00AM 10/01/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drilled By	S. Komen	Borehole Depth	41.5 '
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	499.7 ' (NAVD88)
Borehole Backfill	Portland Cement and Grout	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Hammer Data	Automatic, 140 lbs, 30" drop
Boring Location	N 1689435.679 E 2533022.216 (NAD83)	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Groundwater Level(s)	Not Encountered

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
499.7	0.0		SS-1	24 28 34	556		Very dense, dry, brown, silty GRAVEL (GM) [Road Fill].	4.7							
497.2	2.5		SS-2	10 6 11	556		Stiff to very stiff, dry, brown to very dark brown and gray, lean CLAY (CL) with sand and gravel [Embankment Fill].	14.7				4.5			
			ST-3		417			10.8		22	7	4.5			*Pushed shelby tube from 5.0 to 7.0 feet*
			SS-4	12 14 17	556			14.8				4.0			
			ST-5		417			16.7		31	14	2.5			*Pushed shelby tube from 10.0 to 12.0 feet*
484.7	15.0		SS-6	4 6 8	461		Stiff, dark brown with trace rust, lean CLAY (CL), trace fine to coarse gravel [Embankment Fill].	21.7				1.5			
479.5	20.2		SS-7	6 12 20	433		Dense, dry, brown, clayey GRAVEL with sand (GP-GC).	11.5				1.5			
			SS-8	17 17 43	311			8.8							

Elevation (feet): 495, 490, 485, 480, 475, 470

Depth (feet): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B029

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
	30	▨	SS-9	29 50/5"	122		12.7							*Less fines in Sample 9*
	32													
465	34													
	36	▨	SS-10	20 25 28	339		13.8							
	38													
460	40	▨	SS-11	16 14 15	33		4.6							
458.2	41.5					End of Boring at 41.5 '								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
	42													
	44													
455	46													
	48													
450	50													
	52													
	54													
445	56													
	58													
440	60													
	62													
	64													
435														

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B030

Sheet 1 of 2

Date(s) Drilled	**12:00AM 09/29/2015 to 12:00AM 09/30/2015**	Logged By	**Norm Seiler**	Checked By	**AJW**
Drilling Method	**Hollow-Stem Auger**	Drilled By	**S. Komen**	Borehole Depth	**41.5 '**
Drill Rig Type	**Mobile 57 Truck Mounted**	Drilling Contractor	**Strata Earth Services**	Surface Elevation	**495.4 ' (NAVD88)**
Borehole Backfill	**Portland Cement and Grout**	Drill Bit Size/Type	**3 7/8" Tricone Roller Bit**	Hammer Data	**Automatic, 140 lbs, 30" drop**
Boring Location	**N 1690014.94 E 2533585.318 (NAD83)**	Sampling Method(s)	**Split Spoon/3" Thin Walled Tube**	Groundwater Level(s)	**33.0 ' at 12:00AM on 09/30/2016**

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	Elevation (feet)	Depth (feet)	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
495	0		SS-1	22 17 37	461		495.4	0.0	Very Dense, Brownish gray sand, gravel, and clay [Fill].	7.0							
	2		SS-2	15 17 15	372		492.9	2.5	Dense, Brown and light brown, silty sand with gravel (SM) [Fill].	6.4							
	4						491.4	4.0	Very Dense, Dark gray silty SAND (SM) with trace gravel, sand, and clay, with ASH [Fill].								
490	6		SS-3	18 20 30	461					11.5							
	8		SS-4	4 5 6	556				Becomes medium dense	17.1							9.0 feet: Wet
485	10		ST-5		275		485.4	10.0	Black ASH with gravel [Fill].	18.1							Pushed shelby tube from 10.0 to 11.0 feet 10.0 feet: Switch to mud rotary
	12																
	14																
480	16		SS-6	11 11 16	311		480.4	15.0	Medium dense, light brown and tan, well graded GRAVEL with sand (GW) [Embankment Fill].	17.6							
	18																
475	20		SS-7	3 4 7	122		475.4	20.0	Soft, dark gray and rust CLAY (CL) with organics and wood.	23.9							
	22																
	24																
470	26		SS-8	30 36 40	494		470.4	25.0	Dense to very dense, brown and some black, clayey fine to coarse GRAVEL (GC) with sand.	11.2							25.0 feet - Drillers note - rock pieces in Sample 8
	28																
	30																

Log of Boring HEN-B030

Elevation (feet)	Depth (feet)	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resist. OR Core RQD (%)	SAMPLES Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	MATERIAL DESCRIPTION	MATERIAL DESCRIPTION Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
465	30	▨	SS-9	56	42	▨											
	32					▨											
	34					▨											*33.0 feet - Drillers note - water level at 33.0 feet and dropping*
460	36	▨	SS-10	7 8 25	211	▨				8.9							
	38					▨											
455	40	▨	SS-11	20 46 27		▨	453.9		41.5	9.0							
	42							End of Boring at 41.5 '									*Boring backfilled with 2 batches Portland Cement and bentonite grout*
	44																
450	46																
	48																
445	50																
	52																
	54																
440	56																
	58																
435	60																
	62																
	64																

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B032

Sheet 1 of 2

Date(s) Drilled	12:00AM 09/30/2015 to 12:00AM 09/30/2015	Logged By	Robert Weseljak	Checked By	AJW
Drilling Method	Mud Rotary	Drilled By	S. Komen	Borehole Depth	41.5 '
Drill Rig Type	Mobile 57 Truck Mounted	Drilling Contractor	Strata Earth Services	Surface Elevation	494.3 ' (NAVD88)
Borehole Backfill	Portland Cement and Grout	Drill Bit Size/Type	3 7/8" Tricone Roller Bit	Hammer Data	Automatic, 140 lbs, 30" drop
Boring Location	N 1689837.064 E 2534055.482 (NAD83)	Sampling Method(s)	Split Spoon/3" Thin Walled Tube	Groundwater Level(s)	Not Encountered

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet)	Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
	0	▨	SS-1	32 29 20	372	^ ^ ^	494.3 Very dense, dry, brown, fine to coarse well graded GRAVEL with silt and sand [Fill].	0.0	2.7				4.5			
						▨	493.3 Hard, dry, dark brownish gray, Lean CLAY (CL)with sand and gravel [Embankment Fill]	1.0								
	2					▨										
490	4	▨	SS-2	6 18 17	556	▨			9.7				3.5			
	6	▤	ST-3		329	▨			14.0		35	17	4.5			*Pushed shelby tube from 5.0 to 7.0 feet*
485	8	▨	SS-4	8 12 16	556	▨			16.7				3.5			
	10	▨	SS-5	8 16 20	244	▨			16.2				0.5			*10.0 feet: Coarse gravel*
	12					▨										
480	14					▨										
	16	▨	SS-6	19 39 43	400	∴	479.3 Very dense, moist, brown, Silty SAND (SM) with gravel.	15.0	8.2							
	18					∴										
475	20	▨	SS-7	18 36 50/3"	339	∴			11.1							
	22					∴										
470	24					∴										
	26	▨	SS-8	98 35 50/4"	433	∴			9.1							*24.5: Drillers Note - boulder from 24.5 to 25.2 feet*
	28					∴										
465	30					∴	464.3	30.0								

AECOM

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B032

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
	30	▨	SS-9	18 11 30	556	▨	Hard, moist, brown, fine to coarse gravelly lean CLAY (CL).	10.6				3.0 4.5			
459.3	35.0	▨	SS-10	41 28 40	372	▒	Very dense, moist, brown and black, clayey fine to coarse Silty SAND (SM) with gravel.	5.5							
	40	▨	SS-11	12 18 50/4"	400	▒		10.9							
452.8	41.5						End of Boring at 41.5 '								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*

AECOM

Report: GEO_SOIL; File P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\21_REVISED_CERT_REPORTS\08_HEN\REV 1\GEOTECH\ATTACHMENT REVISIONS\ATT. A&B_FIGURES-GINT\60439752_HENNEPINDYNEGYBORINGLOGS_EAST ASH POND.GPJ; 9/22

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B034

Sheet 1 of 2

Date(s) Drilled	**12:00AM 09/30/2015 to 12:00AM 10/01/2015**	Logged By	**Robert Weseljak**	Checked By	**AJW**
Drilling Method	**Mud Rotary**	Drilled By	**S. Komen**	Borehole Depth	**41.5 '**
Drill Rig Type	**Mobile 57 Truck Mounted**	Drilling Contractor	**Strata Earth Services**	Surface Elevation	**499.3 ' (NAVD88)**
Borehole Backfill	**Portland Cement and Grout**	Drill Bit Size/Type	**3 7/8" Tricone Roller Bit**	Hammer Data	**Automatic, 140 lbs, 30" drop**
Boring Location	**N 1689245.6 E 2533830.734 (NAD83)**	Sampling Method(s)	**Split Spoon/3" Thin Walled Tube**	Groundwater Level(s)	**Not Encountered**

Elevation (feet)	Depth (feet)	SAMPLES Type Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	MATERIAL DESCRIPTION (Elevation (feet) / Depth (feet))	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
499.3	0.0												
498.8	0.5				Very dense, dry, brown, silty SAND (SM) [Fill].								
					Hard, dry, black, gravelly lean CLAY (CL) [Fill].								
		SS-1	25 19 21	556		4.2				1.5 2.5			
		SS-2	7 8 11	556		14.2				3.5 4.5			
494.3	5.0				Dense, dry, brown, silty SAND (SM).								
493.8	5.5				Very dense, moist, brown to gray, silty fine to coarse GRAVEL (GP-GM) with silt [Embankment Fill].								
		SS-3	17 28 32	556		15.9							
		SS-4	11 18 32	556		2.5							
		SS-5	27 35 18	311		11.2							
		SS-6	21 24 25	244		9.1							
479.3	20.0				Medium dense, dry, silty fine to coarse GRAVEL (GM).								
		SS-7	10 11 9	244		12.5							
		SS-8	11 13 16	33									
469.3	30.0												

Report: GEO_SOIL; File P:\PROJECTS\GEOTECH\60428794_DYNEGYCCR\21_REVISED_CERT_REPORTS\08_HEN\REV 1\GEOTECH\ATTACHMENT REVISIONS\ATT. A&B_FIGURES-GINT\60439752_HENNEPINDYNEGYBORINGLOGS_EAST ASH POND.GPJ; 9/22

Project: Hennepin Power Station

Project Location: Hennepin, Illinois
Project Number: 60439752

Log of Boring HEN-B034

Sheet 2 of 2

Elevation (feet)	Depth (feet)	SAMPLES Type	Number	Sampling Resist. OR Core RQD (%)	Recovery (%)	Graphic Symbol	MATERIAL DESCRIPTION Elevation (feet) / Depth (feet)	Natural Moisture Content (%)	Total Unit Weight (pcf)	Liquid Limit	Plasticity Index	Pocket Pen. Su (ksf)	Torvane Su (ksf)	TXUU, Su (ksf)	REMARKS
	30	▨	SS-9	14 14 12	122		Medium dense, moist to wet, light brown and tan, poorly graded GRAVEL (GP-GM) with sand and silt.	13.6							
	32														
465	34														
	36	▨	SS-10	9 11 10	372			10.9							
	38														
460	40	▨	SS-11	10 8 9	94		457.8 / 41.5	1.5							
	42						End of Boring at 41.5 '								*Boring backfilled with 94 pounds of Portland Cement and 25 pounds of bentonite*
455	44														
	46														
	48														
450	50														
	52														
445	54														
	56														
	58														
440	60														
	62														
435	64														

AECOM

Attachment C. Piezometer Logs

Project: Dynegy

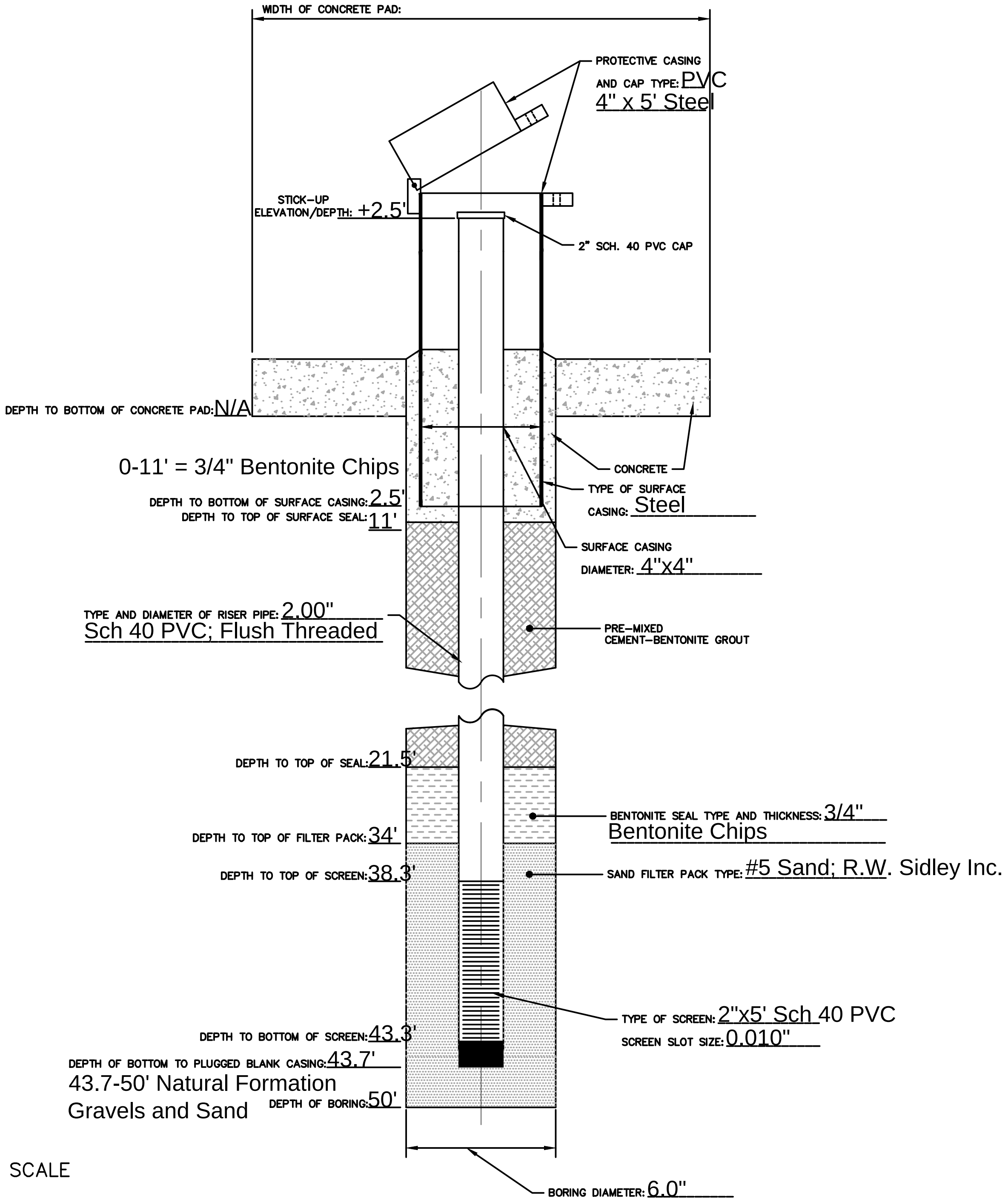
Project Location: Hennepin, IL

Project Number: 60439752

Log of Piezometer

Sheet 1 of 1

Piezometer Location	P006	Date Installed	10/20/15	Time	11:20 A.M.
Installed By	Scott Komen	Observed By	R. Weseljak	Total Depth	50'
Method of Installation	6" Tricone Mud Rotary	Drilling Contractor	Strata	Surface Elevation	495.4'
Screened Interval	38.3-43.3'	Completion Zone	Gravel		
Remarks		Groundwater Level(s)	45.74' T.O.C.		



WIDTH OF CONCRETE PAD:

PROTECTIVE CASING AND CAP TYPE: PVC 4" x 5' Steel

STICK-UP ELEVATION/DEPTH: +2.5'

2" SCH. 40 PVC CAP

DEPTH TO BOTTOM OF CONCRETE PAD: N/A

CONCRETE

0-11' = 3/4" Bentonite Chips

TYPE OF SURFACE CASING: Steel

DEPTH TO BOTTOM OF SURFACE CASING: 2.5'

DEPTH TO TOP OF SURFACE SEAL: 11'

SURFACE CASING DIAMETER: 4"x4"

TYPE AND DIAMETER OF RISER PIPE: 2.00" Sch 40 PVC; Flush Threaded

PRE-MIXED CEMENT-BENTONITE GROUT

DEPTH TO TOP OF SEAL: 21.5'

BENTONITE SEAL TYPE AND THICKNESS: 3/4" Bentonite Chips

DEPTH TO TOP OF FILTER PACK: 34'

DEPTH TO TOP OF SCREEN: 38.3'

SAND FILTER PACK TYPE: #5 Sand; R.W. Sidley Inc.

TYPE OF SCREEN: 2"x5' Sch 40 PVC

SCREEN SLOT SIZE: 0.010"

DEPTH TO BOTTOM OF SCREEN: 43.3'

DEPTH OF BOTTOM TO PLUGGED BLANK CASING: 43.7'

43.7-50' Natural Formation Gravels and Sand

DEPTH OF BORING: 50'

BORING DIAMETER: 6.0"

NOT TO SCALE

AECOM

Project: Dynegy

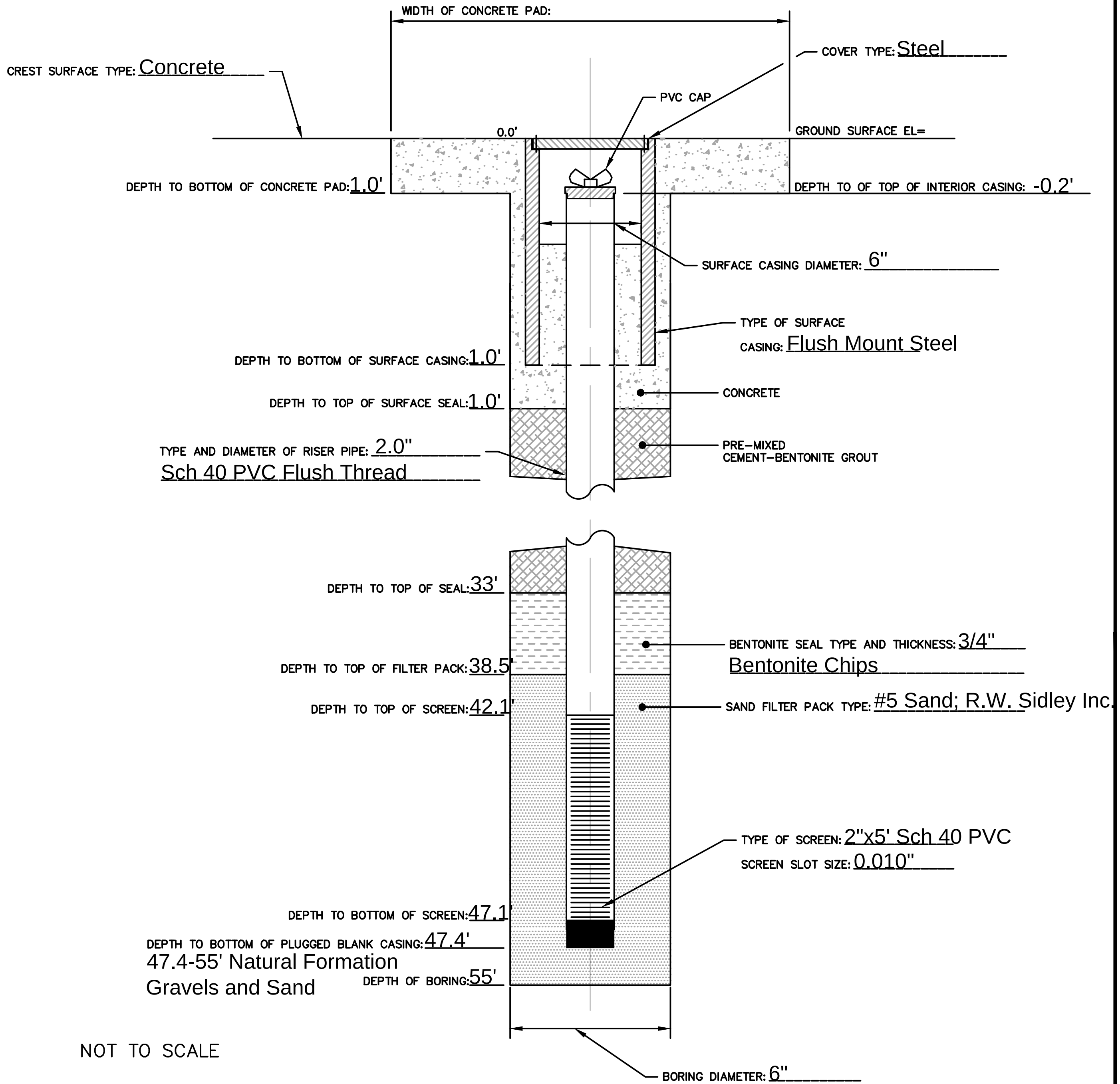
Project Location: Hennepin, IL

Project Number: 60439752

Log of Piezometer

Sheet 1 of 1

Piezometer Location P007	Date Installed 10/21/15	Time 5:00 P.M.
Installed By Scott Komen	Observed By R. Weseljak	Total Depth 55'
Method of Installation 6" Tricone Mud Rotary	Drilling Contractor Strata	Surface Elevation 494.3'
Screened Interval 42.1-47.1'	Completion Zone Gravels	
Remarks	Groundwater Level(s) 44.65' T.O.C.	



CREST SURFACE TYPE: Concrete

COVER TYPE: Steel

DEPTH TO BOTTOM OF CONCRETE PAD: 1.0'

DEPTH TO OF TOP OF INTERIOR CASING: -0.2'

SURFACE CASING DIAMETER: 6"

TYPE OF SURFACE CASING: Flush Mount Steel

DEPTH TO BOTTOM OF SURFACE CASING: 1.0'

DEPTH TO TOP OF SURFACE SEAL: 1.0'

TYPE AND DIAMETER OF RISER PIPE: 2.0" Sch 40 PVC Flush Thread

DEPTH TO TOP OF SEAL: 33'

BENTONITE SEAL TYPE AND THICKNESS: 3/4" Bentonite Chips

DEPTH TO TOP OF FILTER PACK: 38.5'

DEPTH TO TOP OF SCREEN: 42.1'

SAND FILTER PACK TYPE: #5 Sand; R.W. Sidley Inc.

TYPE OF SCREEN: 2"x5' Sch 40 PVC

SCREEN SLOT SIZE: 0.010"

DEPTH TO BOTTOM OF SCREEN: 47.1'

DEPTH TO BOTTOM OF PLUGGED BLANK CASING: 47.4'

47.4-55' Natural Formation
Gravels and Sand

DEPTH OF BORING: 55'

BORING DIAMETER: 6"

NOT TO SCALE

AECOM

Attachment D. CPT Data Report

Cone Penetration Test Summary and

Standard Cone Penetration Test Plots

Job No: 15-53081
Client: AECO
Project: Hennepin Power Station, Hennepin, IL
Start Date: 01-Sep-2015
End Date: 11-Sep-2015

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (ft)	Final Depth (ft)	Shear Wave Velocity Tests	Northing[2] (m)	Easting (m)	Refer to Notation Number
HEN-C029	15-53081_CP29	01-Sep-2015	374:T1500F15U500		21.16		4574869	306935	4
HEN-C030	15-53081_SP30	02-Sep-2015	374:T1500F15U500		11.16	3	4575040	307109	4
HEN-C032	15-53081_CP32	02-Sep-2015	374:T1500F15U500		12.30		4574980	307252	4
HEN-C032B	15-53081_CP32B	02-Sep-2015	374:T1500F15U500		12.14		4574980	307253	4
HEN-C034	15-53081_SP34	02-Sep-2015	374:T1500F15U500		29.53	5	4574804	307178	4

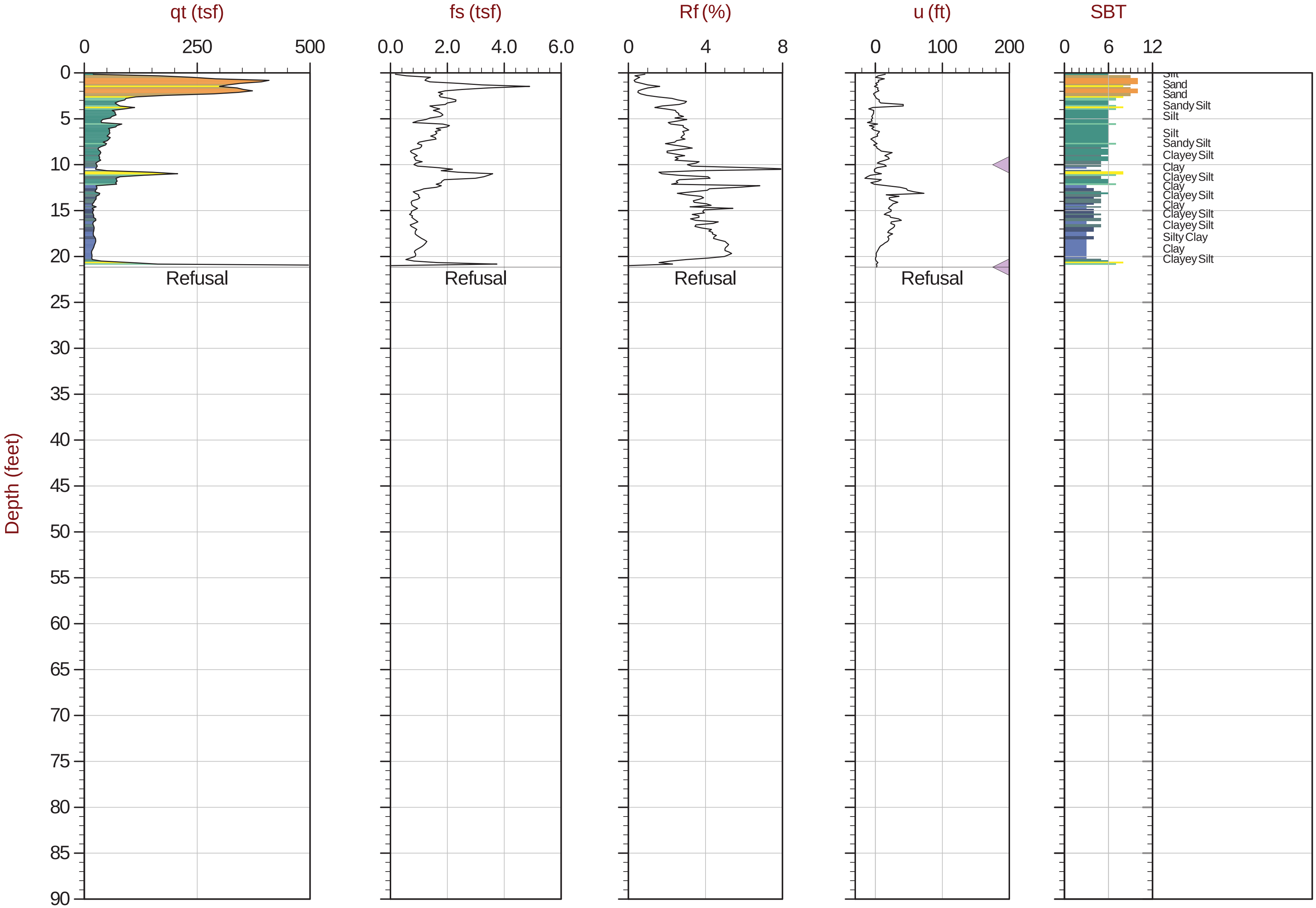
1. Assumed phreatic surface depths were determined from the pore pressure data. Hydrostatic data were used for calculated parameters.
2. Coordinates are WGS 84 / UTM Zone 16 and were collected using a GlobalSat (MR-350) and a handheld GPS Receiver.
3. Assumed phreatic surface estimated from dynamic pore pressure response.
4. No phreatic surface detected

ConeTec

AECOM

Job No: 15-53081
Date: 09:01:15 15:44
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C029
Cone: 374:T1500F15U500



Max Depth: 6.450 m / 21.16 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP29.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574869m E: 306935m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◀ PPD, Ueq not achieved

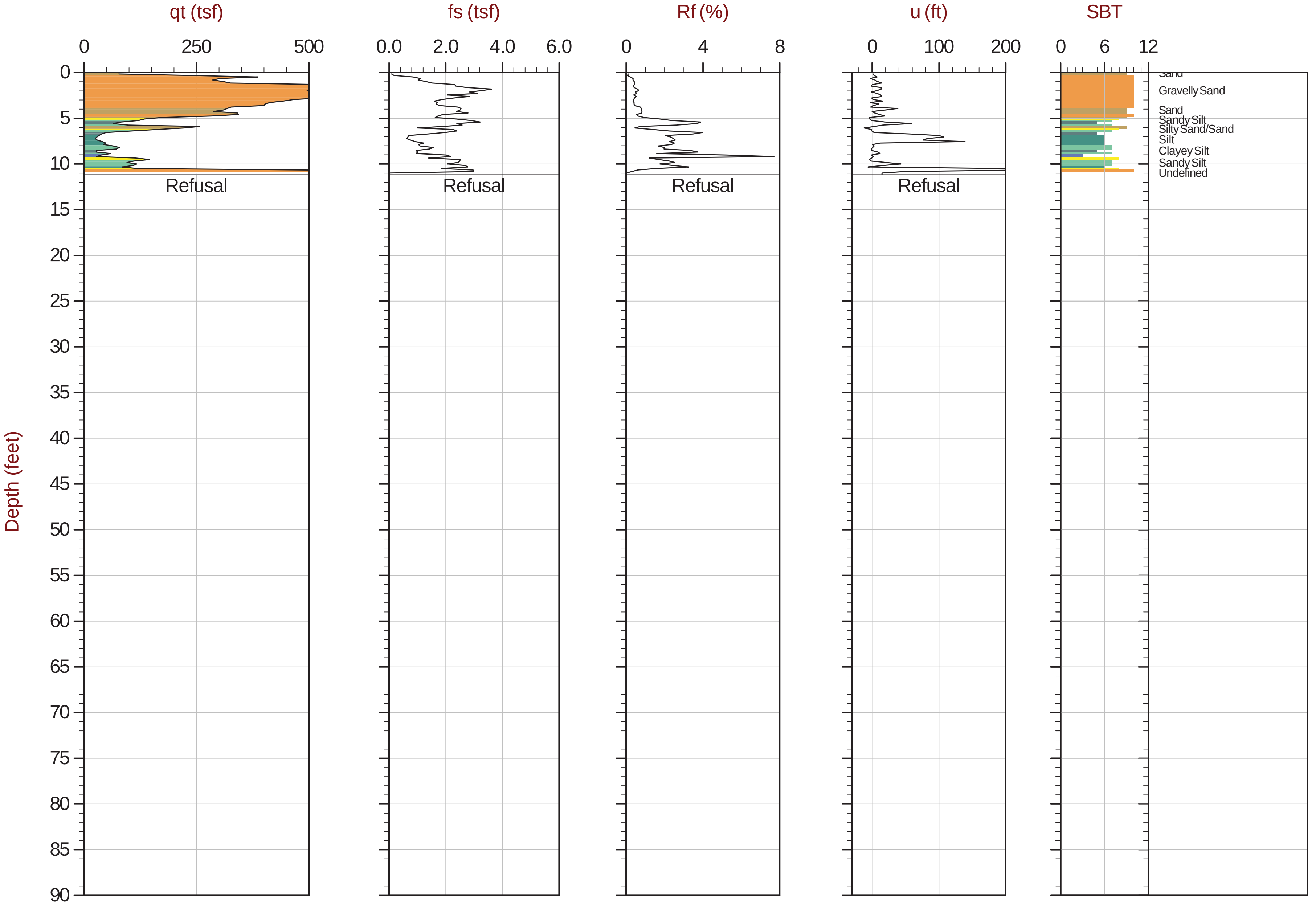
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 14:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C030
Cone: 374:T1500F15U500



Max Depth: 3.400 m / 11.15 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP30.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575040m E: 307109m

Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◁ PPD, Ueq not achieved

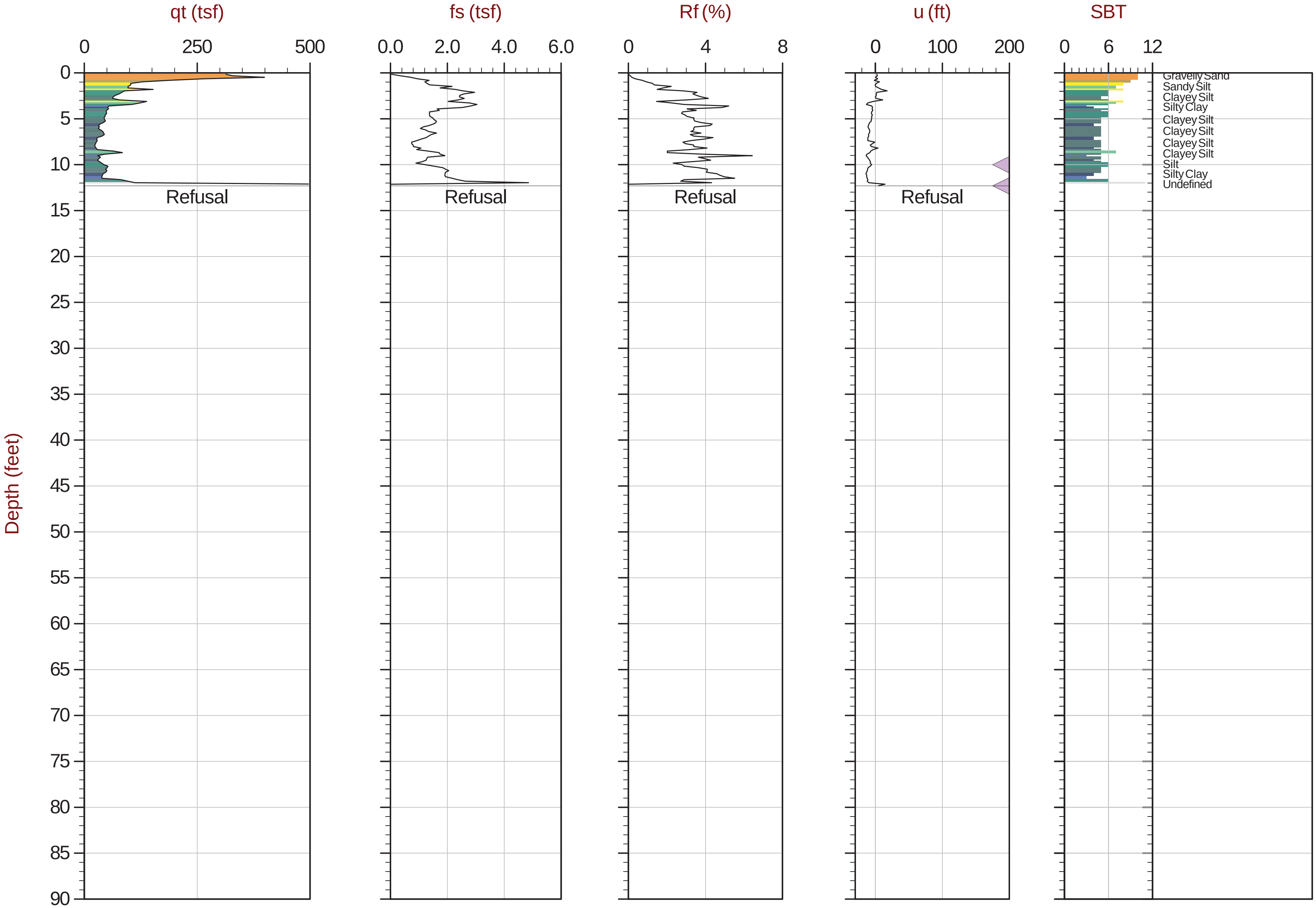
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 10:27
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032
Cone: 374:T1500F15U500



Max Depth: 3.750 m / 12.30 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP32.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574980m E: 307252m

— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◀ PPD, Ueq not achieved

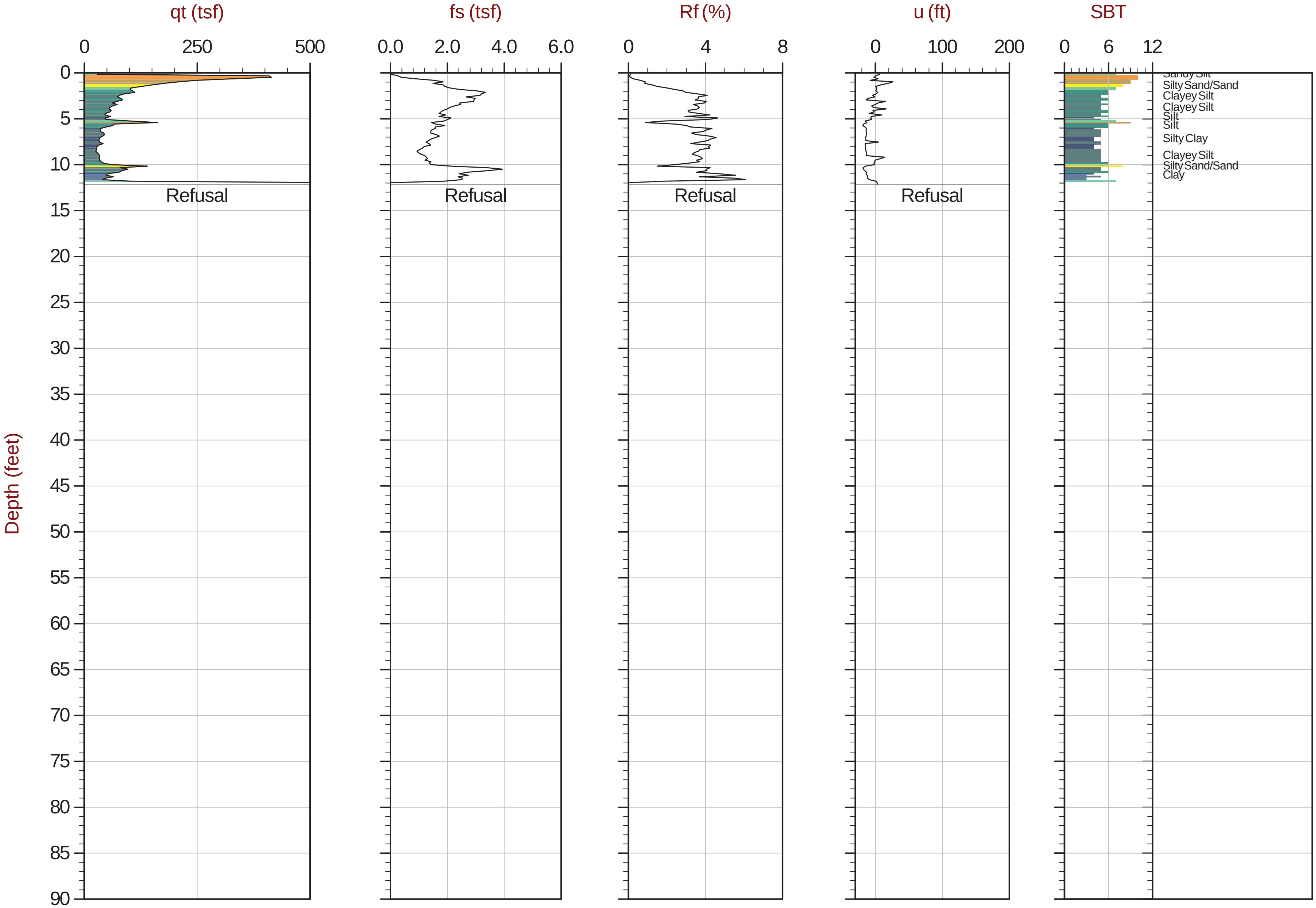
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 11:26
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032B
Cone: 374:T1500F15U500



Max Depth: 3.700 m / 12.14 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_CP32B.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574980m E: 307253m

— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◀ PPD, Ueq not achieved

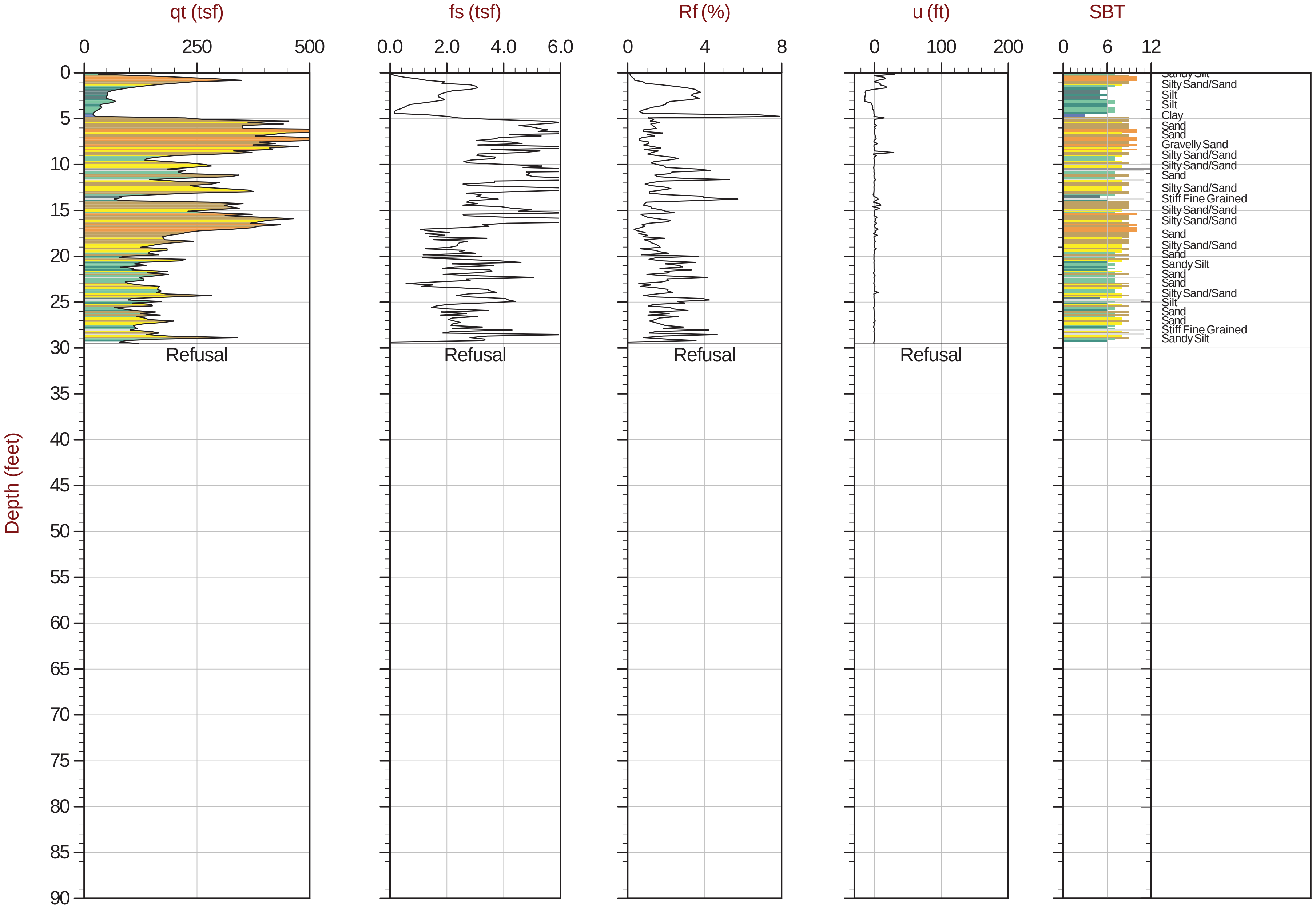
The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 08:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C034
Cone: 374:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP34.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574804m E: 307178m

— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◀ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

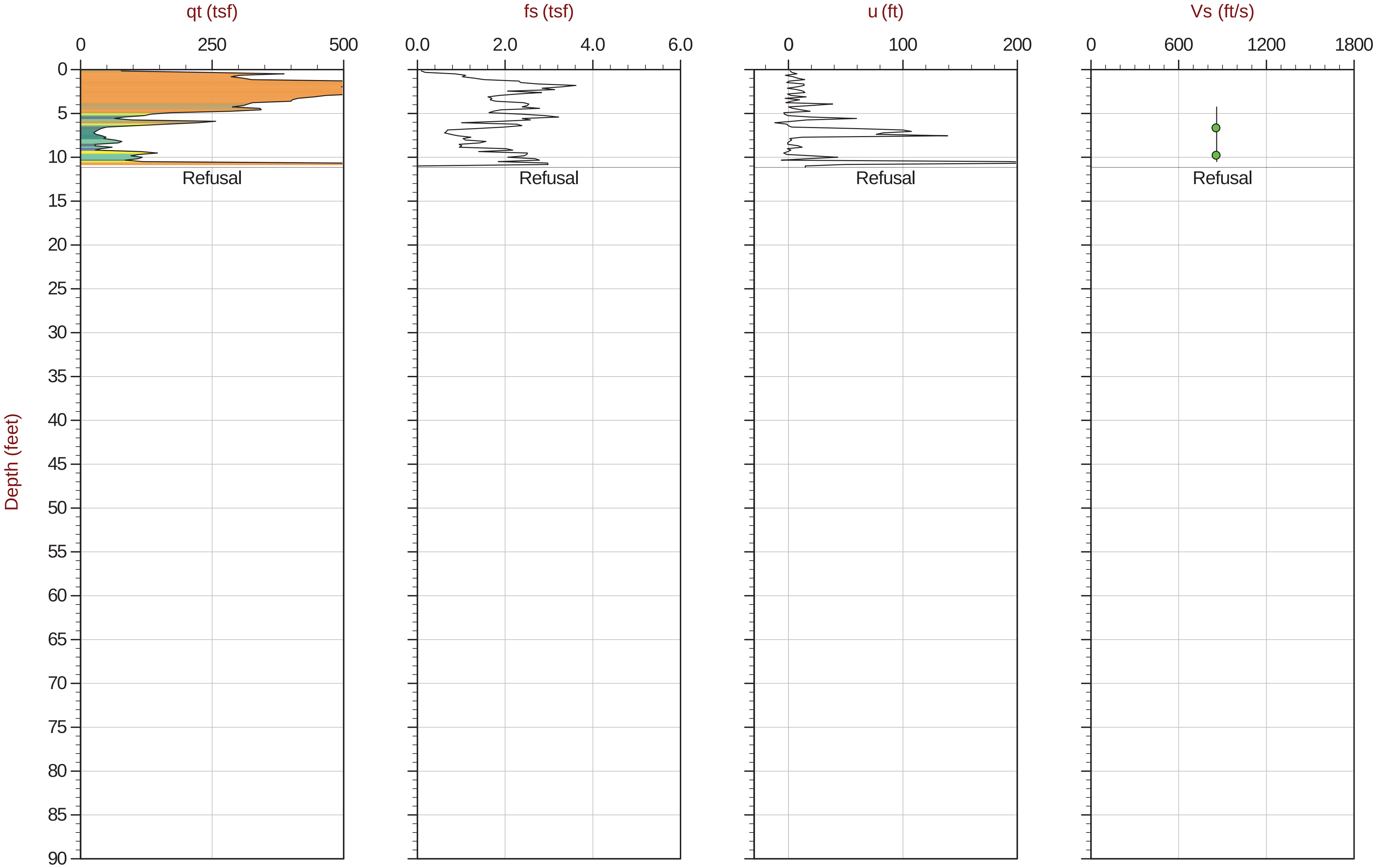
Seismic Cone Penetration Test Plots

CONETEC

AECOM

Job No: 15-53081
Date: 09:02:15 14:24
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C030
Cone: 374:T1500F15U500



Max Depth: 3.400 m / 11.15 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP30.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4575040m E: 307109m

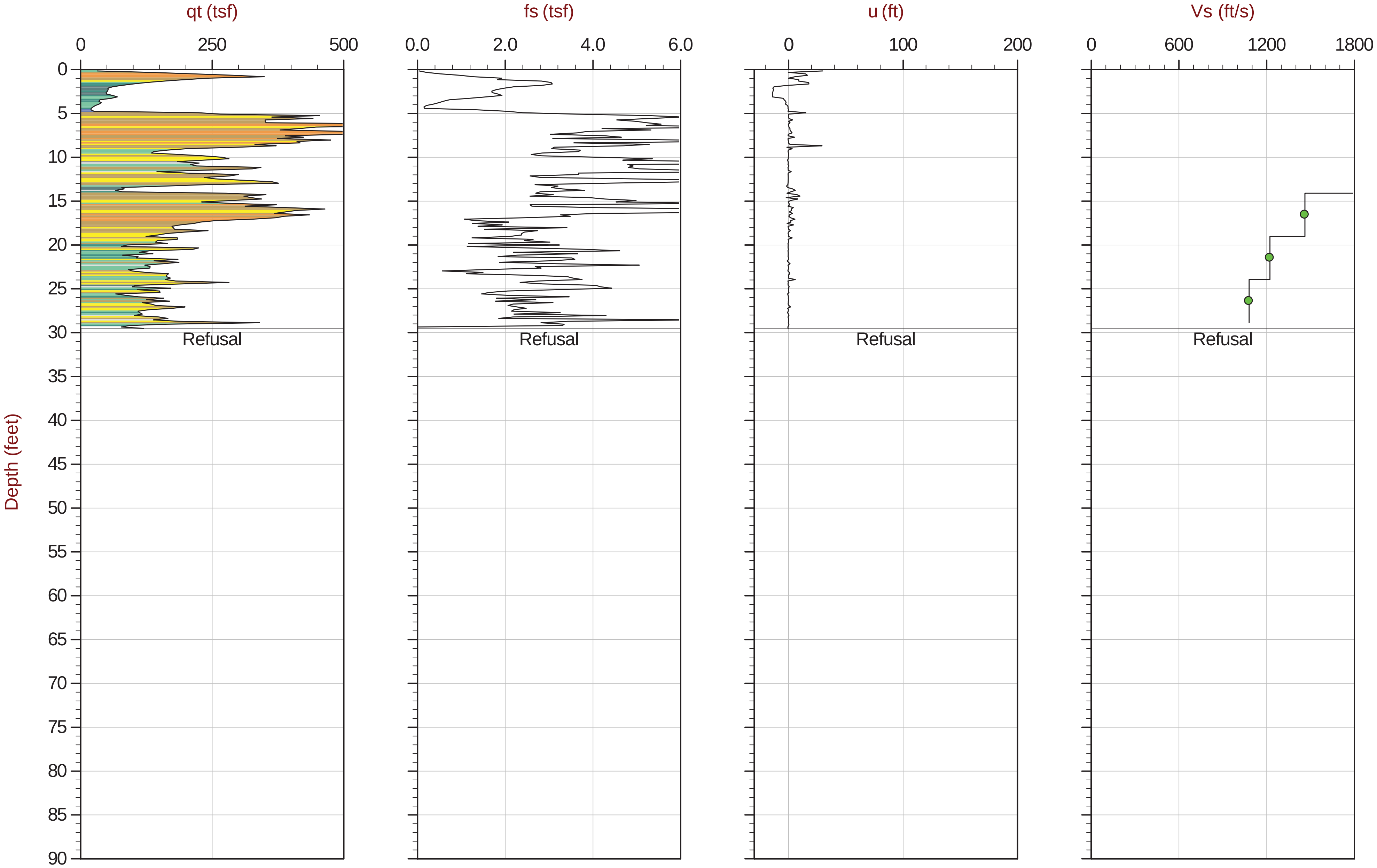
— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◀ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

AECOM

Job No: 15-53081
Date: 09:02:15 08:46
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C034
Cone: 374:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 15-53081_SP34.COR

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 16 N: 4574804m E: 307178m

— Hydrostatic Line ● Ueq ● Assumed Ueq ◁ PPD, Ueq achieved ◀ PPD, Ueq not achieved

The reported coordinates were acquired from consumer-grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Seismic Cone Penetration Test Tabular Results (Vs)

Job No: 15-53081
Client: AECOM
Project: Hennepin Power Plant
Sounding ID: HEN-C030
Date: 02-Sep-2015

Seismic Source: Beam
Source Offset (ft): 7.21
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
4.92	4.27	8.38			
9.84	9.19	11.68	3.30	3.84	860
11.15	10.50	12.74	1.06	1.23	861

Job No: 15-53081
Client: AECOM
Project: Hennepin Power Plant
Sounding ID: HEN-C034
Date: 02-Sep-2015

Seismic Source: Beam
Source Offset (ft): 7.21
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
9.84	9.19	11.68			
14.76	14.11	15.84	4.17	2.04	2038
19.69	19.03	20.35	4.51	3.08	1462
24.61	23.95	25.01	4.66	3.81	1223
29.53	28.87	29.76	4.75	4.39	1080

Pore Pressure Dissipation Summary and

Pore Pressure Dissipation Plots

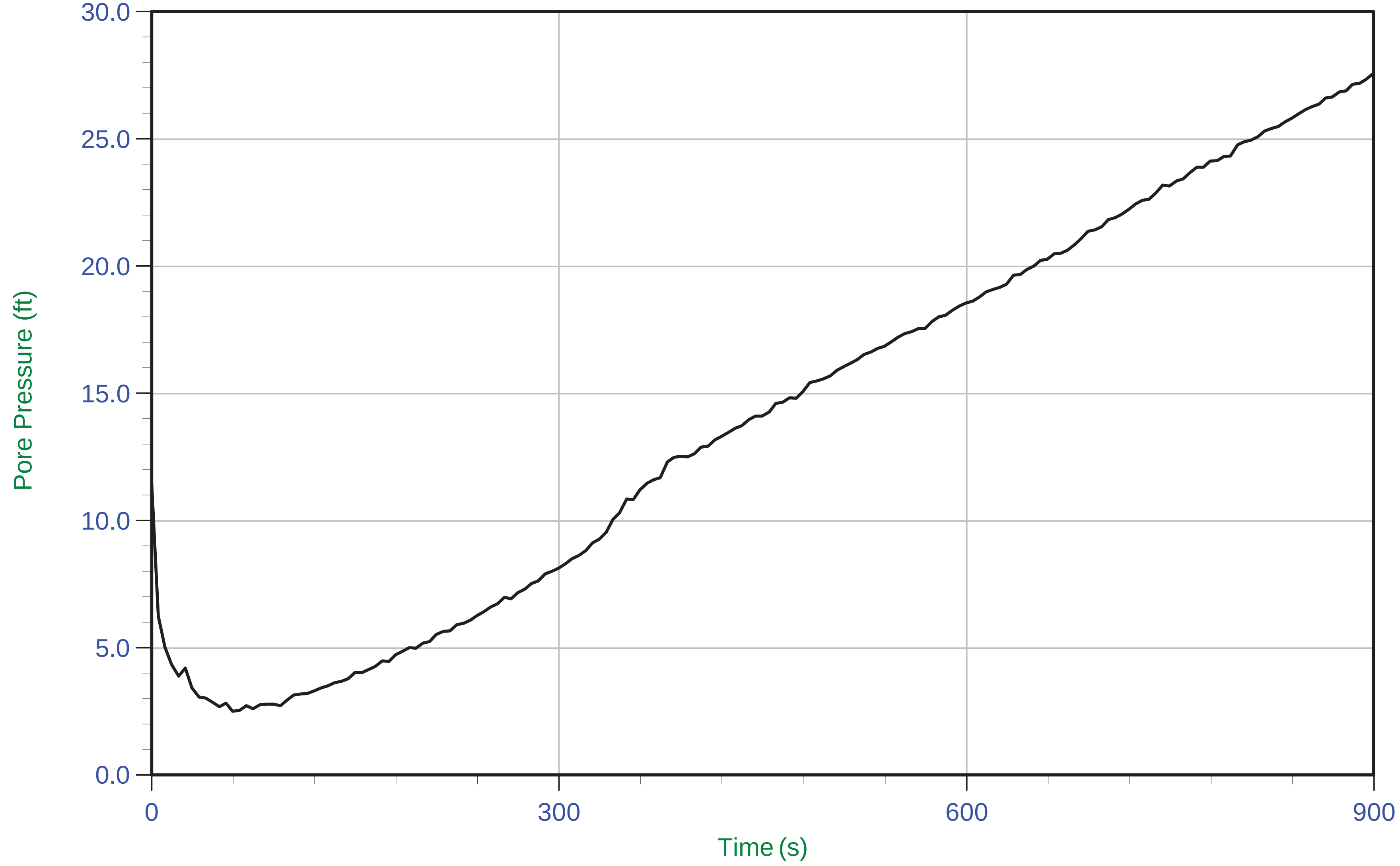
CONETEC

Job No: 15-53081
Client: AECOM
Project: Hennepin Power Station, Hennepin, IL
Start Date: 01-Sep-2015
End Date: 11-Sep-2015

CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)	Estimated Phreatic Surface (ft)	t_{50} [a] (s)	Assumed Rigidity Index (I_r)	c_h [b] (cm^2/min)
HEN-C029	15-53081_CP29	15	900	10.01						
HEN-C029	15-53081_CP29	15	600	21.16						
HEN-C032	15-53081_CP32	15	1200	10.01	2.40					
HEN-C032	15-53081_CP32	15	300	12.30	4.57					

a. Time is relative to where umax occurred
b. Houlsby and Teh, 1991



Trace Summary:

Filename: 15-53081_CP29.PPD
Depth: 3.050 m / 10.006 ft
Duration: 900.0 s

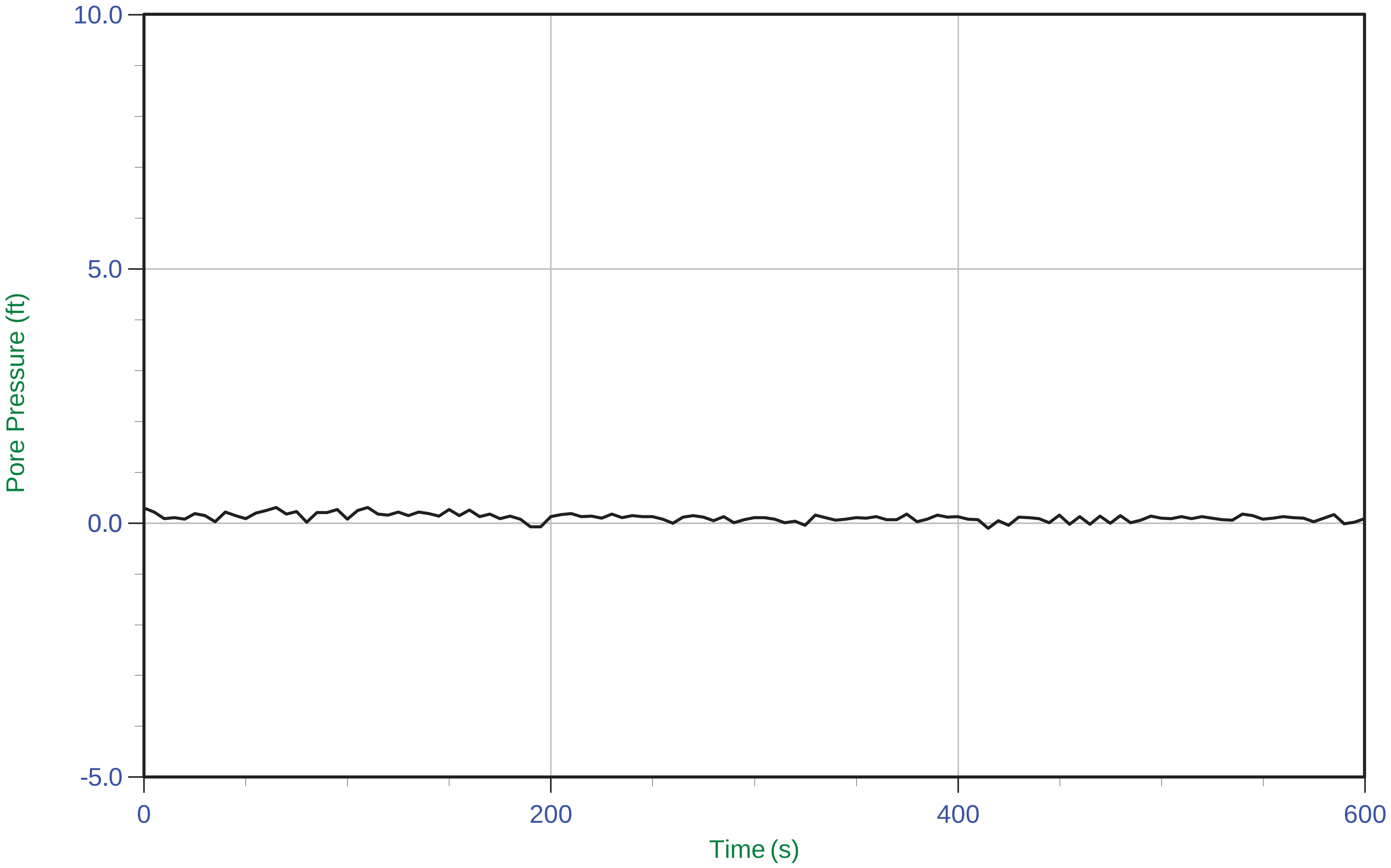
U Min: 2.5 ft
U Max: 27.6 ft

CONETEC

AECOM

Job No: 15-53081
Date: 01-Sep-2015 15:44:33
Site: Hennepin Power Station, Hennepin, IL

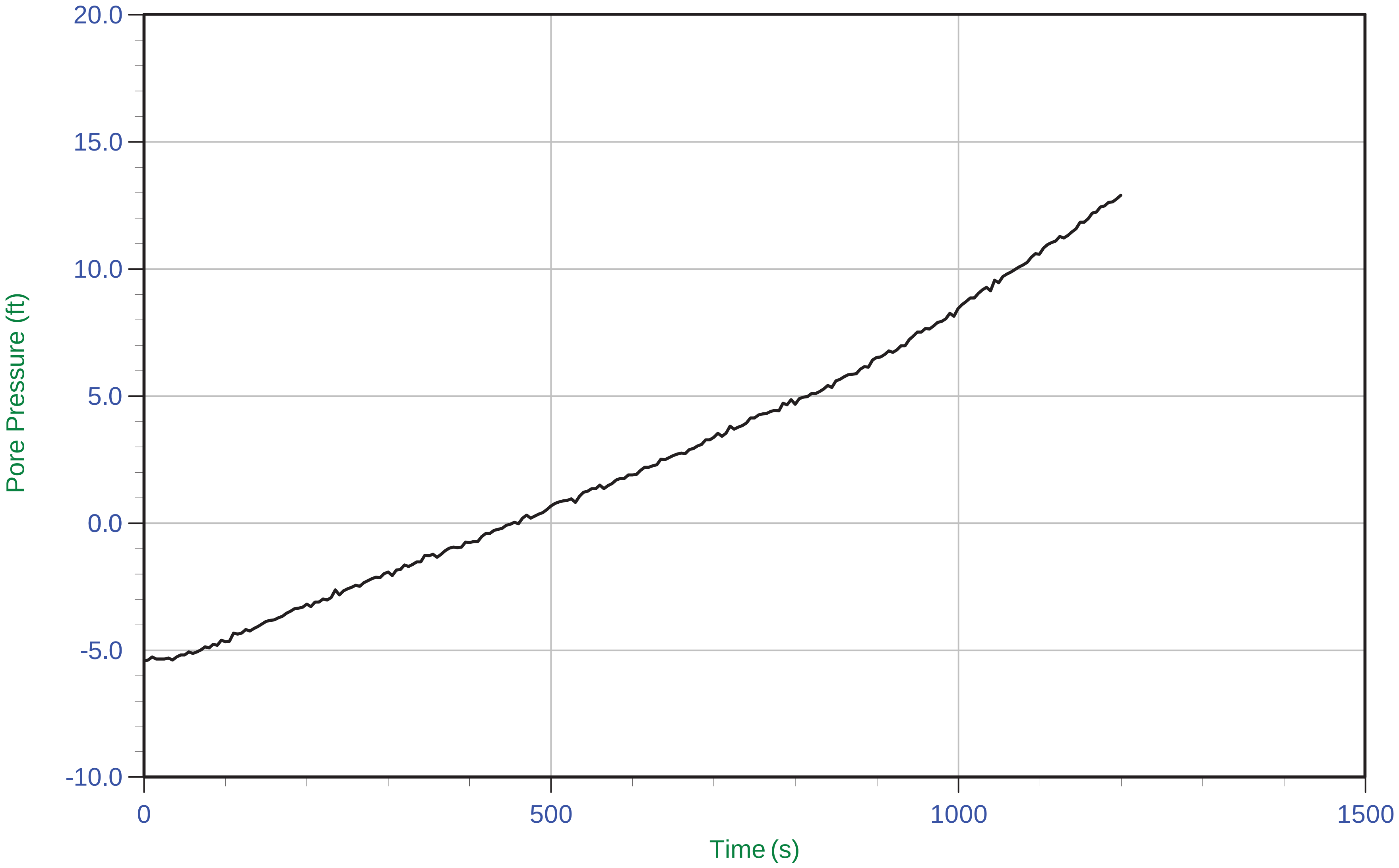
Sounding: HEN-C029
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP29.PPD
Depth: 6.450 m / 21.161 ft
Duration: 600.0 s

U Min: -0.1 ft
U Max: 0.3 ft



Trace Summary:

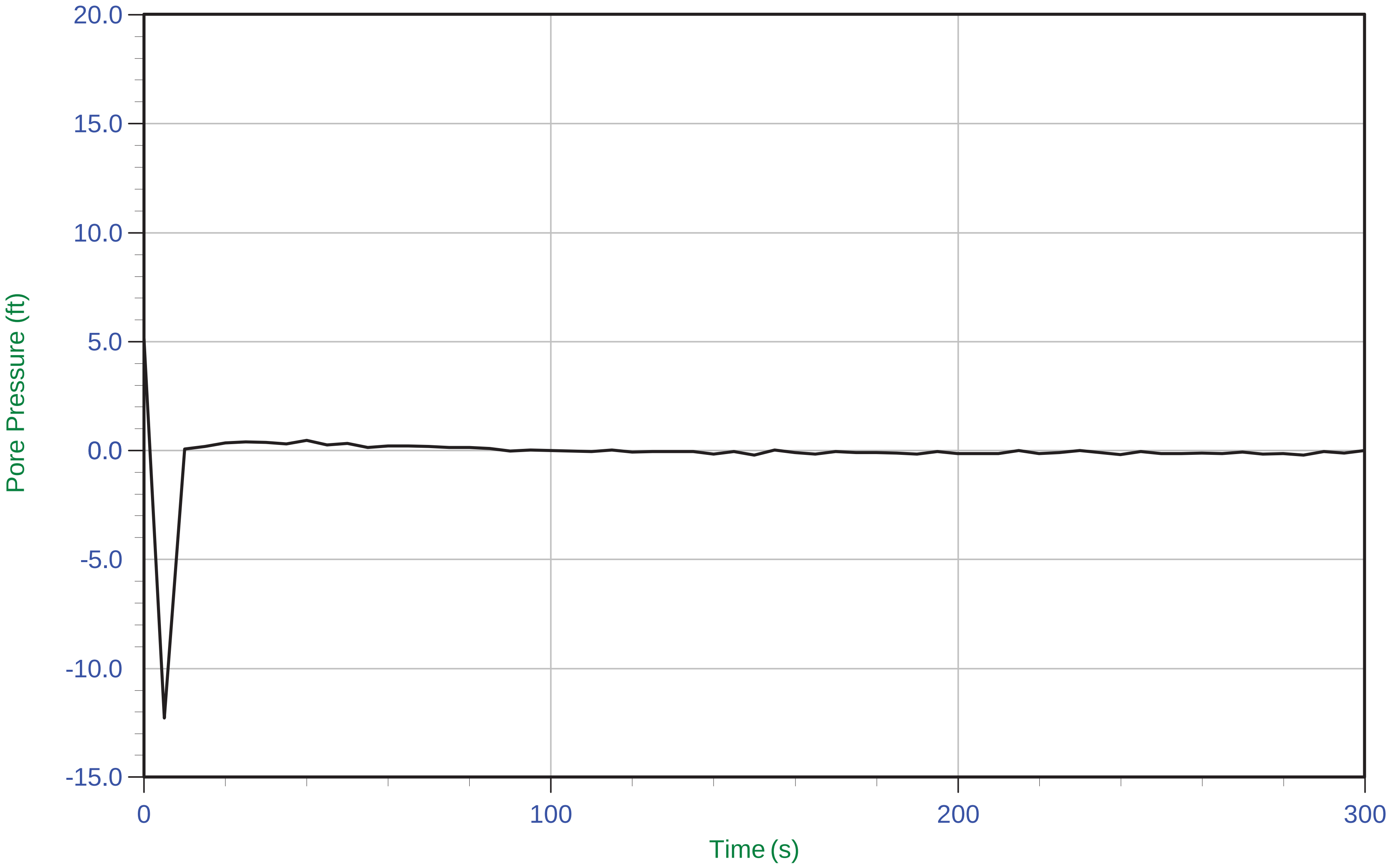
Filename: 15-53081_CP32.PPD
Depth: 3.050 m / 10.006 ft
Duration: 1200.0 s

U Min: -5.4 ft
U Max: 12.9 ft

AECOM

Job No: 15-53081
Date: 02-Sep-2015 10:27:31
Site: Hennepin Power Station, Hennepin, IL

Sounding: HEN-C032
Cone: 374
Cone Area: 15 sq cm



Trace Summary:

Filename: 15-53081_CP32.PPD
Depth: 3.750 m / 12.303 ft
Duration: 300.0 s

U Min: -12.3 ft
U Max: 5.1 ft

Attachment E. Laboratory Test Data

LABORATORY TESTING SUMMARY

PROJECT NAME: Dynegy - Hennepin Site **PROJECT NUMBER:** MR155233 **CLIENT:** AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B029	S-1	0.0'-1.5'	BROWN POORLY GRADED SAND		4.7										
HEN-B029	S-2	2.5'-4.0'	DARK BROWN SANDY LEAN CLAY		14.7										
HEN-B029	S-3	5.0'-7.0'	BROWN LEAN CLAY WITH SAND AND GRAVEL	CL	10.8							22	15	7	
HEN-B029	S-4	7.0'-8.5'	DARK BROWN LEAN CLAY		14.8										
HEN-B029	S-5	10.0'-12.0'	VERY DARK BROWN AND GRAY SLIGHTLY ORGANIC LEAN CLAY WITH SAND AND GRAVEL	CL	16.7							31	17	14	
HEN-B029	S-6	15.0'-16.5'	POSSIBLE FILL: BROWN TO DARK BROWN LEAN CLAY		21.7										
HEN-B029	S-7	20.0'-21.5'	BROWN TO GRAY SILTY LEAN CLAY		11.5										
HEN-B029	S-8	25.0'-26.5'	BROWN SILTY LEAN CLAY WITH SAND		8.8										
HEN-B029	S-9	30.0'-30.9'	BROWN SILTY LEAN CLAY WITH SAND		12.7										
HEN-B029	S-10	35.0'-36.5'	LIGHT BROWN POORLY GRADED GRAVEL WITH SAND AND CLAY	GP-GC	13.8		61.0	26.0			13.0				
HEN-B029	S-11	40.0'-41.5'	BROWN SILTY SAND WITH CLAY		4.6										

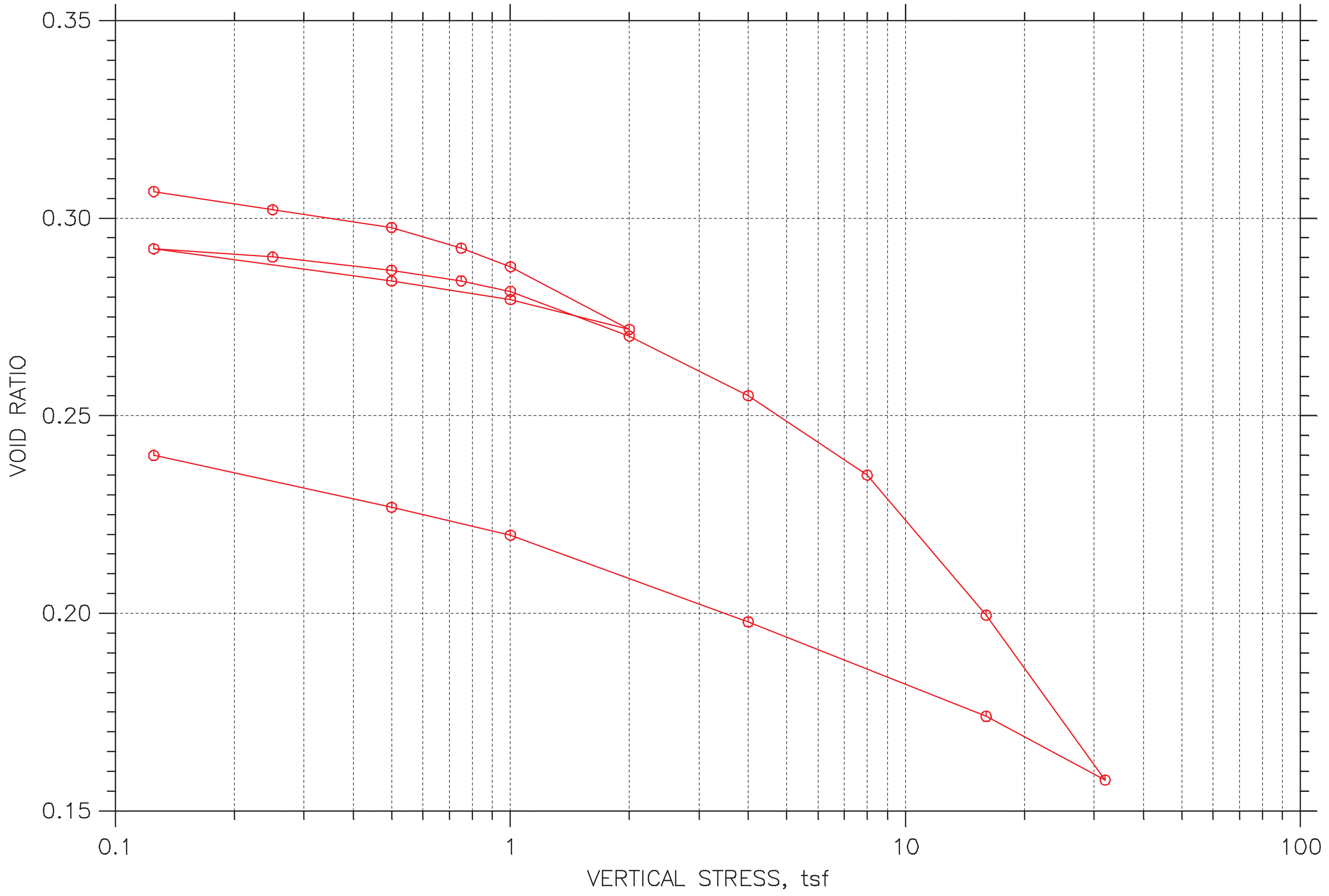
LABORATORY TESTING SUMMARY

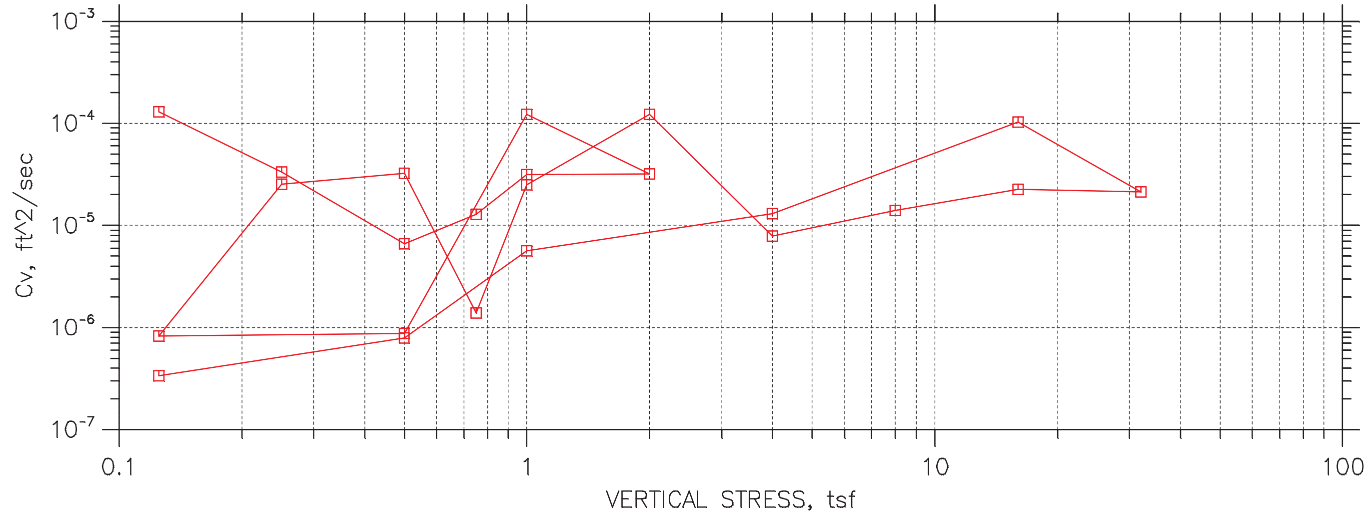
PROJECT NAME: Dynegy - Hennepin Site **PROJECT NUMBER:** MR155233 **CLIENT:** AECOM

Boring Number	Sample Number	Depth	Description	USCS	WC %	Qp (tsf)	% Gravel	% Sand	% Silt	% Clay	% Fines	LL	PL	PI	Specific Gravity
HEN-B030	S-1A	0.0'-1.5'	FILL: DARK BROWN AND BROWN SANDY LEAN CLAY WITH GRAVEL		7.0										
HEN-B030	S-2	2.5'-4.0'	BROWN AND LIGHT BROWN SILTY SAND WITH GRAVEL	SM	6.4		34.0	45.7	11.0	9.3	20.3				
HEN-B030	S-3	5.0'-6.5'	FILL: BROWN AND GRAY LEAN CLAY WITH SILT, SAND AND GRAVEL		11.5										2.746
HEN-B030	S-4	7.5'-9.0'	BROWN LEAN CLAY		17.1										
HEN-B030	S-5	10.0'-11.0'	DARK BROWNISH GRAY FLY ASH AND LEAN CLAY MIXTURE WITH SAND		18.1										
HEN-B030	S-6	15.0'-16.5'	LIGHT BROWN AND TAN WELL GRADED GRAVEL WITH SAND	GW	17.6		81.4	14.8			3.8				
HEN-B030	S-7	21.5'	DARK BROWN AND BLACK ORGANIC CLAY WITH GRAVEL - WOOD NOTED		23.9										
HEN-B030	S-8	25.0'-26.5'	BROWN SILTY SAND WITH GRAVEL		11.2										
HEN-B030	S-10	35.0'-36.5'	BROWN CLAYEY SAND WITH GRAVEL		8.9										
HEN-B030	S-11	40.0'-41.5'	BROWN CLAYEY SAND		9.0										
HEN-B032	S-1A	0.0'-1.0'	BROWN AND GRAYISH BROWN CLAYEY SAND		2.7										
HEN-B032	S-1B	1.0'-1.5'	FILL: BROWN SANDY LEAN CLAY		7.9										
HEN-B032	S-2	2.5'-4.0'	FILL: DARK BROWN SANDY LEAN CLAY		9.7										
HEN-B032	S-3	5.0'-7.0'	DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL	CL	14.0							35	18	17	
HEN-B032	S-4	7.5'-9.0'	DARK BROWN LEAN CLAY		16.7										
HEN-B032	S-5	10.0'-11.5'	DARK BROWN AND DARK GRAY LEAN CLAY WITH GRAVEL		16.2										
HEN-B032	S-6	15.0'-16.5'	BROWN AND GRAYISH BROWN SILTY SAND WITH GRAVEL		8.2										
HEN-B032	S-7	20.0'-21.5'	BROWN SILTY SAND WITH GRAVEL	SM	11.1		30.5	43.6	13.4	12.5	25.9				
HEN-B032	S-8	25.0'-26.5'	BROWN SILTY SAND WITH GRAVEL AND CLAY		9.1										
HEN-B032	S-9	30.0'-31.5'	BROWN LEAN CLAY WITH SAND AND GRAVEL		10.6										
HEN-B032	S-10	35.0'-36.5'	BROWN SILTY SAND WITH GRAVEL		5.5										
HEN-B032	S-11	40.0'-41.3'	BROWN AND GRAYISH BROWN SILTY LEAN CLAY WITH SAND AND GRAVEL		10.9										
HEN-B034	S-1A	0.0'-0.5'	BROWN SILTY SAND WITH GRAVEL		4.2										
HEN-B034	S-1B	0.5'-1.5	POSSIBLE FILL: DARK BROWN LEAN CLAY		9.1										
HEN-B034	S-2	2.5'-4.0'	DARK BROWN LEAN CLAY WITH SILT AND SAND		14.2										2.704
HEN-B034	S-3A	5.0'-5.5'	BROWN SILTY SAND		15.9										
HEN-B034	S-3B	5.5'-6.5'	BROWN GRAVELLY SAND		1.4										
HEN-B034	S-4	7.5'-9.0'	BROWN AND GRAYISH BROWN SILTY SAND WITH GRAVEL		2.5										
HEN-B034	S-5	10.0'-11.5'	BROWN AND LIGHT BROWN POORLY GRADED GRAVEL WITH SILT AND	GP-GM	11.2		60.1	27.0	7.7	5.2	12.9				
HEN-B034	S-6	15.0'-16.5'	BROWN AND LIGHT BROWN POORLY GRADED GRAVEL WITH CLAY AND		9.1										2.808
HEN-B034	S-7	20.0'-21.5'	LIGHT BROWN SILTY SAND WITH GRAVEL		12.5										
HEN-B034	S-9	30.0'-31.5'	BROWN, GRAY AND PINKISH BROWN POORLY GRADED GRAVEL		13.6										
HEN-B034	S-10	35.0'-36.5'	LIGHT BROWN AND TAN POORLY GRADED GRAVEL WITH SAND AND SILT	GP-GM	10.9		82.8	11.3			5.9				
HEN-B034	S-11	40.0'-41.5'	BROWN POORLY GRADED GRAVEL WITH SILT AND SAND		1.5										

One-Dimensional Consolidation Tests
ASTM D 2535

ONE DIMENSIONAL CONSOLIDATION TEST
ASTM D2435





Terracon
Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

Mon, 21-DEC-2015 16:47:42

CONSOLIDATION TEST DATA

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-029 S-3
Tested By: HP
Checked By: BCM
Sample No.: S-3
Test Date: 12/14/15
Depth: 5.0'-7.0'
Test No.: HENB029S3
Sample Type: 3.0" ST
Elevation: -----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435

Estimated Specific Gravity: 2.72
Liquid Limit: 22
Initial Height: 0.74 in
Initial Void Ratio: 0.31
Plastic Limit: 15
Specimen Diameter: 2.49 in
Final Void Ratio: 0.24
Plasticity Index: 7

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	X-7	RING	RING	118
Wt. Container + Wet Soil, gm	167.52	207.79	207.7	156.24
Wt. Container + Dry Soil, gm	155.54	196.84	196.84	145.48
Wt. Container, gm	44.63	74.87	74.87	24.64
Wt. Dry Soil, gm	110.91	121.97	121.97	120.84
Water Content, %	10.80	8.98	8.90	8.90
Void Ratio	---	0.31	0.24	---
Degree of Saturation, %	---	77.94	100.93	---
Dry Unit Weight, pcf	---	129.29	136.94	---

CONSOLIDATION TEST DATA

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: HENB029S3

Location: HENNEPIN, IL
Tested By: HP
Test Date: 12/14/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: BCM
Depth: 5.0'-7.0'
Elevation: -----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435

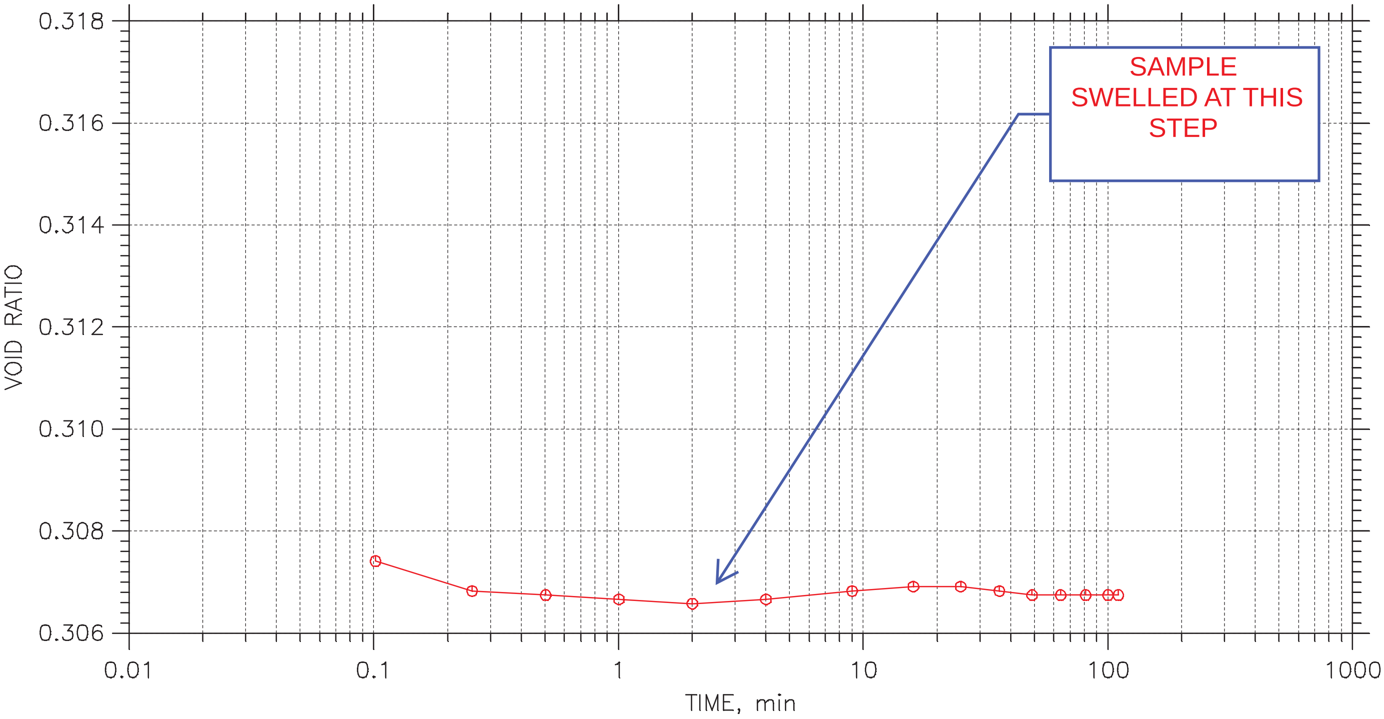
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	Log min	Coefficient of Consolidation Sq.Rt. ft^2/sec	Log ft^2/sec	Ave. ft^2/sec
1	0.125	0.00369	0.307	0.50	0.0	0.0	1.30e-004	0.00e+000	1.30e-004
2	0.25	0.006259	0.302	0.85	0.1	0.0	3.32e-005	0.00e+000	3.32e-005
3	0.5	0.008782	0.298	1.19	0.5	0.0	6.59e-006	0.00e+000	6.59e-006
4	0.75	0.01172	0.292	1.59	0.2	0.0	1.28e-005	0.00e+000	1.28e-005
5	1	0.01434	0.288	1.95	0.1	0.0	3.13e-005	0.00e+000	3.13e-005
6	2	0.02322	0.272	3.16	0.1	0.0	3.18e-005	0.00e+000	3.18e-005
7	1	0.01901	0.279	2.58	0.0	0.0	1.23e-004	0.00e+000	1.23e-004
8	0.5	0.0164	0.284	2.23	3.4	0.0	8.69e-007	0.00e+000	8.69e-007
9	0.125	0.01182	0.292	1.61	3.6	0.0	8.29e-007	0.00e+000	8.29e-007
10	0.25	0.01299	0.290	1.76	0.1	0.0	2.54e-005	0.00e+000	2.54e-005
11	0.5	0.01485	0.287	2.02	0.1	0.0	3.22e-005	0.00e+000	3.22e-005
12	0.75	0.01635	0.284	2.22	2.1	0.0	1.38e-006	0.00e+000	1.38e-006
13	1	0.01784	0.281	2.43	0.1	0.0	2.51e-005	0.00e+000	2.51e-005
14	2	0.0242	0.270	3.29	0.0	0.0	1.23e-004	0.00e+000	1.23e-004
15	4	0.03265	0.255	4.44	0.4	0.0	7.87e-006	0.00e+000	7.87e-006
16	8	0.04391	0.235	5.97	0.2	0.0	1.39e-005	0.00e+000	1.39e-005
17	16	0.06376	0.200	8.67	0.1	0.0	2.26e-005	0.00e+000	2.26e-005
18	32	0.08712	0.158	11.84	0.1	0.0	2.12e-005	0.00e+000	2.12e-005
19	16	0.0781	0.174	10.61	0.0	0.0	1.03e-004	0.00e+000	1.03e-004
20	4	0.0647	0.198	8.79	0.2	0.0	1.30e-005	0.00e+000	1.30e-005
21	1	0.05241	0.220	7.12	0.5	0.0	5.63e-006	0.00e+000	5.63e-006
22	0.5	0.04844	0.227	6.58	3.4	0.0	7.92e-007	0.00e+000	7.92e-007
23	0.125	0.04111	0.240	5.59	8.1	0.0	3.37e-007	0.00e+000	3.37e-007

CONSOLIDATION TEST DATA

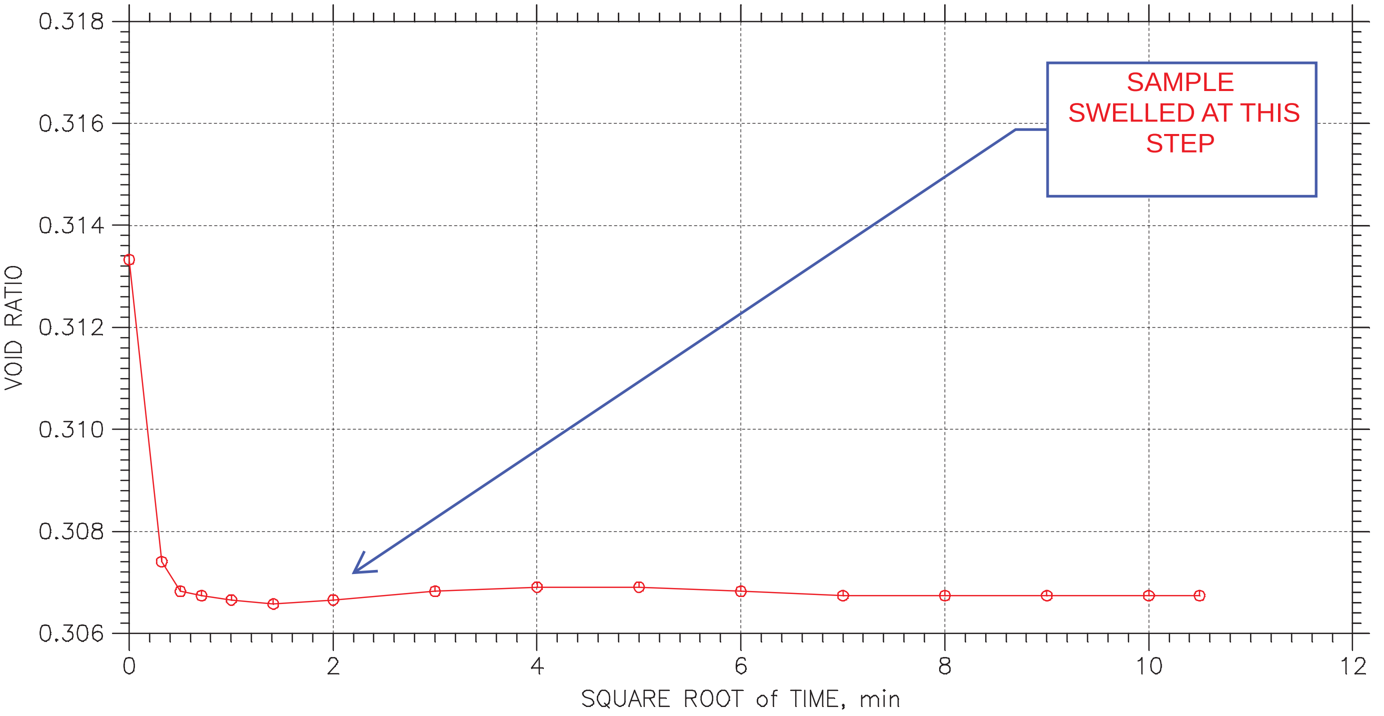
TIME CURVES

Constant Load Step: 1 of 23

Stress: 0.125 tsf



SAMPLE SWELLED AT THIS STEP



SAMPLE SWELLED AT THIS STEP

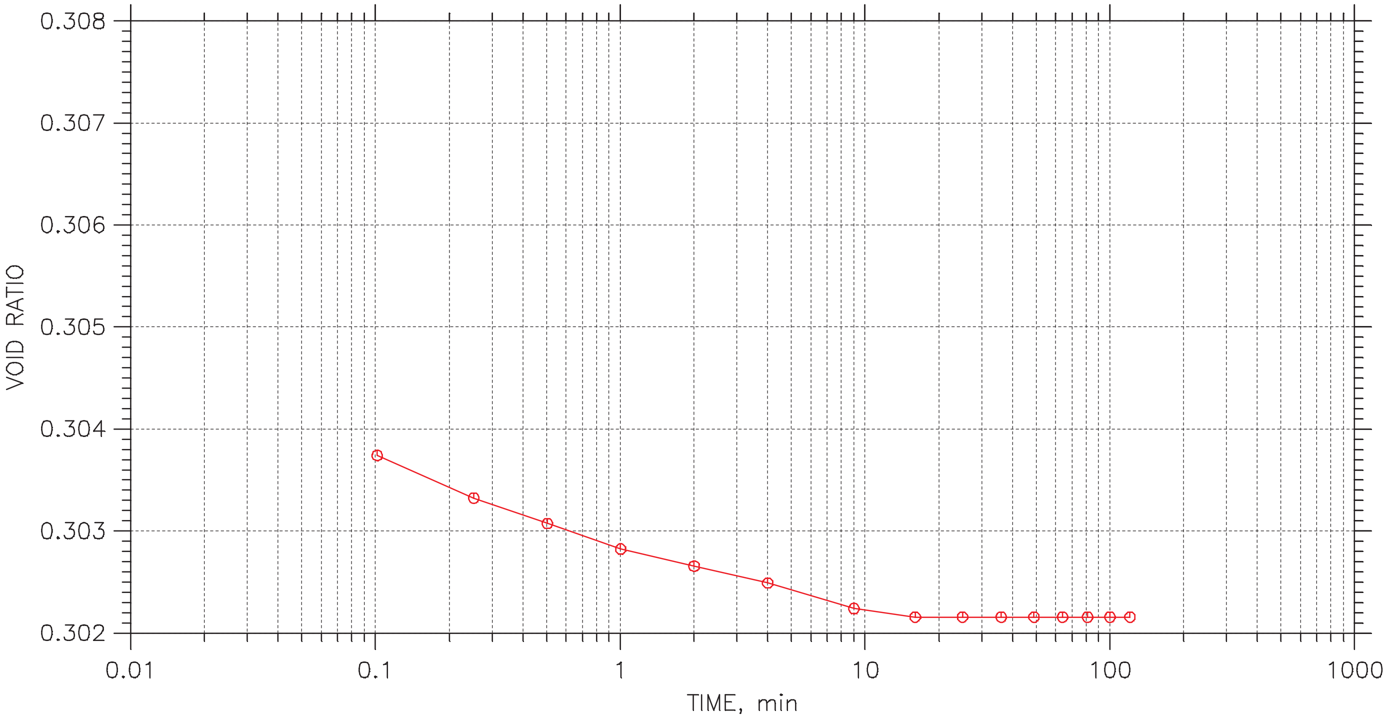
Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

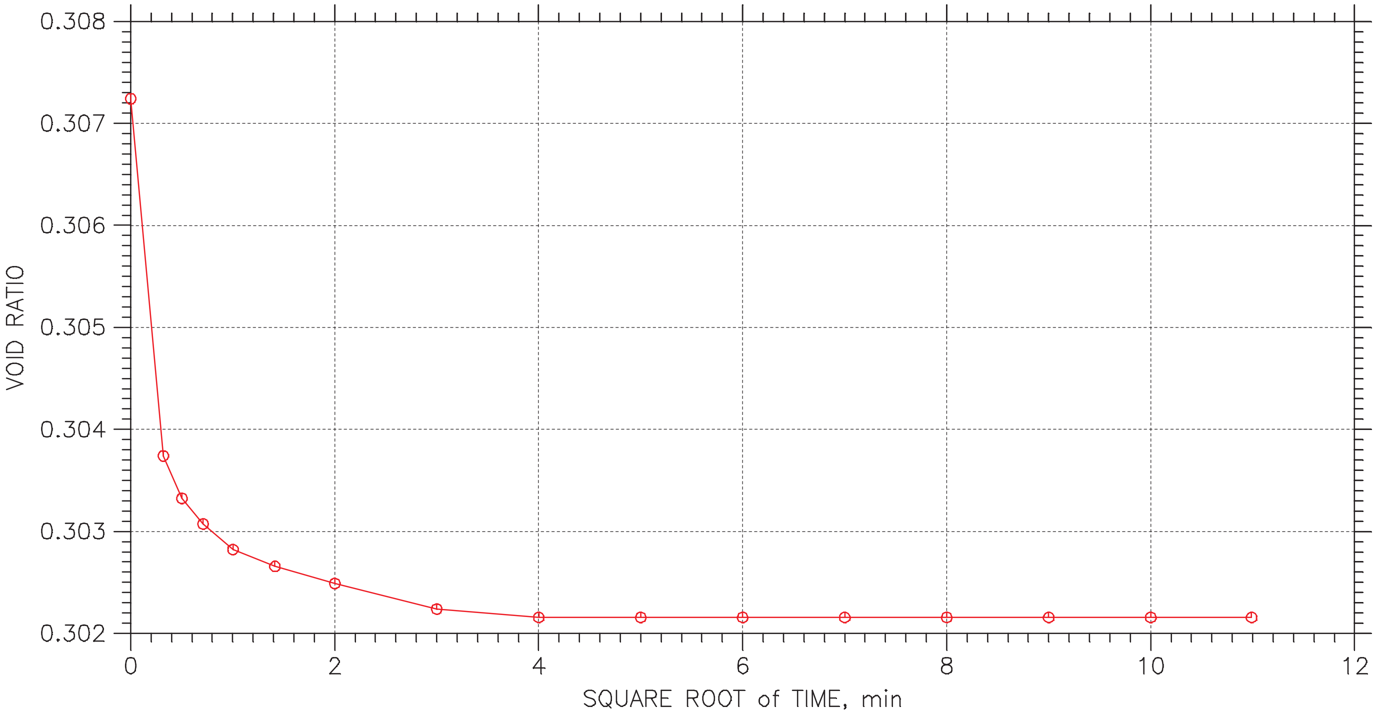
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

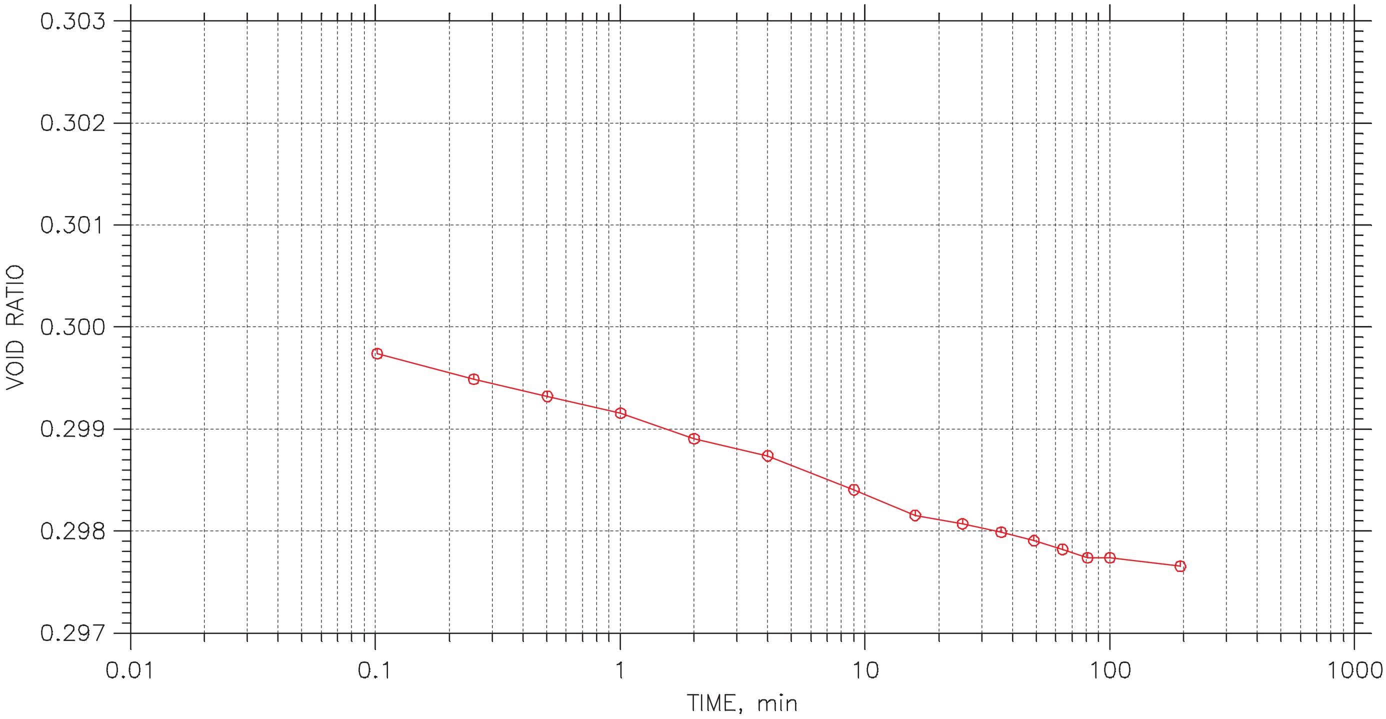
Mon, 21-DEC-2015 16:48:16

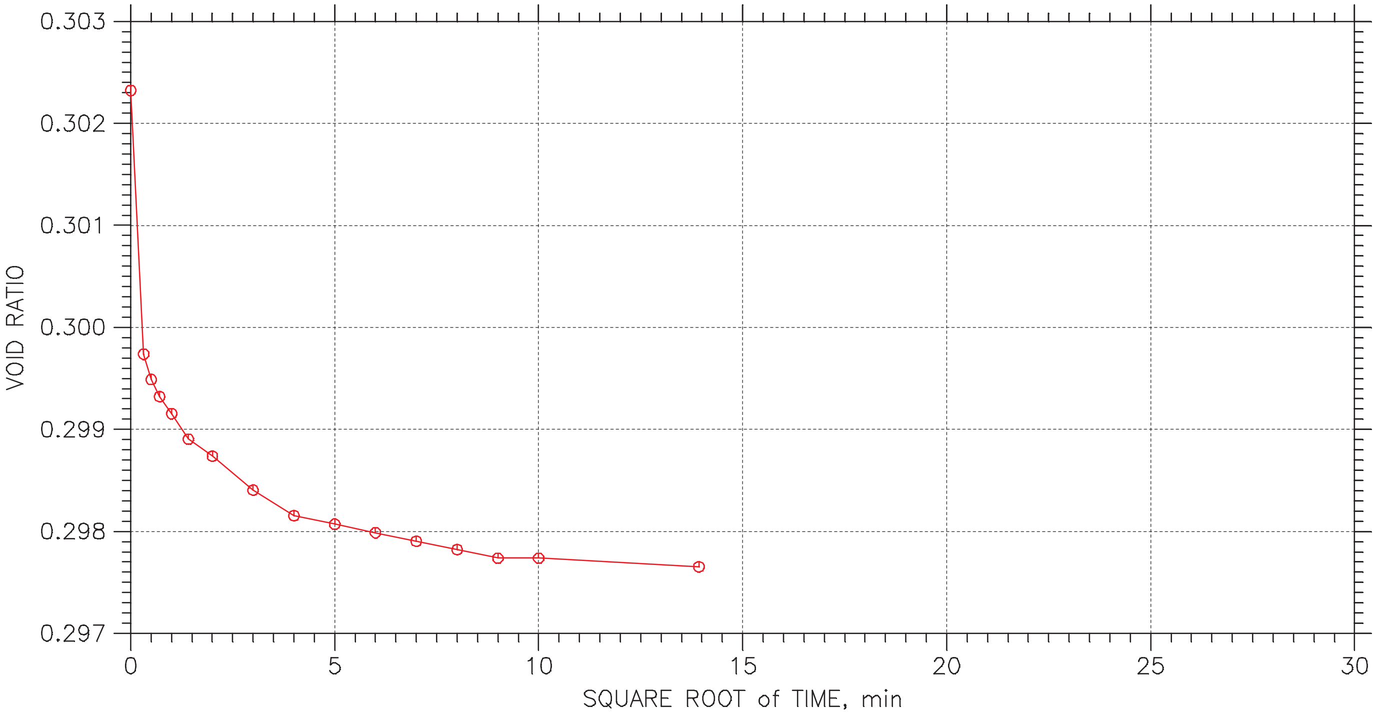
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

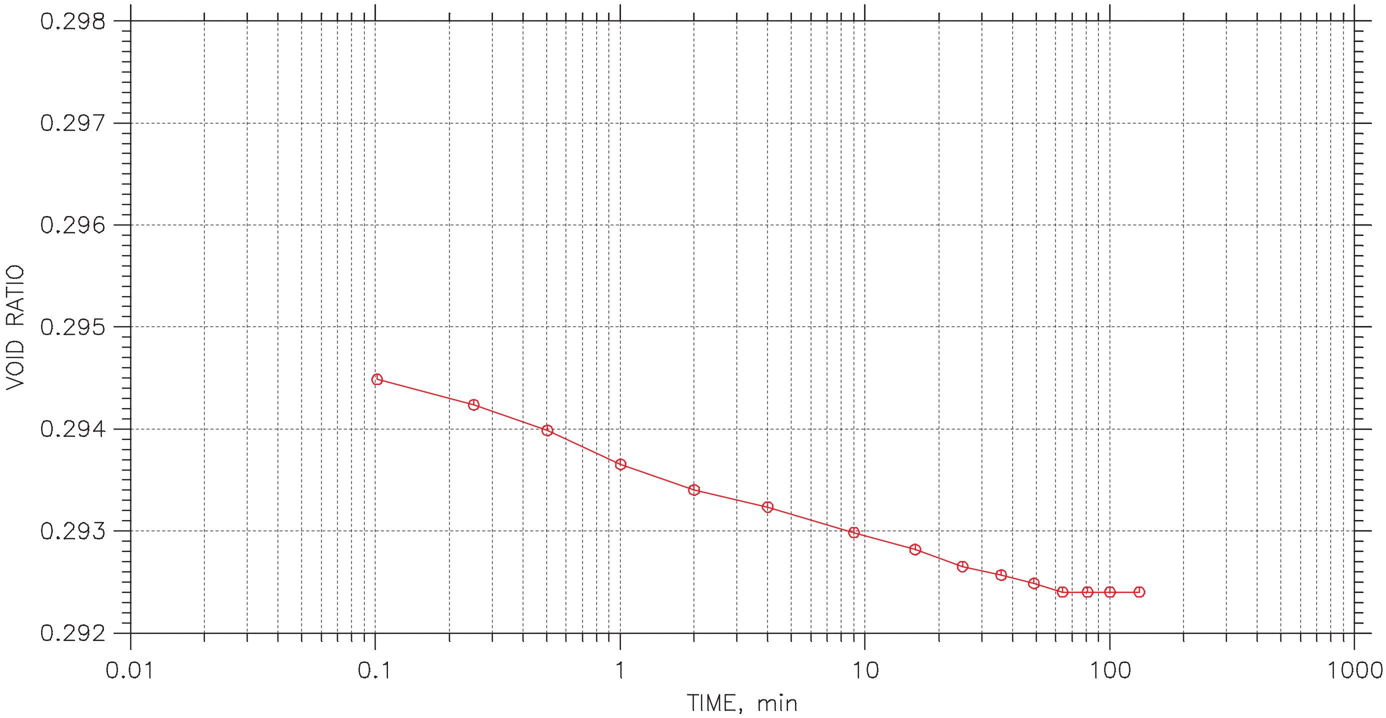
Mon, 21-DEC-2015 16:48:17

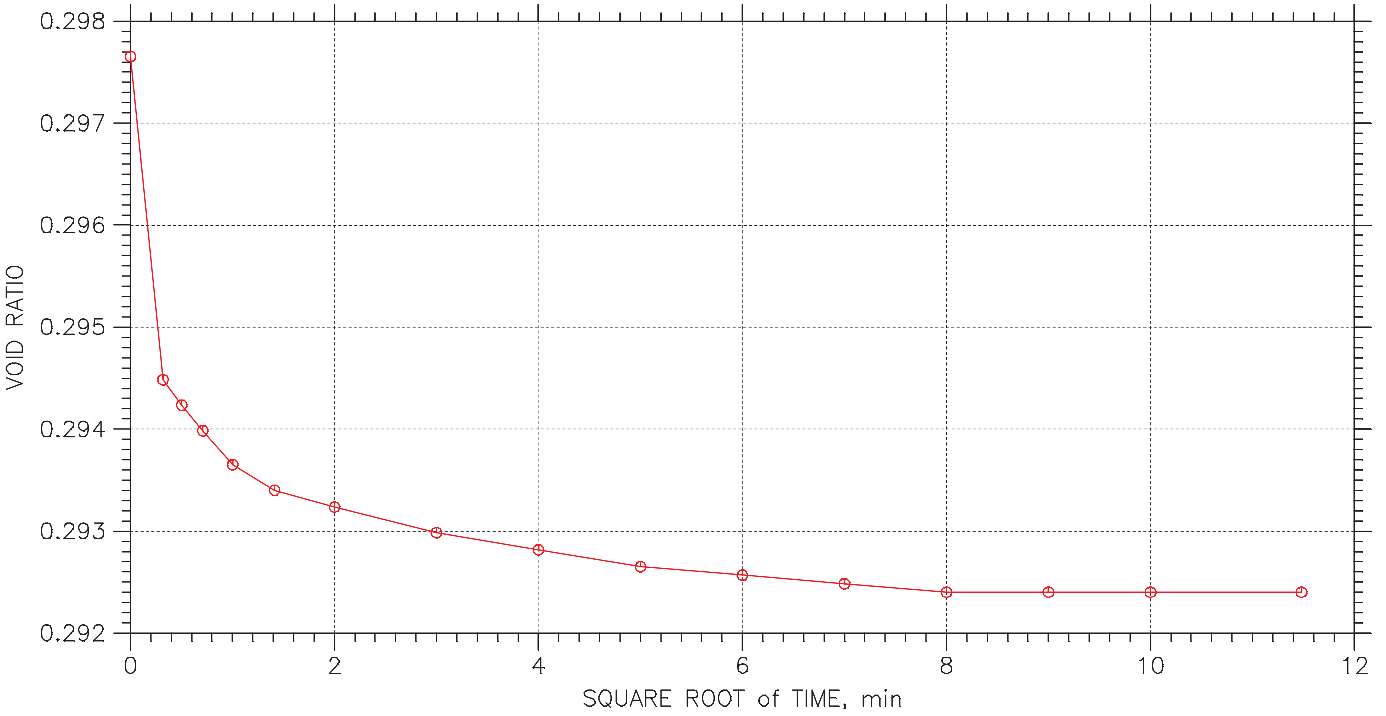
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 23

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

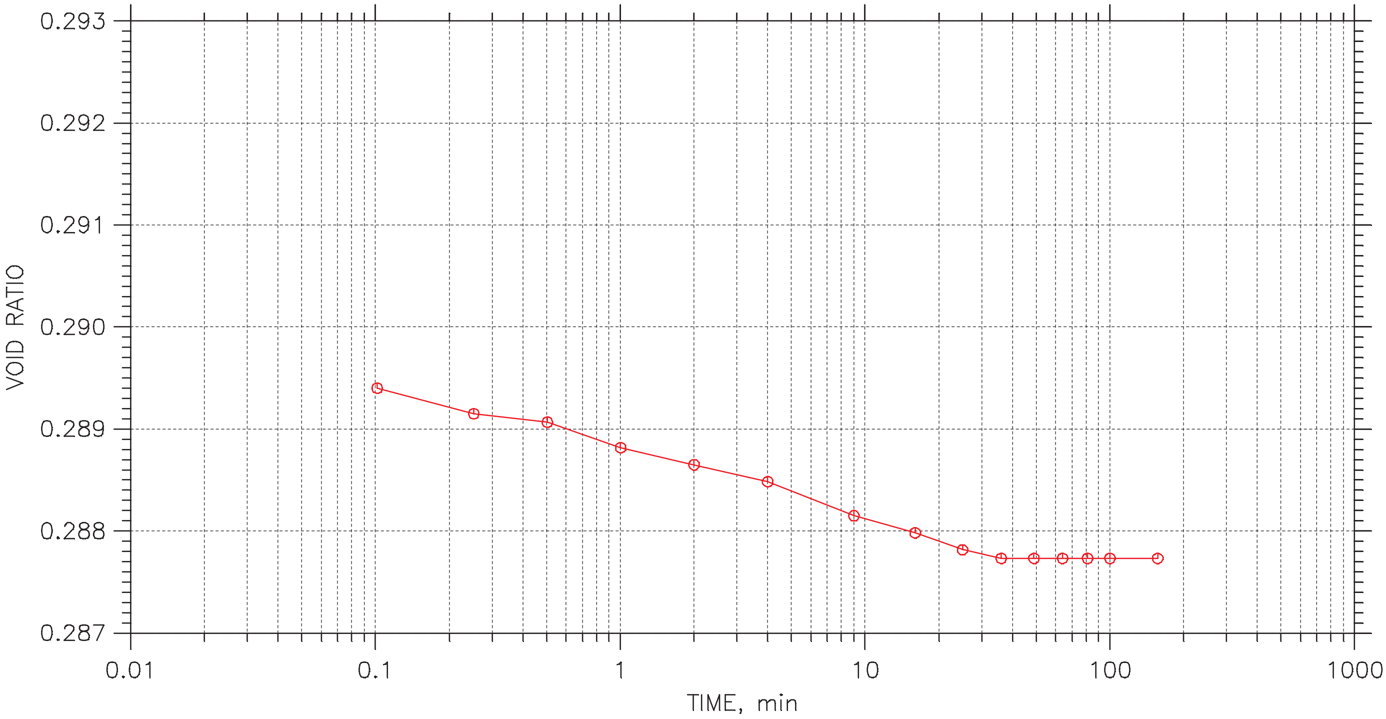
Mon, 21-DEC-2015 16:48:19

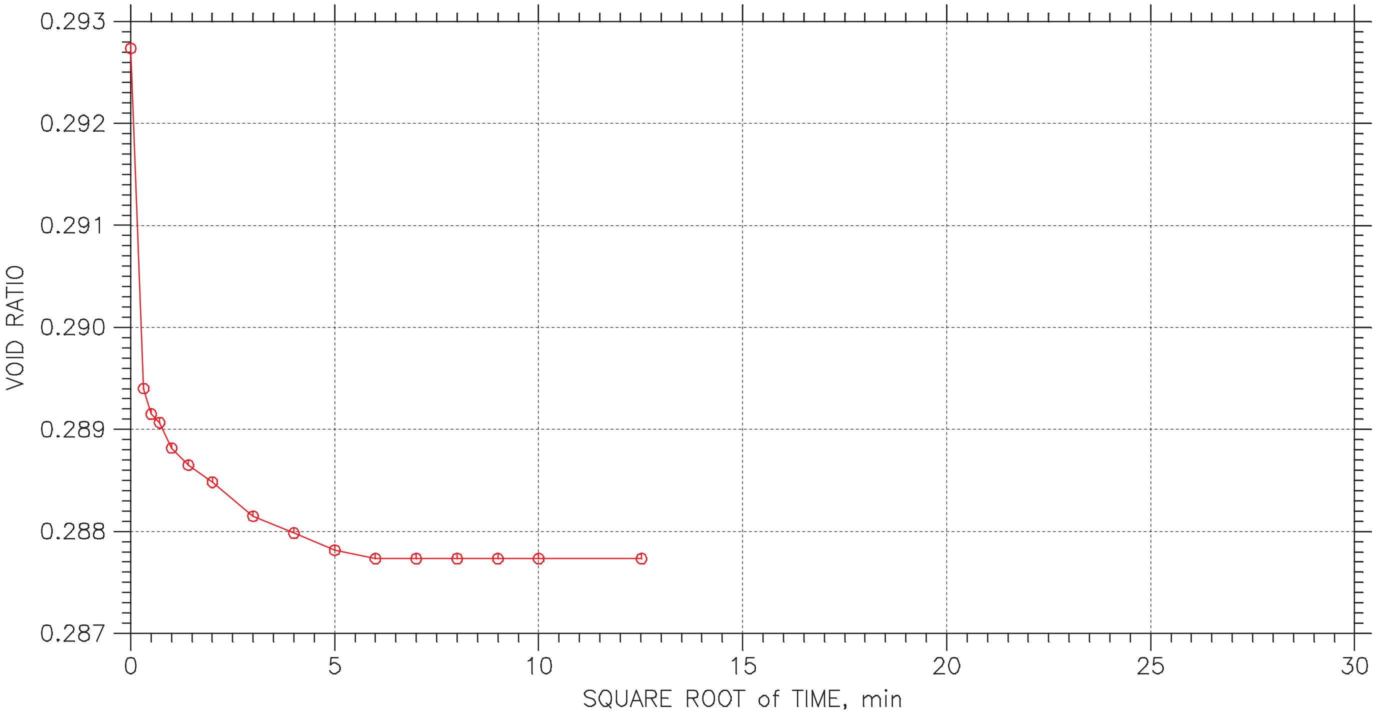
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

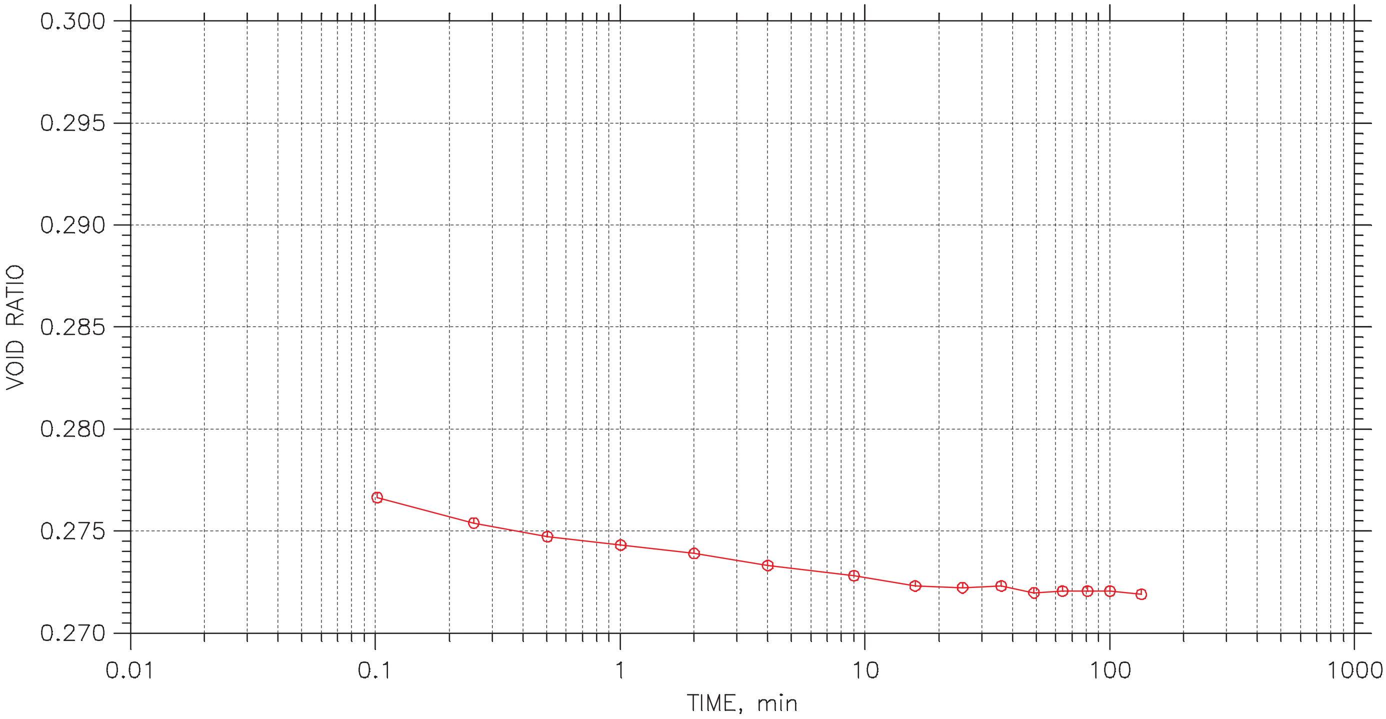
Mon, 21-DEC-2015 16:48:20

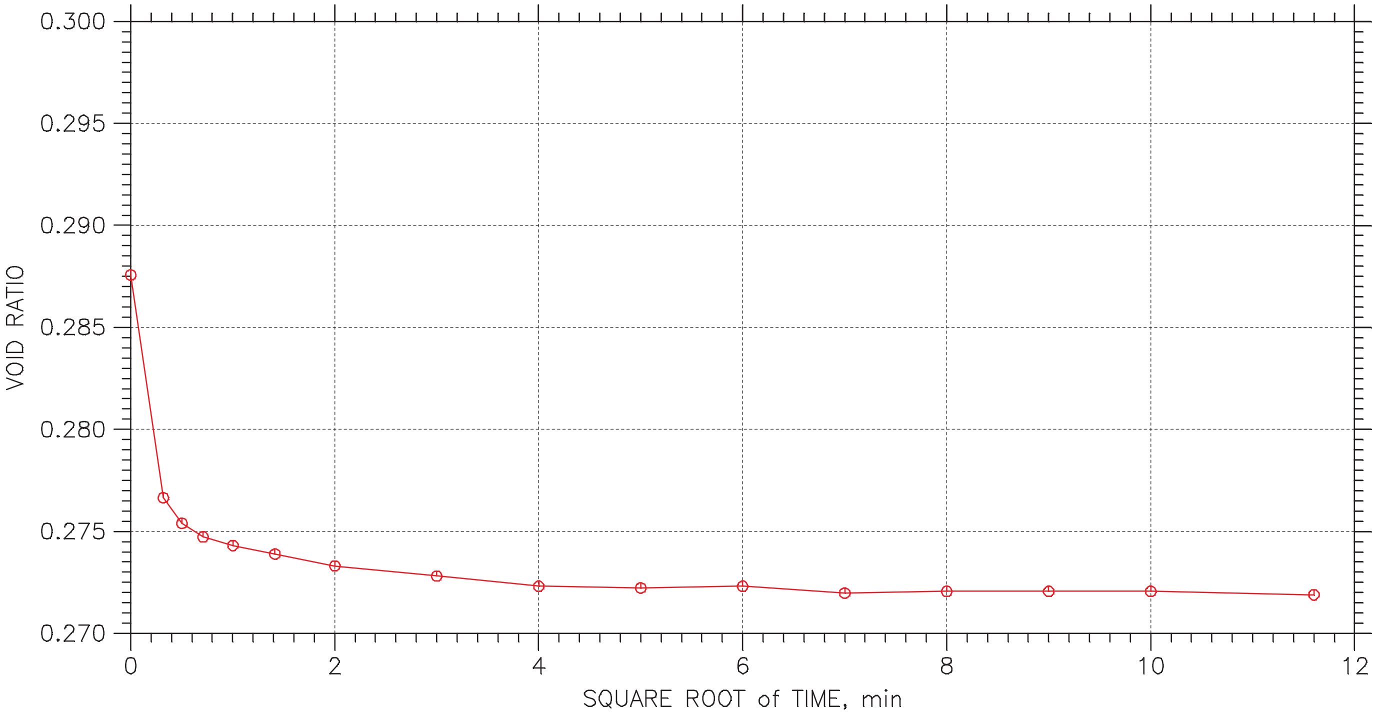
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: **DYNEGY HENNEPIN**	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

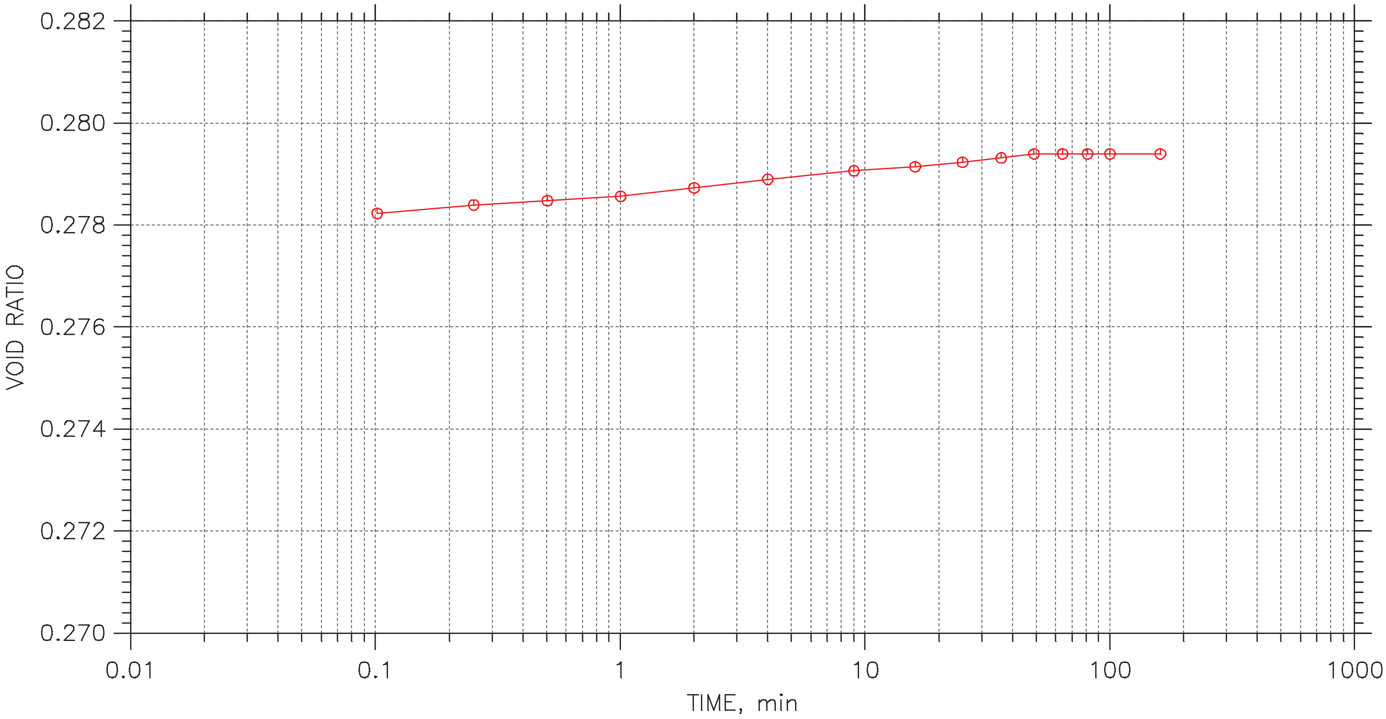
Mon, 21-DEC-2015 16:48:21

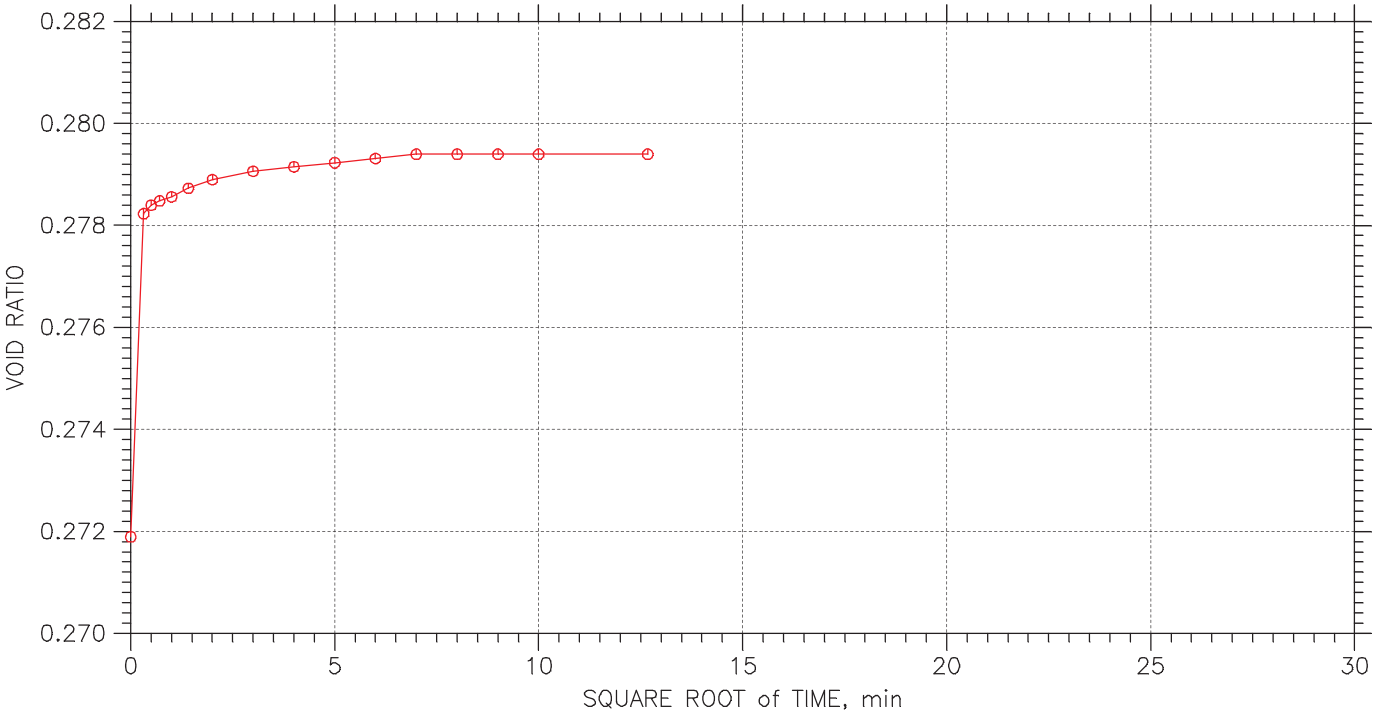
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

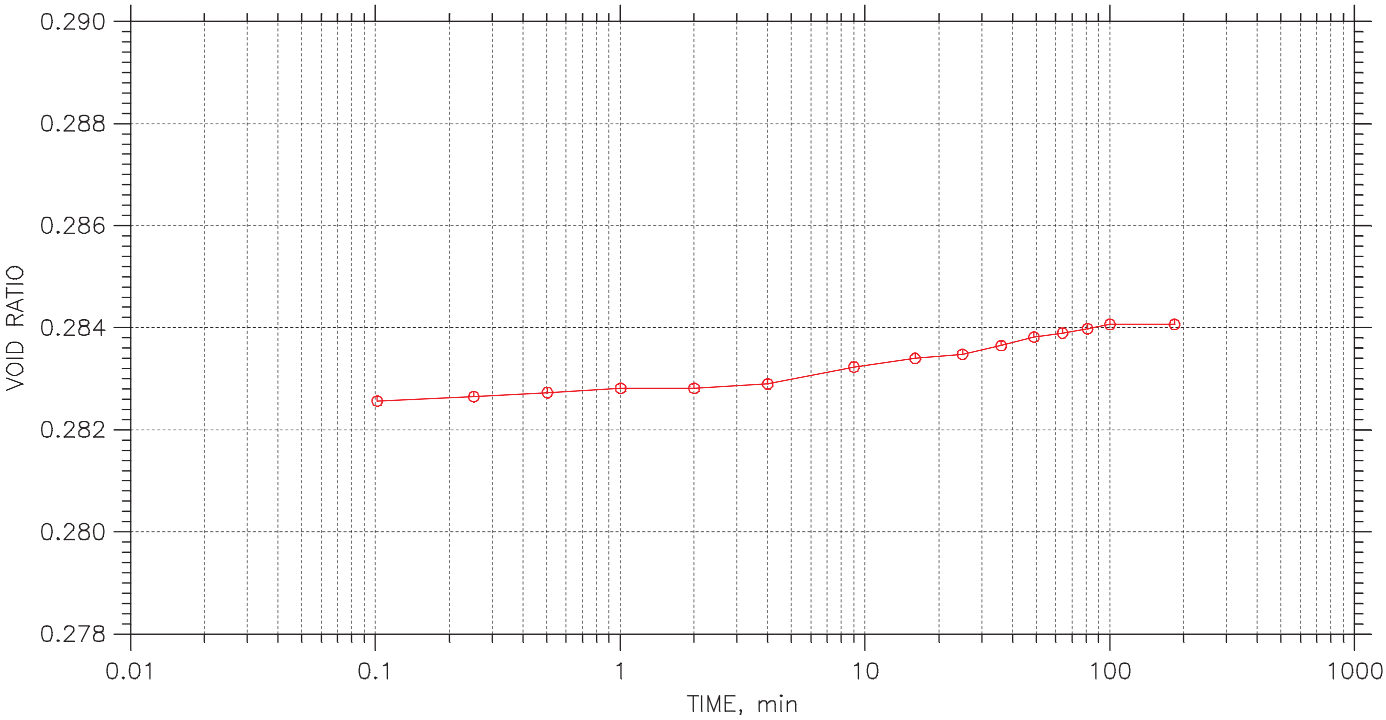
Mon, 21-DEC-2015 16:48:23

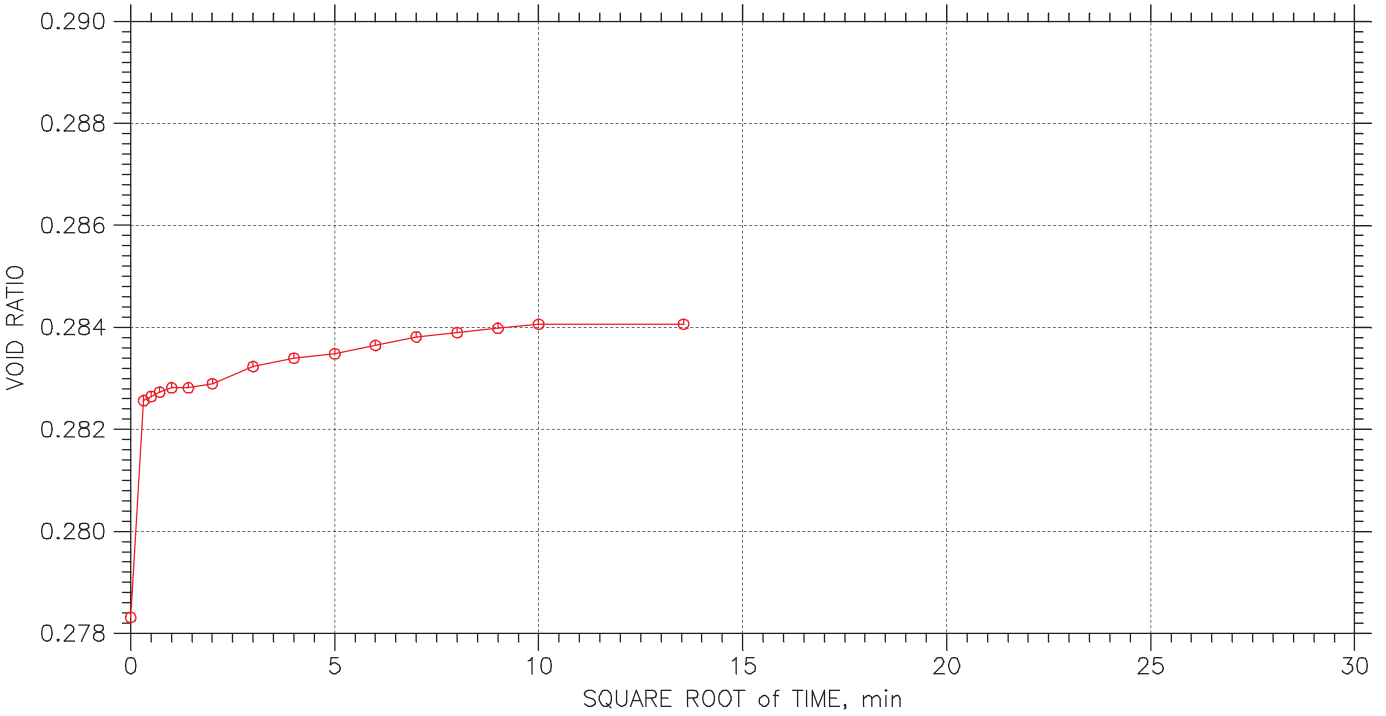
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

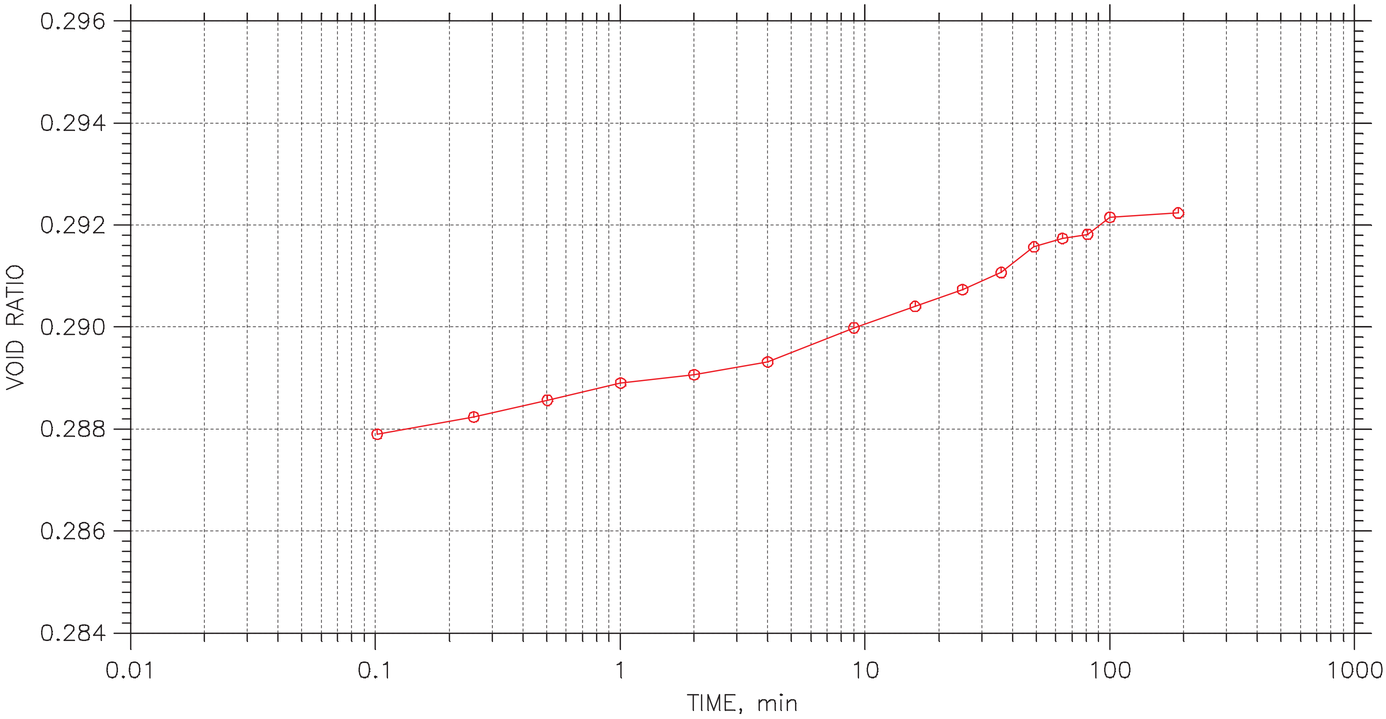
Mon, 21-DEC-2015 16:48:24

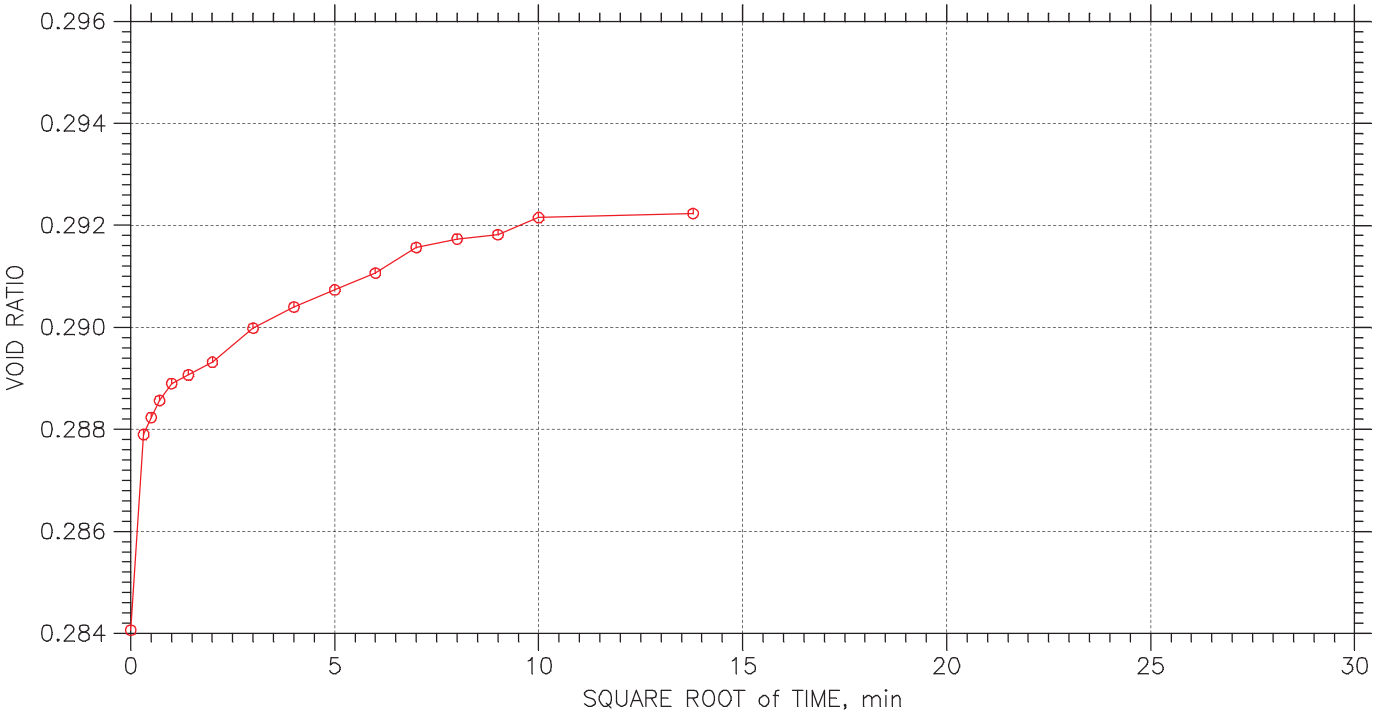
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 23

Stress: 0.125 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

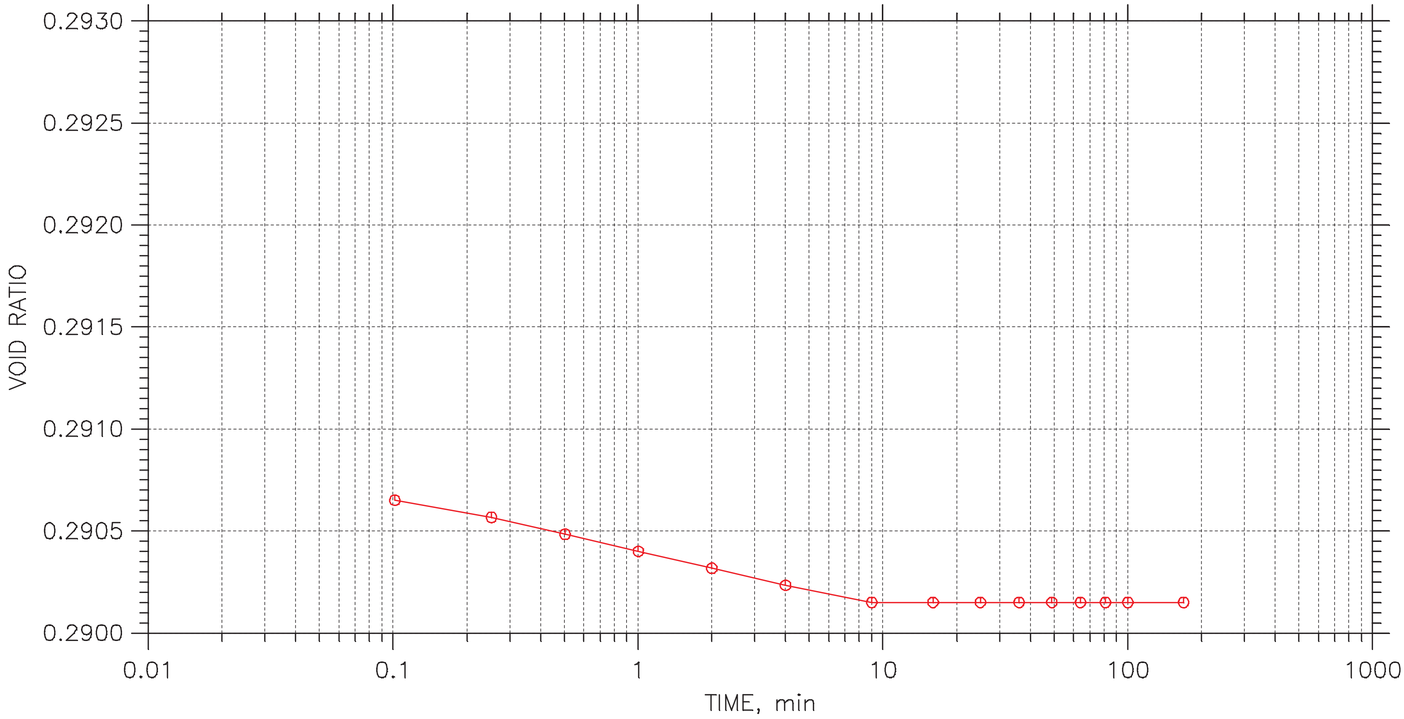
Mon, 21-DEC-2015 16:48:26

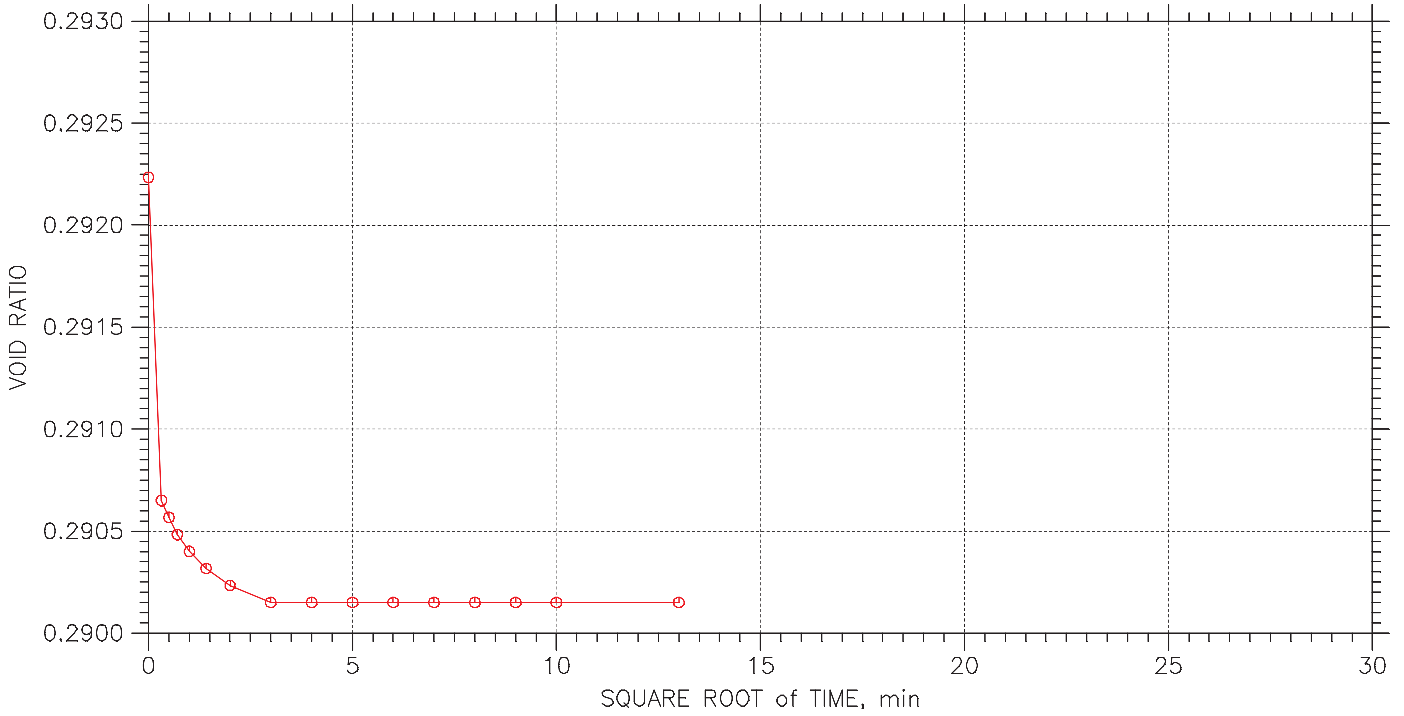
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 23

Stress: 0.25 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

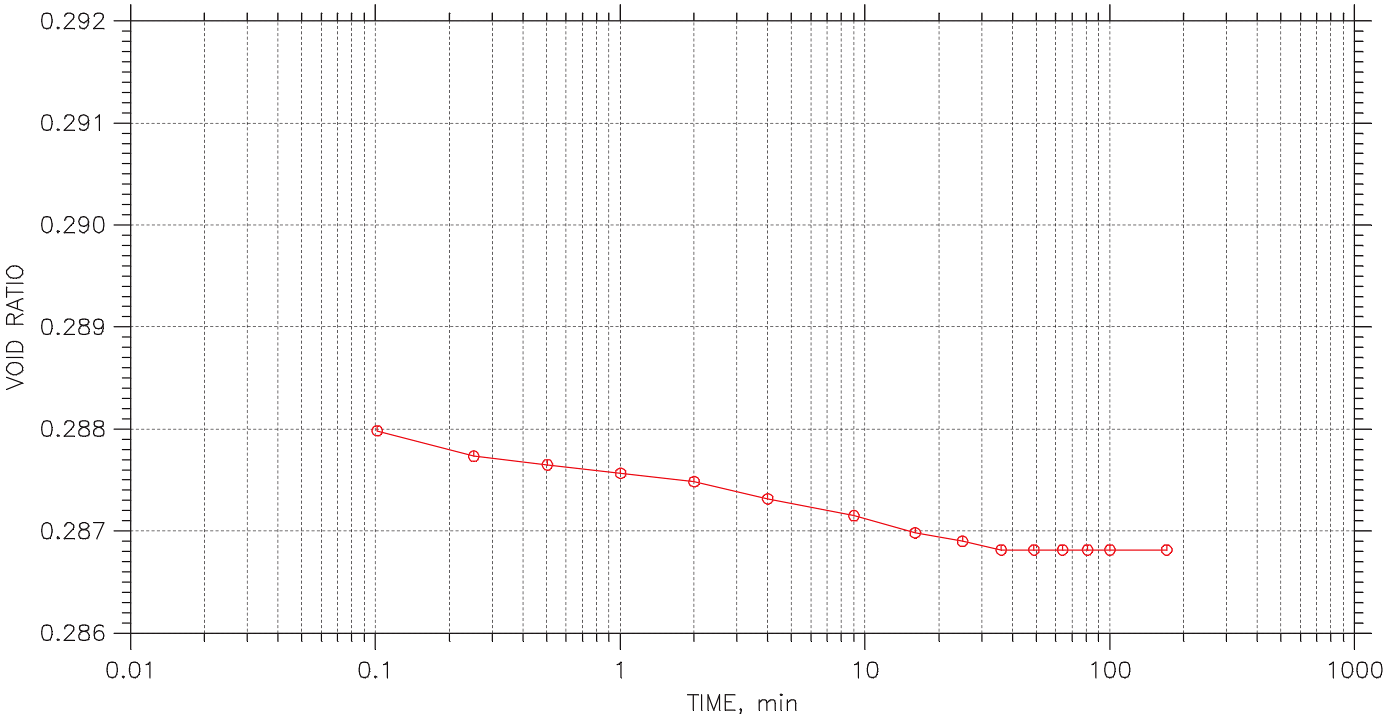
Mon, 21-DEC-2015 16:48:27

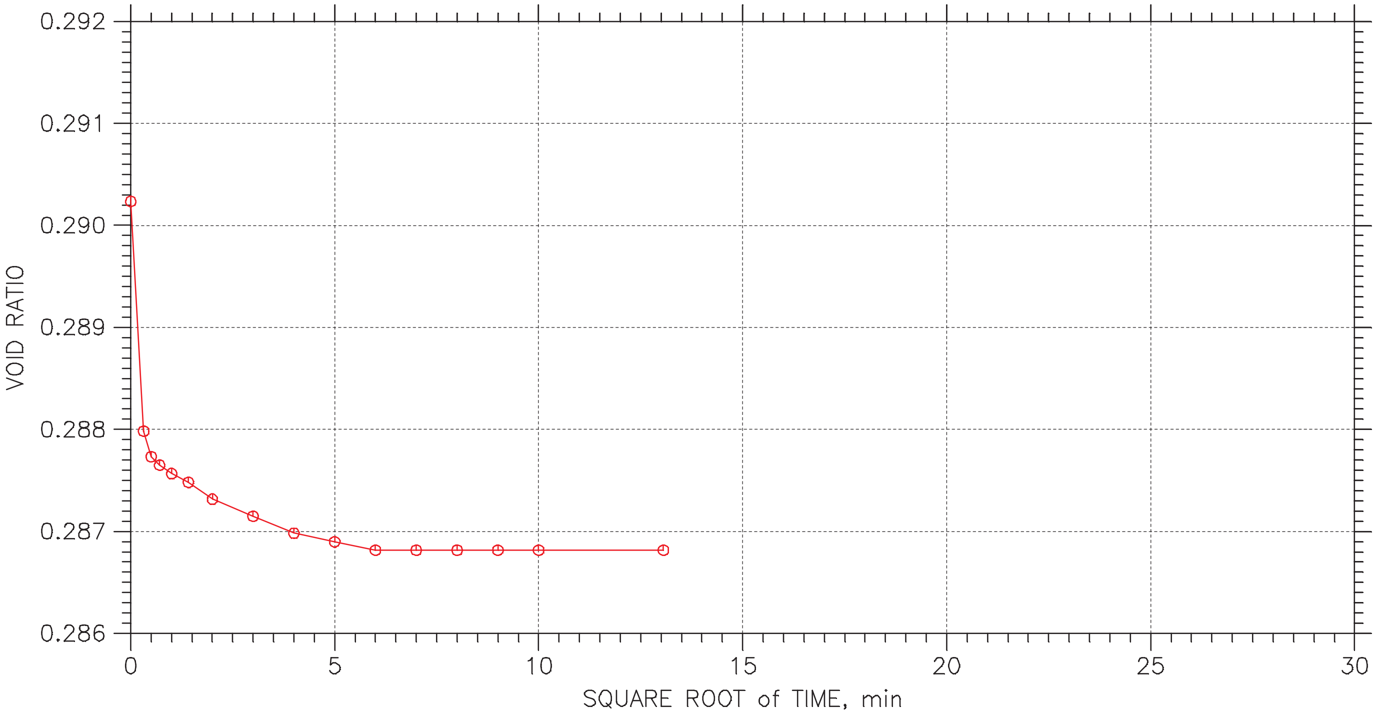
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 23

Stress: 0.5 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

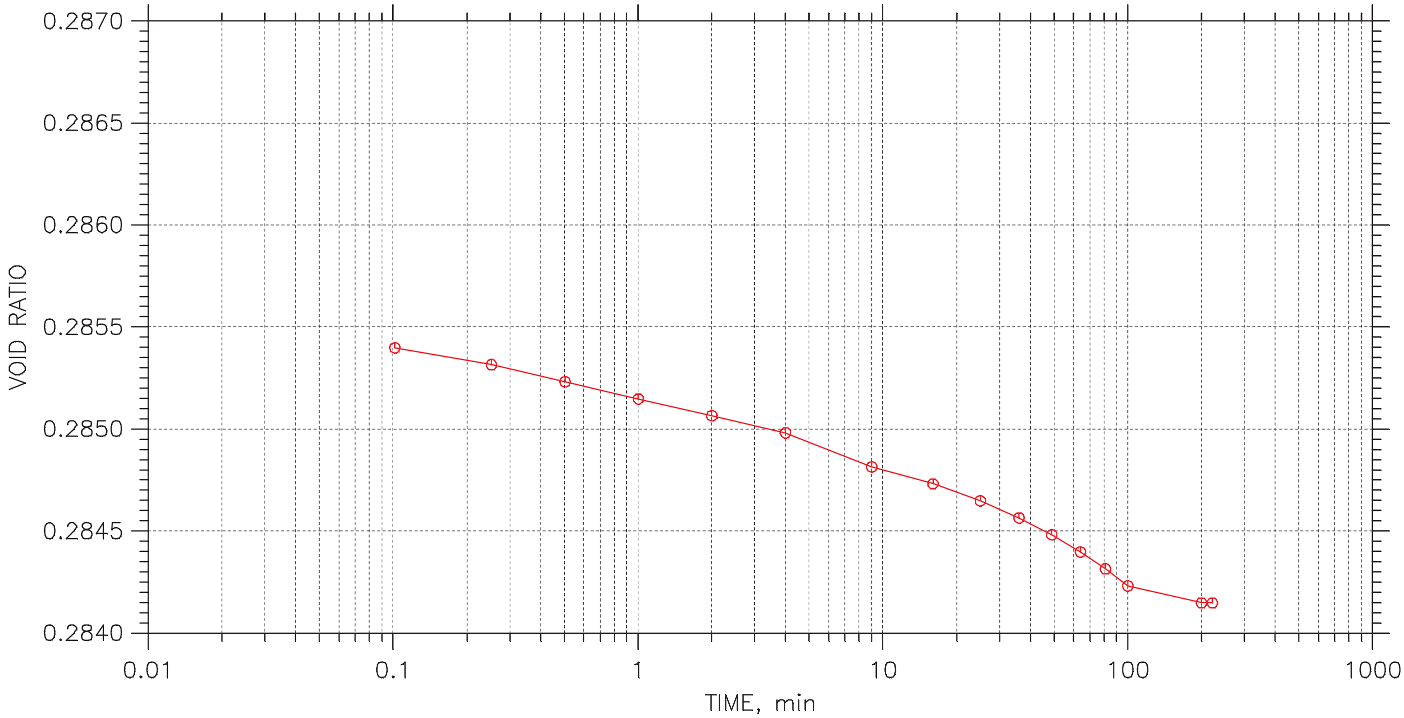
Mon, 21-DEC-2015 16:48:28

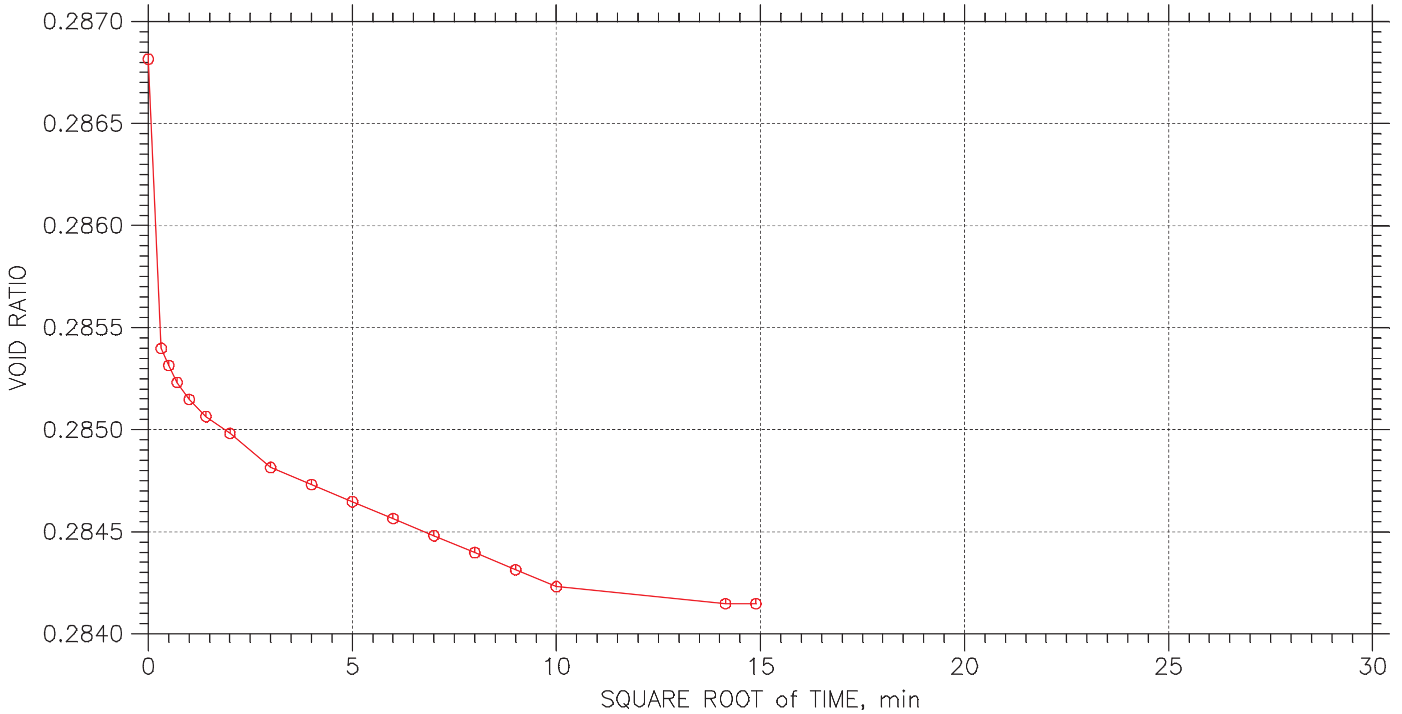
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 23

Stress: 0.75 tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

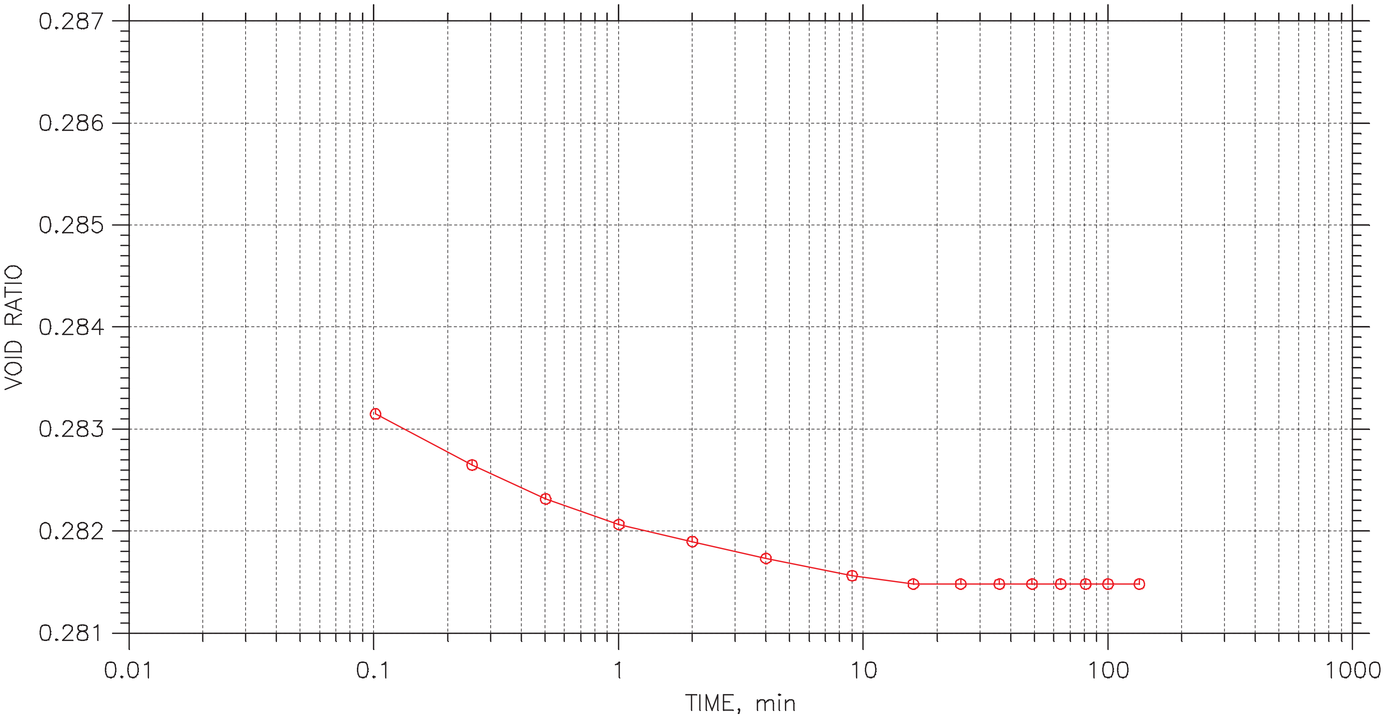
Mon, 21-DEC-2015 16:48:30

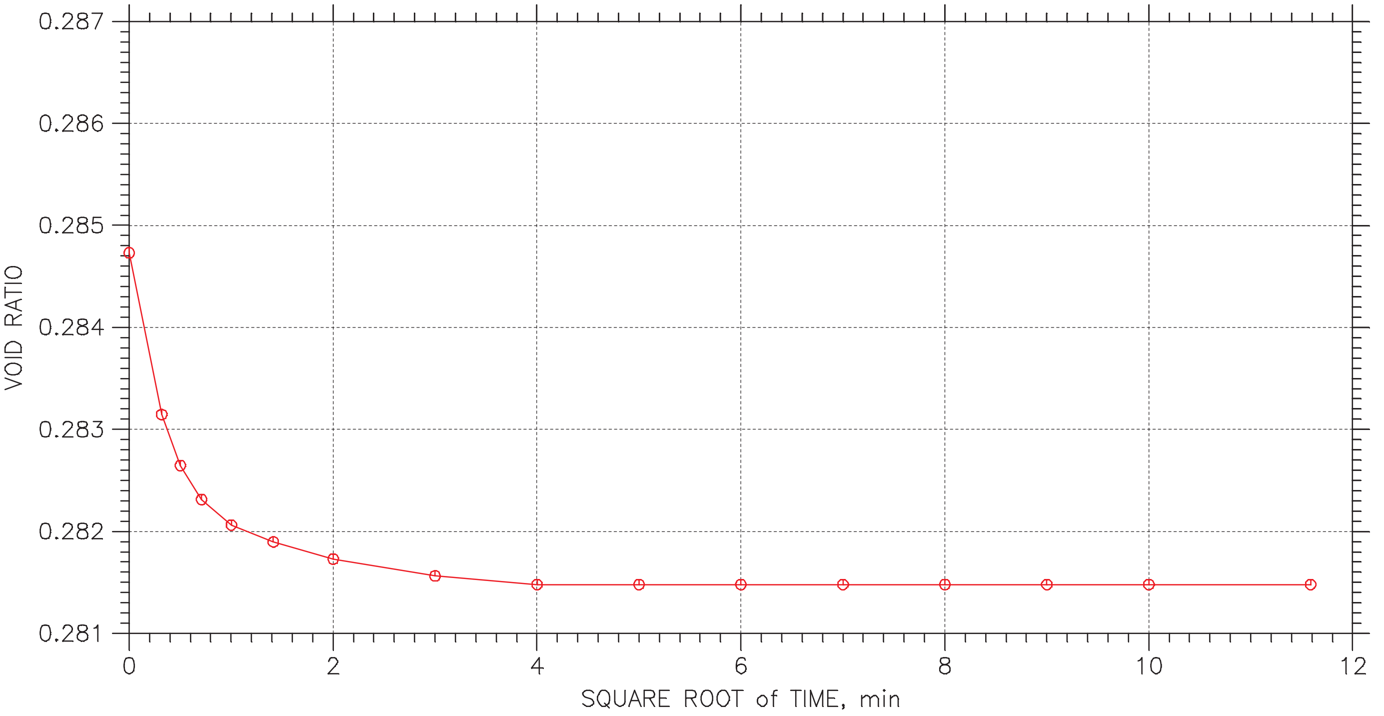
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 23

Stress: 1. tsf





Terracon Consulting Engineers & Scientists			
	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

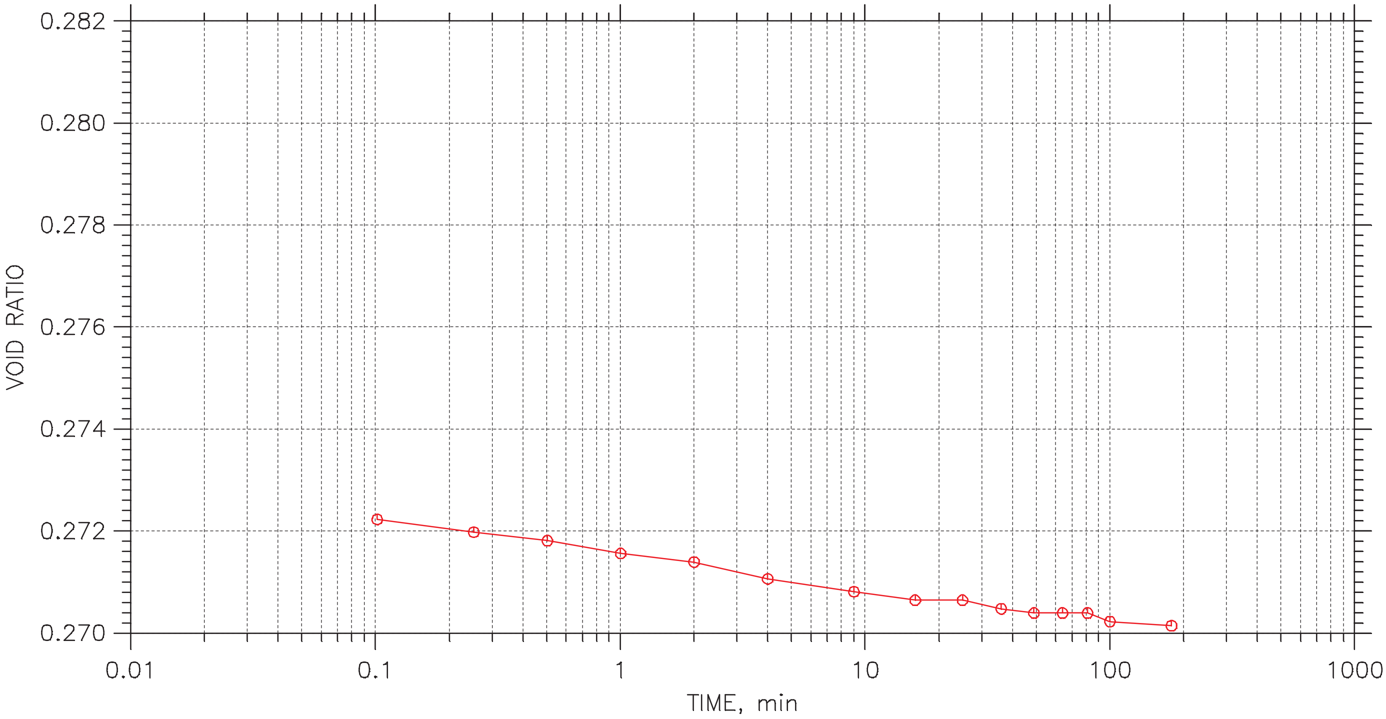
Mon, 21-DEC-2015 16:48:31

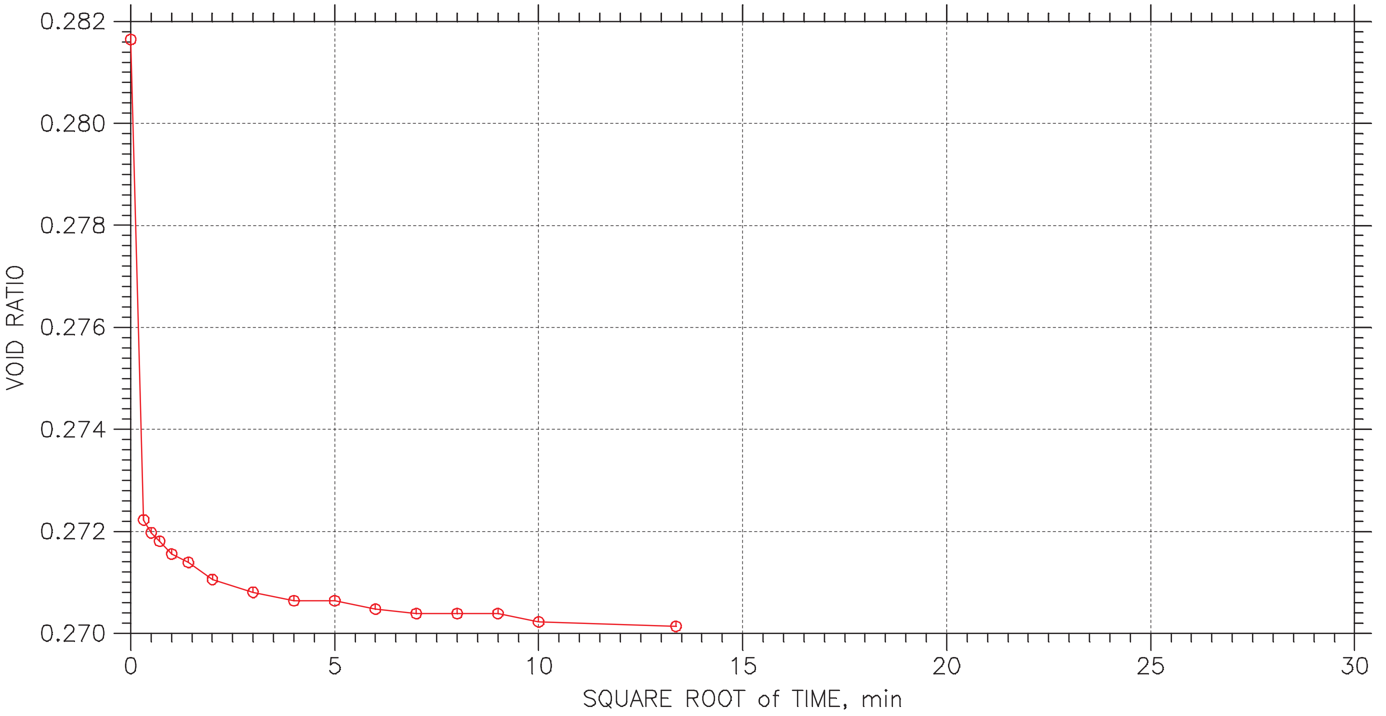
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 23

Stress: 2. tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

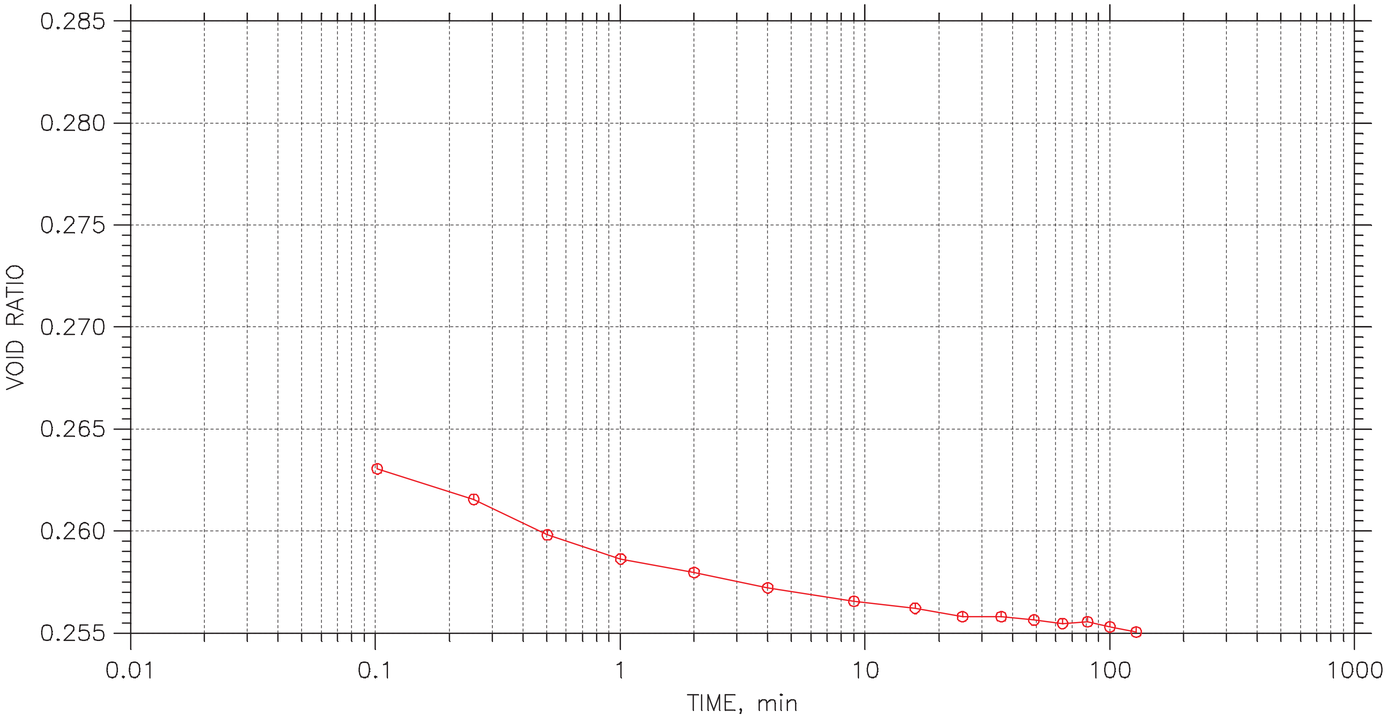
Mon, 21-DEC-2015 16:48:33

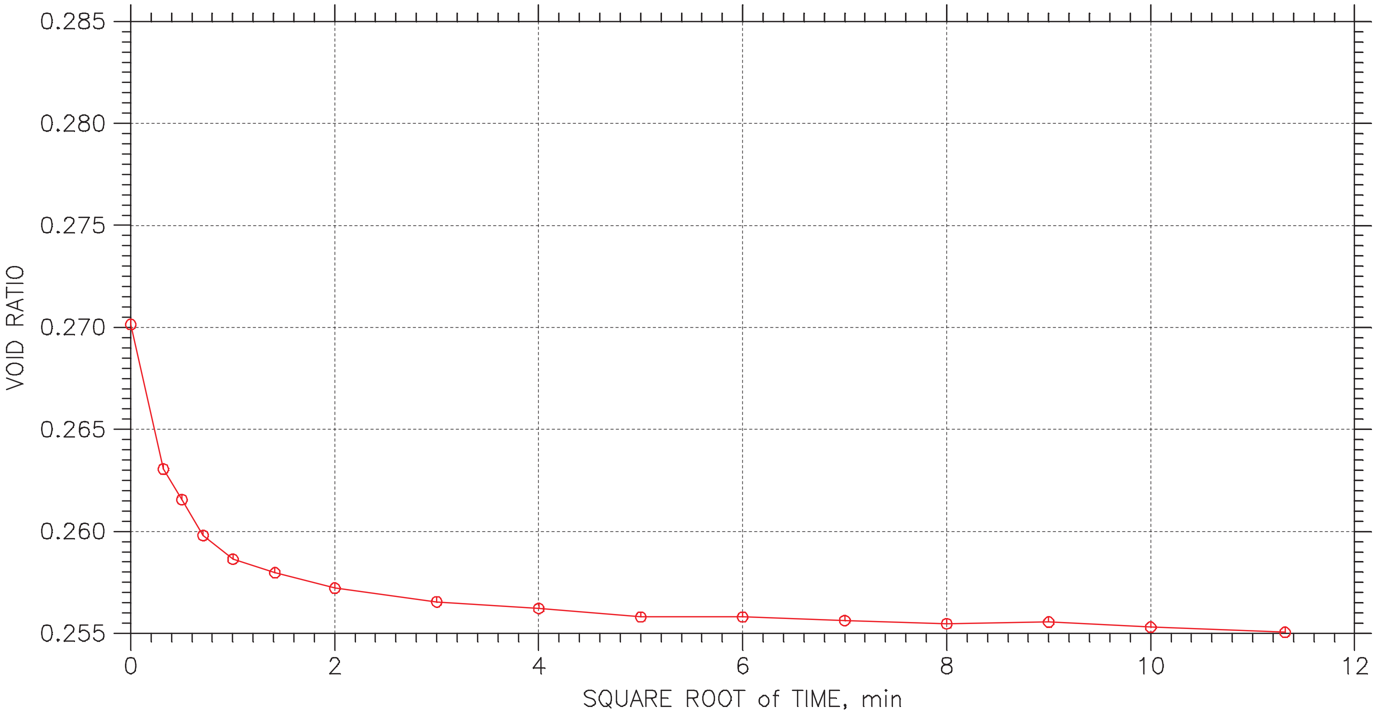
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

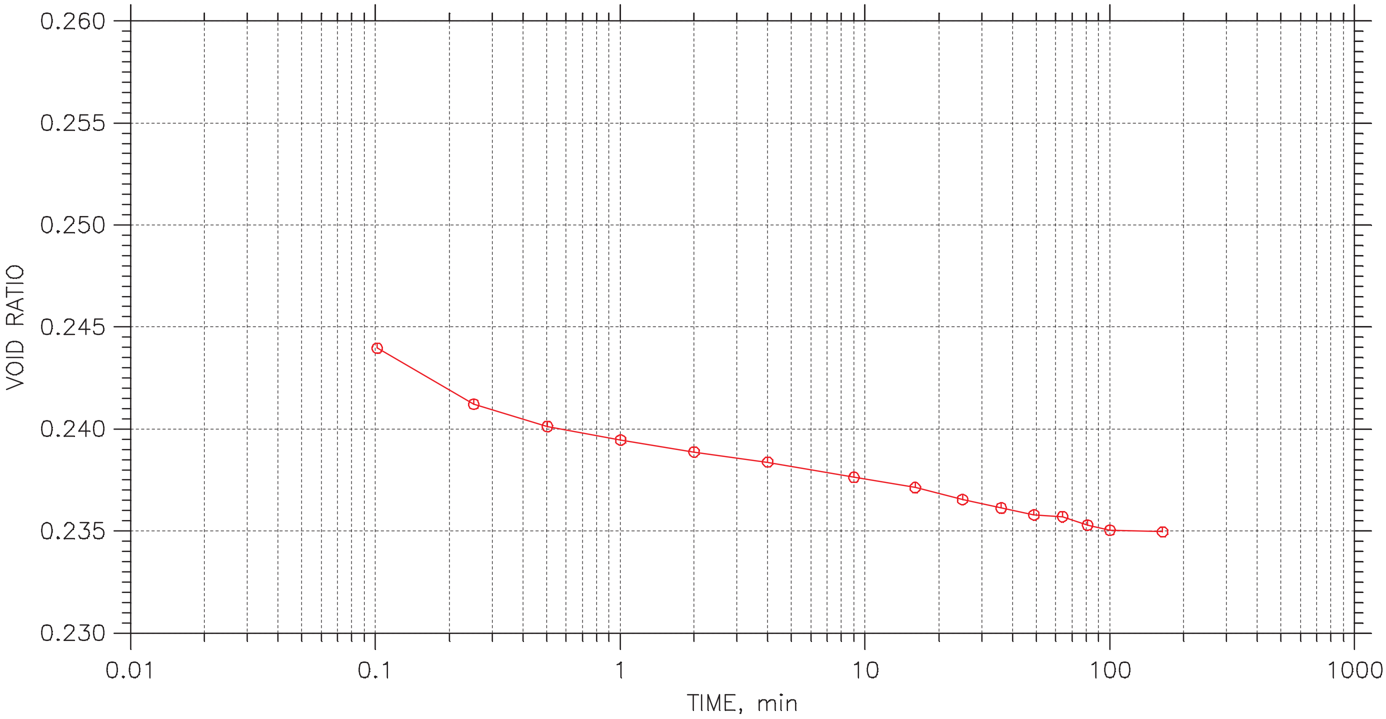
Mon, 21-DEC-2015 16:48:34

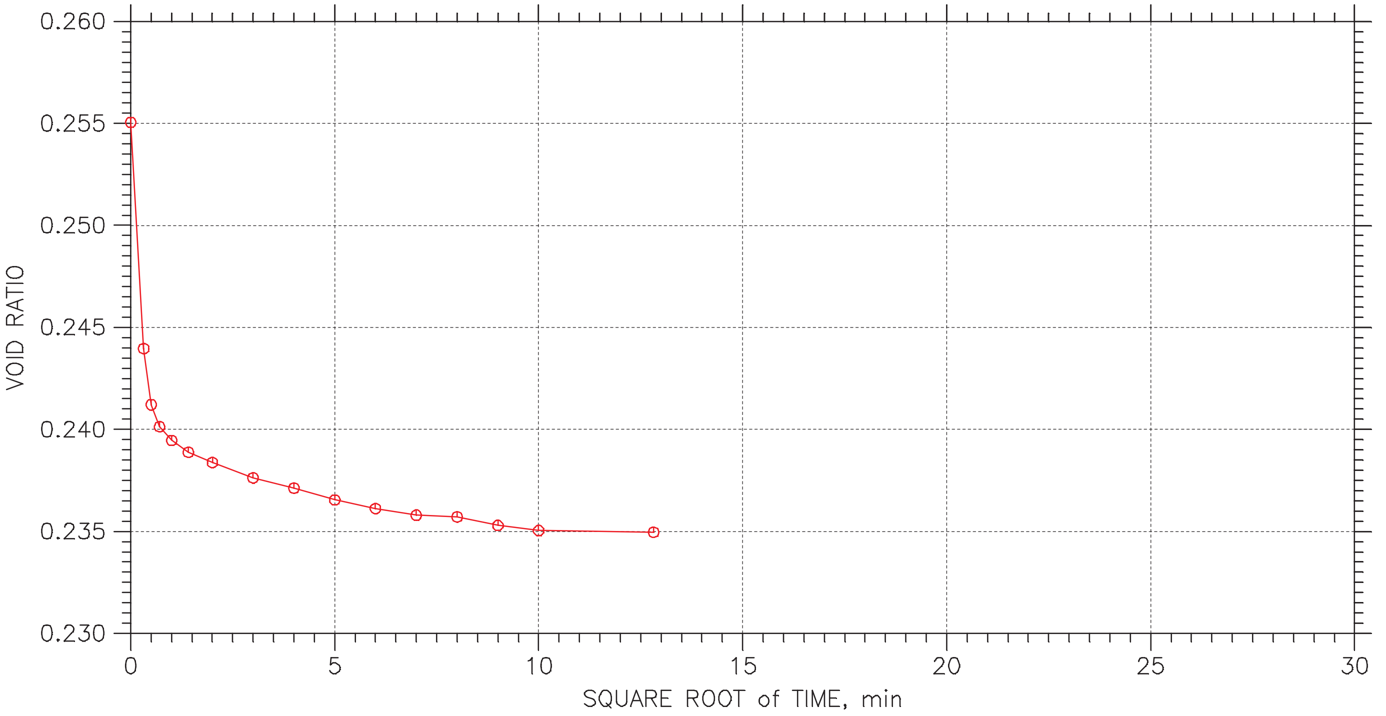
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 23

Stress: 8. tsf





Project: **DYNEGY HENNEPIN**	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

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Consulting Engineers & Scientists

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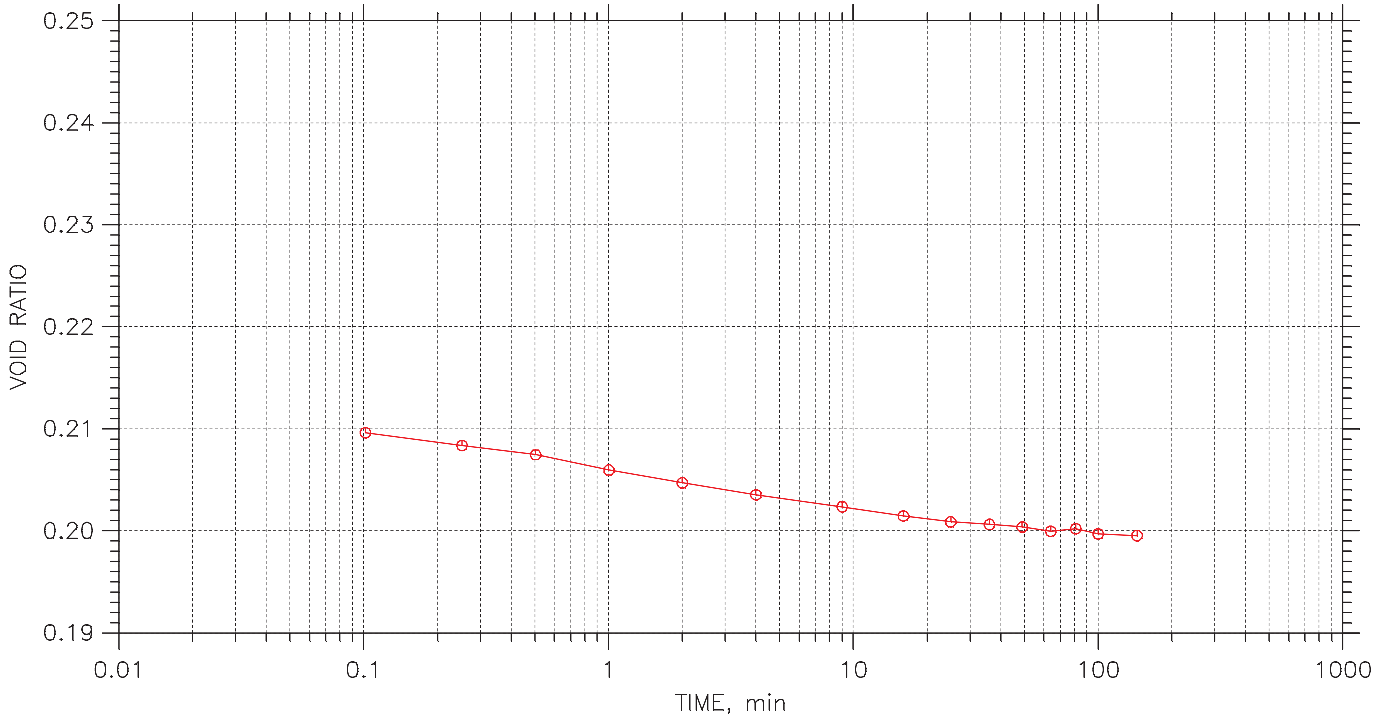
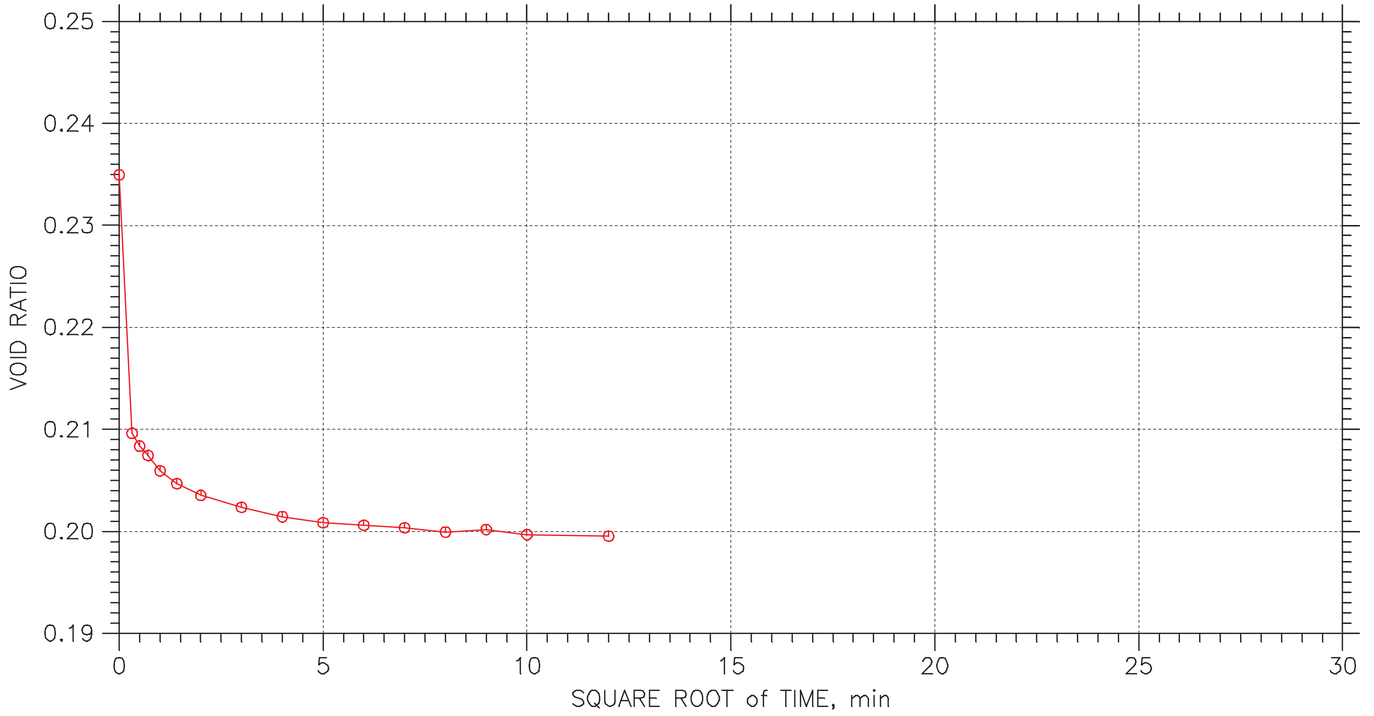
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 23

Stress: 16. tsf





Terracon Consulting Engineers & Scientists			
	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

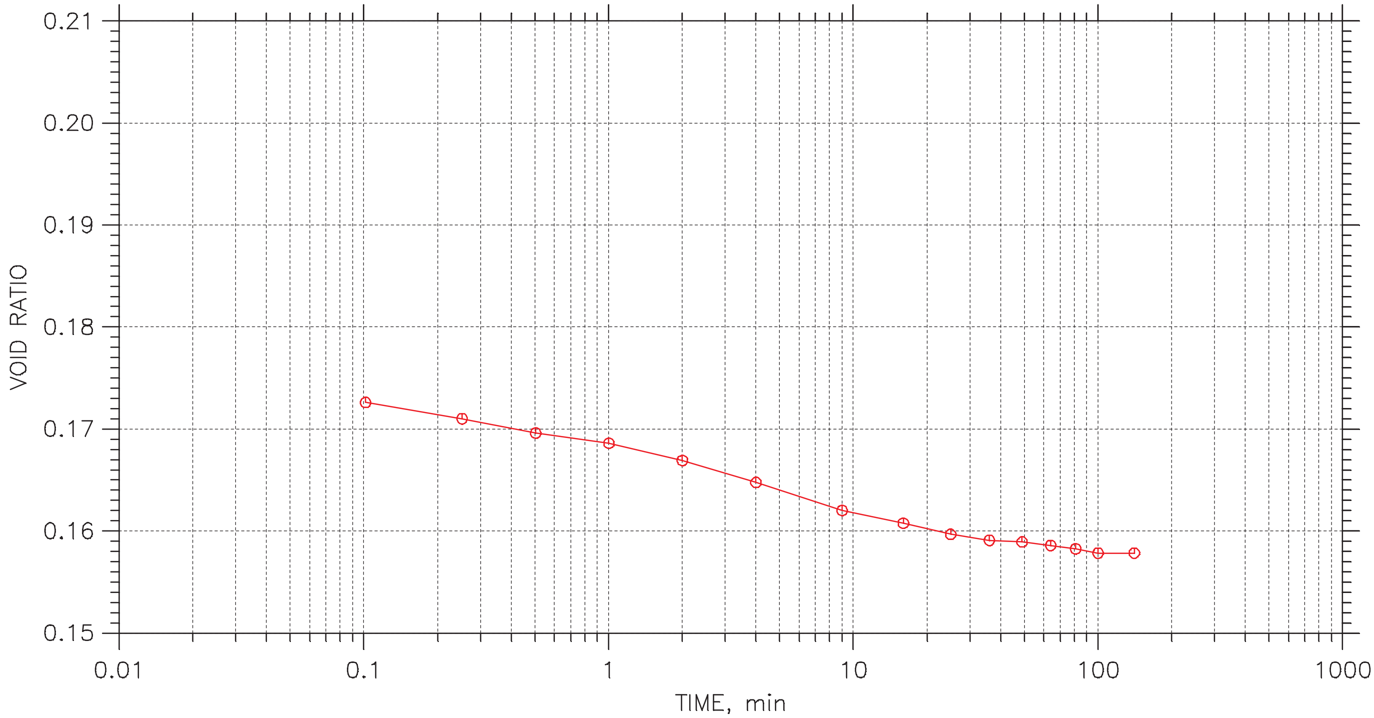
Mon, 21-DEC-2015 16:48:37

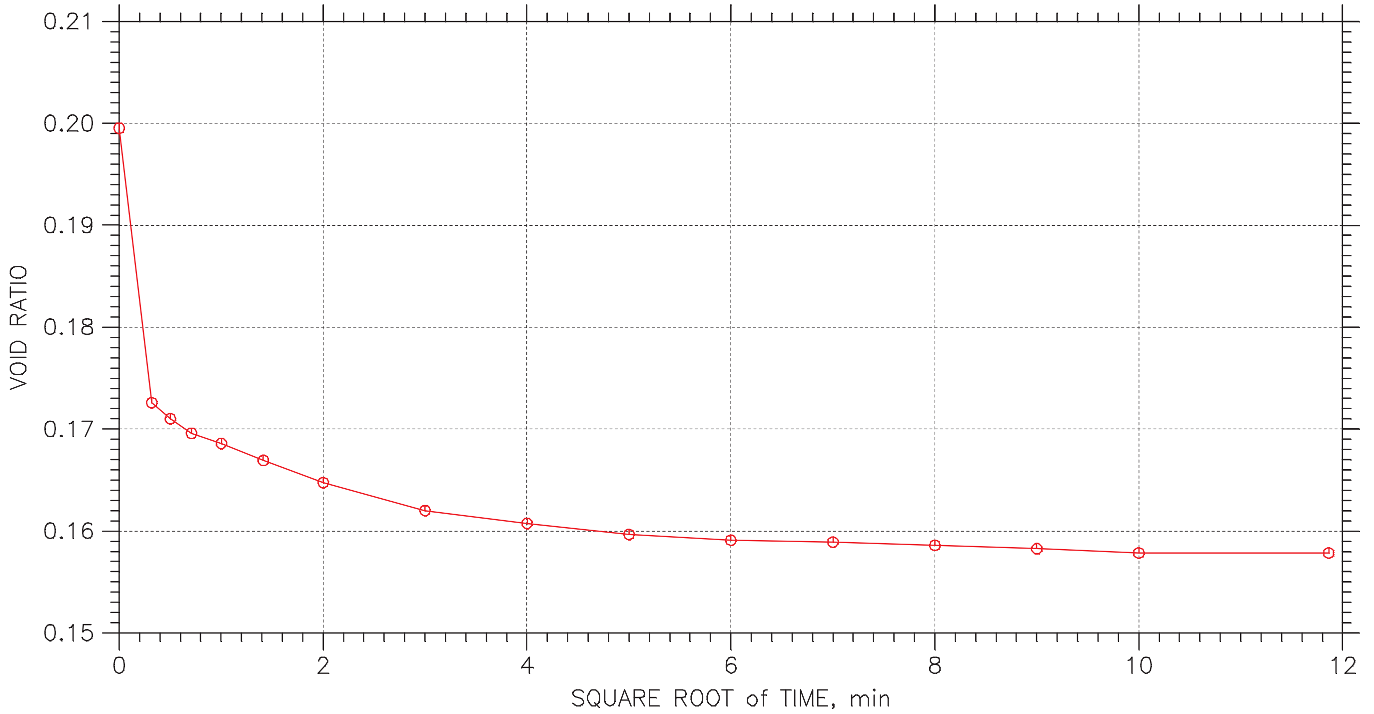
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 23

Stress: 32. tsf





Terracon
Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----

Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL

Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435

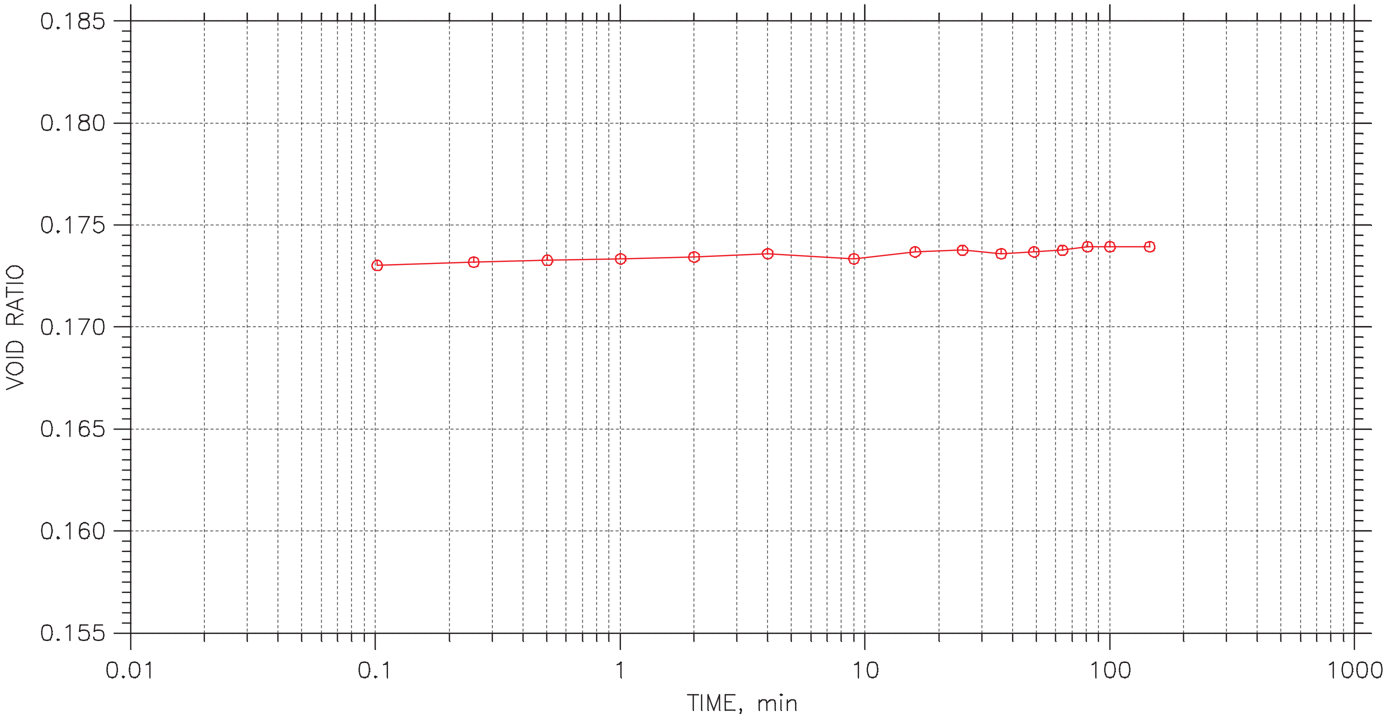
Mon, 21-DEC-2015 16:48:38

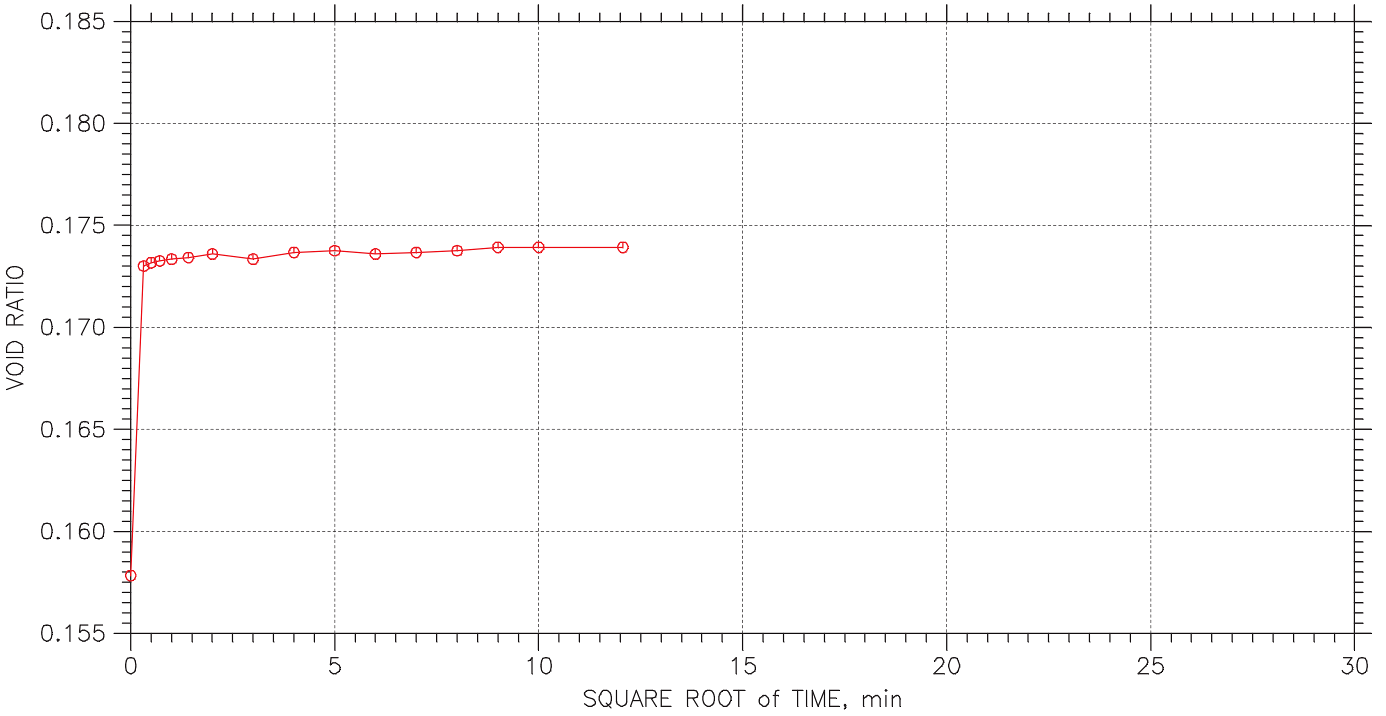
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 23

Stress: 16. tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

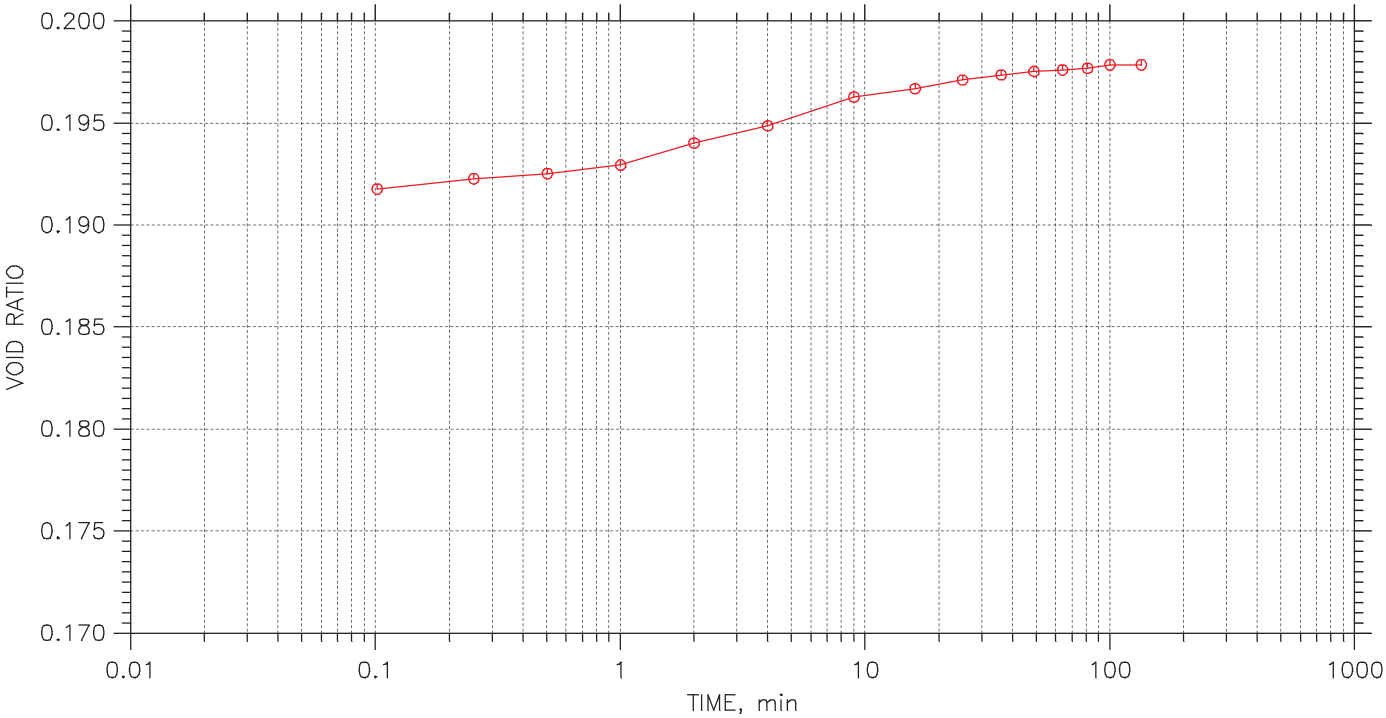
Mon, 21-DEC-2015 16:48:40

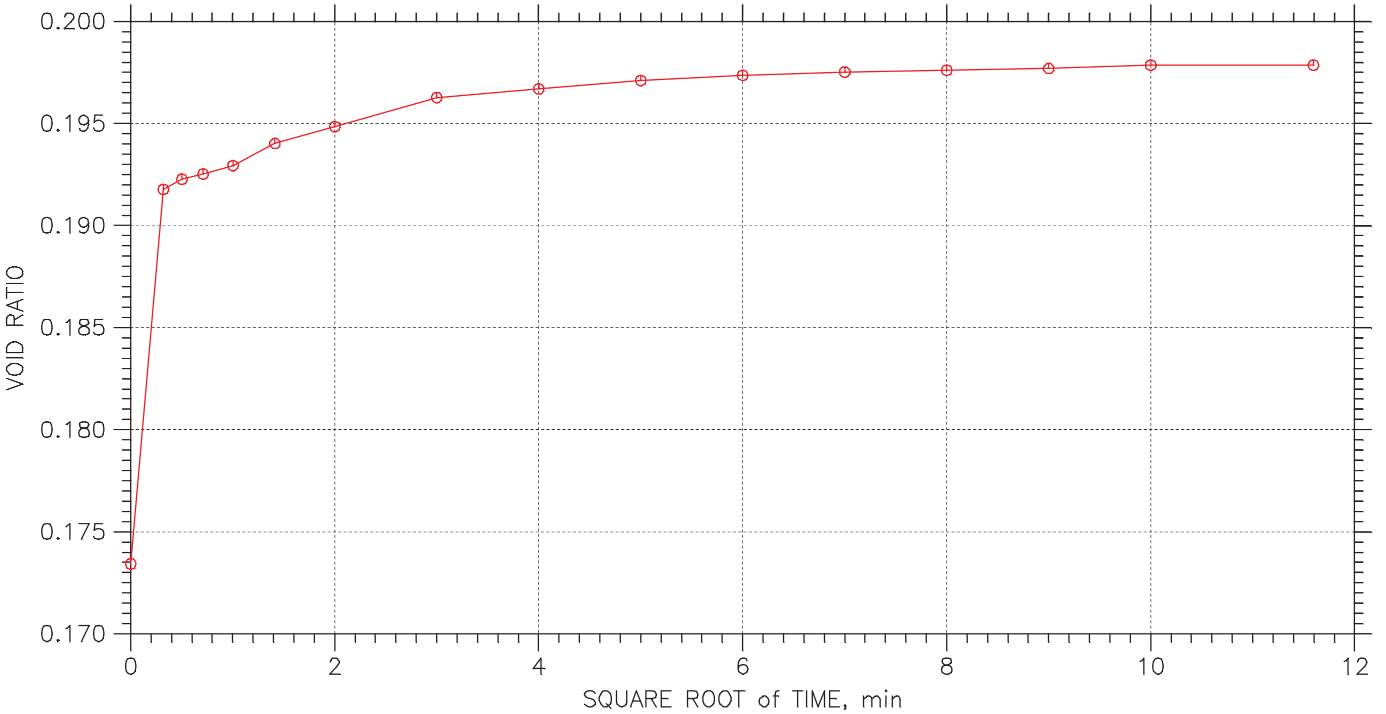
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 23

Stress: 4. tsf





Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

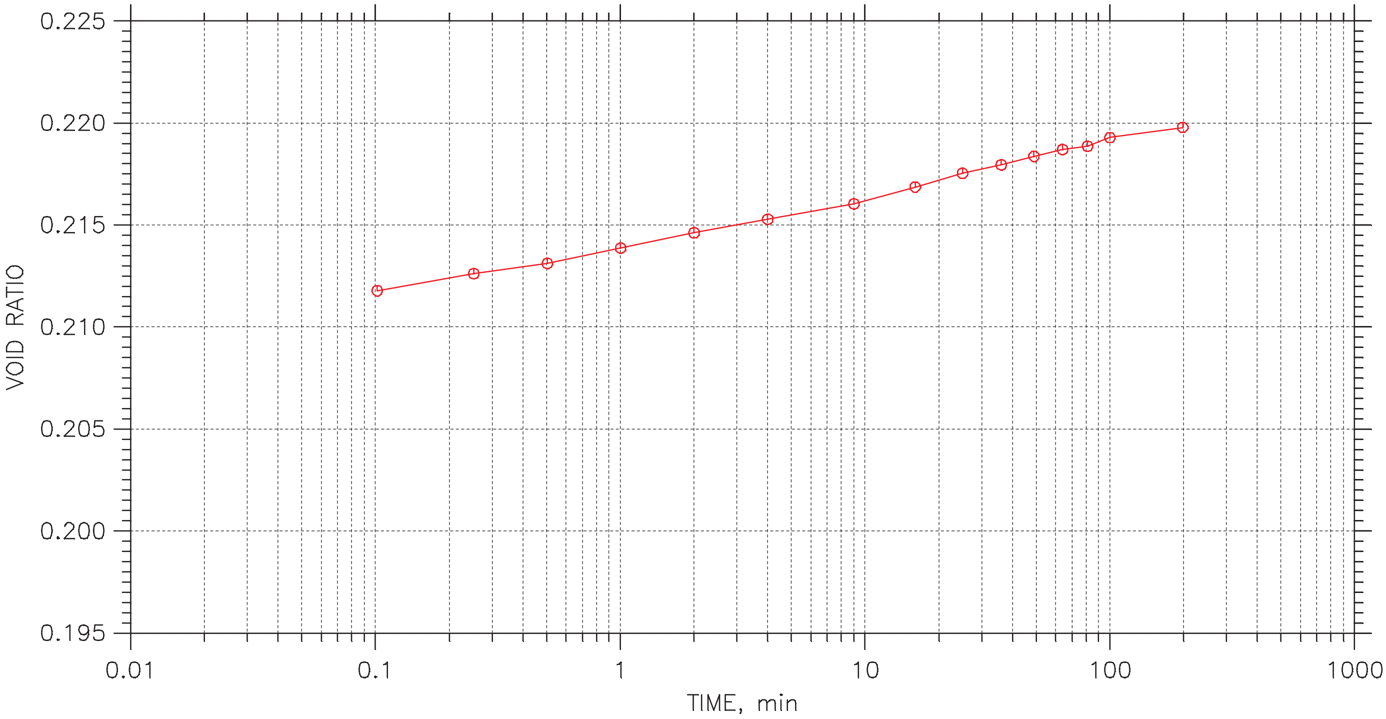
Mon, 21-DEC-2015 16:48:41

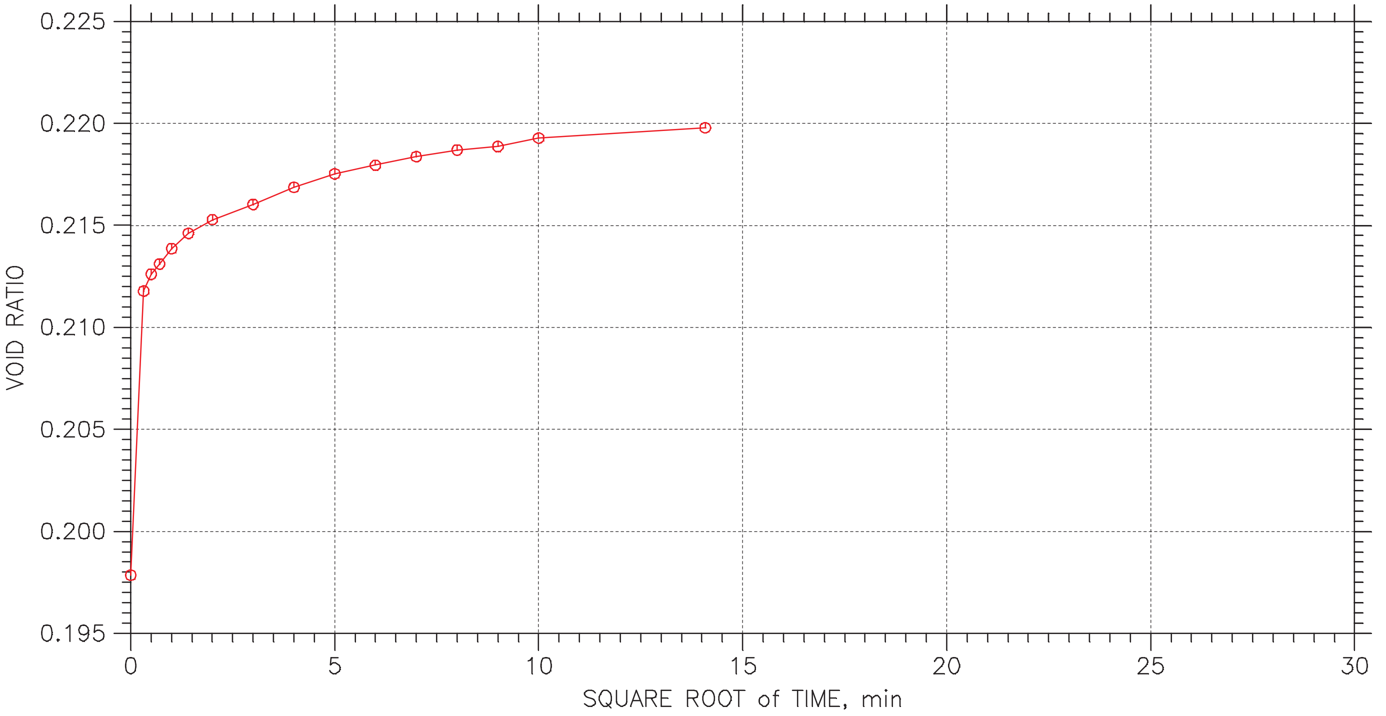
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 23

Stress: 1. tsf





Terracon
Consulting Engineers & Scientists

Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0’-7.0’
Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

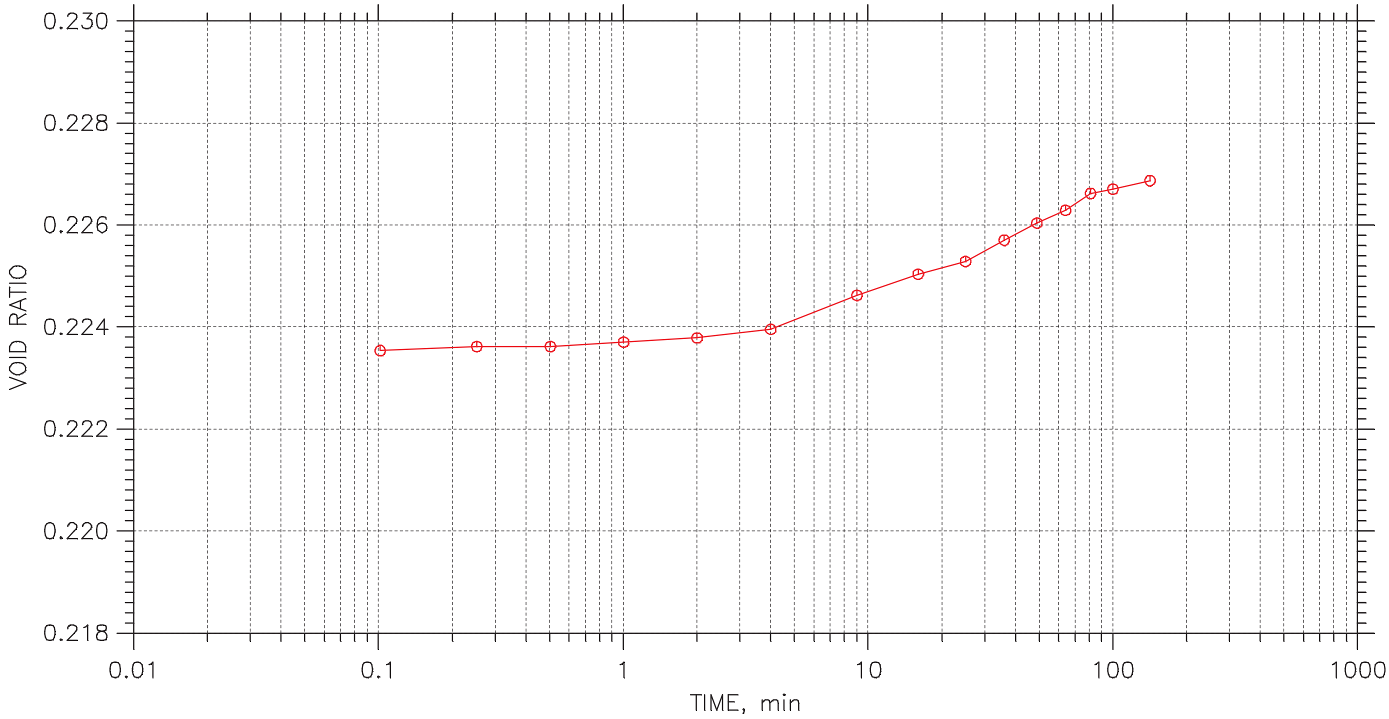
Mon, 21-DEC-2015 16:48:42

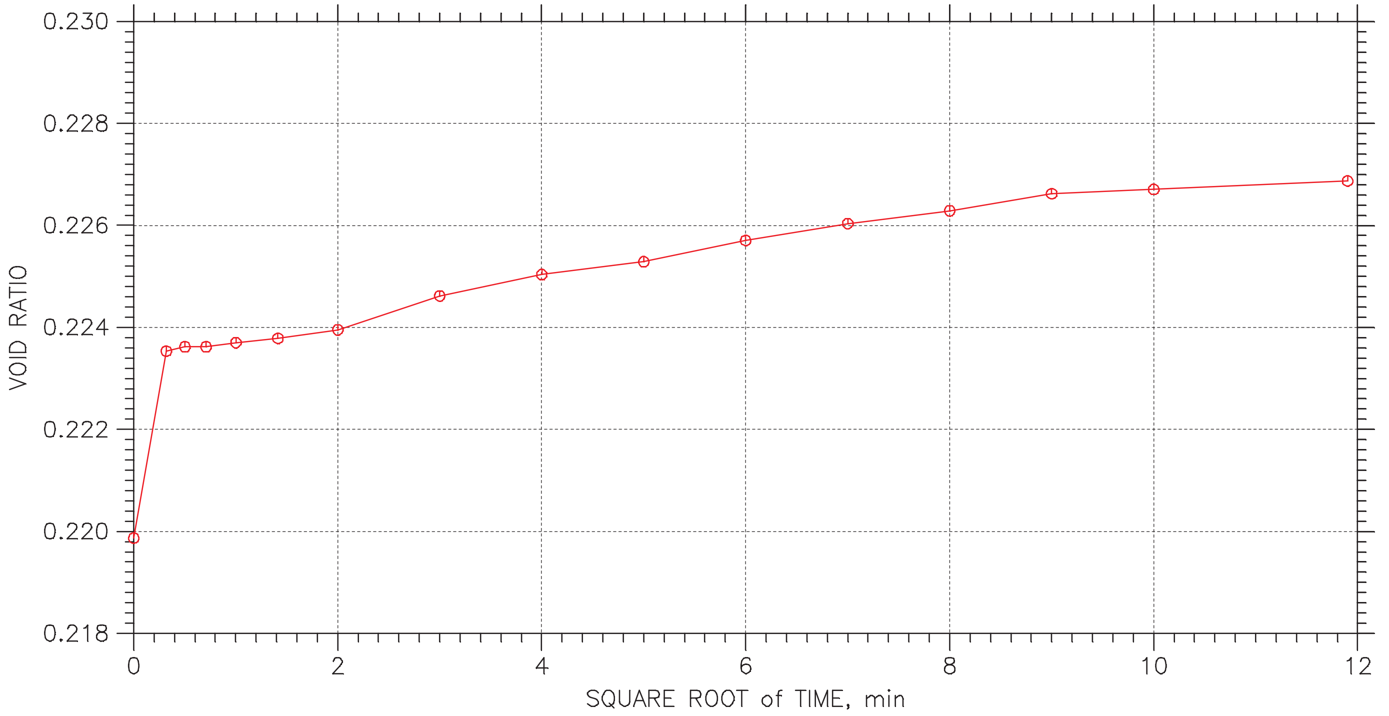
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 23

Stress: 0.5 tsf





Project: **DYNEGY HENNEPIN**	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
Test No.: HENB029S3	Sample Type: 3.0" ST	Elevation: -----
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

Terracon
Consulting Engineers & Scientists

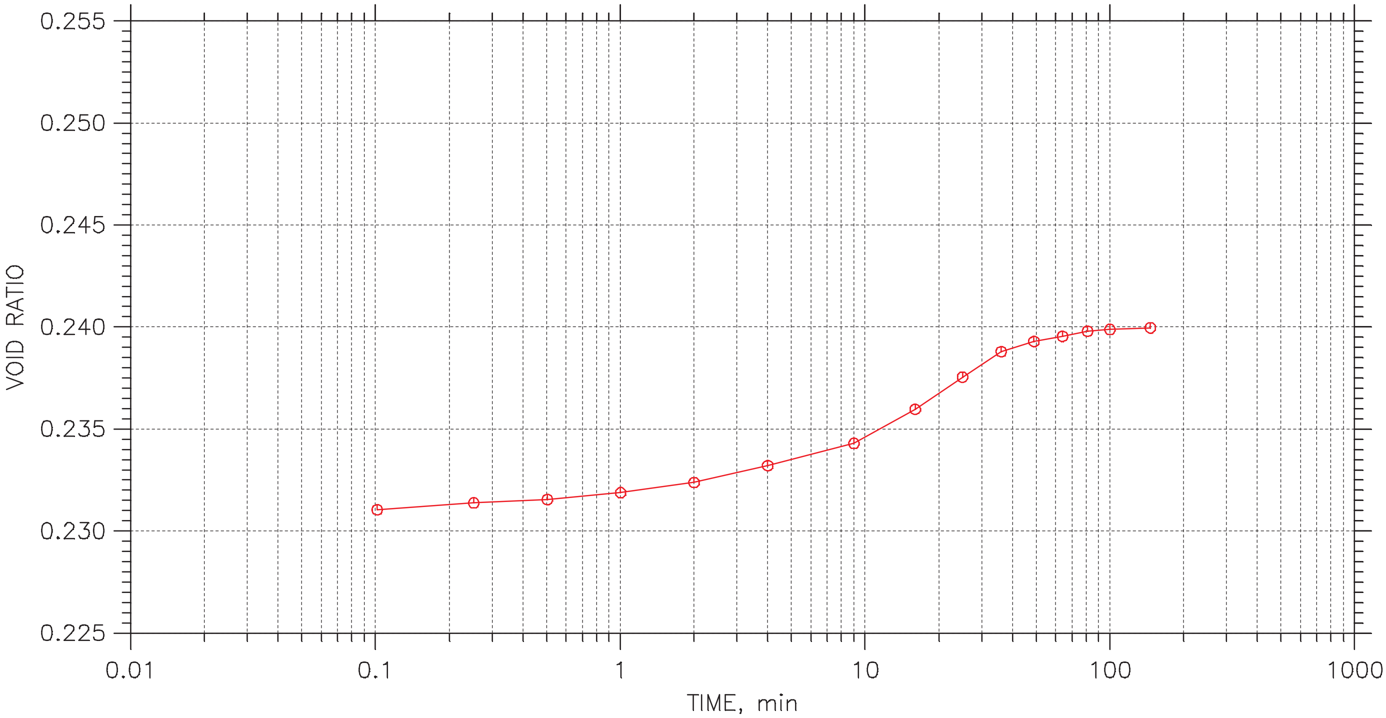
Mon, 21-DEC-2015 16:48:44

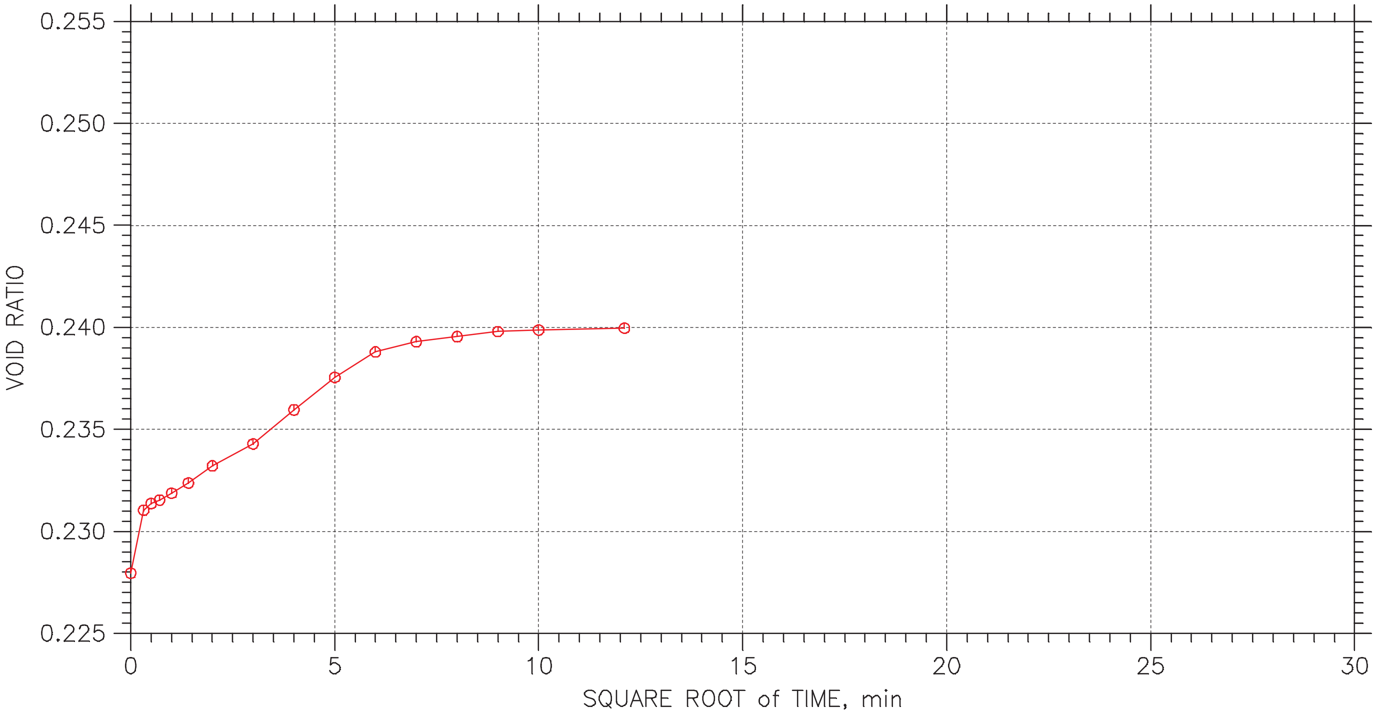
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 23

Stress: 0.125 tsf





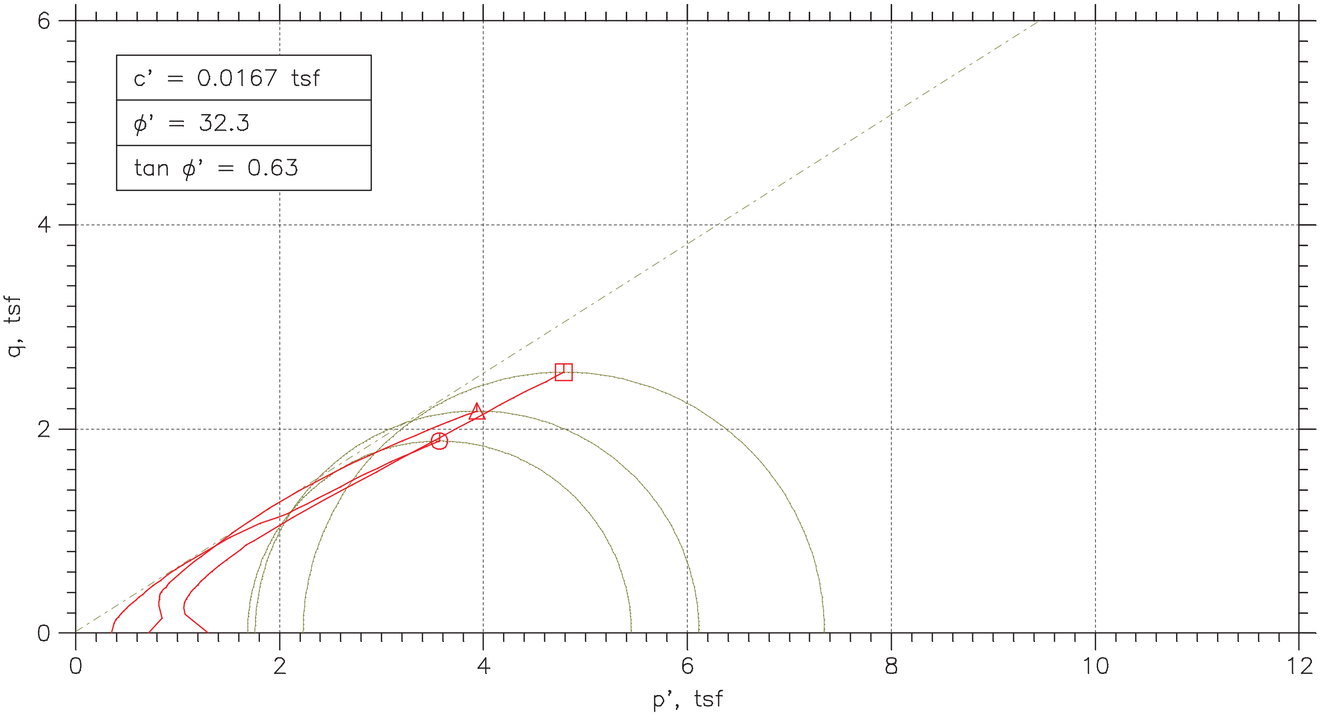
Terracon Consulting Engineers & Scientists	Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
	Boring No.: HEN-029 S-3	Tested By: HP	Checked By: BCM
	Sample No.: S-3	Test Date: 12/14/15	Depth: 5.0'-7.0'
	Test No.: HENB029S3	Sample Type: 3.0'' ST	Elevation: -----
	Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
	Remarks: Pc = 3.1 tsf Cc = 0.128 Ccr = 0.034 TEST PERFORMED AS PER ASTM D2435		

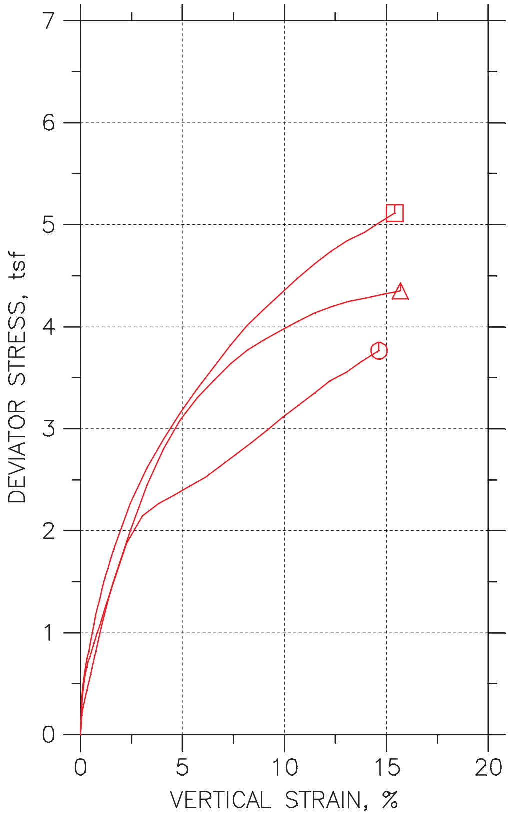
Mon, 21-DEC-2015 16:48:45

Consolidated Undrained Triaxial Compression Tests
ASTM D 4767

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

Terracon
Consulting Engineers & Scientists





Symbol		○	△	□	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Initial	Diameter, in	2.813	2.7921	2.8256	
	Height, in	6.0902	5.9878	6.0303	
	Water Content, %	8.98	11.83	8.88	
	Dry Density, pcf	128.2	127.1	126.	
	Saturation, %	75.28	95.64	69.49	
	Void Ratio	0.32442	0.33638	0.34747	
Before Shear	Water Content, %	13.14	12.04	11.49	
	Dry Density, pcf	125.1	127.9	129.4	
	Saturation, %	100.00	100.00	100.00	
	Void Ratio	0.35748	0.32749	0.31248	
	Back Press., tsf	5.0458	5.0445	5.1811	
Minor Prin. Stress, tsf		0.35425	0.71546	1.2989	
Max. Dev. Stress, tsf		3.764	4.3529	5.114	
Time to Failure, min		1147.2	1143.8	1128.7	
Strain Rate, %/min		0.02	0.02	0.02	
B-Value		0.95	0.97	0.95	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		22	22	22	
Plastic Limit		15	15	15	
Plasticity Index		7	7	7	
Failure Sketch					

Project: DYNEGY HENNEPIN

Location: HENNEPIN, IL

Project No.: MR155233

Boring No.: HEN-029 S-3

Sample Type: 3.0'' ST

Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL

Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Tue, 22-DEC-2015 13:46:20

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST
ASTM D4767

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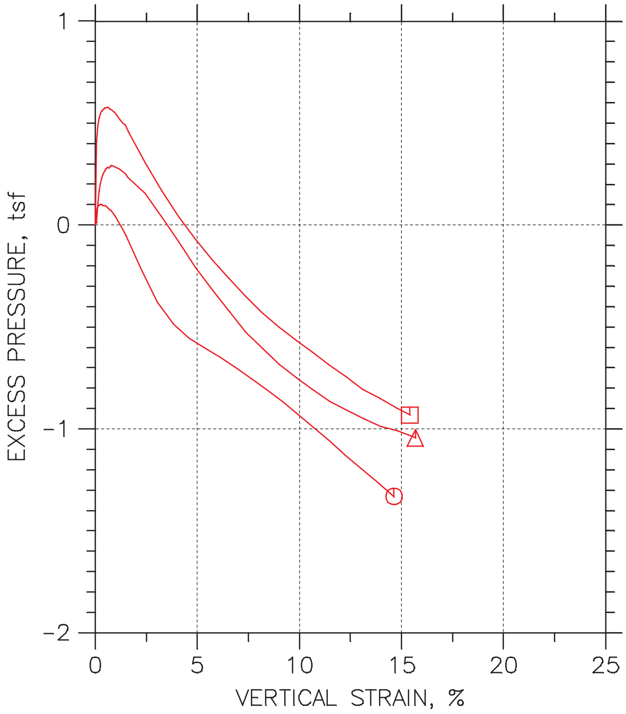

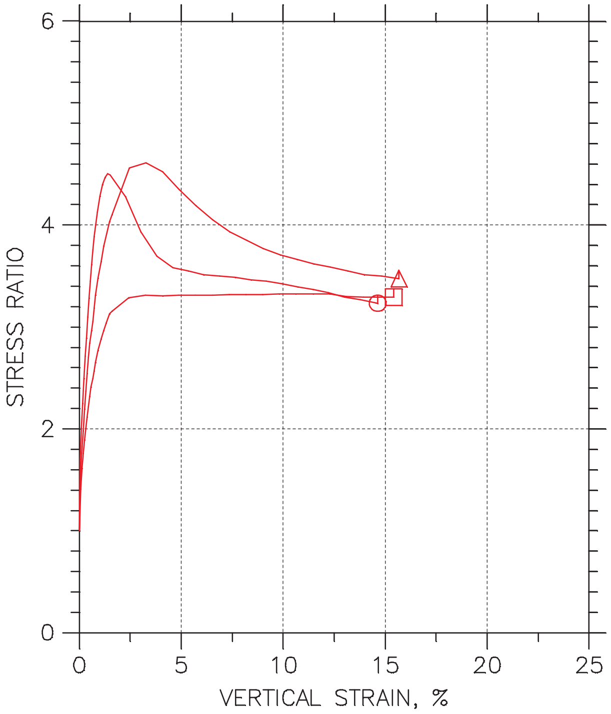

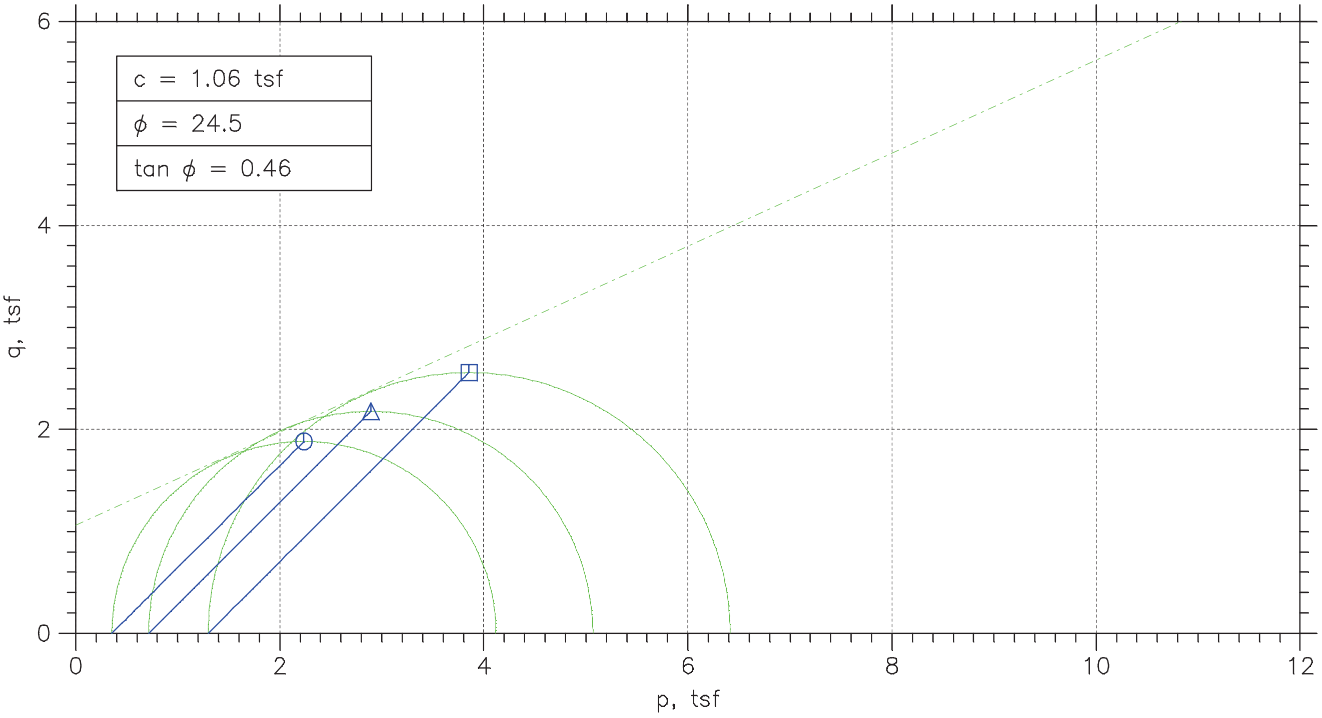

Project: DYNEGY HENNEPIN	Location: HENNEPIN, IL	Project No.: MR155233
Boring No.: HEN-029 S-3	Tested By: BCM	Checked By: WPQ
Sample No.: S-3	Test Date: 12/17/15	Depth: 5.0'-7.0'
Test No.: HEN-029 S-3	Sample Type: 3.0" ST	Elevation: ----
Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL		
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.		

TRIAXIAL TEST

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-029 S-3
Tested By: BCM
Checked By: WPQ
Sample No.: S-3
Test Date: 12/17/15
Depth: 5.0'-7.0'
Test No.: 5.0 PSI
Sample Type: 3.0" ST
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.09 in
Piston Area: 0.00 in^2
Filter Strip Correction: 0.00 tsf
Specimen Area: 6.21 in^2
Piston Friction: 0.00 lb
Membrane Correction: 0.00 lb/in
Specimen Volume: 37.85 in^3
Piston Weight: 0.00 lb
Correction Type: Uniform

Liquid Limit: 22
Plastic Limit: 15
Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.2148	0	0	5.0458	5.4	5.4
2	5.0035	0.055219	6.2182	17.005	0.1969	5.1201	5.4	5.5969
3	10.003	0.11893	6.2222	23.059	0.26683	5.1363	5.4	5.6668
4	15.003	0.17981	6.226	27.85	0.32207	5.1427	5.4	5.7221
5	20.003	0.24353	6.23	32.852	0.37967	5.1462	5.4	5.7797
6	25.003	0.30866	6.234	37.643	0.43475	5.1462	5.4	5.8348
7	30.003	0.37237	6.238	42.276	0.48795	5.1422	5.4	5.8879
8	35.003	0.43609	6.242	46.961	0.54168	5.1422	5.4	5.9417
9	40.003	0.49838	6.2459	51.752	0.59657	5.1392	5.4	5.9966
10	45.003	0.5621	6.2499	56.385	0.64956	5.1346	5.4	6.0496
11	50.003	0.6244	6.2538	61.386	0.70674	5.1294	5.4	6.1067
12	55.003	0.68811	6.2579	66.335	0.76322	5.123	5.4	6.1632
13	60.003	0.75041	6.2618	71.126	0.81783	5.1172	5.4	6.2178
14	70.003	0.87784	6.2698	80.918	0.92923	5.1027	5.4	6.3292
15	80.003	1.0067	6.278	90.553	1.0385	5.0835	5.4	6.4385
16	90.003	1.1341	6.2861	99.661	1.1415	5.0638	5.4	6.5415
17	100	1.2601	6.2941	108.72	1.2436	5.0411	5.4	6.6436
18	110	1.3904	6.3024	117.14	1.3382	5.0179	5.4	6.7382
19	120	1.5164	6.3105	124.88	1.4248	4.9917	5.4	6.8248
20	180	2.271	6.3592	165.63	1.8753	4.828	5.4	7.2753
21	240	3.037	6.4095	191.27	2.1486	4.6677	5.4	7.5486
22	300	3.8158	6.4613	203.48	2.2674	4.5591	5.4	7.6674
23	360	4.5789	6.513	212.11	2.3449	4.4923	5.4	7.7449
24	420	5.3421	6.5655	222.17	2.4364	4.4447	5.4	7.8364
25	480	6.1095	6.6192	231.96	2.5232	4.3959	5.4	7.9232
26	540	6.874	6.6735	244.18	2.6344	4.346	5.4	8.0344
27	600	7.6386	6.7288	257.13	2.7513	4.2926	5.4	8.1513
28	660	8.4116	6.7856	270.03	2.8652	4.2357	5.4	8.2652
29	720	9.1663	6.842	283.82	2.9867	4.1793	5.4	8.3867
30	780	9.9295	6.8999	298.25	3.1122	4.1172	5.4	8.5122
31	840	10.708	6.9601	312.3	3.2307	4.051	5.4	8.6307
32	900	11.471	7.0201	326.83	3.3521	3.986	5.4	8.7521
33	960	12.232	7.0809	340.94	3.4668	3.9169	5.4	8.8668
34	1020	13.009	7.1442	352.31	3.5507	3.8512	5.4	8.9507
35	1080	13.774	7.2075	366.11	3.6572	3.7891	5.4	9.0572
36	1140	14.538	7.272	379.11	3.7536	3.7217	5.4	9.1536
37	1147.2	14.632	7.28	380.59	3.764	3.7142	5.4	9.164

TRIAXIAL TEST

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.09 in
Specimen Area: 6.21 in^2
Specimen Volume: 37.85 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.4	5.4	0	0.000	0.35425	0.35425	1.000	0.35425	0
2	0.06	5.5969	5.4	0.07433	0.378	0.47681	0.27992	1.703	0.37837	0.098449
3	0.12	5.6668	5.4	0.09059	0.340	0.53049	0.26366	2.012	0.39707	0.13342
4	0.18	5.7221	5.4	0.096978	0.301	0.57934	0.25727	2.252	0.4183	0.16104
5	0.24	5.7797	5.4	0.10046	0.265	0.63345	0.25378	2.496	0.44362	0.18983
6	0.31	5.8348	5.4	0.10046	0.231	0.68854	0.25378	2.713	0.47116	0.21738
7	0.37	5.8879	5.4	0.096397	0.198	0.7458	0.25785	2.892	0.50182	0.24397
8	0.44	5.9417	5.4	0.096397	0.178	0.79953	0.25785	3.101	0.52869	0.27084
9	0.50	5.9966	5.4	0.093494	0.157	0.85732	0.26075	3.288	0.55904	0.29829
10	0.56	6.0496	5.4	0.088848	0.137	0.91496	0.2654	3.447	0.59018	0.32478
11	0.62	6.1067	5.4	0.083622	0.118	0.97736	0.27062	3.611	0.62399	0.35337
12	0.69	6.1632	5.4	0.077234	0.101	1.0402	0.27701	3.755	0.65862	0.38161
13	0.75	6.2178	5.4	0.071427	0.087	1.1007	0.28282	3.892	0.69173	0.40892
14	0.88	6.3292	5.4	0.056909	0.061	1.2266	0.29734	4.125	0.76195	0.46462
15	1.01	6.4385	5.4	0.037746	0.036	1.355	0.3165	4.281	0.83576	0.51926
16	1.13	6.5415	5.4	0.018002	0.016	1.4777	0.33624	4.395	0.907	0.57075
17	1.26	6.6436	5.4	-0.0046456	-0.004	1.6025	0.35889	4.465	0.98071	0.62182
18	1.39	6.7382	5.4	-0.027874	-0.021	1.7203	0.38212	4.502	1.0512	0.66911
19	1.52	6.8248	5.4	-0.054006	-0.038	1.8331	0.40825	4.490	1.1207	0.71241
20	2.27	7.2753	5.4	-0.21776	-0.116	2.4473	0.57201	4.278	1.5096	0.93763
21	3.04	7.5486	5.4	-0.37804	-0.176	2.8809	0.73229	3.934	1.8066	1.0743
22	3.82	7.6674	5.4	-0.48663	-0.215	3.1083	0.84088	3.696	1.9746	1.1337
23	4.58	7.7449	5.4	-0.55341	-0.236	3.2525	0.90766	3.583	2.0801	1.1724
24	5.34	7.8364	5.4	-0.60103	-0.247	3.3917	0.95528	3.550	2.1735	1.2182
25	6.11	7.9232	5.4	-0.64981	-0.258	3.5272	1.0041	3.513	2.2656	1.2616
26	6.87	8.0344	5.4	-0.69975	-0.266	3.6884	1.054	3.499	2.3712	1.3172
27	7.64	8.1513	5.4	-0.75318	-0.274	3.8588	1.1074	3.484	2.4831	1.3757
28	8.41	8.2652	5.4	-0.81008	-0.283	4.0295	1.1643	3.461	2.5969	1.4326
29	9.17	8.3867	5.4	-0.86641	-0.290	4.2074	1.2207	3.447	2.714	1.4934
30	9.93	8.5122	5.4	-0.92855	-0.298	4.395	1.2828	3.426	2.8389	1.5561
31	10.71	8.6307	5.4	-0.99475	-0.308	4.5797	1.349	3.395	2.9643	1.6153
32	11.47	8.7521	5.4	-1.0598	-0.316	4.7661	1.414	3.371	3.0901	1.676
33	12.23	8.8668	5.4	-1.1289	-0.326	4.9499	1.4831	3.337	3.2165	1.7334
34	13.01	8.9507	5.4	-1.1945	-0.336	5.0994	1.5488	3.293	3.3241	1.7753
35	13.77	9.0572	5.4	-1.2566	-0.344	5.2681	1.6109	3.270	3.4395	1.8286
36	14.54	9.1536	5.4	-1.324	-0.353	5.4318	1.6783	3.237	3.555	1.8768
37	14.63	9.164	5.4	-1.3316	-0.354	5.4499	1.6858	3.233	3.5678	1.882

TRIAXIAL TEST

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.99 in
Specimen Area: 6.12 in^2
Specimen Volume: 36.66 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.1229	0	0	5.0445	5.76	5.76
2	5.0033	0.057527	6.1265	25.039	0.29426	5.058	5.76	6.0543
3	10.003	0.12145	6.1304	37.584	0.44142	5.1518	5.76	6.2014
4	15.003	0.19176	6.1347	45.895	0.53865	5.2102	5.76	6.2986
5	20.003	0.25727	6.1387	52.089	0.61094	5.2487	5.76	6.3709
6	25.003	0.32599	6.143	57.012	0.66822	5.2731	5.76	6.4282
7	30.003	0.3931	6.1471	61.458	0.71985	5.2947	5.76	6.4799
8	35.003	0.46021	6.1512	65.375	0.76522	5.3111	5.76	6.5252
9	40.003	0.52573	6.1553	69.134	0.80868	5.321	5.76	6.5687
10	45.003	0.59444	6.1596	72.945	0.85267	5.3262	5.76	6.6127
11	50.003	0.66316	6.1638	76.651	0.89536	5.3239	5.76	6.6554
12	55.003	0.72867	6.1679	80.356	0.93803	5.3315	5.76	6.698
13	60.003	0.79898	6.1723	84.009	0.97997	5.3355	5.76	6.74
14	70.003	0.93481	6.1807	91.314	1.0637	5.3309	5.76	6.8237
15	80.003	1.0674	6.189	98.884	1.1504	5.3251	5.76	6.9104
16	90.003	1.2049	6.1976	106.24	1.2343	5.3186	5.76	6.9943
17	110	1.4781	6.2148	121.28	1.405	5.2971	5.76	7.165
18	120	1.6155	6.2235	129.06	1.4931	5.2784	5.76	7.2531
19	180	2.4465	6.2765	174.42	2.0009	5.1979	5.76	7.7609
20	240	3.2615	6.3294	215.08	2.4466	5.0819	5.76	8.2066
21	300	4.0812	6.3835	248.9	2.8074	4.9623	5.76	8.5674
22	360	4.909	6.439	275.85	3.0845	4.8381	5.76	8.8445
23	420	5.7319	6.4952	298.08	3.3042	4.7238	5.76	9.0642
24	480	6.5549	6.5524	316.61	3.479	4.6206	5.76	9.239
25	540	7.3826	6.611	334.34	3.6413	4.5173	5.76	9.4013
26	600	8.1976	6.6697	349.06	3.7681	4.4392	5.76	9.5281
27	660	9.0189	6.7299	362.08	3.8737	4.3628	5.76	9.6337
28	720	9.8547	6.7923	374.04	3.9649	4.2946	5.76	9.7249
29	780	10.668	6.8541	386.11	4.056	4.2374	5.76	9.816
30	840	11.485	6.9174	397.49	4.1373	4.1808	5.76	9.8973
31	900	12.324	6.9836	407.45	4.2007	4.1354	5.76	9.9607
32	960	13.15	7.05	415.97	4.2482	4.0945	5.76	10.008
33	1020	13.976	7.1177	423.01	4.279	4.0578	5.76	10.039
34	1080	14.808	7.1873	430.74	4.315	4.0345	5.76	10.075
35	1140	15.625	7.2568	438.47	4.3503	4.003	5.76	10.11
36	1143.8	15.678	7.2613	438.99	4.3529	4.0001	5.76	10.113

TRIAXIAL TEST

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 5.99 in
Specimen Area: 6.12 in^2
Specimen Volume: 36.66 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	5.76	5.76	0	0.000	0.71546	0.71546	1.000	0.71546	0
2	0.06	6.0543	5.76	0.013413	0.046	0.99631	0.70205	1.419	0.84918	0.14713
3	0.12	6.2014	5.76	0.10731	0.243	1.0496	0.60815	1.726	0.82886	0.22071
4	0.19	6.2986	5.76	0.16562	0.307	1.0885	0.54984	1.980	0.81916	0.26932
5	0.26	6.3709	5.76	0.20411	0.334	1.1223	0.51135	2.195	0.81681	0.30547
6	0.33	6.4282	5.76	0.22861	0.342	1.1551	0.48685	2.373	0.82096	0.33411
7	0.39	6.4799	5.76	0.25019	0.348	1.1851	0.46527	2.547	0.8252	0.35993
8	0.46	6.5252	5.76	0.26651	0.348	1.2142	0.44895	2.704	0.83155	0.38261
9	0.53	6.5687	5.76	0.27643	0.342	1.2477	0.43903	2.842	0.84337	0.40434
10	0.59	6.6127	5.76	0.28168	0.330	1.2865	0.43378	2.966	0.86012	0.42633
11	0.66	6.6554	5.76	0.27935	0.312	1.3315	0.43612	3.053	0.8838	0.44768
12	0.73	6.698	5.76	0.28693	0.306	1.3666	0.42853	3.189	0.89755	0.46901
13	0.80	6.74	5.76	0.29101	0.297	1.4044	0.42445	3.309	0.91444	0.48999
14	0.93	6.8237	5.76	0.28634	0.269	1.4928	0.42912	3.479	0.96098	0.53186
15	1.07	6.9104	5.76	0.28051	0.244	1.5853	0.43495	3.645	1.0101	0.57518
16	1.20	6.9943	5.76	0.2741	0.222	1.6756	0.44136	3.796	1.0585	0.61713
17	1.48	7.165	5.76	0.25252	0.180	1.8679	0.46294	4.035	1.1654	0.7025
18	1.62	7.2531	5.76	0.23386	0.157	1.9747	0.4816	4.100	1.2281	0.74654
19	2.45	7.7609	5.76	0.15338	0.077	2.563	0.56208	4.560	1.5625	1.0004
20	3.26	8.2066	5.76	0.037324	0.015	3.1248	0.67814	4.608	1.9014	1.2233
21	4.08	8.5674	5.76	-0.082229	-0.029	3.6051	0.79769	4.519	2.2014	1.4037
22	4.91	8.8445	5.76	-0.20645	-0.067	4.0064	0.92191	4.346	2.4641	1.5422
23	5.73	9.0642	5.76	-0.32075	-0.097	4.3404	1.0362	4.189	2.6883	1.6521
24	6.55	9.239	5.76	-0.42397	-0.122	4.6184	1.1394	4.053	2.8789	1.7395
25	7.38	9.4013	5.76	-0.5272	-0.145	4.8839	1.2427	3.930	3.0633	1.8206
26	8.20	9.5281	5.76	-0.60534	-0.161	5.0889	1.3208	3.853	3.2049	1.8841
27	9.02	9.6337	5.76	-0.68174	-0.176	5.2709	1.3972	3.772	3.3341	1.9369
28	9.85	9.7249	5.76	-0.74997	-0.189	5.4304	1.4654	3.706	3.4479	1.9825
29	10.67	9.816	5.76	-0.80713	-0.199	5.5785	1.5226	3.664	3.5506	2.028
30	11.48	9.8973	5.76	-0.8637	-0.209	5.7165	1.5792	3.620	3.6478	2.0687
31	12.32	9.9607	5.76	-0.90918	-0.216	5.8254	1.6246	3.586	3.725	2.1004
32	13.15	10.008	5.76	-0.95001	-0.224	5.9137	1.6655	3.551	3.7896	2.1241
33	13.98	10.039	5.76	-0.98675	-0.231	5.9812	1.7022	3.514	3.8417	2.1395
34	14.81	10.075	5.76	-1.0101	-0.234	6.0405	1.7255	3.501	3.883	2.1575
35	15.62	10.11	5.76	-1.0416	-0.239	6.1074	1.757	3.476	3.9322	2.1752
36	15.68	10.113	5.76	-1.0445	-0.240	6.1128	1.7599	3.473	3.9364	2.1764

TRIAXIAL TEST

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

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Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.03 in
Specimen Area: 6.27 in^2
Specimen Volume: 37.81 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Time min	Vertical Strain %	Corrected Area in^2	Deviator Load lb	Deviator Stress tsf	Pore Pressure tsf	Horizontal Stress tsf	Vertical Stress tsf
1	0	0	6.2706	0	0	5.1811	6.48	6.48
2	5.0002	0.061721	6.2745	31.946	0.36658	5.5924	6.48	6.8466
3	10	0.12796	6.2786	43.274	0.49624	5.6668	6.48	6.9762
4	15	0.19419	6.2828	51.605	0.59138	5.7058	6.48	7.0714
5	20	0.26043	6.287	58.557	0.67061	5.7267	6.48	7.1506
6	25	0.32817	6.2912	65.03	0.74424	5.7413	6.48	7.2242
7	30	0.39441	6.2954	71.383	0.8164	5.7511	6.48	7.2964
8	35	0.45914	6.2995	77.257	0.88301	5.7558	6.48	7.363
9	40	0.52538	6.3037	83.31	0.95156	5.7575	6.48	7.4316
10	45	0.59312	6.308	89.244	1.0186	5.7587	6.48	7.4986
11	50	0.66086	6.3123	94.878	1.0822	5.7558	6.48	7.5622
12	55	0.72861	6.3166	100.57	1.1464	5.7511	6.48	7.6264
13	60	0.79635	6.3209	106.15	1.2091	5.7477	6.48	7.6891
14	70	0.93334	6.3297	116.22	1.3219	5.7337	6.48	7.8019
15	80.001	1.0688	6.3383	126.22	1.4338	5.718	6.48	7.9138
16	90.001	1.2043	6.347	135.51	1.5373	5.6994	6.48	8.0173
17	100	1.3428	6.3559	144.26	1.6342	5.6796	6.48	8.1142
18	110	1.4798	6.3648	152.18	1.7215	5.6726	6.48	8.2015
19	120	1.6183	6.3737	160.81	1.8165	5.6371	6.48	8.2965
20	180	2.4372	6.4272	202.52	2.2687	5.4865	6.48	8.7487
21	240	3.2501	6.4812	235.37	2.6147	5.3475	6.48	9.0947
22	300	4.0781	6.5372	263.42	2.9013	5.2224	6.48	9.3813
23	360	4.8865	6.5927	289.19	3.1583	5.1119	6.48	9.6383
24	420	5.7054	6.65	313.16	3.3906	5.0119	6.48	9.8706
25	480	6.5349	6.709	335.88	3.6046	4.92	6.48	10.085
26	540	7.3478	6.7679	358.41	3.813	4.8328	6.48	10.293
27	600	8.1637	6.828	379.99	4.0069	4.7525	6.48	10.487
28	660	8.9992	6.8907	399.41	4.1734	4.6792	6.48	10.653
29	720	9.8151	6.953	417.75	4.3259	4.6164	6.48	10.806
30	780	10.631	7.0165	435.67	4.4706	4.5565	6.48	10.951
31	840	11.459	7.0821	453.83	4.6139	4.4954	6.48	11.094
32	900	12.269	7.1475	470.55	4.7401	4.4396	6.48	11.22
33	960	13.094	7.2154	485.54	4.8451	4.3744	6.48	11.325
34	1020	13.928	7.2853	498.42	4.9259	4.3314	6.48	11.406
35	1080	14.742	7.3549	513.89	5.0307	4.2854	6.48	11.511
36	1128.7	15.412	7.4131	526.53	5.114	4.2494	6.48	11.594

TRIAXIAL TEST

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-3
Sample No.: S-3
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/17/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Soil Description: BROWN LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: FAILURE CRITERIA = MAXIMUM EFFECTIVE STRESS RATIO TEST PERFORMED AS PER ASTM D4767.

Specimen Height: 6.03 in
Specimen Area: 6.27 in^2
Specimen Volume: 37.81 in^3

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

Filter Strip Correction: 0.00 tsf
Membrane Correction: 0.00 lb/in
Correction Type: Uniform

Liquid Limit: 22

Plastic Limit: 15

Estimated Specific Gravity: 2.72

	Vertical Strain %	Total Vertical Stress tsf	Total Horizontal Stress tsf	Excess Pore Pressure tsf	A Parameter	Effective Vertical Stress tsf	Effective Horizontal Stress tsf	Stress Ratio	Effective p tsf	q tsf
1	0.00	6.48	6.48	0	0.000	1.2989	1.2989	1.000	1.2989	0
2	0.06	6.8466	6.48	0.41121	1.122	1.2542	0.88764	1.413	1.0709	0.18329
3	0.13	6.9762	6.48	0.48566	0.979	1.3094	0.81319	1.610	1.0613	0.24812
4	0.19	7.0714	6.48	0.52463	0.887	1.3656	0.77423	1.764	1.0699	0.29569
5	0.26	7.1506	6.48	0.54557	0.814	1.4239	0.75329	1.890	1.0886	0.33531
6	0.33	7.2242	6.48	0.56011	0.753	1.483	0.73875	2.007	1.1109	0.37212
7	0.39	7.2964	6.48	0.57	0.698	1.5453	0.72886	2.120	1.1371	0.4082
8	0.46	7.363	6.48	0.57465	0.651	1.6072	0.72421	2.219	1.1657	0.4415
9	0.53	7.4316	6.48	0.57639	0.606	1.674	0.72246	2.317	1.1982	0.47578
10	0.59	7.4986	6.48	0.57756	0.567	1.7399	0.7213	2.412	1.2306	0.50932
11	0.66	7.5622	6.48	0.57465	0.531	1.8064	0.72421	2.494	1.2653	0.5411
12	0.73	7.6264	6.48	0.57	0.497	1.8752	0.72886	2.573	1.302	0.57319
13	0.80	7.6891	6.48	0.56651	0.469	1.9414	0.73235	2.651	1.3369	0.60454
14	0.93	7.8019	6.48	0.55255	0.418	2.0683	0.74631	2.771	1.4073	0.66097
15	1.07	7.9138	6.48	0.53684	0.374	2.1959	0.76201	2.882	1.4789	0.71692
16	1.20	8.0173	6.48	0.51823	0.337	2.3179	0.78062	2.969	1.5493	0.76863
17	1.34	8.1142	6.48	0.49846	0.305	2.4346	0.8004	3.042	1.6175	0.81712
18	1.48	8.2015	6.48	0.49148	0.285	2.5288	0.80738	3.132	1.6681	0.86073
19	1.62	8.2965	6.48	0.456	0.251	2.6594	0.84286	3.155	1.7511	0.90827
20	2.44	8.7487	6.48	0.30535	0.135	3.2622	0.9935	3.284	2.1279	1.1344
21	3.25	9.0947	6.48	0.16635	0.064	3.7472	1.1325	3.309	2.4399	1.3073
22	4.08	9.3813	6.48	0.041296	0.014	4.1588	1.2576	3.307	2.7082	1.4506
23	4.89	9.6383	6.48	-0.069214	-0.022	4.5263	1.3681	3.309	2.9472	1.5791
24	5.71	9.8706	6.48	-0.16925	-0.050	4.8588	1.4681	3.310	3.1634	1.6953
25	6.53	10.085	6.48	-0.26115	-0.072	5.1646	1.56	3.311	3.3623	1.8023
26	7.35	10.293	6.48	-0.3484	-0.091	5.4602	1.6472	3.315	3.5537	1.9065
27	8.16	10.487	6.48	-0.42866	-0.107	5.7345	1.7275	3.319	3.731	2.0035
28	9.00	10.653	6.48	-0.50195	-0.120	5.9742	1.8008	3.318	3.8875	2.0867
29	9.82	10.806	6.48	-0.56476	-0.131	6.1895	1.8636	3.321	4.0266	2.1629
30	10.63	10.951	6.48	-0.62467	-0.140	6.3942	1.9235	3.324	4.1588	2.2353
31	11.46	11.094	6.48	-0.68574	-0.149	6.5985	1.9846	3.325	4.2915	2.3069
32	12.27	11.22	6.48	-0.74158	-0.156	6.7805	2.0404	3.323	4.4105	2.3701
33	13.09	11.325	6.48	-0.80672	-0.167	6.9506	2.1056	3.301	4.5281	2.4225
34	13.93	11.406	6.48	-0.84976	-0.173	7.0745	2.1486	3.293	4.6116	2.463
35	14.74	11.511	6.48	-0.89571	-0.178	7.2252	2.1946	3.292	4.7099	2.5153
36	15.41	11.594	6.48	-0.93177	-0.182	7.3446	2.2306	3.293	4.7876	2.557

Drained Direct Shear Tests
ASTM D 3080

DIRECT SHEAR TEST by ASTM D3080

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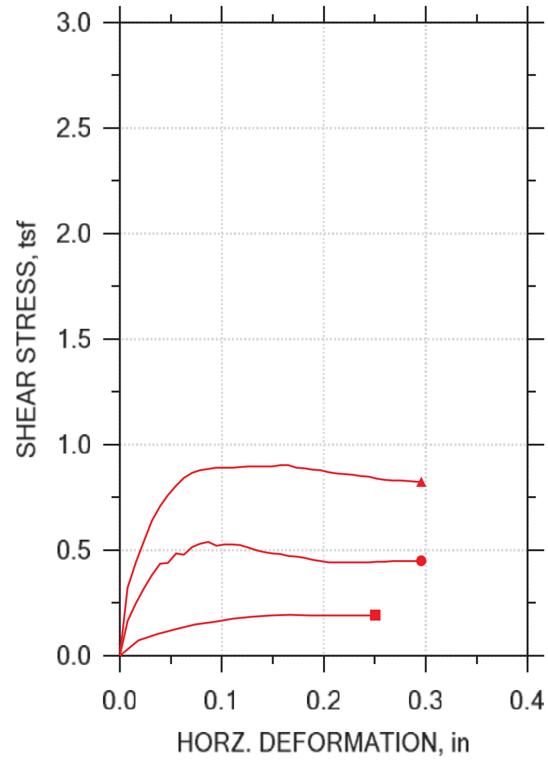
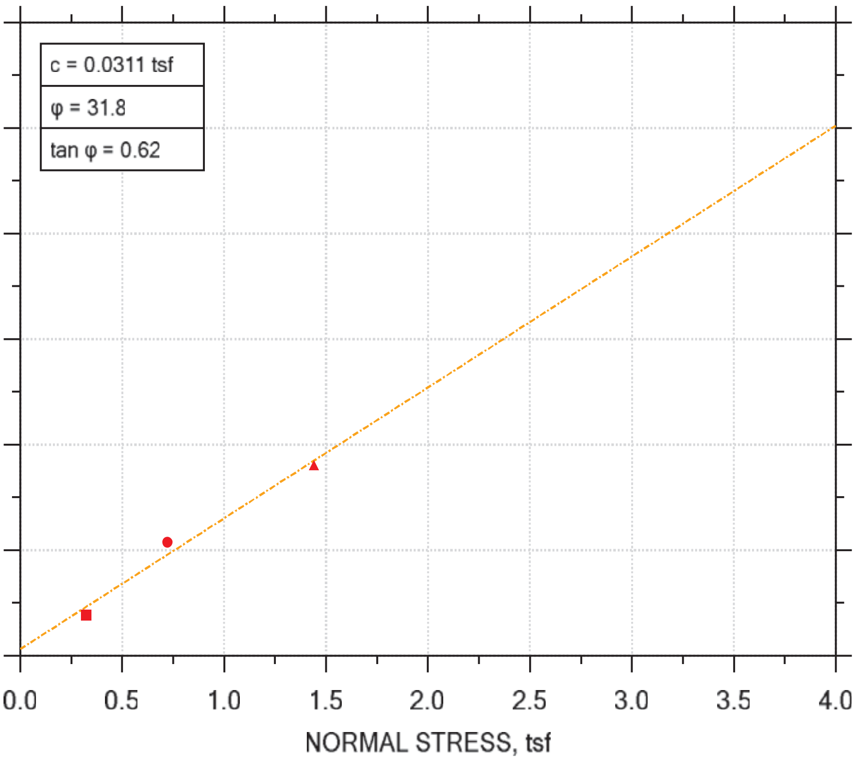
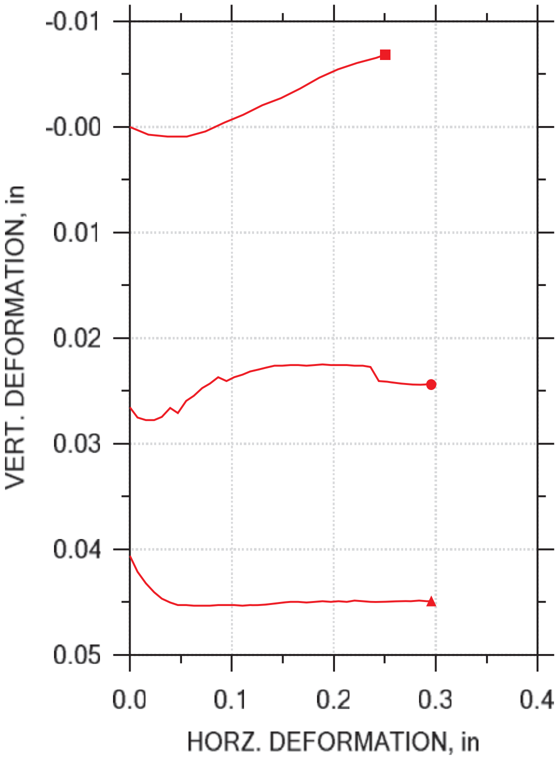






Symbol		■	●	▲	
Test No.		5.0 PSI	10.0 PSI	20.0 PSI	
Sample No.		S-5	S-5	S-5	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.4913	2.4941	2.4976	
	Area, in²	4.8748	4.8856	4.8995	
	Height, in	0.9878	0.99094	0.99252	
	Water Content, %	16.30	16.70	16.83	
	Dry Density, pcf	112.2	111.3	110.7	
	Saturation, %	86.28	86.36	85.72	
	Void Ratio	0.51397	0.52594	0.53408	
Consol. Height, in		0.9878	0.9644	0.95193	
Consol. Void Ratio		0.51397	0.48506	0.47134	
Final	Water Content, %	19.67	18.05	17.75	
	Dry Density, pcf	111.4	114.1	115.9	
	Saturation, %	102.01	100.52	103.90	
	Void Ratio	0.52446	0.48839	0.46469	
Normal Stress, tsf		0.32343	0.72072	1.4396	
Max. Shear Stress, tsf		0.19271	0.53843	0.90226	
Ult. Shear Stress, tsf		0.19231	0.44946	0.82371	
Time to Failure, min		39.855	23.081	41.061	
Disp. Rate, in/min		0.047244	0.004	0.004	
Estimated Specific Gravity		2.72	2.72	2.72	
Liquid Limit		31	31	31	
Plastic Limit		17	17	17	
Plasticity Index		14	14	14	

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN-029 S-5
Sample Type: TRIMMED
Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-5
Sample No.: S-5
Test No.: 5.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Soil Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.323	0.0000	0.000202	0.0000	0.0000
2	5.49	0.322	0.0007383	0.0717	0.01854	0.01854
3	10.36	0.323	0.0009004	0.104	0.03709	0.03709
4	15.03	0.323	0.0009004	0.128	0.05563	0.05563
5	19.38	0.323	0.0004142	0.147	0.07418	0.07418
6	23.15	0.323	-0.0003962	0.161	0.09280	0.09280
7	27.26	0.323	-0.001135	0.175	0.1113	0.1113
8	31.47	0.323	-0.002053	0.186	0.1299	0.1299
9	35.85	0.324	-0.002755	0.191	0.1484	0.1484
10	39.85	0.323	-0.003638	0.193	0.1670	0.1670
11	44.32	0.323	-0.004646	0.192	0.1856	0.1856
12	48.69	0.323	-0.005475	0.192	0.2041	0.2041
13	53.17	0.323	-0.006051	0.192	0.2228	0.2228
14	57.05	0.323	-0.006537	0.192	0.2413	0.2413
15	60.08	0.322	-0.006843	0.192	0.2506	0.2506

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-5
Sample No.: S-5
Test No.: 10.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	0.719	0.02654	0.000	0.0000	0.0000
2	2.71	0.719	0.02752	0.165	0.007902	0.007902
3	4.89	0.719	0.02777	0.248	0.01580	0.01580
4	7.16	0.720	0.02779	0.321	0.02364	0.02364
5	9.14	0.721	0.02746	0.382	0.03150	0.03150
6	11.21	0.721	0.02662	0.436	0.03940	0.03940
7	12.99	0.722	0.02710	0.441	0.04727	0.04727
8	14.76	0.722	0.02597	0.484	0.05517	0.05517
9	16.83	0.722	0.02543	0.479	0.06300	0.06300
10	18.94	0.722	0.02471	0.516	0.07087	0.07087
11	21.09	0.721	0.02433	0.529	0.07877	0.07877
12	23.08	0.721	0.02372	0.538	0.08664	0.08664
13	25.09	0.720	0.02404	0.521	0.09451	0.09451
14	26.95	0.721	0.02370	0.527	0.1024	0.1024
15	28.84	0.720	0.02343	0.528	0.1102	0.1102
16	30.60	0.720	0.02318	0.523	0.1182	0.1182
17	32.68	0.720	0.02294	0.512	0.1260	0.1260
18	34.69	0.720	0.02280	0.499	0.1339	0.1339
19	36.76	0.720	0.02262	0.491	0.1417	0.1417
20	38.80	0.720	0.02258	0.485	0.1496	0.1496
21	40.72	0.720	0.02256	0.482	0.1575	0.1575
22	42.71	0.720	0.02253	0.474	0.1654	0.1654
23	44.65	0.720	0.02258	0.468	0.1732	0.1732
24	46.29	0.720	0.02255	0.463	0.1811	0.1811
25	48.27	0.720	0.02249	0.455	0.1890	0.1890
26	50.29	0.720	0.02255	0.448	0.1969	0.1969
27	52.42	0.720	0.02253	0.444	0.2047	0.2047
28	54.59	0.720	0.02253	0.441	0.2126	0.2126
29	56.45	0.720	0.02260	0.441	0.2205	0.2205
30	58.41	0.720	0.02264	0.441	0.2283	0.2283
31	60.25	0.720	0.02271	0.443	0.2362	0.2362
32	62.14	0.719	0.02408	0.443	0.2441	0.2441
33	64.05	0.720	0.02410	0.444	0.2520	0.2520
34	66.14	0.720	0.02424	0.447	0.2598	0.2598
35	68.26	0.719	0.02431	0.448	0.2678	0.2678
36	70.36	0.719	0.02438	0.449	0.2756	0.2756
37	72.12	0.719	0.02442	0.449	0.2835	0.2835
38	74.01	0.719	0.02437	0.449	0.2914	0.2914
39	75.01	0.719	0.02438	0.449	0.2953	0.2953

Project: DYNEGY HENNEPIN
Boring No.: HEN-029 S-5
Sample No.: S-5
Test No.: 20.0 PSI

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/13/15
Sample Type: TRIMMED

Project No.: MR155233
Checked By: WPQ
Depth: 10.0'-12.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

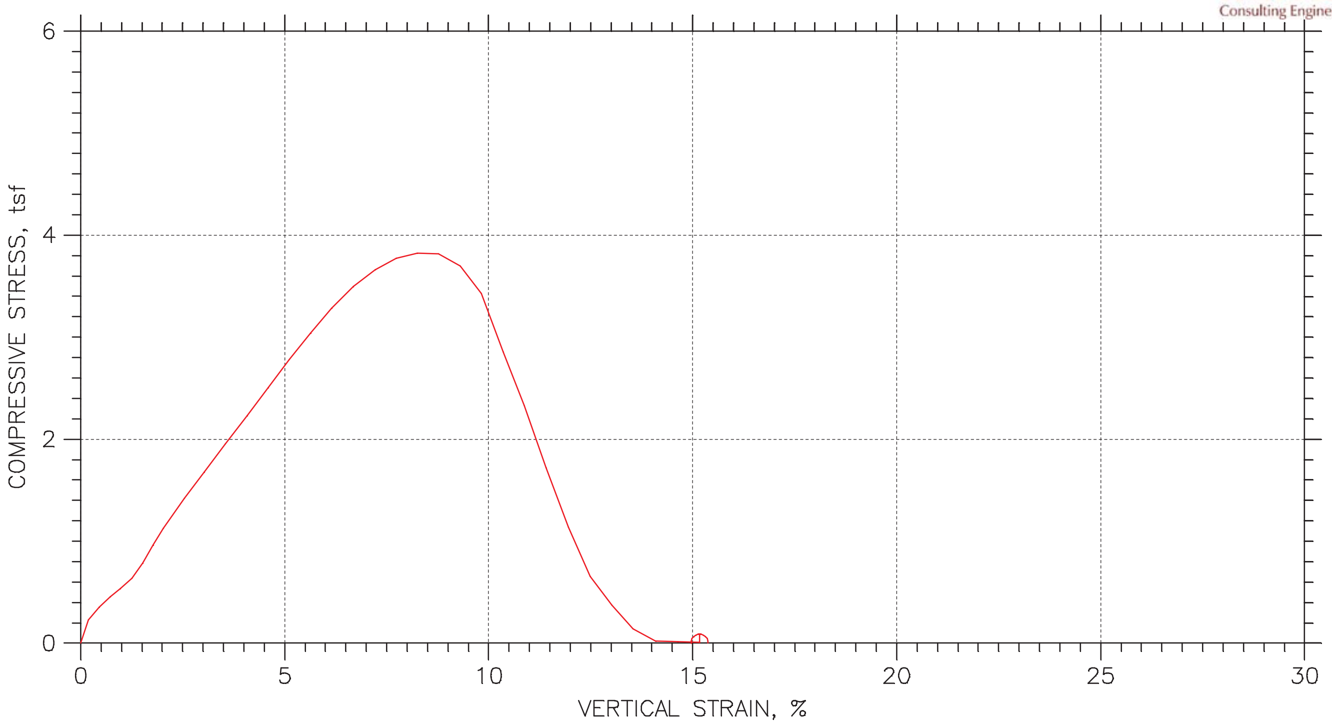
Soil Description: DARK BROWN AND GRAY SLIGHTLY ORGANIC CLAY CL SAND POCKETS NOTED
Remarks:

Step: 1 of 1

	Elapsed Time min	Vertical Stress tsf	Vertical Displacement in	Horizontal Stress tsf	Horizontal Displacement in	Cumulative Displacement in
1	0.00	1.44	0.04059	0.000	0.0000	0.0000
2	2.82	1.44	0.04214	0.321	0.007867	0.007867
3	4.83	1.44	0.04324	0.444	0.01573	0.01573
4	7.10	1.44	0.04405	0.546	0.02360	0.02360
5	9.38	1.44	0.04470	0.641	0.03147	0.03147
6	11.33	1.44	0.04504	0.710	0.03937	0.03937
7	13.35	1.44	0.04526	0.759	0.04724	0.04724
8	15.20	1.44	0.04529	0.807	0.05510	0.05510
9	17.03	1.44	0.04533	0.841	0.06297	0.06297
10	19.00	1.44	0.04531	0.865	0.07087	0.07087
11	21.09	1.44	0.04531	0.877	0.07877	0.07877
12	23.26	1.44	0.04527	0.883	0.08660	0.08660
13	25.19	1.44	0.04529	0.890	0.09447	0.09447
14	27.24	1.44	0.04527	0.891	0.1023	0.1023
15	29.09	1.44	0.04533	0.890	0.1102	0.1102
16	30.98	1.44	0.04529	0.893	0.1181	0.1181
17	32.82	1.44	0.04526	0.896	0.1260	0.1260
18	34.93	1.44	0.04524	0.896	0.1338	0.1338
19	36.84	1.44	0.04513	0.895	0.1417	0.1417
20	39.05	1.44	0.04500	0.896	0.1496	0.1496
21	41.06	1.44	0.04499	0.902	0.1575	0.1575
22	42.87	1.44	0.04495	0.902	0.1653	0.1653
23	44.87	1.44	0.04502	0.889	0.1732	0.1732
24	46.86	1.44	0.04497	0.888	0.1811	0.1811
25	48.59	1.44	0.04493	0.883	0.1889	0.1889
26	50.54	1.44	0.04499	0.877	0.1968	0.1968
27	52.49	1.44	0.04493	0.869	0.2047	0.2047
28	54.68	1.44	0.04497	0.865	0.2126	0.2126
29	56.76	1.44	0.04488	0.862	0.2204	0.2204
30	58.63	1.44	0.04493	0.858	0.2283	0.2283
31	60.64	1.44	0.04497	0.850	0.2362	0.2362
32	62.54	1.44	0.04497	0.847	0.2441	0.2441
33	64.42	1.44	0.04499	0.840	0.2519	0.2519
34	66.26	1.44	0.04493	0.834	0.2598	0.2598
35	68.32	1.44	0.04493	0.831	0.2677	0.2677
36	70.44	1.44	0.04493	0.830	0.2756	0.2756
37	72.48	1.44	0.04488	0.828	0.2834	0.2834
38	74.27	1.44	0.04490	0.825	0.2913	0.2913
39	75.29	1.44	0.04490	0.824	0.2955	0.2955

Unconfined Compression Tests
ASTM D 2166

UNCONFINED COMPRESSION TEST REPORT



Symbol		⦶			
Test No.		HEN032S3			
Initial	Diameter, in	2.8303			
	Height, in	5.85			
	Water Content, %	14.10			
	Dry Density, pcf	115.8			
	Saturation, %	82.27			
	Void Ratio	0.46619			
Unconfined Compressive Strength, tsf		3.8231			
Undrained Shear Strength, tsf		1.9116			
Time to Failure, min		8.0041			
Strain Rate, %/min		1.14			
Estimated Specific Gravity		2.72			
Liquid Limit		35			
Plastic Limit		18			
Plasticity Index		17			
Failure Sketch					

Project: DYNEGY HENNEPIN
Location: HENNEPIN, IL
Project No.: MR155233
Boring No.: HEN032 S-3
Sample Type: 3.0'' ST
Description: DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Tue, 22-DEC-2015 15:25:34

UNCONFINED COMPRESSION TEST

Project: DYNERGY HENNEPIN
Boring No.: HEN032 S-3
Sample No.: ST-3
Test No.: HEN032S3

Location: HENNEPIN, IL
Tested By: BCM
Test Date: 12/15/15
Sample Type: 3.0" ST

Project No.: MR155233
Checked By: WPQ
Depth: 5.0'-7.0'
Elevation: ----

Terracon
Consulting Engineers & Scientists

Soil Description: DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL CL
Remarks: TEST PERFORMED AS PER ASTM D2166.

Specimen Height: 5.85 in
Specimen Area: 6.29 in^2
Specimen Volume: 36.81 in^3

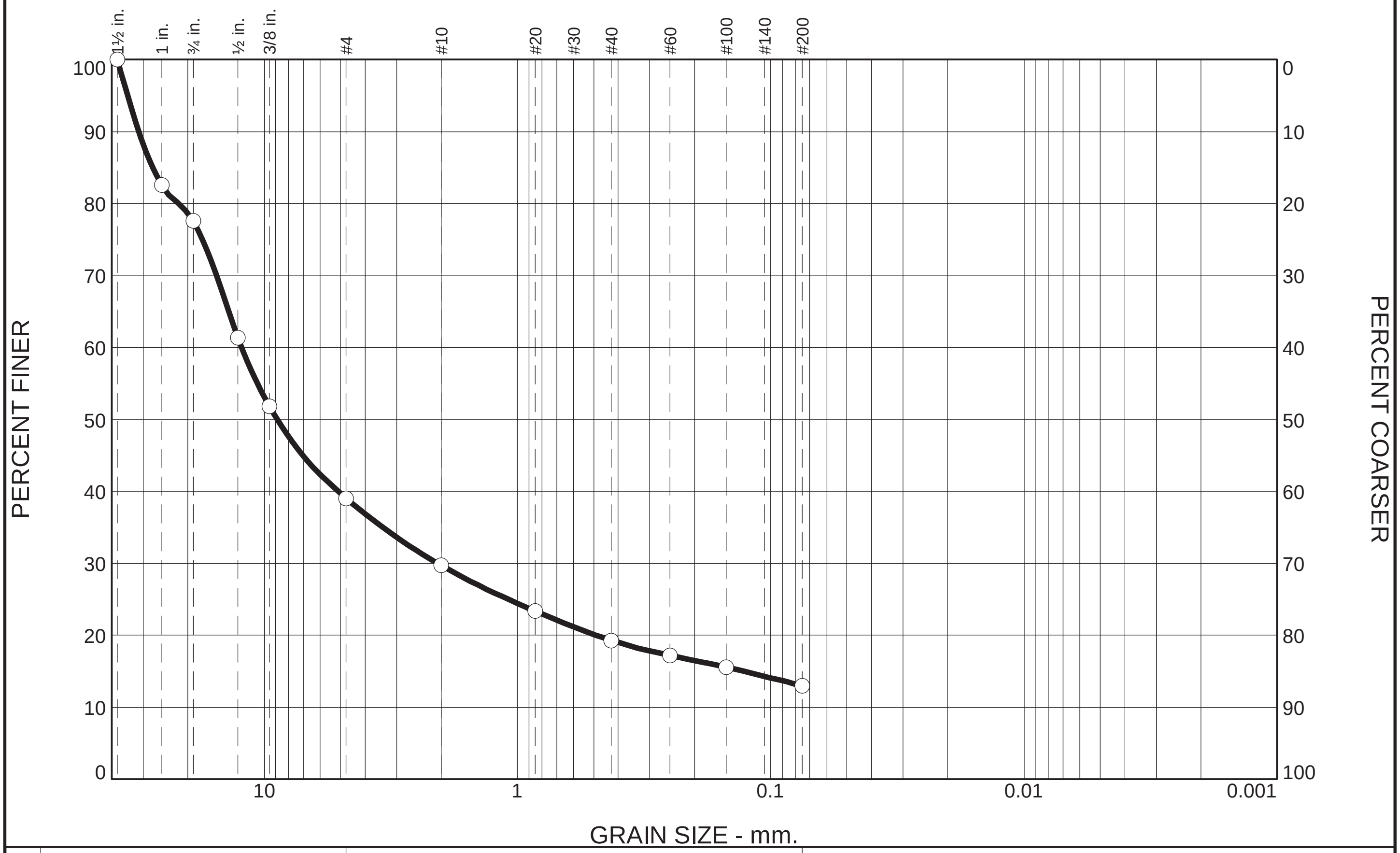
Liquid Limit: 35
Plastic Limit: 18
Estimated Specific Gravity: 2.72

Cap Mass: 0 gm

	Time min	Axial Displacement in	Axial Strain %	Load lb	Corrected Area in^2	Vertical Stress tsf	Shear Stress tsf
1	0	0	0	0	6.2916	0	0
2	0.25403	0.011115	0.18999	20.059	6.3036	0.22911	0.11456
3	0.50403	0.026602	0.45474	30.798	6.3203	0.35085	0.17543
4	0.75403	0.041999	0.71793	39.748	6.3371	0.45161	0.22581
5	1.004	0.057395	0.98111	47.382	6.3539	0.53692	0.26846
6	1.254	0.073065	1.249	56.543	6.3711	0.63899	0.31949
7	1.504	0.088735	1.5168	69.915	6.3885	0.78796	0.39398
8	1.7541	0.10358	1.7707	85.657	6.405	0.96289	0.48144
9	2.0041	0.11853	2.0261	100.35	6.4217	1.1251	0.56254
10	2.504	0.14841	2.5369	127.09	6.4553	1.4175	0.70875
11	3.004	0.17738	3.0321	151.41	6.4883	1.6802	0.8401
12	3.5041	0.20726	3.5429	176.95	6.5227	1.9532	0.97661
13	4.0041	0.23833	4.074	203.01	6.5588	2.2285	1.1143
14	4.5041	0.26903	4.5988	229.49	6.5949	2.5055	1.2527
15	5.0041	0.29937	5.1174	256.29	6.6309	2.7828	1.3914
16	5.5041	0.32943	5.6313	281.66	6.667	3.0418	1.5209
17	6.0041	0.36004	6.1545	305.56	6.7042	3.2816	1.6408
18	6.5041	0.39092	6.6825	327.41	6.7421	3.4965	1.7482
19	7.0041	0.42172	7.2089	344.52	6.7804	3.6584	1.8292
20	7.5041	0.45215	7.729	357.32	6.8186	3.773	1.8865
21	8.0041	0.48248	8.2476	364.11	6.8571	3.8231	1.9116
22	8.5041	0.51319	8.7724	365.79	6.8966	3.8189	1.9094
23	9.0041	0.54443	9.3066	356.58	6.9372	3.7009	1.8504
24	9.5041	0.57495	9.8283	332.2	6.9773	3.428	1.714
25	10.004	0.60556	10.352	278.29	7.0181	2.8551	1.4275
26	10.504	0.63636	10.878	228.38	7.0595	2.3293	1.1646
27	11.004	0.66724	11.406	169.79	7.1016	1.7214	0.8607
28	11.504	0.69895	11.948	113.14	7.1453	1.14	0.57002
29	12.004	0.73056	12.488	65.651	7.1894	0.65748	0.32874
30	12.504	0.76144	13.016	37.169	7.233	0.36999	0.185
31	13.004	0.79242	13.546	14.32	7.2773	0.14168	0.070839
32	13.504	0.82403	14.086	2.3165	7.3231	0.022775	0.011388
33	14.004	0.85619	14.636	1.5794	7.3703	0.015429	0.0077146
34	14.503	0.88735	15.168	0.7897	7.4165	0.0076665	0.0038332

Particle Size Analysis of Soils
ASTM D 422

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	22.4	38.6	9.3	10.4	6.3	13.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	82.5		
.75	77.6		
.5	61.4		
.375	51.8		
#4	39.0		
#10	29.7		
#20	23.4		
#40	19.3		
#60	17.2		
#100	15.6		
#200	13.0		

* (no specification provided)

LIGHT BROWN POORLY GRADED GRAVEL WITH SAND AND CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 31.2310 D_{85}= 27.6077 D_{60}= 12.2743
D_{50}= 8.8861 D_{30}= 2.0649 D_{15}= 0.1281
D_{10}= C_u= C_c=

Classification

USCS= GP-GC AASHTO=

Remarks

F.M.=5.20

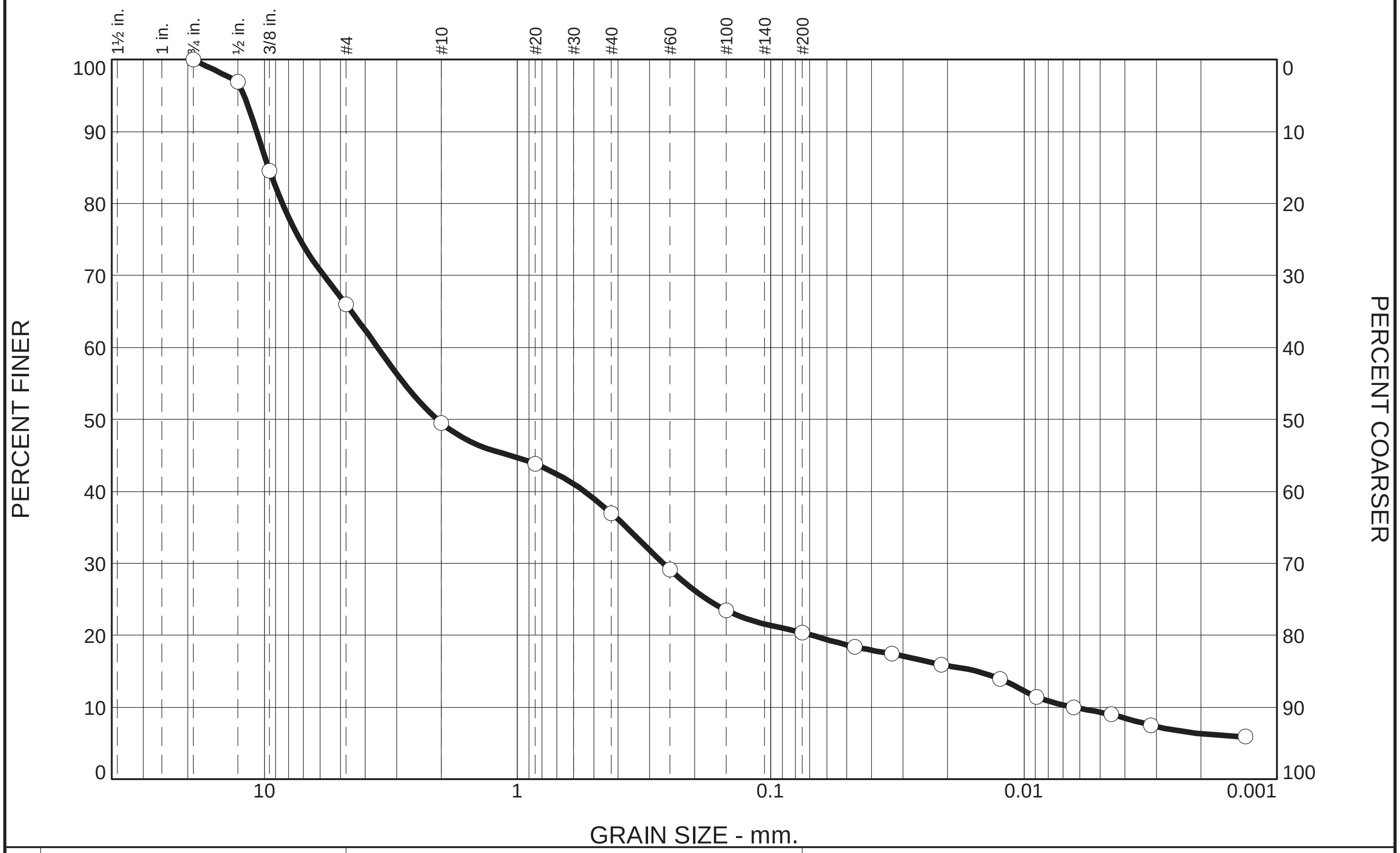
Source of Sample: HEN-B029 **Depth:** 35.0'-36.5'
Sample Number: S-10
Date: 12-10-15

Terracon

Client: AECOM
Project: DYNERGY - HENNEPIN
Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	34.0	16.5	12.6	16.6	11.0	9.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	97.0		
.375	84.6		
#4	66.0		
#10	49.5		
#20	43.8		
#40	36.9		
#60	29.1		
#100	23.5		
#200	20.3		

* (no specification provided)

BROWN AND LIGHT BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL=
LL=
PI=

Coefficients

D_{90}= 10.7082
D_{85}= 9.6174
D_{60}= 3.5682
D_{50}= 2.0785
D_{30}= 0.2659
D_{15}= 0.0154
D_{10}= 0.0064
C_u= 557.69
C_c= 3.10

Classification

USCS= SM
AASHTO=

Remarks

F.M.=3.56

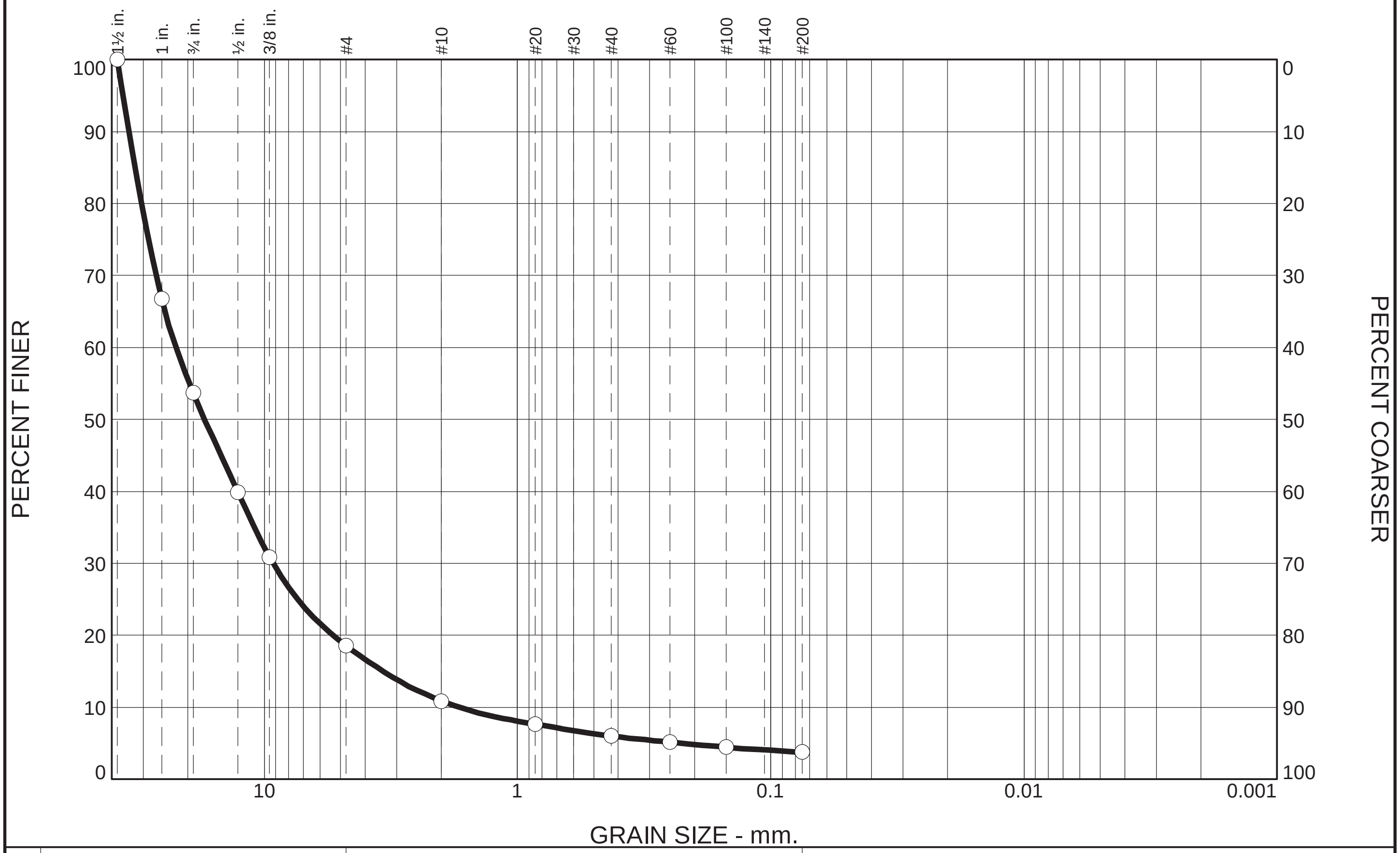
Source of Sample: HEN-B030 **Depth:** 2.5'-4.0'
Sample Number: S-2
Date: 12-15-15

Terracon

Client: AECOM
Project: DYNEGY - HENNEPIN
Project No: MR155233
Figure

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	46.3	35.1	7.7	4.9	2.2	3.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	66.8		
.75	53.7		
.5	39.9		
.375	30.9		
#4	18.6		
#10	10.9		
#20	7.6		
#40	6.0		
#60	5.1		
#100	4.4		
#200	3.8		

* (no specification provided)

LIGHT BROWN AND TAN WELL GRADED GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 34.1590 D_{85}= 32.2869 D_{60}= 22.3306
D_{50}= 17.1780 D_{30}= 9.2189 D_{15}= 3.3953
D_{10}= 1.7025 C_u= 13.12 C_c= 2.24

Classification

USCS= GW AASHTO=

Remarks

F.M.=6.60

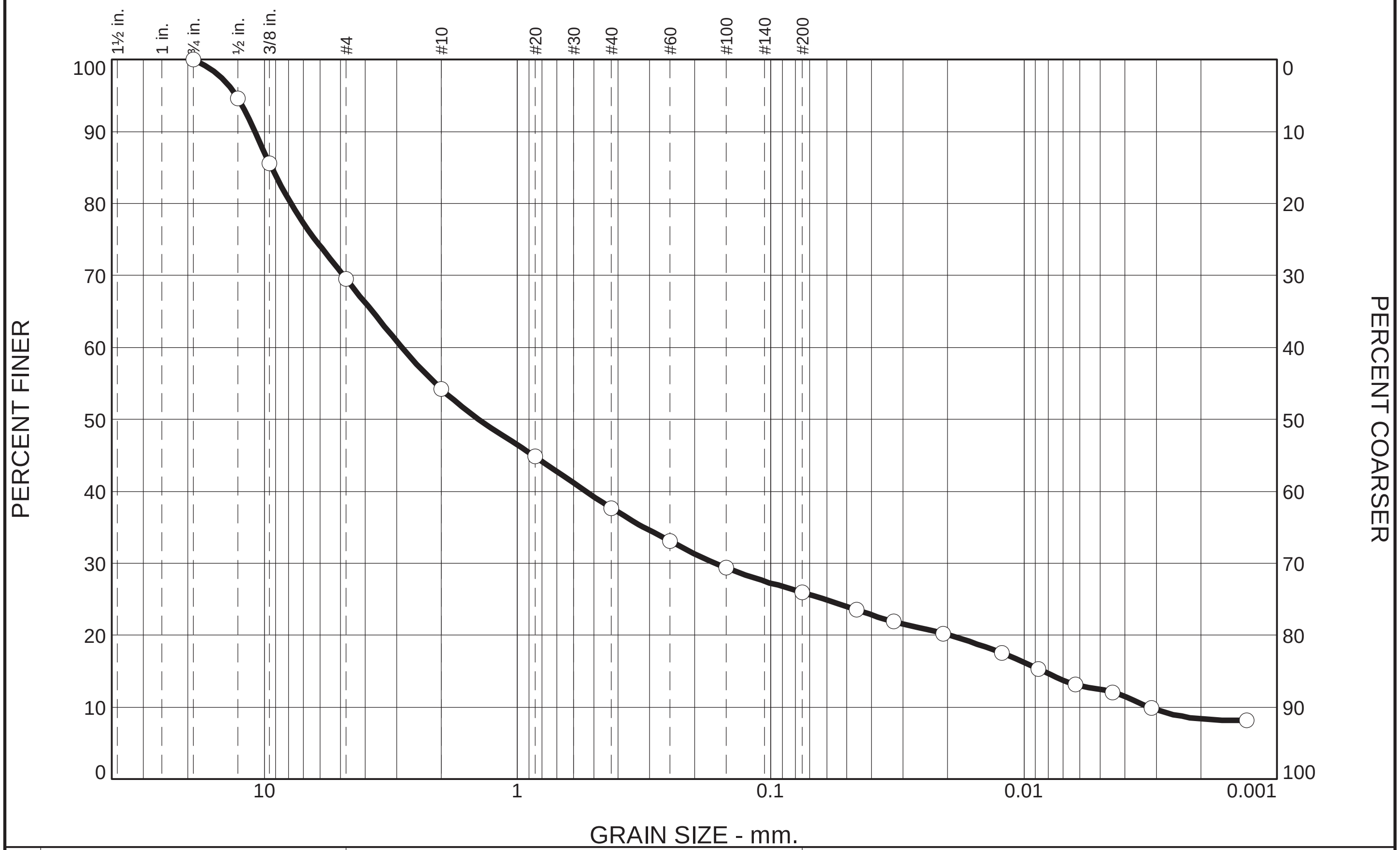
Source of Sample: HEN-B030 **Depth:** 15.0'-16.5'
Sample Number: S-6 **Date:** 12-10-15

Terracon

Client: AECOM
Project: DYNEGY - HENNEPIN
Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	30.5	15.3	16.5	11.8	13.4	12.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	94.6		
.375	85.6		
#4	69.5		
#10	54.2		
#20	44.8		
#40	37.7		
#60	33.1		
#100	29.4		
#200	25.9		

* (no specification provided)

BROWN SILTY SAND WITH GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.8888	D_{85}= 9.3568	D_{60}= 2.8565
D_{50}= 1.4206	D_{30}= 0.1654	D_{15}= 0.0084
D_{10}= 0.0032	C_u= 894.95	C_c= 3.00

Classification

USCS= SM AASHTO=

Remarks

F.M.=3.35

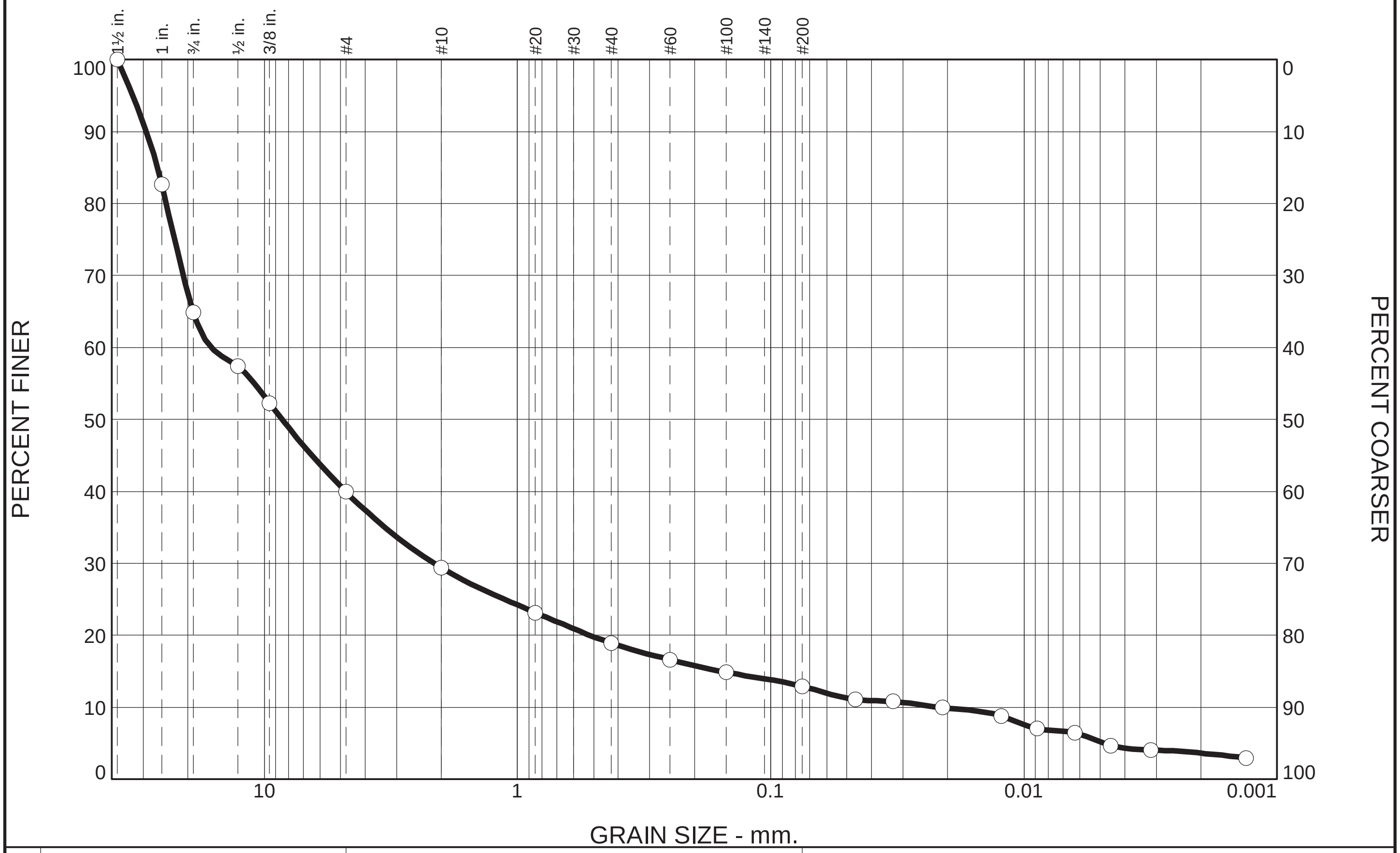
Source of Sample: HEN-B032 **Depth:** 20.0'-21.5'
Sample Number: S-7
Date: 12-15-15

Terracon

Client: AECOM
Project: DYNEGY - HENNEPIN
Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	35.1	25.0	10.5	10.5	6.0	7.7	5.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	82.7		
.75	64.9		
.5	57.4		
.375	52.3		
#4	39.9		
#10	29.4		
#20	23.2		
#40	18.9		
#60	16.6		
#100	14.8		
#200	12.9		

* (no specification provided)

BROWN AND LIGHT BROWN POORLY GRADED
GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 29.2016	D_{85}= 26.4297	D_{60}= 16.1803
D_{50}= 8.4958	D_{30}= 2.1337	D_{15}= 0.1581
D_{10}= 0.0218	C_u= 742.74	C_c= 12.92

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=5.34

Source of Sample: HEN-B034 **Depth:** 10.0'-11.5'
Sample Number: S-5 **Date:** 12-17-15

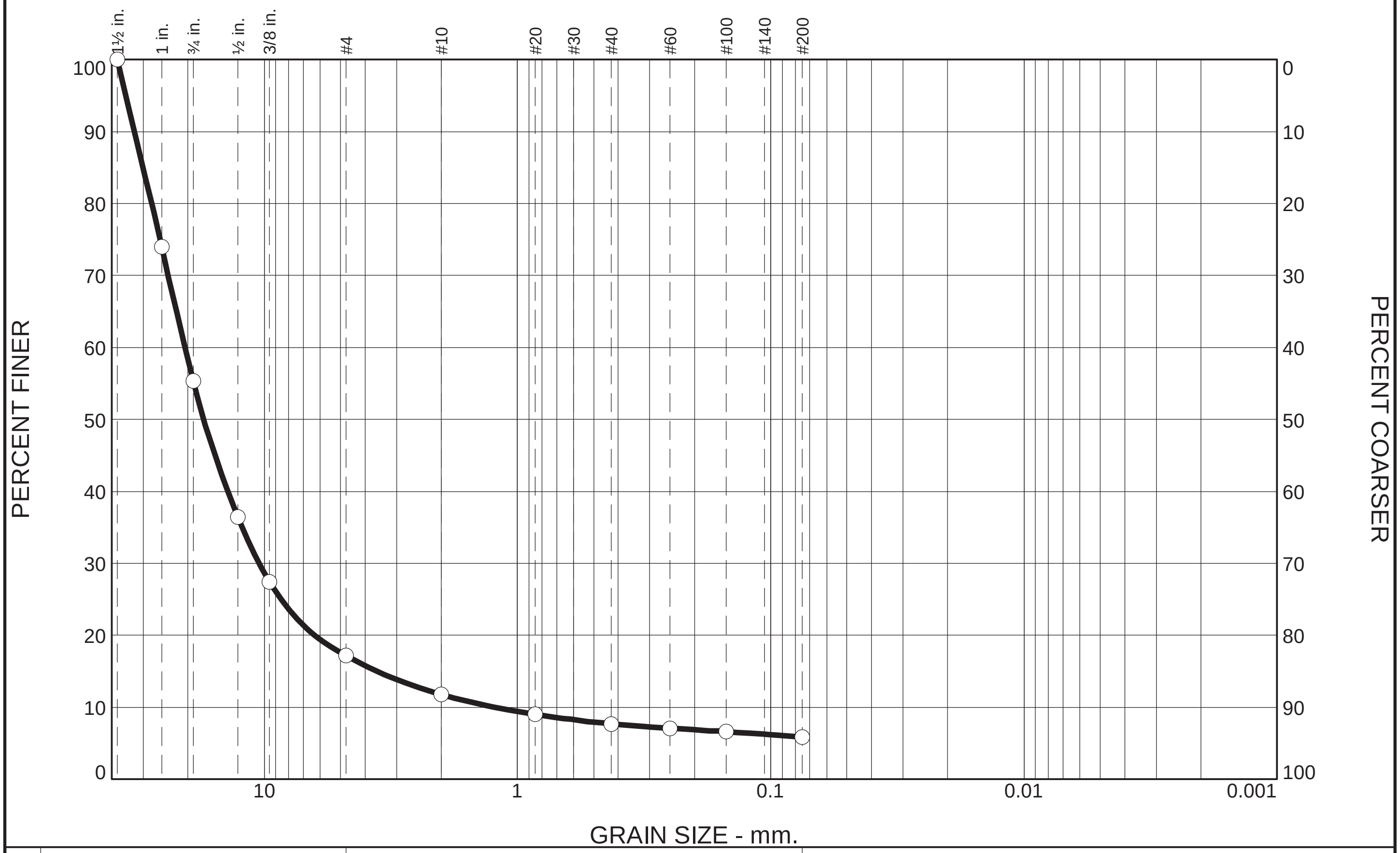
Terracon

Client: AECOM
Project: DYNEGY - HENNEPIN

Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

PARTICLE SIZE ANALYSIS OF SOILS ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	44.7	38.1	5.4	4.1	1.8	5.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	74.0		
.75	55.3		
.5	36.4		
.375	27.4		
#4	17.2		
#10	11.8		
#20	9.0		
#40	7.7		
#60	7.1		
#100	6.6		
#200	5.9		

* (no specification provided)

LIGHT BROWN AND TAN POORLY GRADED GRAVEL WITH SAND AND SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 32.5083 D_{85}= 30.0560 D_{60}= 20.5658
D_{50}= 17.3171 D_{30}= 10.4646 D_{15}= 3.5815
D_{10}= 1.2300 C_u= 16.72 C_c= 4.33

Classification

USCS= GP-GM AASHTO=

Remarks

F.M.=6.56

Source of Sample: HEN-B034 **Depth:** 35.0'-36.5'
Sample Number: S-10
Date: 12-10-15

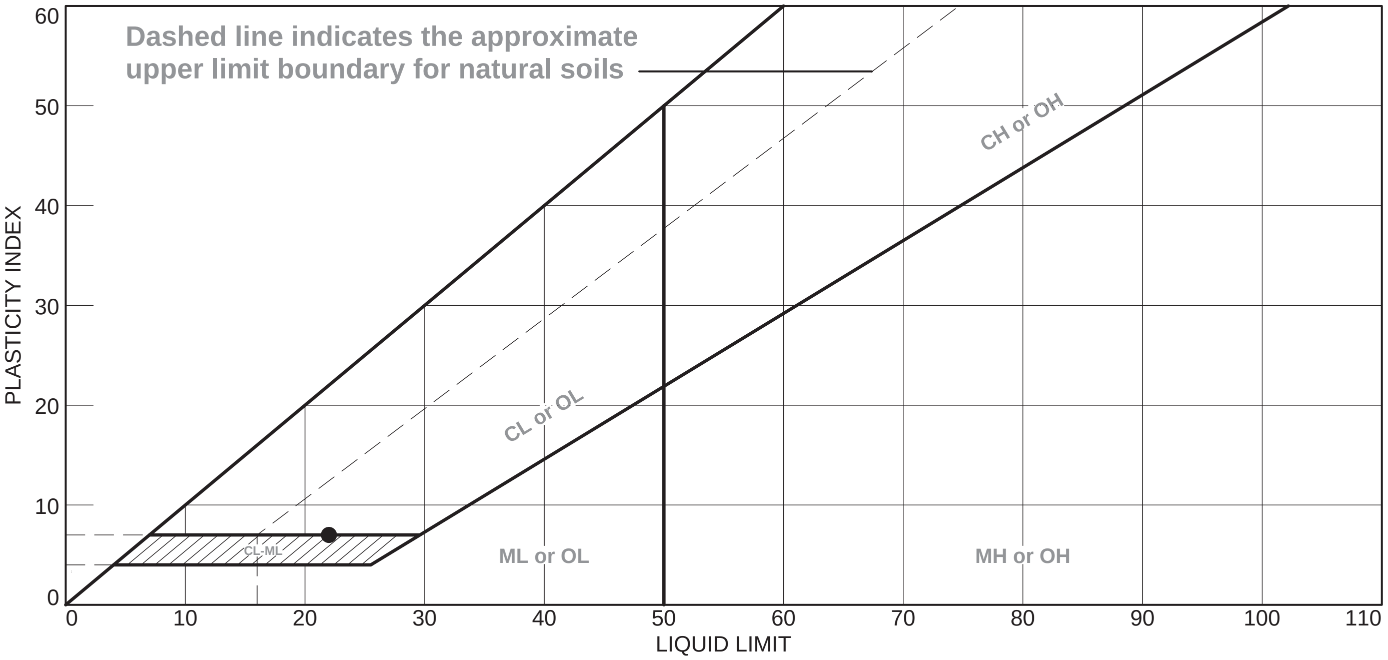
Terracon

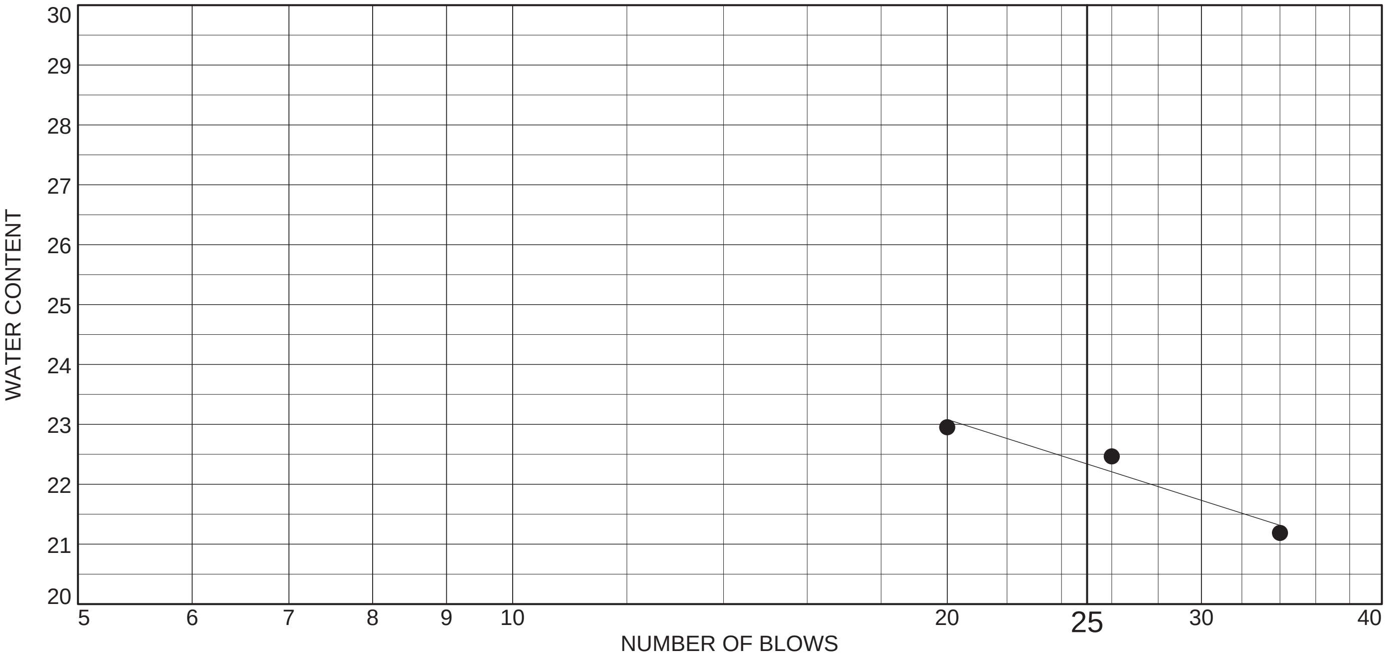
Client: AECOM
Project: DYNEGY - HENNEPIN
Project No: MR155233 **Figure**

Tested By: SJH **Checked By:** WPQ

Liquid Limit, Plastic Limit and Plasticity Index of Soils
ASTM D 4318

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BROWN LEAN CLAY WITH SAND AND GRAVEL	22	15	7			CL

Project No. MR155233 **Client:** AECOM

Project: DYNEGY - HENNEPIN

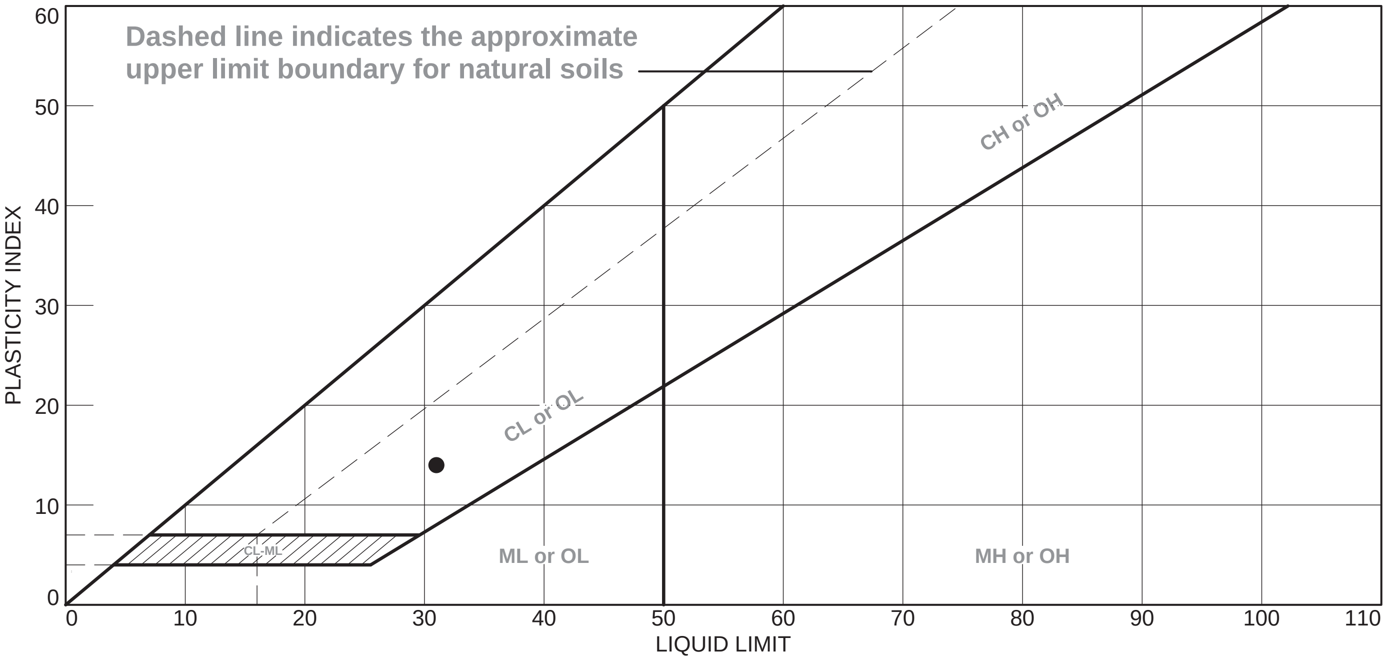
Source of Sample: HEN-B029 **Depth:** 5.0'-7.0'
Sample Number: S-3

Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	VERY DARK BROWN AND GRAY SLIGHTLY ORGANIC LEAN CLAY WITH SAND AND GRAVEL	31	17	14			CL

Project No. MR155233 **Client:** AECOM

Project: DYNEGY - HENNEPIN

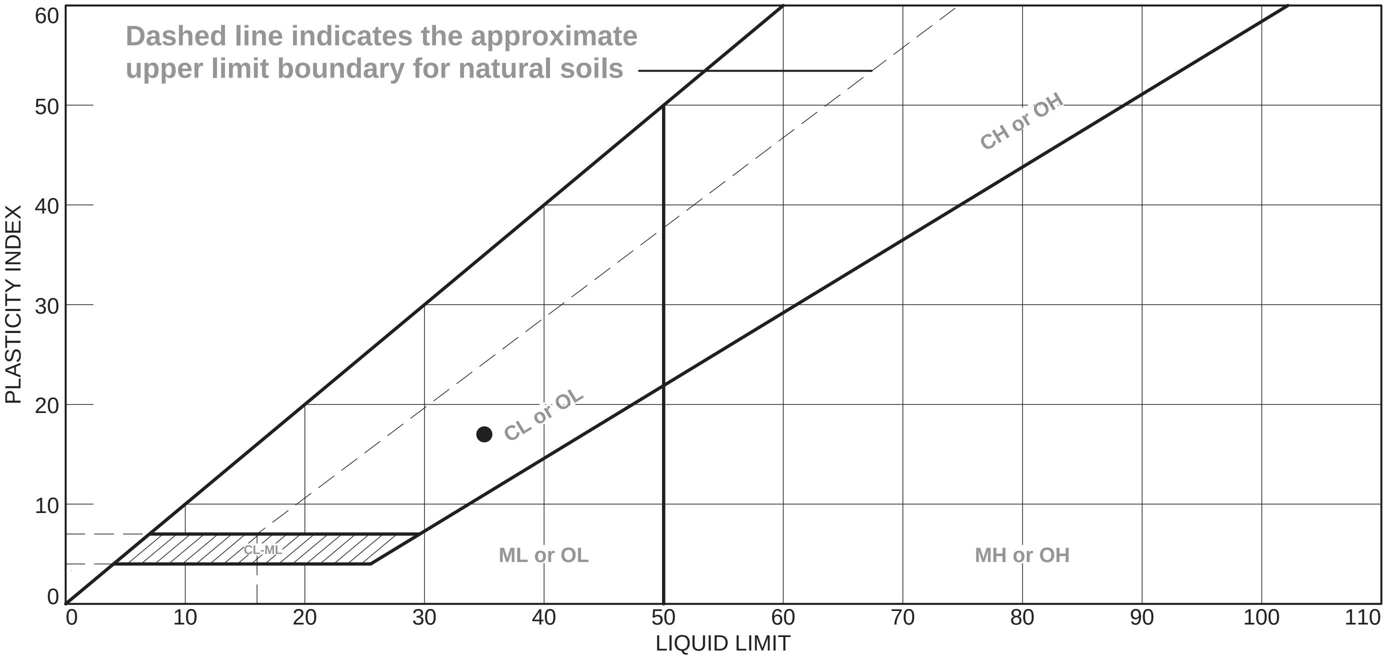
Source of Sample: HEN-B029 **Depth:** 10.0'-12.0'
Sample Number: S-5

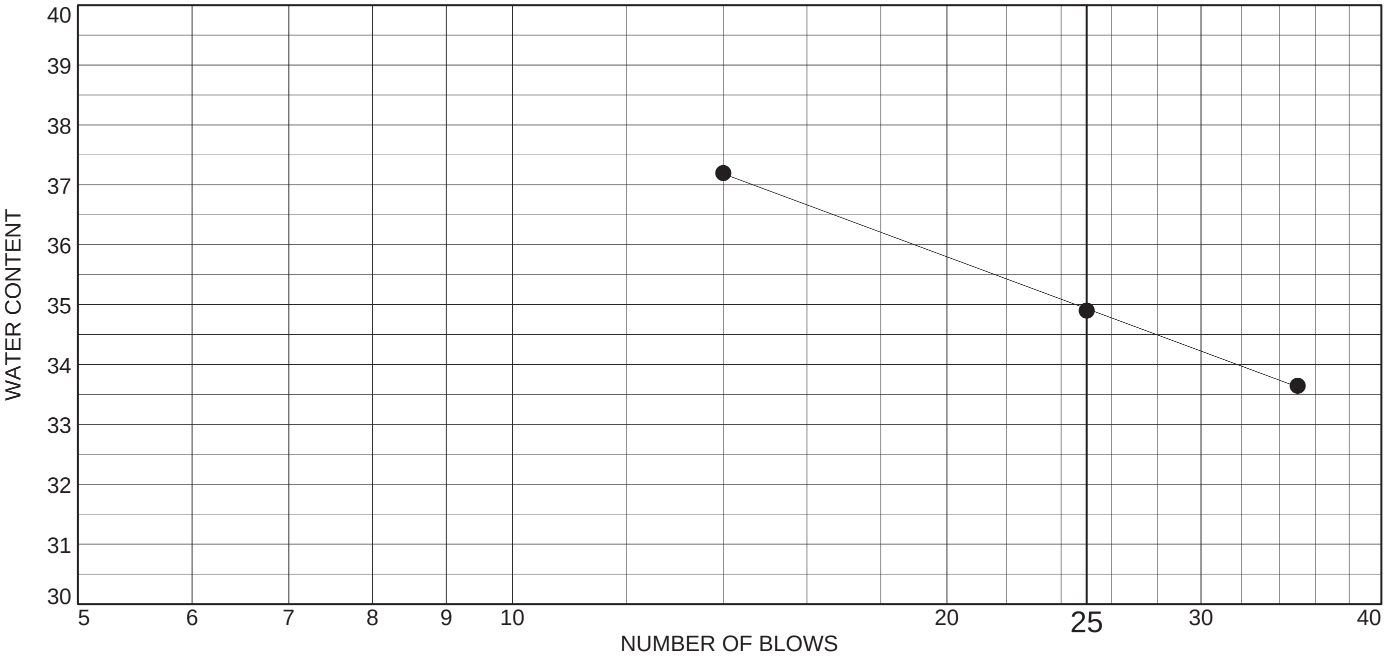
Remarks:

Figure

Tested By: BCM **Checked By:** WPQ

LIQUID AND PLASTIC LIMITS ASTM D4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	DARK BROWNISH GRAY LEAN CLAY WITH SAND AND GRAVEL	35	18	17			CL

Project No. MR155233 **Client:** AECOM

Project: DYNEGY - HENNEPIN

Source of Sample: HEN-B032 **Depth:** 5.0'-7.0'
Sample Number: S-3

Remarks:

Terracon

Figure

Tested By: HP **Checked By:** WPQ

Specific Gravity of Soils
ASTM D 854

Terracon
Consulting Engineers & Scientists

SPECIFIC GRAVITY OF SOIL SOLIDS
ASTM D-854

Project Number: MR155233
Project Name: Dynegy Hennepin
Test Date: 12/11/2015

Results Summary

Boring / Sample	Sample Description	USCS	Sample Number	Depth (ft)	Passing #4	Specific Gravity (Gs)
HEN-B030	FILL: BROWN AND GRAY LEAN CLAY WITH SILT, SAND AND GRAVEL	CL	S-3	5.0'-6.5'	100.00%	2.746
HEN-B034	DARK BROWN LEAN CLAY WITH SILT AND SAND	CL	S-2	2.5'-4.0'	100.00%	2.704
HEN-B034	BROWN AND LIGHT BROWN GRAVEL WITH CLAY AND SAND	GP-GC	S-6	15.0'-16.5'	100.00%	2.808

Attachment F. Material Characterization Calculations

1. Objective

This calculation package summarizes the material characteristics of the subsurface strata encountered during AECOM's geotechnical investigation of the Hennepin East Ash Pond at Dynegy's Hennepin Power Station in Hennepin, Illinois. Selection of material properties for slope stability analyses are also developed and summarized within this package.

2. Subsurface Conditions

A subsurface exploration was performed at the Hennepin East Ash Pond between September 1 and October 21, 2015. The subsurface exploration included the following; four soil borings, installation of two piezometers to monitor phreatic conditions, and a program of four cone penetrometer test (CPT) soundings. Pore pressure dissipation testing and seismic shear wave velocity measurements were conducted on a selection of the CPT soundings. A full set of AECOM's boring logs, including soil descriptions, types of sampling, and choice laboratory test results, is provided in Attachment B of the report. A complete report that includes the graphical CPT logs and the results of the SCPTu and PPD tests is included in Attachment D of the report. The geotechnical exploration locations are shown on Figure 2-1 – Hennepin East Ash Pond Geotechnical Site Plan in Attachment A of the report.

Based on the results of the investigation, five main stratigraphic materials were identified at the site. These are listed below and briefly summarized:

Road Fill: A gravel road surrounds the perimeter of the Hennepin East Ash Pond. The material is generally comprised of gravel with varying amounts of sand, silt, and clay. The relative density of the road fill measured by the standard penetration test was very dense.

Table F-1: Road Fill Material Summary

Category	Min.	Max.	Representative Average
First Encountered (ft bgs)	<0.5	<0.5	<0.5
Thickness (feet)	0.5	7.5	1.3
SPT-N	32	62	51
Pocket Penetrometer (tsf)	1.25	4.5	2.8
Cone Resistance (tsf)	20.0	654.6	334.7
Sleeve Resistance (tsf)	0.03	4.9	1.7
Cone/Sleeve Ratio (%)	0.01	1.6	0.5
SCPTu Shear Wave Velocity (ft/sec)	N/A	N/A	N/A

Embankment Fill: The perimeter embankment / dike of the Hennepin East Ash Pond was constructed in two stages, with an original embankment, and a later raise constructed on top of the existing dike. This raise was completed in the early 2000s, raising the dike crest from an original elevation around 483 ft to the current elevation ranging from 494 to 500 ft. As indicated by the CPT logs, the new dike section was backfilled primarily with clay, although some zones of silty sand and gravel were also encountered. The consistency of the fill, as measured by the standard penetration test and pocket penetrometer tests, ranged from stiff to hard. Per construction drawings, the backfill material was to be compacted to 95 percent (minimum) ASTM D698. Historical compaction data for the fill material was not available, but field data are generally indicative of well-compacted materials.

Table F-2: Embankment Fill Material Summary

Category	Min.	Max.	Representative Average
First Encountered (ft bgs)	0.5	10	4.7
Thickness (feet)	4.5	10	6.9
SPT-N	11	50	28
Pocket Penetrometer (tsf)	0.5	4.5	3.2
Cone Resistance (tsf)	16.1	891.5	63.5
Sleeve Resistance (tsf)	0	4.9	1.5
Cone/Sleeve Ratio (%)	0	8.7	3.2
SCPTu Shear Wave Velocity (ft/sec)	860	861	861

Alluvial Foundation: Gravel materials with varying amounts of silt and clay were encountered in the borings drilled around the perimeter of the Hennepin East Ash Pond. The relative density of the alluvial foundation as measured by the standard penetration test ranged from medium dense to very dense.

Table F-3: Alluvial Foundation Material Summary

Category	Min.	Max.	Representative Average
First Encountered (ft bgs)	6	20	14
Thickness (feet)	5	36	16.8
SPT-N	17	120	55.5
Pocket Penetrometer (tsf)	1.5	1.5	1.5
Cone Resistance (tsf)	16.7	720.3	233.6
Sleeve Resistance (tsf)	0	9.7	3.4
Cone/Sleeve Ratio (%)	0	5.7	1.8
SCPTu Shear Wave Velocity (ft/sec)	1080	2038	1451

Fly Ash (Impounded CCR Materials): AECOM did not want to compromise the existing liner system within the Hennepin East Ash Pond, so borings and CPTs were not performed within the footprint of the impoundment. CPT's were obtained in the adjacent unlined impoundment, Hennepin East Ash Pond No. 2. CCR material properties for the Hennepin East Ash Pond are estimated based on materials encountered in the Hennepin East Ash Pond No. 2. The material was generally silt to sand size with some gravel and clay.

Liner System: Per record drawings, the Hennepin East Ash Pond has a 4 ft compacted clay liner on the bottom and side slopes of the pond. Underlying the clay liner is a 6 in thick sand filter layer on the bottom of the pond and 12 in thick sand layer on the side slopes of the pond. The bottom of the sand layer was constructed at an approximate elevation of 456 ft sloping up at a 4:1 on the sides of the pond to an elevation of approximate 483. In the early 2000's, the perimeter dike was raised from an elevation of 483 ft to current grades ranging from 494 to approximately 500 ft at 3:1 slopes. The liner system from top to bottom was comprised of a 45 mil thick reinforced polypropylene geomembrane, a 12-inch thick clay layer, and a 8 oz/sy polypropylene geotextile. In some areas, 2 layers of geomembrane were used. CPT's and borings were not performed within the lined area and construction documentation data was not available, therefore material properties for the liner system were estimated based on AECOM's experience.

Bedrock: Bedrock was not encountered in the soil borings. It is estimated that bedrock is greater than 100 ft below ground surface based on borings completed within the vicinity.

Other Materials: Other materials were encountered in relatively small quantities at the site, appearing at only two exploration locations, and were not considered part of the site-wide stratigraphy. These materials include ash fill material within the road embankment at boring HEN-B030 and a 6 in dense sand layer encountered in boring HEN-B034. The ash fill material was modeled in the slope stability analyses as an embankment fill layer based on CPT readings in HEN-C030. The sand layer was modeled with the gravel layer in the slope stability analysis.

3. Laboratory Testing Program

Representative samples were collected at regular intervals from the borings and were utilized for laboratory testing. The laboratory tests were assigned to characterize the site materials including index (moisture content, unit weight, Atterberg limits, specific gravity, and particle size analysis), permeability and consolidation tests. Strength testing included isotropically consolidated-undrained triaxial tests with pore pressure measurements (CIU), Unconfined Compression (UC) tests, and direct shear tests (DS) on the native clay materials, embankment materials, and ash materials.

Table F-4: Laboratory Testing Program for East Ash Pond

ASTM Designation	Test Type	Number of Tests				
		Total	Road Fill	Embankment Fill	Alluvial Foundation	Other Material
D2216	Moisture Content	45	5	16	22	2
D4318	Atterberg Limits	3	-	3	-	-
T311[1], D1140, D422	Gradation / Hydrometer	6	1	-	5	-
D854	Specific Gravity	3	-	2	1	-
D5084	Hydraulic Conductivity	0	-	-	-	-
D2435	Consolidation	1	-	1	-	-
D 2166	Unconfined Compression	1	-	1	-	-
D4767	Consolidated Undrained Triaxial (CIU)	1	-	1	-	-
D6528	Direct Shear (DS)	1	-	1	-	-

[1] American Association of State Highway and Transportation Officials (AASHTO) test designation

Compete results of the laboratory tests are included in Attachment E of the report.

4. Material Properties

Material properties for slope stability analyses were developed using both laboratory testing data (index and strength testing) and strength correlations from SPT and CPT data.

The following specific material properties were developed for the road fill, embankment fill, alluvial foundation, fly ash, and liner system for use in the various stability analyses performed as part of this study:

- Unit Weight
- Drained and Undrained Shear Strength of Fine-Grained Soil Strata
- Drained and Undrained Shear Strength of Ash

Material properties for the liner system were conservatively estimated based on empirical correlations and experience with similar materials.

Unit Weight

Unit weight for the road fill, embankment fill, and alluvial foundation materials were evaluated using measured results from samples collected. Values were plotted and design unit weight lines were then fit to the plotted data, and layers were divided where warranted by differences in the data. Plots of these measured values are included as Attachments F.1 through F.3 at the end of this document.

For materials that could not be directly measured for unit weight (fly ash and the liner system materials), estimates of the unit weight were based on empirical correlations and experience with similar materials.

Refer to table F-5 for total unit weights used in the stability analyses.

Drained Shear Strength Selection

Drained shear strengths were selected for all materials for use in the Long Term and Max Pool analyses. Drained strengths were primarily based on results from DS and CIU testing. Plots of both effective friction angle and effective cohesion values were created for each material type to estimate average values across each material. To supplement the effective friction angle measured in laboratory testing, correlated values of phi' were calculated using the procedure developed by Peck, Hanson, and Thornburn, 1974, based on corrected SPT blow counts. Measured laboratory values were given precedence when selecting design values. For materials that could not be directly measured for drained shear strength (fly ash and the liner systerm materials), the above correlation was used for effective friction angles. Effective cohesion values for these materials were conservatively estimated based on experience with similar materials. Design strength lines were then fit to the plotted data, and layers were divided where warranted by differences in the data. Plots of the measured and correlated drained shear strength values for the materials are included as Attachments F.1 through F.3.

Undrained Shear Strength Selection

Undrained shear strengths were selected for the cohesive materials for use in the analysis. Undrained strengths were based on results from CIU and UC testing, and correlated values of undrained shear strength from the CPT tests. Plots of undrained shear strength were created for each material type to estimate average values across each material. To supplement the undrained shear strengths measured in laboratory testing, correlated values were calculated using the procedure developed by Aas, et al (1986), based on CPT data. An NKT factor of 18 was selected for use in this correlation based on published values. Su / σ'vo lines were also calculated and plotted for comparison purposes. Design strength lines were then fit to the plotted data, and layers were divided where warranted by differences in the data. Plots of the measured and correlated undrained shear strength values for the materials are included as Attachments F.1 through F.3.

5. Material Properties for Analysis

The table below summarizes the material parameters used in the stability analysis, based on the analysis and strength selection procedures and considerations presented in the preceding sections.

Table F-5: Summary of Material Parameters used in Stability Analysis

Material	Total Unit Weight (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	**Φ**' (°)	c (psf)	**Φ** (°)
Road Fill	130	0	38	0	38
Embankment Fill	105	30	32	2500	0
Alluvial Foundation	135	0	38	0	38
Fly Ash	105	100	27	600	0
Liner System	120	60	30	2500	0

6. References

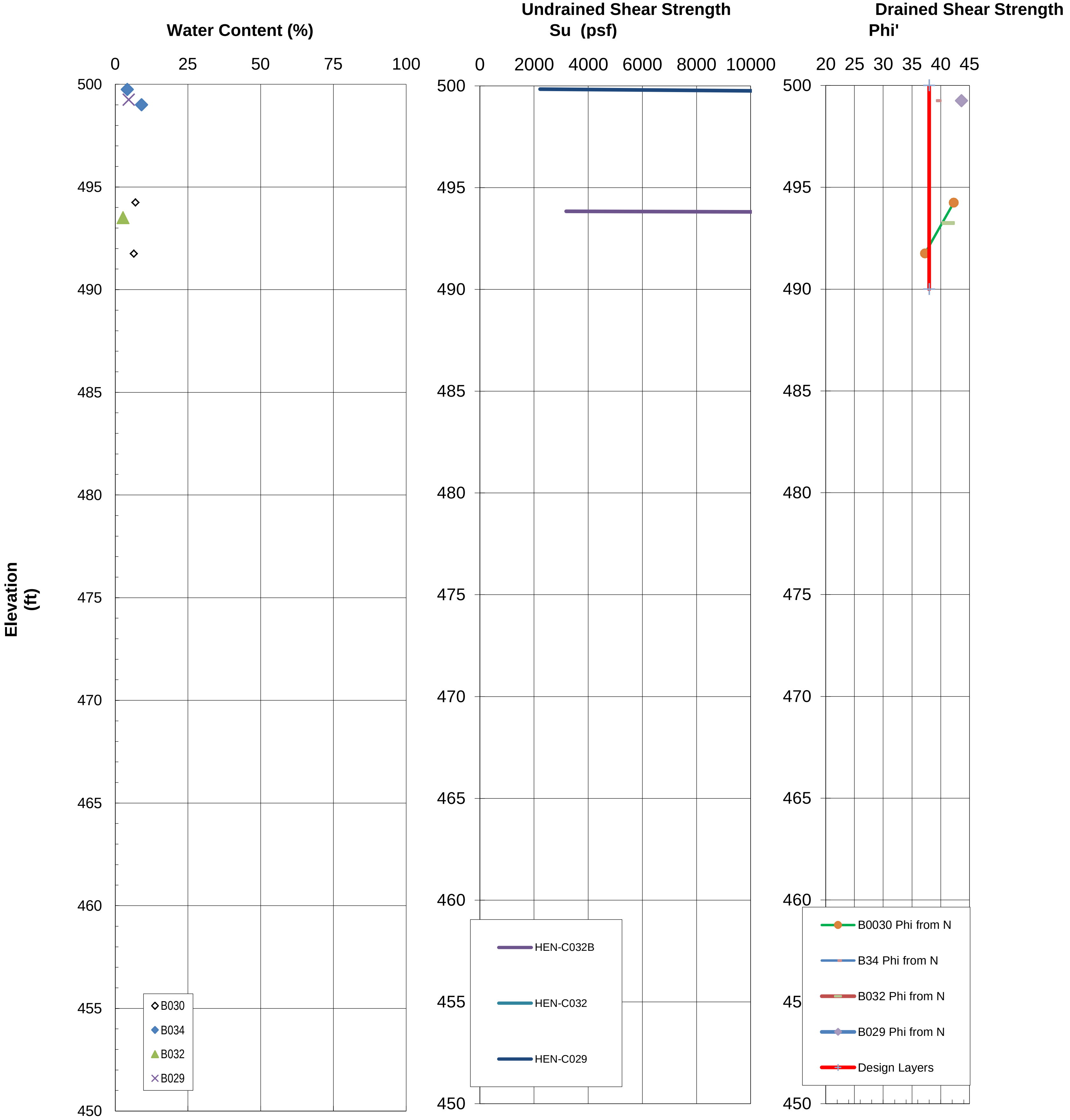
Aas, G., Lacasse, S., Lunne, I., and Hoeg, K. (1986). "Use of In situ Tests for Foundation Design in Clay," Proceedings, In Situ 86, American Society of Civil Engineers, pp. 30.

Peck, R.B., Hanson, W.E. and Thornburn, T.H., 1974. Foundation Engineering, 2nd edition, John Wiley and Sons, Inc.

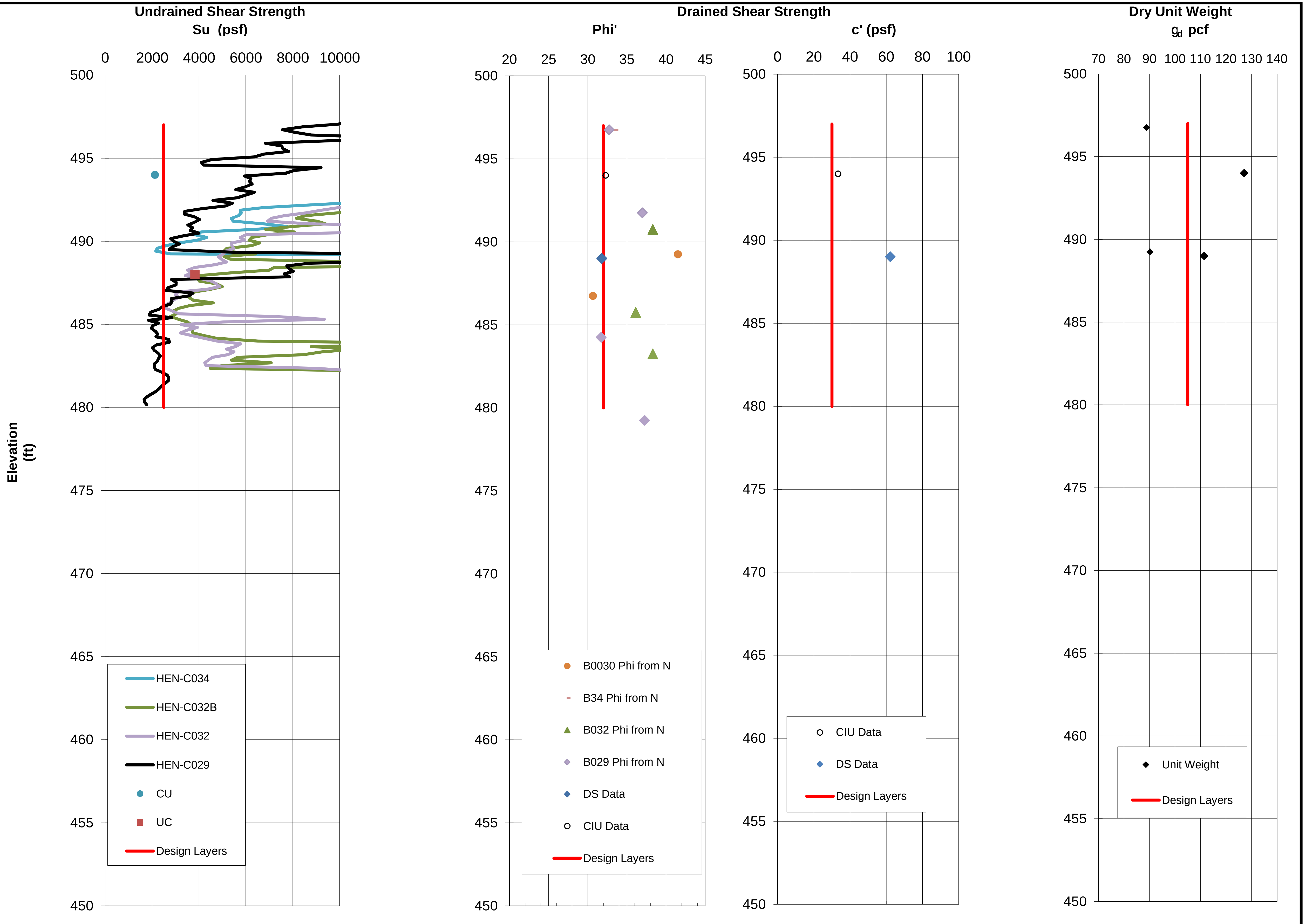
Idriss, I. M., and Boulanger, R. W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute, Oakland, California, USA.

7. Attachments

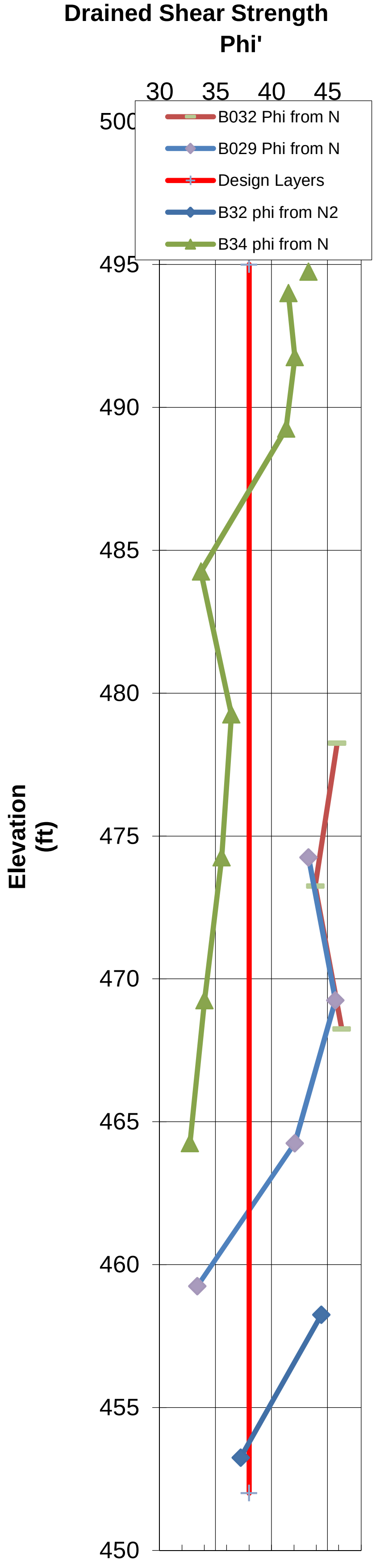
F.1	Material Characterization Plot – Road Fill
F.2	Material Characterization Plot – Embankment Fill
F.3	Material Characterization Plot – Alluvial Foundation

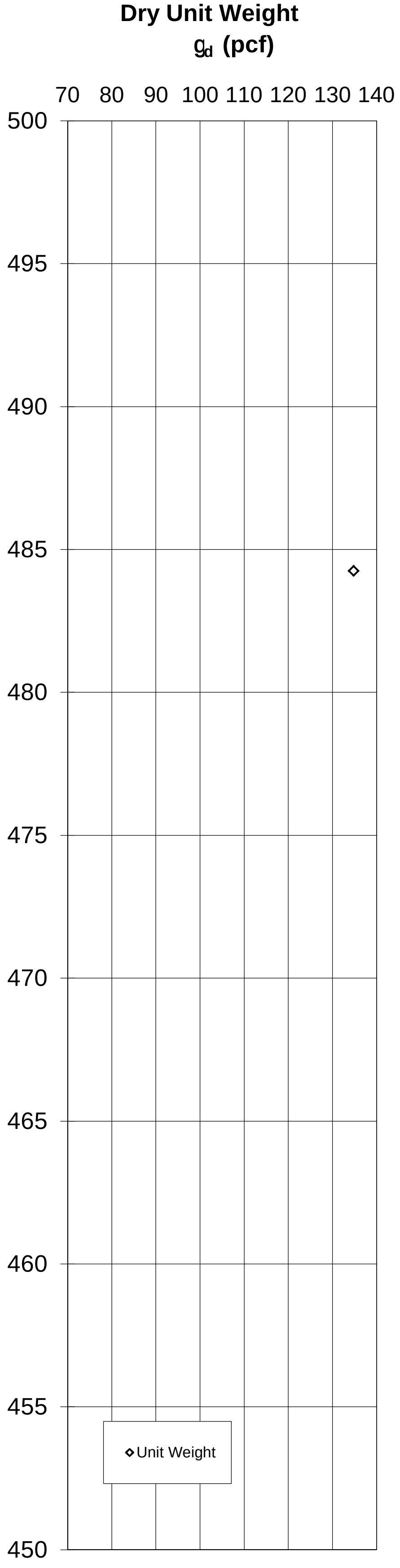


Dynegy Hennepin Hennepin, IL East Ash Pond	Project No. 60439752	Summary of Index and Engineering Properties - Road Fill	AECOM	DRN. BY: NDS DSGN. BY: AJW CHKD. BY: JMT	Attachment F.1



Dynegy Hennepin Hennepin, IL East Ash Pond	Project No. 60439752	Summary of Index and Engineering Properties - Embankment Fill	AECOM	DRN. BY: NDS DSGN. BY: AJW CHKD. BY: JMT	Attachment F.2





Dynegy Hennepin Hennepin, IL East Ash Pond	Project No. 60439752	Summary of Index and Engineering Properties - Alluvial Foundation	AECOM	DRN. BY: NDS DSGN. BY: AJW CHKD. BY: JMT	Attachment F.3

Attachment G. Slope Stability Analysis

1. Objective & Introduction

This calculation package summarizes the limit equilibrium slope stability analyses for both the static and seismic loading conditions performed in support of the Hennepin East Ash Pond CCR Unit Geotechnical Report for the Hennepin Power Station. Figures, calculations and computer program outputs are provided as attachments and are referenced herein. Slope stability analyses have been completed for two cross-sections within the Hennepin East Ash Pond to evaluate the stability of the embankment under the loading conditions described below.

The objective for the slope stability analysis is to determine factors of safety (FS) at critical cross section locations across the Hennepin East Ash Pond dike for the following loading cases:

- Static, Steady-State, Normal Pool Conditions;
- Static, Maximum Pool Surcharge Conditions;
- Seismic Slope Stability Analysis;

The methodology used to perform the slope stability analysis and the results of the analyses are summarized in the subsequent sections listed below.

2. Development of Cross-Sections for Analysis

Two cross-sections (SL-10 and SL-12) were utilized to evaluate the perimeter embankment stability at the Hennepin East Ash Pond. The north and south sides of the pond were not analyzed because the downstream side of the north embankment is filled with ash and the south side is not an embankment but is incised; therefore, neither the north nor south represent critical sections for slope stability analyses. A cross section on the east and west embankments, SL-12 and SL-10, respectively, were analyzed. The location of these sections can be found in **Attachment A, Figure 2**.

The section geometry for each analysis cross-section was determined based on the site specific aerial and bathymetric survey completed by Weaver Consultants Group in September 2015. The survey is spatially referenced to the Illinois NAD 1983 State Plane West, Zone 12020. Elevations are in feet and referenced with respect to the North American Vertical Datum 1988 (NAVD 88).

3. Subsurface Conditions

Subsurface materials and extents (stratigraphy) at each cross section were developed by utilizing nearby subsurface explorations (CPTs and borings) from AECOM's exploration activities and historic geotechnical explorations. The subsurface strata generally encountered across the exploration locations can be generalized into five typical layers. These layers are listed below and are further described in **Appendix F – Material Characterization**.

- Road Fill
- Embankment Fill
- Alluvial Foundation
- Fly Ash
- Liner System

Material interfaces inferred from the subsurface explorations nearest to the cross-sections were transposed onto the profile and a reasonable interpretation of the subsurface stratigraphy between the exploration locations was developed. Table G-1 below summarizes the exploration locations utilized to construct each cross-section:

Table G-1
Cross-section Locations for Slope Stability Analyses

Cross-Section	Location (Crest/Toe)	Boring/CPT Number
SL-10	CREST	HEN-B029, HEN-C029
SL-12	CREST	HEN-B032, HEN-C032, HEN-C032B

Additionally, design drawings from “1995 Ash Facility Hennepin Power Station” by Illinois Power Company (1993) and “Modification to Primary Ash Pond Hennepin Power Station” by Sargent & Lundy (2003) were used to supplement the subsurface investigation in developing the subsurface embankment geometry.

Phreatic surfaces were modeled as a piezometric line in SLOPE/W. Elevations and configuration of the piezometric lines were established based on the phreatic water water levels recorded from the piezometers installed during the 2015 AECOM exploration ranging from approximately 449 to 452 and the normal pool elevation of 490.4 ft impounded in the Hennepin East Ash Pond, based on the 2016 AECOM Hydraulics and Hydrology report (AECOM, 2016).

4. Analysis Methodology

Analyses were performed using Spencer’s Method which is a limit equilibrium slope stability analysis procedure. The computer program SLOPE/W 2012 by Geo-Slope International was utilized. The program analyzes a large number of potential slip surface geometries and identifies the geometry that results in a critical (i.e. lowest) factor of safety (FS). Additional information on the program is available at http://www.geo-slope.com/. Circular shaped failure surfaces, with optimization, were analyzed for the each of the loading cases considered. The optimization option within SLOPE/W allows the checking of non-circular failure surfaces by incrementally altering the location of the failure surface to find the lowest factor of safety. This procedure allows the failure surface to follow thin layers of lower strength, and interface boundaries to calculate a more critical factor of safety.

To account for the two piezometric lines in each cross section, the piezometric line within the Hennepin East Ash Pond was applied only to the fly ash and liner system. A second piezometric line was used to model phreatic water and was applied the alluvial foundation, embankment fill and road fill. This piezometric surface was modeled at elevation 450 ft and 452 ft for SL-12 and SL-10, respectively. At SL-12, the phreatic surface was assumed to rise to meet the typical pool elevation for the East Polishing Pond (482.2 ft).

Each section was analyzed for the following cases:

- **Static, Steady-State, Normal Pool Condition:** This case models the conditions under static, long-term conditions, under the normal storage water level within the impoundment. Drained (effective stress) shear strength parameters were used for all materials, and phreatic conditions were estimated based on available data as described above. A target **Factor of Safety of 1.50** is needed for this loading condition. The operating water level of the Ash Pond is El. 490.4 ft for the Hennepin East Ash Pond..

- **Static, Maximum Surcharge Pool Condition:** This case models the conditions under short term surcharge pool conditions. Drained (effective stress) shear strength parameters were used for all materials, as the change in pool elevation is temporary and fairly small, and is unlikely to initiate total stress mechanisms of failure. Because the impoundment is lined, the phreatic surface does not extend past the embankment. Therefore, the phreatic surface in the foundation was modeled equivalent to the steady state case. A target **Factor of Safety of 1.40** is needed for this loading condition. The water level of the East Ash Pond was modeled at El. 492.2 ft for this case. This value is from the 2016 AECOM Hydraulics and Hydrology report generated for this project.

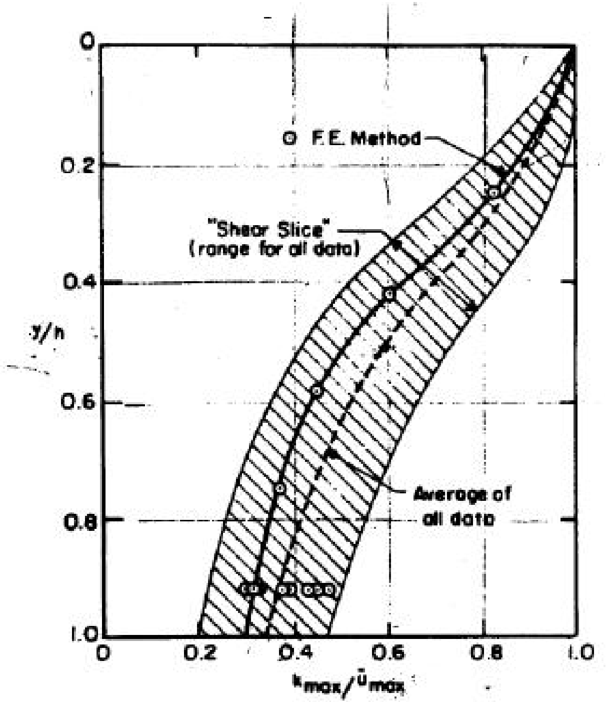
- **Seismic Stability Condition:** These analyses incorporate a horizontal seismic coefficient kh selected to be representative of expected loading during the design earthquake event (i.e., a "pseudostatic" analysis). The analyses utilized peak undrained strength parameters in soils that are not consider to be rapidly draining materials, and peak drained strengths in soils considered to freely drain. The phreatic surface and pore water pressures corresponding to the Steady State Normal Storage Pool case from the static analyses were utilized. Seismic loading was included in this analysis using a pseudostatic coefficient (kh). A **Factor of Safety of 1.00** is required for this loading condition.

Ground motion parameters for the pseudostatic analysis were estimated using the USGS Interactive Deaggregation tool (http:earthquake.usgs.gov/hazards/apps/). This application generates acceleration values, including peak ground acceleration (PGA), and mean and modal moment magnitudes, based on user entered values of location, exceedance probability, and spectral period. Results are computed based on the 2008 NSHMP PSHA Seismic Hazard Maps.

For the Hennepin Power Station, the calculated PGA for a 2,500-year event was 0.072g for top of hard rock. To determine the free-field, ground surface horizontal acceleration, the site was classified according to the site classes defined in IBC (2003) and amplified using the site amplification factors found in NEHRP (2009). The site class was determined based on the weighted average of the shear wave velocity of the foundation soils ($600 \leq vs \leq 1{,}200$ ft/s) and found to be Site Class D. This corresponds to a NEHRP amplification factor of 1.6, resulting in a ground surface acceleration of 0.119g. The Peak Transverse Acceleration at the dike crest was estimated using the ground surface acceleration and the procedure proposed by Idriss (2015), resulting in a crest acceleration of 0.35g.

The pseudostatic coefficient was calculated based on the simplified procedure developed by Makdisi and Seed (1978). Specifically, the pseudostatic coefficient was taken as the parameter kmax, which represents the peak average acceleration along the failure surface. As shown in Figure 1 below (excerpted from the above reference), the ratio kmax/umax (where umax is the peak acceleration at the crest of the embankment) for a full height failure surface (y/H = 1.0) is 0.34. From the procedure noted above, the anticipated maximum peak crest acceleration is approximately 0.35g. Therefore, the pseudostatic coefficient kh was estimated as kh= 0.34*0.35g = 0.119g for these analyses.

The seismic hazard deaggregation output and calculations for the pseudostatic coefficient are provided at the back of this document.



VARIATION OF "MAXIMUM ACCELERATION RATIO" WITH DEPTH OF SLIDING MASS

Figure 1: Determination of Maximum Average Acceleration Along Failure Surface

5. Material Properties for Analysis

Material properties for slope stability analyses were developed using both laboratory testing data (index and strength testing) and strength correlations from CPT and SPT data. Details of the material characterization and strength parameter selection for each stratum are provided in **Attachment F** of this report. The properties used in the stability analysis are summarized in the table below:

Table G-2: Summary of Material Parameters used in Stability Analysis

Material	Unit Weight Above WT (pcf)	Effective (drained) Shear Strength Parameters		Total (undrained) Shear Strength Parameters	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)
Road Fill	130	0	38	0	38
Embankment Fill	105	30	32	2500	0
Alluvial Foundation	135	0	38	0	38
Fly Ash	105	100	27	600	0
Liner System	120	60	30	2500	0

6. Results

Table G-3 summarizes the results of the stability analyses for each section, and output figures from the SLOPE/W models are provided at the back of this document.

Table G-3: Summary of Minimum Slope Stability Factors

Cross Section	Factor of Safety		
	Drained		Undrained
	Steady State (Normal Pool)	Surcharge Pool (Flood)	Seismic (Pseudostatic)
CCR Rule Criteria	*FS ≥ 1.50*	*FS ≥ 1.40*	*FS ≥ 1.00*
SL-10	2.14	2.14	4.23
SL-12	2.81	2.81	2.53

7. Conclusions

Load cases analyzed for this study included static (steady-state) normal pool, maximum flood surcharge pool and seismic (pseudostatic). The calculated factors of safety from the limit equilibrium slope stability analysis satisfy the USEPA CCR Rule § 257.73(e) requirements for all the load cases analyzed at the critical analysis sections for the perimeter of the impoundment.

8. References

AECOM (2016). Hydrologic and Hydraulic Summary Report for Hennepin Power Station, Primary Ash Pond CCR Unit. (DRAFT)

GEO-SLOPE International Ltd. (2015). “GeoStudio 2012 (SLOPE/W and SEEP/W).” Calgary, Alberta, Canada.

Idriss, I. M., and Boulanger, R. W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute, Oakland, California, USA.

International Code Council, (2003), 2003 International Building Code.

Weaver Consultants Group. (September 2015). Survey data.

Makdisi, F.I. and Seed, B. H., August, 1977. “A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments”, Earthquake Engineering Research Center Report No. UCB/EERC-77/19, University of California, Berkeley, CA.

NEHRP (National Earthquake Hazards Reduction Program), (2009) Recommended Seismic Provisions for New and Other Structures, (FEMA P-750), 2009 Edition.

U.S. Environmental Protection Agency [USEPA]. (2015). Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. 40 CFR §257. Federal Register 80, Subpart D, April 17, 2015.

9. Attachments

G.1 Slope Stability Analysis Output Data
G.2 Seismic Parameter Calculations

Attachment G.1 Slope Stability Analysis Output Data

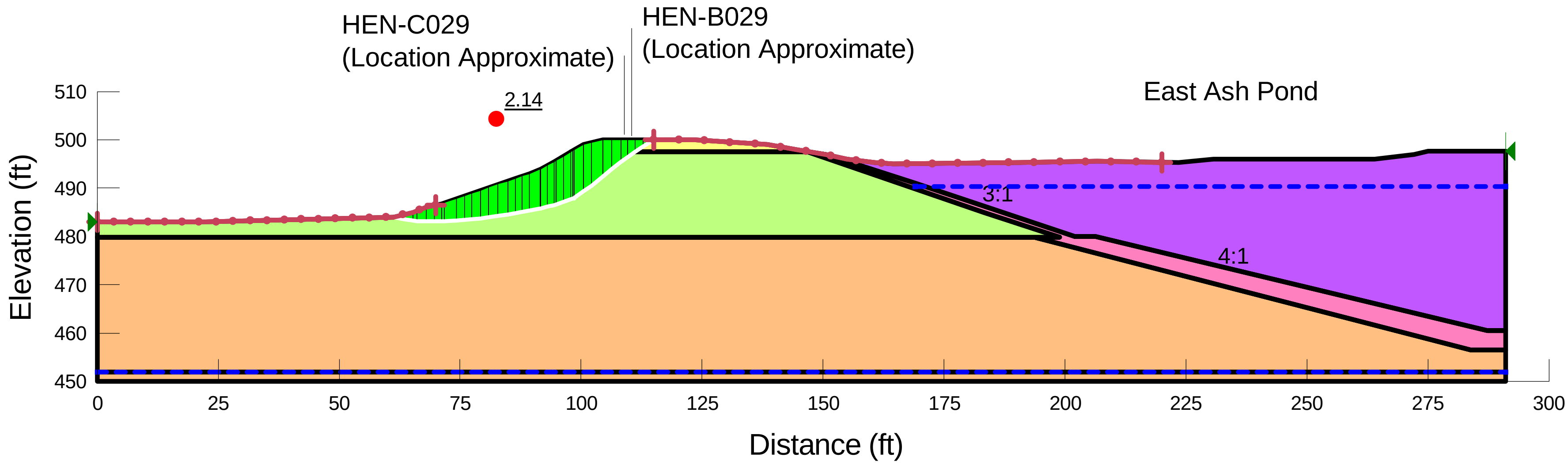
Calculated By: ZJF Date:9-21-2016
Checked By: LPC Date:9/22/16

Hennepin East Ash Pond
Cross Section SL-10
Effective (Drained)-Static Normal Pool

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟥 Liner System (Drained)
- 🟪 Fly Ash (Drained)
- 🟩 Embankment Fill (Drained)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 2
Name: Fly Ash (Drained) Unit Weight: 105 pcf Cohesion': 100 psf Phi': 27 ° Piezometric Line: 2
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 1



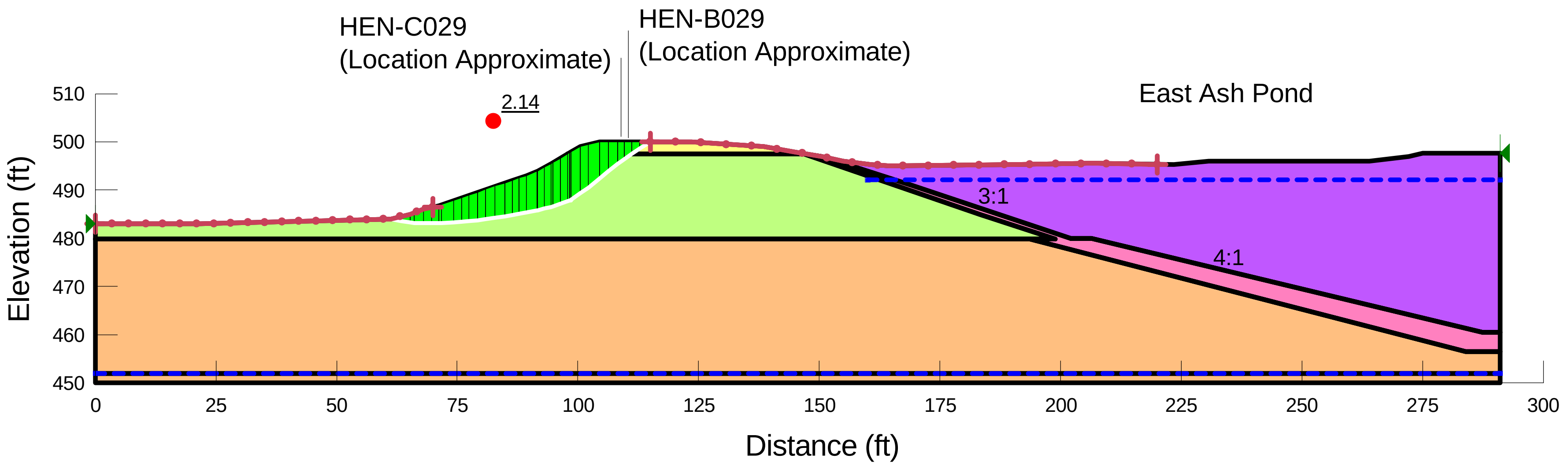
Hennepin East Ash Pond
Cross Section SL-10
Effective (Drained) - Static Max Pool

Calculated By: ZJF Date:9-21-2016
Checked By:LPC Date:9/22/16

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟥 Liner System (Drained)
🟪 Fly Ash (Drained)
🟩 Embankment Fill (Drained)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 2
Name: Fly Ash (Drained) Unit Weight: 105 pcf Cohesion': 100 psf Phi': 27 ° Piezometric Line: 2
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 1



Hennepin East Ash Pond
Cross Section SL-10
Total (Undrained) - Pseudostatic

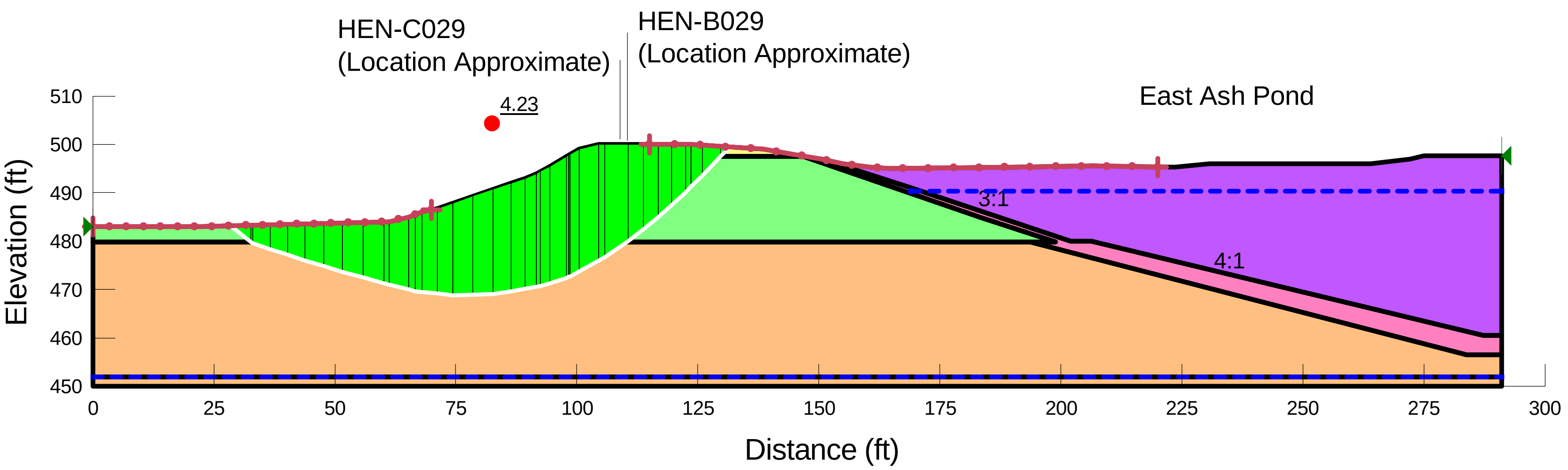
Calculated By: ZJF Date:9-21-2016
Checked By: LPC Date:9/22/16

Horz Seismic Coef.: 0.119

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟥 Liner System (Undrained)
- 🟪 Fly Ash (Undrained)
- 🟩 Embankment Fill (Undrained)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Undrained) Unit Weight: 120 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 2
Name: Fly Ash (Undrained) Unit Weight: 105 pcf Cohesion': 600 psf Phi': 0 ° Piezometric Line: 2
Name: Embankment Fill (Undrained) Unit Weight: 105 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 1



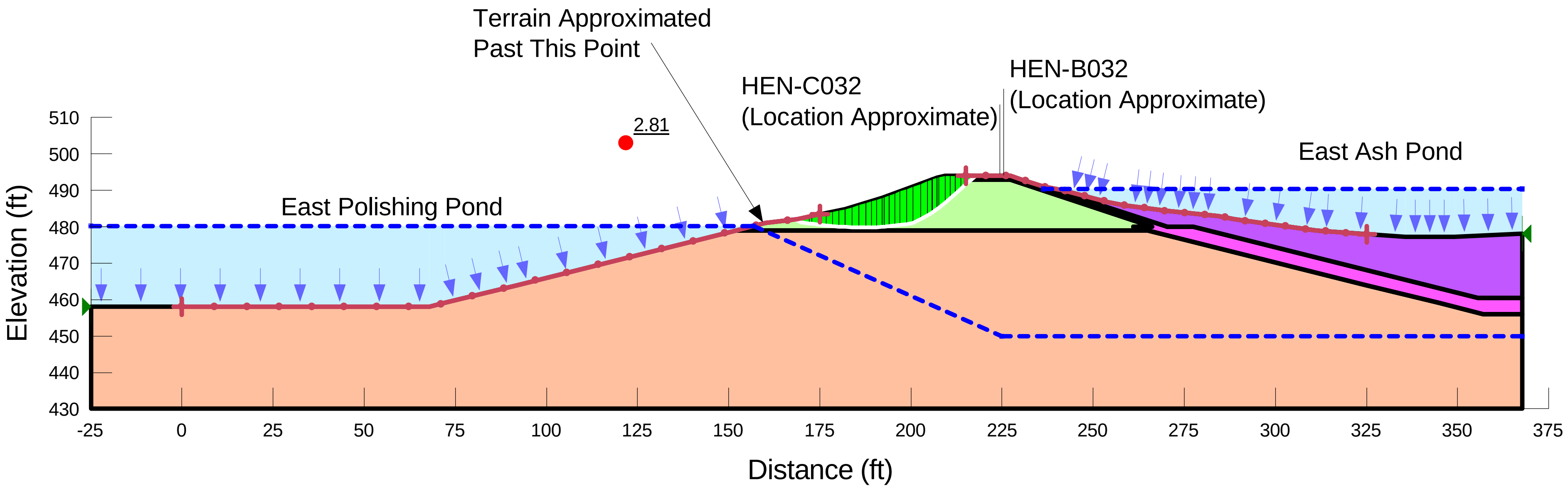
East Ash Pond
Cross Section SL-12
Effective (Drained) - Static Normal Pool

Calculated By: ZJF Date: 9/21/16
Checked By: LPC Date: 9/22/16

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 Fly Ash (Drained)
- 🟪 Liner System (Drained)
- 🟩 Embankment Fill (Drained)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Fly Ash (Drained) Unit Weight: 105 pcf Cohesion': 100 psf Phi': 27 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 1
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 2



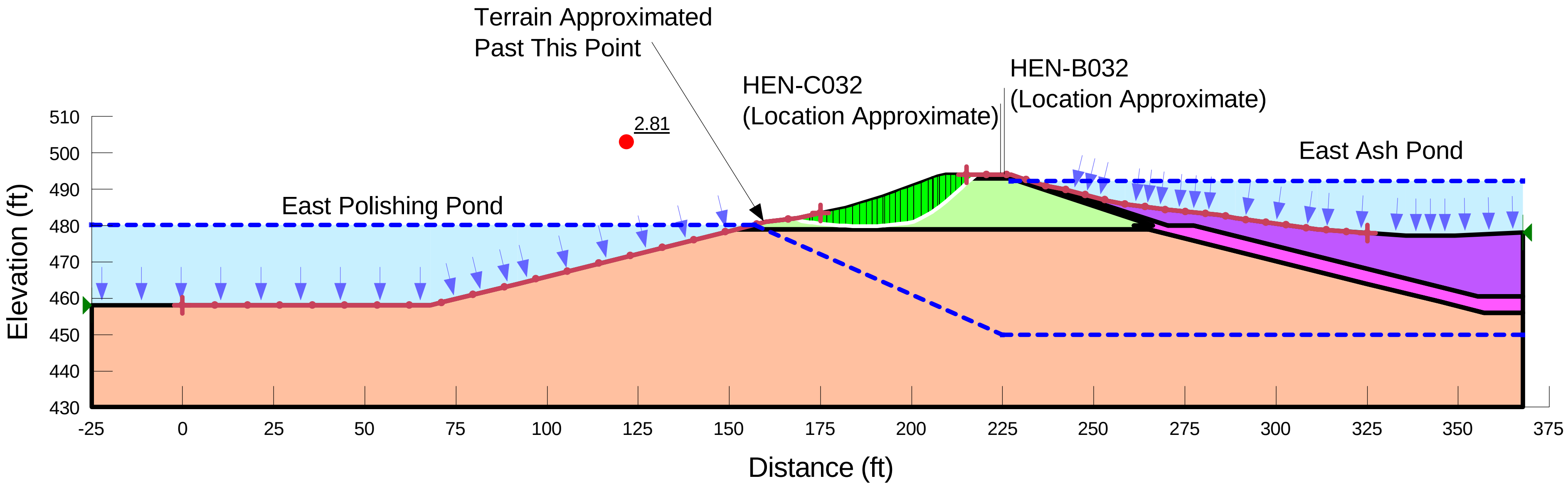
East Ash Pond
Cross Section SL-12
Effective (Drained) - Static Max Pool

Calculated By: ZJF Date: 9/21/16
Checked By: LPC Date: 9/22/16

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 Fly Ash (Drained)
- 🟪 Liner System (Drained)
- 🟩 Embankment Fill (Drained)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Fly Ash (Drained) Unit Weight: 105 pcf Cohesion': 100 psf Phi': 27 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 1
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 2



East Ash Pond
Cross Section SL-12
Total (Undrained) - Pseudostatic

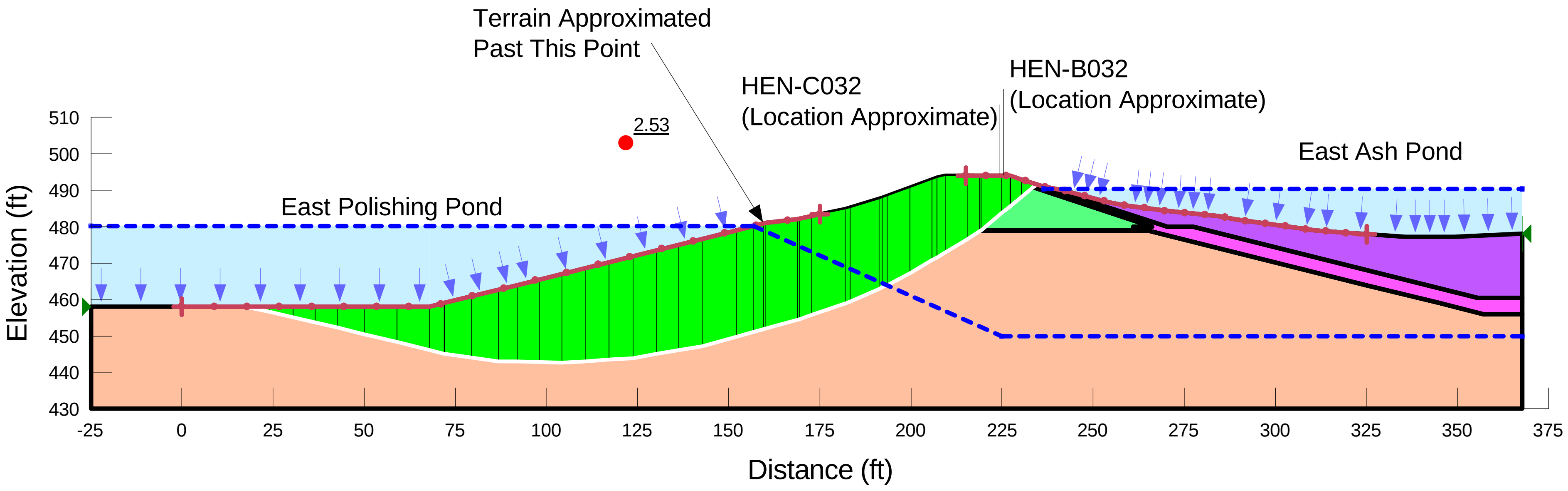
Calculated By: ZJF Date: 9/21/16
Checked By: LPC Date: 9/22/16

Horz Seismic Coef.: 0.119

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 Liner System (Undrained)
- 🟪 Fly Ash (Undrained)
- 🟩 Embankment Fill (Undrained)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Liner System (Undrained) Unit Weight: 120 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 1
Name: Fly Ash (Undrained) Unit Weight: 105 pcf Cohesion': 600 psf Phi': 0 ° Piezometric Line: 1
Name: Embankment Fill (Undrained) Unit Weight: 105 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 2



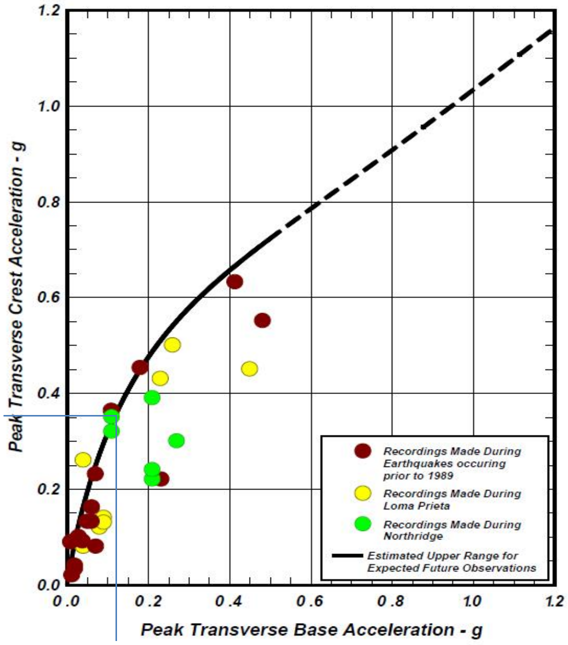
Attachment G.2 Seismic Parameter Calculations

Calc By:	AJW
Date:	2/23/2016
Check By:	JMT
Date:	2/24/2016

Calculation of K_h for Pseudostatic Analysis

Objective: Estimate kh for pseudostatic analysis.

Given:
Seismic Hazard Deaggregation with PGA_{BC} = 0.07298, M=5.9
Site Class D, based on IBC (2008)
FPGA = 1.6, based on NEHRP (2009)
Holzer (1998) Figure for estimation of crest acceleration
Makdisi Seed (1978) Figure for Max Acc of Slide Mass



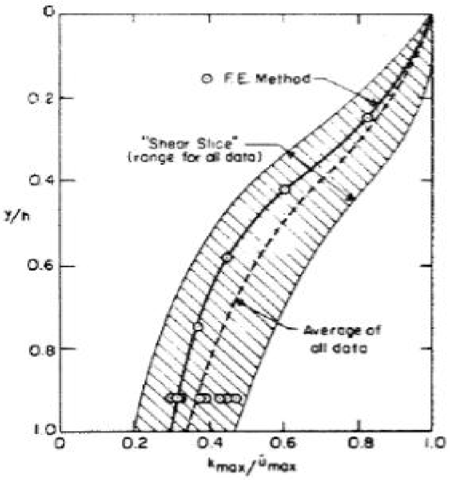


Figure 4. Variations of Maximum Acceleration Ratio with Depth of Sliding Mass (Makdisi and Seed, 1977). Maximum Acceleration Ratio is the Ratio between $(PGA)_{base\ of\ slide\ mass}$ and $(PGA)_{crest}$.

Figure 3. Variations of Recorded Peak Crest Accelerations versus those Recorded at the Base of Earth and Rock Fill Dams by Idriss (2015). Source of recorded values for Loma Prieta Earthquake and prior earthquakes: Holzer, (1998).

PGA_{BC}	Site class	F_{PGA}	PGA_{BASE}	PGA_{CREST}	Makdisi -Seed reduction for full height failure	k_h
0.07298	D	1.6	0.117	0.35	0.34	0.119

Results:

Use k_h = 0.119 for pseudostatic analyses.

APPENDIX B

Excerpts from 2021 Geosyntec Investigation

Legend

- ⊕ Leachate Wells
- ⊕ Staff Gauge
- ⊕ Monitoring Wells
- ▭ CCR Unit Boundary

Notes

- Coal Combustion Residual (CCR) Unit boundary is approximate.
- Aerial imagery provided by Esri

N

0 200 Feet

Well Location and Staff Gauge Map

Hennepin Power Station
Hennepin, Illinois

Geosyntec consultants

St. Louis

March 2021

Figure

2

\\stlouismo-01\data\Company\Projects_post_2014\GLP8020_Vistra Hennepin East Part 845 Field Efforts\GIS\Hennepin East Ash Pond MW and Staff Gauge Locations.mxd 3/30/2021 2:38:18 PM

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Client: **Dynegy**
Project: **GLP8020, Hennepin East Ash Pond**
Address: **13498 E 800th, Hennepin, IL**

BORING LOG
Boring No. **MW52**
Page: **1 of 4**

Drilling Start Date:	**02/11/2021**	Boring Depth (ft):	**61**
Drilling End Date:	**02/11/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**497.74**
Logged By:	**Will Blocher**	Location (Lat, Long):	**41.3024578, -89.3063692**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE	DEPTH (ft)
				Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample	
0	▨			DP	48/60			(0') GRAVELLY LEAN CLAY WITH SAND (CL); dense, somewhat cohesive, dark brown (10YR 4/3).		0
	▨							(3.25') SANDY LEAN CLAY (CL); dark brown (10YR 4/3), medium consistency, medium plasticity, moist.		
	▨							(3.75') Same as above: except darker (10YR 3/2).	4-8 Geotech Sample 1	
5	▨			DP	42/60			(5') LEAN CLAY WITH SAND (CL); trace gravel, stiff, medium plasticity, very dark (10YR 2/1).		5
	▨							(8.5') 1" Sandy interbed.		
10	▨			DP	102/120			(10') Same as above: some gravel, lighter (10YR 3/2).		10
15	▥							(15') SANDY SILT (ML); with some gravel, loose, dry, pale yellowish tan (10YR 6/2), color lightens downward to (10YR 7/2).		15
20										20

NOTES: Sample 1: 21.4% moisture content, 8080 mg/kg total organic carbon, 95.0 pcf dry unit weight, 2.675 specific gravity, 7.1x10^{-8} cm/s vertical hydraulic conductivity, 32 LL, 17 PL, 15 PI, 0.7% gravel, 21.0% sand, 78.3% fines.

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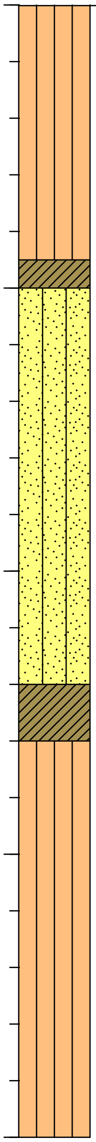
BORING LOG

Boring No. MW52
Page: 2 of 4

Drilling Start Date:	**02/11/2021**	Boring Depth (ft):	**61**
Drilling End Date:	**02/11/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**497.74**
Logged By:	**Will Blocher**	Location (Lat, Long):	**41.3024578, -89.3063692**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
20				DP	66/ 120					20
								(24.5') LEAN CLAY WITH SAND (CL); moist, medium consistency, medium plasticity, dark (10YR 2/2).		
25								(25') SILTY SAND WITH GRAVEL (SM); loose, dry, dull red (10YR 4/4).		25
								(27.5') WELL-GRADED SAND WITH SILT AND GRAVEL (SM); loose, dry, grayish tan (10YR 6/3).		
30				DP	96/ 120					30
								(32') LEAN CLAY WITH SAND AND GRAVEL (CL); stiff, medium plasticity, dark brown (10YR 5/2).		
								(33') SANDY SILT WITH GRAVEL (ML); loose, dry, light dull red (10YR 5/4).		
35										35
								(38.5') <1" clay interbed.		
								Begin drilling with water.		
40										40

NOTES:

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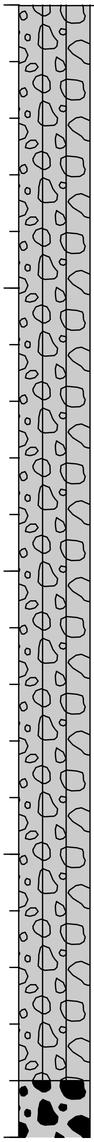
Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG

Boring No. MW52
Page: 3 of 4

Drilling Start Date: **02/11/2021**
Drilling End Date: **02/11/2021**
Drilling Company: **Cascade Drilling**
Drilling Method: **Sonic**
Drilling Equipment:
Driller: **Jason Green**
Logged By: **Will Blocher**

Boring Depth (ft): **61**
Boring Diameter (in): **6**
Sampling Method(s): **Direct Push**
DTW During Drilling (ft):
DTW After Drilling (ft):
Ground Surface Elev. (ft): **497.74**
Location (Lat, Long): **41.3024578, -89.3063692**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE	DEPTH (ft)
				Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample	
40				DP	96/ 120			(40') WELL-GRADED SILTY GRAVEL WITH SAND (GM); pebble to cobble, loose, moist, light dull red (10YR 5/4).		40
45										45
								(48.5-49.5') Lighter colored interval (10YR 7/3).	49-50 Geotech (not tested)	
50				DP	24/ 132	5 5 4 5				50
55										55
								(59') WELL-GRADED GRAVEL (GW); wet, fines likely removed in drilling.		
60										60

NOTES:

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Client: **Dynegy**
Project: **GLP8020, Hennepin East Ash Pond**
Address: **13498 E 800th, Hennepin, IL**

BORING LOG
Boring No. **MW52**

Drilling Start Date:	**02/11/2021**	Boring Depth (ft):	**61**
Drilling End Date:	**02/11/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**497.74**
Logged By:	**Will Blocher**	Location (Lat, Long):	**41.3024578, -89.3063692**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE	DEPTH (ft)
				Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample	
60	▨			🟧						60
								(61') End of Boring.		
65										65

NOTES:

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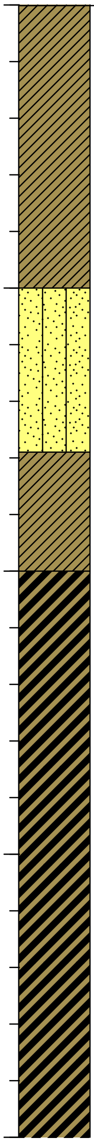
Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG

Boring No. MW54
Page: 1 of 4

Drilling Start Date: **02/08/2021**
Drilling End Date: **02/09/2021**
Drilling Company: **Cascade Drilling**
Drilling Method: **Sonic**
Drilling Equipment:
Driller: **Jason Green**
Logged By: **SWB**

Boring Depth (ft): **75**
Boring Diameter (in): **6**
Sampling Method(s): **Direct Push**
DTW During Drilling (ft):
DTW After Drilling (ft):
Ground Surface Elev. (ft): **497.14**
Location (Lat, Long): **41.3034315, -89.3052197**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE	DEPTH (ft)
				Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample	
0				DP	60/60			(0') SANDY LEAN CLAY (CL); little gravel, stiff, dark brown (10YR 3/2), low plasticity, non-cohesive, moist.		0
5				DP	60/60			(5') SILTY SAND WITH GRAVEL (SM); medium dense, reddish brown (5Y 4/6), moist, non-plastic, non-cohesive.		5
								(7.9') SANDY LEAN CLAY (CL); trace gravel, stiff, mottled reddish brown (5Y 4/6), gray (2.5Y 4/1).		
10				SH	20/24	6 4 5 5		(10') FAT CLAY WITH SAND (CH); trace gravel, medium dark brown (5Y 3/1), moist, high plasticity.	10-12 Geotech (not tested) & Chem	10
				DP	60/96			(12') As above: few gravel (large).		
15										15
								(17') As above: gradational color change to darker brown (10YR 2/1).		
20										20

NOTES:

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Client: **Dynegy**
Project: **GLP8020, Hennepin East Ash Pond**
Address: **13498 E 800th, Hennepin, IL**

BORING LOG

Boring No. **MW54**
Page: **2 of 4**

Drilling Start Date:	**02/08/2021**	Boring Depth (ft):	**75**
Drilling End Date:	**02/09/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**497.14**
Logged By:	**SWB**	Location (Lat, Long):	**41.3034315, -89.3052197**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE	DEPTH (ft)
				Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample	
20	▨			DP	90/ 120			(20') As above: trace gravel.		20
25	░							(24.5') SILTY SAND WITH GRAVEL (SM); very loose, pale yellow tan (10YR 6/3), dry, non-cohesive. (25.5') As above: color change to white (10YR 7/1). (25.8') As above: color change to yellow (10YR 6/4), color is mottled, few to some gravel.		25
30				DP	91/ 120			(30') No Recovery.		30
	▨							(32.5') FAT CLAY WITH SAND (CH); medium stiff, very dark brown (10YR 3/1), trace gravel, cohesive, moist, medium plasticity. (possible slough)		
35	░							(35') WELL-GRADED SILTY SAND (SM); few gravel, non-cohesive, very loose, light tan (10YR 7/2), dry.		35
	▨							(37.6') GRAVELLY FAT CLAY WITH SAND (CH); medium stiff, dark brown (10YR 3/2), dry to moist, medium plasticity.		
40	░							(38.6') SILTY SAND WITH GRAVEL (SM); loose, tan (10YR 6/3), dry.		40

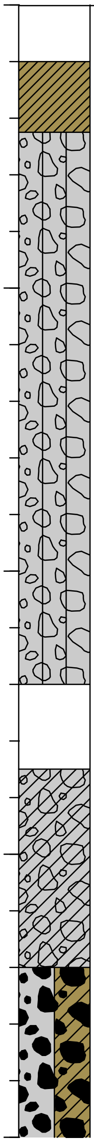
NOTES:

Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG

Boring No. MW54
Page: 3 of 4

Drilling Start Date:	**02/08/2021**
Drilling End Date:	**02/09/2021**
Drilling Company:	**Cascade Drilling**
Drilling Method:	**Sonic**
Drilling Equipment:	
Driller:	**Jason Green**
Logged By:	**SWB**
Boring Depth (ft):	**75**
Boring Diameter (in):	**6**
Sampling Method(s):	**Direct Push**
DTW During Drilling (ft):	
DTW After Drilling (ft):	
Ground Surface Elev. (ft):	**497.14**
Location (Lat, Long):	**41.3034315, -89.3052197**



DEPTH (ft)	COLLECT Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
40	DP	108/ 120			(40') No Recovery.		40
					(41') LEAN CLAY WITH GRAVEL (CL); medium stiff, dark gray (10YR 3/1), dry to moist, medium plasticity, cohesive. (possible slough)		
					(42.25') SILTY GRAVEL WITH SAND (GM); loose, dark yellowish tan (10YR 5/3), dry.		
45							45
					(48') As above: wet.		
					(49.3') As above: dry, with siltstone (compacted silt).		
50	SH	12/24	10 8 9 9		(50') As above: wet, no silt rock.		50
	DP	78/ 120			(52') No Recovery.		
					(53.5') CLAYEY GRAVEL WITH SAND (GC); medium dense, yellowish brown (10YR 4/3), moist, cohesive, clay matrix.	53.5-54.5 Chem 54.5-56 Geotech (not tested)	
55							55
					(57') WELL-GRADED GRAVEL WITH CLAY AND SAND (GW-GC); gradational contact (1ft), increased sand and decreased clay content, still moist to dry, no color change.		
60							60

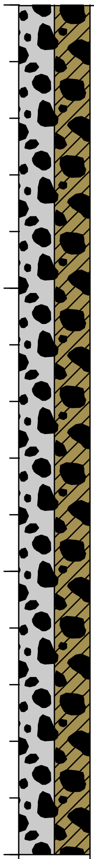
NOTES:

Client: **Dynegy**
Project: **GLP8020, Hennepin East Ash Pond**
Address: **13498 E 800th, Hennepin, IL**

BORING LOG

Boring No. **MW54**
Page: **4 of 4**

Drilling Start Date:	**02/08/2021**	Boring Depth (ft):	**75**
Drilling End Date:	**02/09/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**497.14**
Logged By:	**SWB**	Location (Lat, Long):	**41.3034315, -89.3052197**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT Sample Type	COLLECT Recovery (in)	COLLECT Blow Counts	COLLECT N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
60				DP	108/ 120					60
								(61') WELL-GRADED GRAVEL WITH SAND AND CLAY (GW-GC); loose, pale yellowish brown (10Y 5/4), wet.		
65										65
70										70
75								(75') End of Boring.		75
80										80

NOTES:

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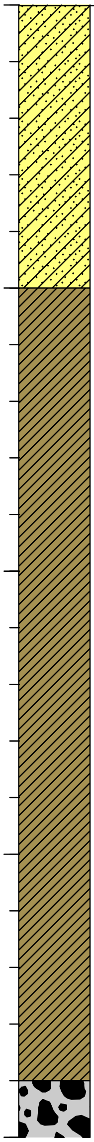
Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG

Boring No. MW55
Page: 1 of 5

Drilling Start Date:	**02/10/2021**	Boring Depth (ft):	**100**
Drilling End Date:	**02/10/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**495.65**
Logged By:	**Will Blocher**	Location (Lat, Long):	**41.303651, -89.3043529**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE	DEPTH (ft)
				Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample	
0				DP	60/60			(0') CLAYEY SAND WITH GRAVEL (SC); yellowish brown (10YR 4/4), medium dense, clay matrix, cohesive, medium plasticity, moist.		0
5				DP	78/ 120			(5') SANDY LEAN CLAY WITH GRAVEL (CL); yellowish brown (10YR 4/4), medium consistency, medium plasticity, cohesive, moist.		5
									8-10 Chem	
10								(10') As above: darker color (10YR 2/2).		10
15				DP	56/60	17 11 7 4			15-17.5 ST Sample 1	15
								(18.3') Thin (<1") interval of grayish green silt.		
								(19') WELL-GRADED GRAVEL WITH CLAY AND SAND (GW); yellowish tan (10YR 4/2), dry, loose, non-cohesive.		
20										20

NOTES: Sample 1: 14.4% moisture content, 9800 mg/kg total organic carbon, 109.0 pcf dry unit weight, 2.720 specific gravity, 1.5x10^{-7} cm/s vertical hydraulic conductivity, 32 LL, 19 PL, 13 PI, 12.4% gravel, 39.6% sand, 48.0% fines.

Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG

Boring No. MW55
Page: 2 of 5

Drilling Start Date: **02/10/2021**
Drilling End Date: **02/10/2021**
Drilling Company: **Cascade Drilling**
Drilling Method: **Sonic**
Drilling Equipment:
Driller: **Jason Green**
Logged By: **Will Blocher**

Boring Depth (ft): **100**
Boring Diameter (in): **6**
Sampling Method(s): **Direct Push**
DTW During Drilling (ft):
DTW After Drilling (ft):
Ground Surface Elev. (ft): **495.65**
Location (Lat, Long): **41.303651, -89.3043529**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT Sample Type	COLLECT Recovery (in)	COLLECT Blow Counts	COLLECT N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
20	●			DP	94/ 120					20
25	●							(24.5') As above: with more clay, red (2.5YR 3/6). (25.5') As above: less clay, yellowish tan (10YR 4/2). (28.75') As above: little clay, pale yellow (5YR 10/2).		25
30	▨			DP	100/ 120			(30') SANDY LEAN CLAY WITH GRAVEL (CL); moist, dark yellowish brown (10YR 2/2), medium consistency, medium plasticity.		30
	●							(32.5') WELL-GRADED GRAVEL WITH CLAY AND SAND (GW); reddish yellowish brown (7.5YR 3/3), dry, loose, non-cohesive.		
35	●									35
	▨							(37') LEAN CLAY WITH SAND AND GRAVEL (CL); clay-rich interval, low plasticity, stiff.		
40										40

NOTES:

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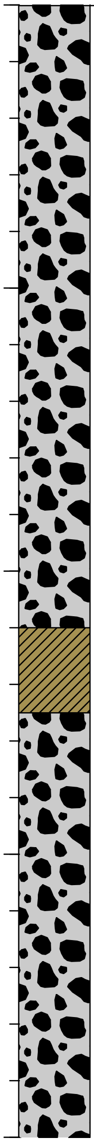
Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG
Boring No. MW55
Page: 3 of 5

Drilling Start Date:	**02/10/2021**	Boring Depth (ft):	**100**
Drilling End Date:	**02/10/2021**	Boring Diameter (in):	**6**
Drilling Company:	**Cascade Drilling**	Sampling Method(s):	**Direct Push**
Drilling Method:	**Sonic**	DTW During Drilling (ft):	
Drilling Equipment:		DTW After Drilling (ft):	
Driller:	**Jason Green**	Ground Surface Elev. (ft):	**495.65**
Logged By:	**Will Blocher**	Location (Lat, Long):	**41.303651, -89.3043529**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
40				DP	96/ 120			(40') WELL-GRADED GRAVEL WITH CLAY AND SAND (GW); reddish yellowish brown (7.5YR 3/3), dry, loose, non-cohesive. Short, clay-rich interval at top of recovered core.		40
45										45
50				DP	102/ 120	2 8 5 8			50-52 ST Sample 2	50
								(51') LEAN CLAY WITH SAND AND GRAVEL (CL); dark yellowish brown (10YR 3/2), dry, medium plasticity, stiff.		
								(52.5') WELL-GRADED GRAVEL WITH SAND (GW); yellowish brown (10YR 4/3), dry, loose, non-cohesive.		
55										55
								(57') Gradually wetter beginning at 57 ft.		
								(59') Wet.		
60										60

NOTES: Sample 2: 8.2% moisture content, 50,000 mg/kg total organic carbon, 2.823 specific gravity, 21 LL, 15 PL, 6 PI, 60.0% gravel, 23.2% sand, 16.8% fines.

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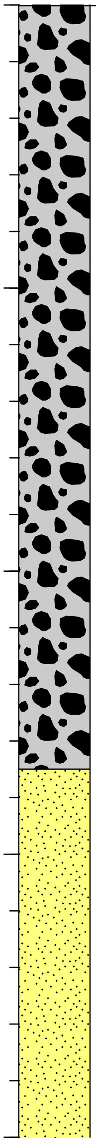
Client: **Dynegy**
Project: **GLP8020, Hennepin East Ash Pond**
Address: **13498 E 800th, Hennepin, IL**

BORING LOG

Boring No. **MW55**
Page: **4 of 5**

Drilling Start Date: **02/10/2021**
Drilling End Date: **02/10/2021**
Drilling Company: **Cascade Drilling**
Drilling Method: **Sonic**
Drilling Equipment:
Driller: **Jason Green**
Logged By: **Will Blocher**

Boring Depth (ft): **100**
Boring Diameter (in): **6**
Sampling Method(s): **Direct Push**
DTW During Drilling (ft):
DTW After Drilling (ft):
Ground Surface Elev. (ft): **495.65**
Location (Lat, Long): **41.303651, -89.3043529**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	BORING COMPLETION	COLLECT Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
60				DP	100/ 120					60
								(61') No clay at top of core.		
65								(65') Interval consistently wet.		65
								(68.5') Thin interval dark clay (10YR 2/2). (69') Trace pebble sized gravel.		
70				DP	100/ 120					70
								(71') No clay.		
								(73') Gravel fines downward in last 1' to pebble size, poorly graded.		
								(73.5') POORLY GRADED SAND (SP); trace pebbles, dark yellowish brown (10YR 3/4), very clean, dense, wet.		
75										75
								(77.5') Quartz & feldspar black grains, sharp upper contact. (78') As above: with more pebbles, darker (10Y 4/4).		
80										80

NOTES:

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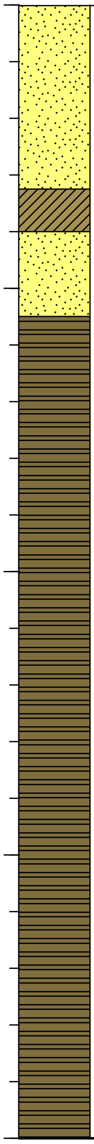
Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

BORING LOG

Boring No. MW55
Page: 5 of 5

Drilling Start Date: **02/10/2021**
Drilling End Date: **02/10/2021**
Drilling Company: **Cascade Drilling**
Drilling Method: **Sonic**
Drilling Equipment:
Driller: **Jason Green**
Logged By: **Will Blocher**

Boring Depth (ft): **100**
Boring Diameter (in): **6**
Sampling Method(s): **Direct Push**
DTW During Drilling (ft):
DTW After Drilling (ft):
Ground Surface Elev. (ft): **495.65**
Location (Lat, Long): **41.303651, -89.3043529**



DEPTH (ft)	WATER LEVEL	BORING COMPLETION	COLLECT Sample Type	COLLECT Recovery (in)	COLLECT Blow Counts	COLLECT N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE Lab Sample	DEPTH (ft)
80			DP	96/ 108			(80') As above.		80
							(83.25') PEBBLY CLAY (CL); trace pebbles.		
							(84') POORLY GRADED SAND WITH CLAY AND GRAVEL (SP); medium dense, non-cohesive, moist.		
85							(85.5') SILTY SHALE; grayish green (GLEY1 10Y 5/2), cohesive rock chips, reacts weakly with 5% acetic acid.	85-89 Chem	85
			DP	84/ 132					
90									90
95									95
100							(100') End of Boring.		100

NOTES:

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Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

WELL LOG
Well No. XPW01
Page: 1 of 1

Drilling Start Date: **01/14/2021**
Drilling End Date: **01/14/2021**
Drilling Company: **Geotechnology**
Drilling Method: **Hollow Stem Auger**
Drilling Equipment: **CME 55**
Driller:
Logged By: **D. Mateas**

Boring Depth (ft): **17**
Boring Diameter (in): **10**
DTW During Drilling (ft):
DTW After Drilling (ft):
Top of Casing Elev. (ft)
Ground Elev. (ft): **498.19**
Location (Lat/Long): **41.30259, -89.30584**

Well Depth (ft):
Well Diameter (in):
Screen Slot (in):
Riser Material:
Screen Material:
Seal Material(s):
Filter Pack:

				COLLECT					MEASURE	
DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	Lab Sample	DEPTH (ft)
0				SS	15/24	4 6 5 4	11	(0.0') WELL-GRADED SAND (SW); light brown (2.5Y 5/4), fine to medium grained, some slag and coal fragments, 2-inch piece of slag at surface, medium dense, dry, brick fragments at 0.3 to 0.4 ft. [BOT ASH]		
				SS	21/24	2 4 4 5	8	(2.0') SILT (ML); dark gray (10YR 4/1), non-plastic, trace fine grained sand, medium stiff, moist. [FLY ASH] (2.5') As above: light gray (7.5YR 7/1), trace slag and coal fragments. (3.3') WELL-GRADED SAND (SW); light brown (2.5Y 5/4), fine to medium grained, some slag and coal fragments, 2-inch piece of slag at surface, medium dense, dry, brick fragments at 0.3 to 0.4 ft. [BOT ASH]		
5				SS	15/24	2 2 2 1	4	(4.0') As above.		
				SS	20/24	2 2 0 1	2	(4.5') SILT (ML); gray (2.5Y 5/1), non-plastic, trace fine grained sand, soft, moist. [FLY ASH] (6.0') WELL-GRADED SAND (SW); olive brown (2.5Y 4/4), fine to medium grained, little slag and coal fragments, very loose, moist. [BOTTOM ASH]		
				SS	24/24	0 1 2 4	3	(6.75') SILT (ML); brownish gray (2.5Y 6/2), non-plastic, little medium grained sand, soft, wet. [FLY ASH] (8.0') As above.	8-10 Chem	
10				SH	16/24			(10') As above. Failed Shelby Tube from 10-12' bgs.	10-12 Geotech Sample 1	
				SH	24/24			(12') WELL-GRADED SAND (SW); light olive brown (2.5Y 3/3), fine to medium grained, some slag and coal fragments, loose, wet.	12-14 ST Sample 2	
				SS	5/12	0 2			14-15 Chem	
15				SH	24/24				15-17 ST Sample 3	
								(17') End of Boring.		
20										

NOTES: Split Fly ash and bottom ash from 0 to 17 ft bgs. Split spoon sampler advanced to 17 ft bgs. Augers advanced to 17.25 ft bgs.
Sample 1: 157.0% moisture content, 2.635 specific gravity, 4.0% gravel, 22.2% sand, 73.8% fines.
Sample 2: 42.3% moisture content, 71.0 pcf dry unit weight, 2.859 specific gravity, 14.1% gravel, 71.8% sand, 14.1% fines.
Sample 3: 31.0% moisture content, 79.0 pcf dry unit weight, 2.622 specific gravity, 10.1% gravel, 83.1% sand, 6.8% fines.

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Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

WELL LOG

Well No. XPW02
Page: 1 of 1

Drilling Start Date: **01/15/2021**
Drilling End Date: **01/15/2021**
Drilling Company: **Geotechnology**
Drilling Method: **Hollow Stem Auger**
Drilling Equipment: **CME 55**
Driller:
Logged By: **D. Mateas**

Boring Depth (ft): **18.5**
Boring Diameter (in): **10**
DTW During Drilling (ft):
DTW After Drilling (ft):
Top of Casing Elev. (ft)
Ground Elev. (ft): **501.60**
Location (Lat/Long): **41.30186, -89.30372**

Well Depth (ft):
Well Diameter (in):
Screen Slot (in):
Riser Material:
Screen Material:
Seal Material(s):
Filter Pack:

DEPTH (ft)	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	MEASURE
	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)		Lab Sample
0	SS	24/24	3 9 10 11	19	(0.0') SILT (ML); light yellowish brown (2.5Y 6/3), non-plastic, cohesive, few medium to coarse grained sand, few fine gravel, few clay, very stiff, wet. [FLY ASH]	
2	SS	7/24	1 2 1 2	3	(2.0') WELL-GRADED GRAVEL (GW); light yellowish brown (2.5Y 6/3), fine to coarse grained, little sand, trace silt, very loose, wet. [BOTTOM ASH] (2.3') FAT CLAY (CH); black (2.5Y 2.5/1), medium plasticity, soft, wet. [FILL]	
4	SS	13/24	2 5 34 50/2	39	(4') As above. (4.3') WELL-GRADED GRAVEL (GW); light yellowish brown (2.5Y 6/3), fine to coarse grained, little sand, trace silt, very loose, wet. [BOTTOM ASH] (4.9') As above: gray (2.5Y 5/1)	
6	SS	18/24	5 5 3 4	3	(6.0') WELL-GRADED SAND (SW); light gray (5Y 4/1), fine to coarse grained sand, fine gravel, few silt, trace slag, loose, wet. [BOTTOM ASH]	6-8 Chem
8	SS	17/24	2 3 3 2	6	(8') As above.	
10	SS	22/24	2 2 1 1	3	(10') As above: olive gray (5Y 5/2), very loose. (11') SILT (ML); light gray (5Y 4/1), non-plastic, trace fine grained sand, soft, saturated. [FLY ASH]	
12	SH	24/24			(12') As above: no sand. Failed Shelby Tube from 12-14' bgs. (13') Grades to partially lithified structures.	
14	SH	26/26			(14') As above.	14-16 ST
16	SH	24/24			(16') As above. Failed Shelby Tube from 16-18' bgs.	16-18 Geotech
18	SH	6/6			(18') As above. (18.5') End of Boring.	
20						

NOTES: Fly ash, bottom ash and fill material from 0 to 18.5 ft bgs. Split spoon sampler advanced to 18.5 ft bgs. Augers advanced to 18.6 ft bgs. Sample 1: 123.3% moisture content, 36.0 pcf dry unit weight, 2.615 specific gravity, 2.9x10^{-4} cm/s vertical hydraulic conductivity, NP, 0.0% gravel, 20.8% sand, 79.2% fines. Sample 2: 113.2% moisture content, 2.622 specific gravity, NP, 0.5% gravel, 22.1% sand, 77.4% fines.

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Client: Dynegy
Project: GLP8020, Hennepin East Ash Pond
Address: 13498 E 800th, Hennepin, IL

WELL LOG

Well No. XPW03
Page: 1 of 1

Drilling Start Date: **01/14/2021**
Drilling End Date: **01/14/2021**
Drilling Company: **Geotechnology**
Drilling Method: **Hollow Stem Auger**
Drilling Equipment: **CME 55**
Driller:
Logged By: **D. Mateas**

Boring Depth (ft): **20**
Boring Diameter (in): **10**
DTW During Drilling (ft):
DTW After Drilling (ft):
Top of Casing Elev. (ft)
Ground Elev. (ft): **492.03**
Location (Lat/Long):**41.30326, -89.30378**

Well Depth (ft):
Well Diameter (in):
Screen Slot (in):
Riser Material:
Screen Material:
Seal Material(s):
Filter Pack:

DEPTH (ft)	Sample Type	Recovery (in)	Blow Counts	N Value RQD (%)	MEASURE Lab Sample
0	SS	13/24	2 2 2 1	4	
2	SS	19/24	1 0 3 2	3	
4	SS	22/24	0 0 0 1	0	4-6 Chem
6	SH	24/24			
8	SS	24/24	1 0 1 0	1	
10	SS	24/24	0 0 0 1	0	
12	SH	23/24			
14	SH	18/24			14-16 ST Sample 1
16	SS	24/24	0 0 0 0	0	16-18 Chem
18	SH	11/24			18-20 ST Sample 2
20					

SOIL/ROCK VISUAL DESCRIPTION

(0.0') SILT (ML); gray (10YR 5/1), non-plastic, stiff, moist. [FLY ASH]

(0.4') WELL-GRADED SAND (SW); dark yellowish brown (10YR 4/4), fine to medium grained sand, little slag and coal fragments, very loose, moist. [BOTTOM ASH]

(0.9') As above: saturated, few silt.

(2.0') As above: moist, no silt, fine to coarse grained sand.

(2.6') SILT (ML); pale yellow (2.5Y 7/3), non-plastic, very soft, saturated.

(4.0') As above.

(6.0') As above. Failed Shelby Tube from 6-8' bgs.

(8.0') As above.

(10.75-11.75') As above: light brownish gray (2.5Y 6/2)

(12') As above. Failed Shelby Tube from 12-14' bgs.

(14') As above.

(17.25-17.75') As above: grayish brown (2.5Y 5/2)

(17.75-18') As above: light olive brown (2.5Y 5/3)

(20') End of Boring.

NOTES: Fly ash from 0 to 20 ft bgs. Split spoon sampler advanced to 20 ft bgs. Augers advanced to 19.43 ft bgs. Sample 1: 177.0% moisture content, 28.0 pcf dry unit weight, 2.595 specific gravity, 1.7x10^{-4} cm/s vertical hydraulic conductivity, NP, 0.0% gravel, 13.7% sand, 86.3% fines. Sample 2: 138.8% moisture content, 34.0 pcf dry unit weight, 2.585 specific gravity, 2.0x10^{-4} cm/s vertical hydraulic conductivity, NP, 0.0% gravel, 18.6% sand, 81.4% fines.

GEOTECHNOLOGY INC
FROM THE GROUND UP

Via email: akreinberg@geosyntec.com

March 29, 2021

Ms. Allison Kreinberg
Geosyntec Consultants, Inc.
941 Chatham Lane Suite 103
Columbus, Ohio 43221

Re: Laboratory Testing Services
Vistra Energy
Hennepin, Illinois
Geotechnology Project No. J037936.01

Dear Ms. Kreinberg:

Provided herein are the laboratory test results for the referenced project. Our services were performed in accordance with ASTM procedures.

This report has been prepared for the exclusive use of Geosyntec Consultants, Inc. Our scope of services was limited to performing specific tests on the provided samples and did not include engineering or interpretation of the test results.

Our services shall not be construed to constitute an expressed or implied warranty, including, but not limited to, any warranty for merchantability or fitness for a particular use. We do not accept responsibility for the manner in which the test results are used.

It has been our pleasure to provide laboratory testing services to you, and we would welcome the opportunity to provide other services during the course of the project. Please contact us if you need further information or clarification about this document.

* * * * *

Yours very truly,
GEOTECHNOLOGY, INC.

Erin Grimes

Erin Grimes
Laboratory Manager

EKG/CKK:ekg

Attachments: Appendix A – Summary of Laboratory Results
Appendix B – Atterberg Limits Results
Appendix C – Grain Size Distribution
Appendix D – Test Report

Copies submitted: PDF

APPENDIX A

Summary of Laboratory Results

Sheet 1 of 1

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Moisture Content (%)	Dry Unit Weight (pcf)	Qu/2 (tsf)	Specific Gravity (20°C)
MW55	15.0	32	19	13	19	48.0	SC	14.4	109.0		2.720
SB52	4.0	32	17	15	9.5	78.3	CL	21.4	95.0		2.675
SB53	2.0	29	16	13	25	51.1	CL	13.7	120.0		2.680
SB53	56.0				37.5	8.3		9.9			
SB55	50.0	21	15	6	50	16.8	GC-GM	8.2			2.823
XPW01	10.0				19	73.8		157.0			2.635
XPW01	12.0				19	14.1		42.3	71.0		2.859
XPW01	15.0				9.5	6.8		31.0	79.0		2.622
XPW02	14.0	NP	NP	NP	0.84	79.2	ML	123.3	36.0		2.615
XPW02	16.0	NP	NP	NP	9.5	77.4	ML	113.2			2.622
XPW03	14.0	NP	NP	NP	2	86.3	ML	177.0	28.0		2.595
XPW03	18.0	NP	NP	NP	2	81.4	ML	138.8	34.0		2.585

GEOTECHNOLOGY INC

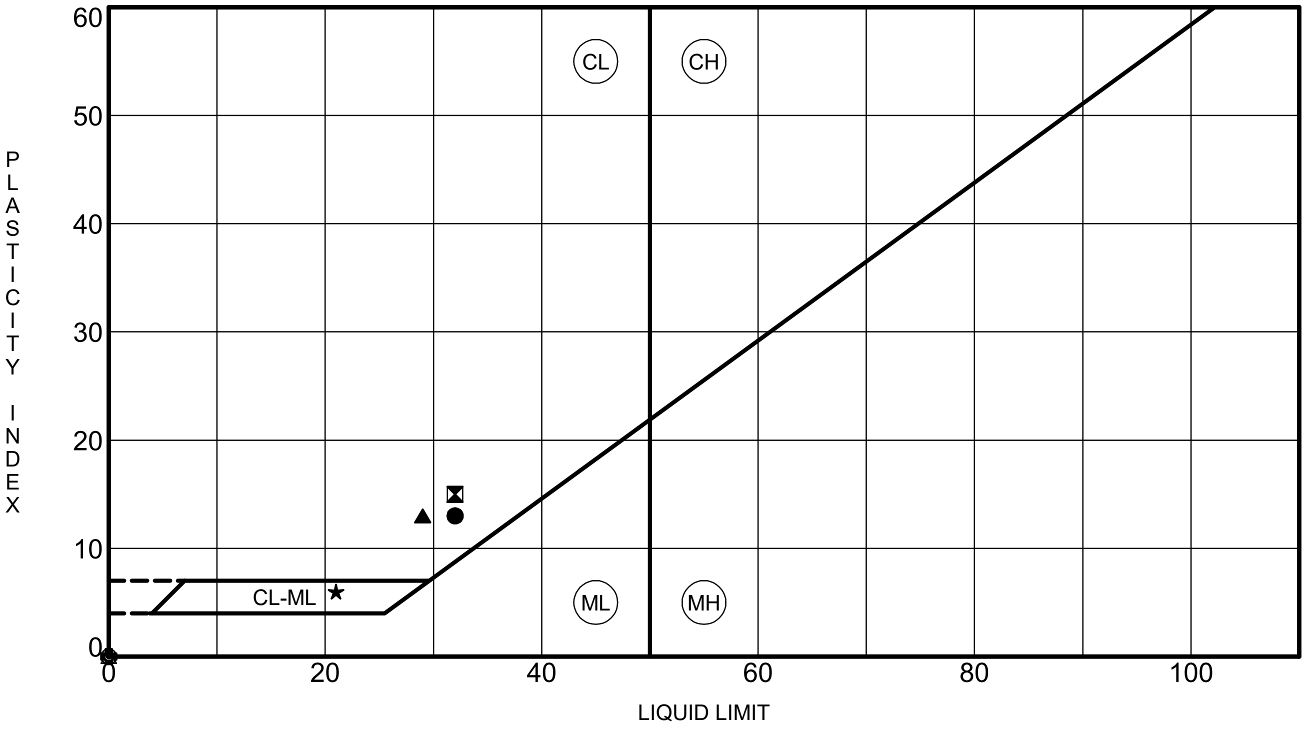
FROM THE GROUND UP

Summary of Laboratory Results

Vistra Energy
Hennepin, Illinois
J037936.01

APPENDIX B

Atterberg Limits Results



	Boring	Depth (ft.)	LL	PL	PI	Fines	Sample Description
●	**MW55**	**15.0**	**32**	**19**	**13**	**48**	**CLAYEY SAND(SC)**
⧗	**SB52**	**4.0**	**32**	**17**	**15**	**78**	**LEAN CLAY with SAND(CL)**
▲	**SB53**	**2.0**	**29**	**16**	**13**	**51**	**SANDY LEAN CLAY(CL)**
★	**SB55**	**50.0**	**21**	**15**	**6**	**17**	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**
⊙	**XPW02**	**14.0**	**NP**	**NP**	**NP**	**79**	**SILT with SAND(ML)**
✿	**XPW02**	**16.0**	**NP**	**NP**	**NP**	**77**	**SILT with SAND(ML)**
○	**XPW03**	**14.0**	**NP**	**NP**	**NP**	**86**	**SILT(ML)**
△	**XPW03**	**18.0**	**NP**	**NP**	**NP**	**81**	**SILT with SAND(ML)**

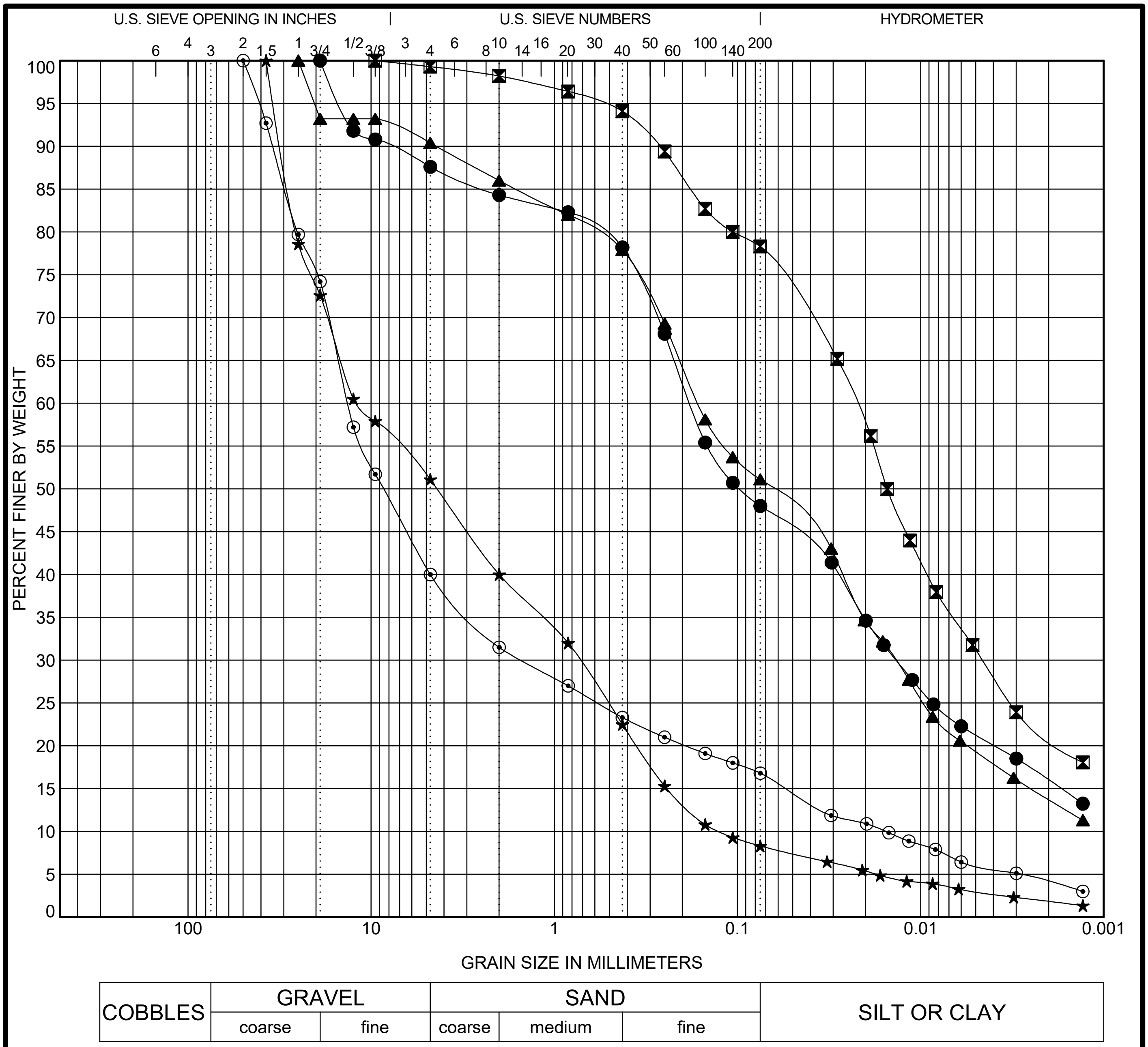
GEOTECHNOLOGY INC
FROM THE GROUND UP

ATTERBERG LIMITS RESULTS

Vistra Energy
Hennepin, Illinois
J037936.01

APPENDIX C

Grain Size Distribution



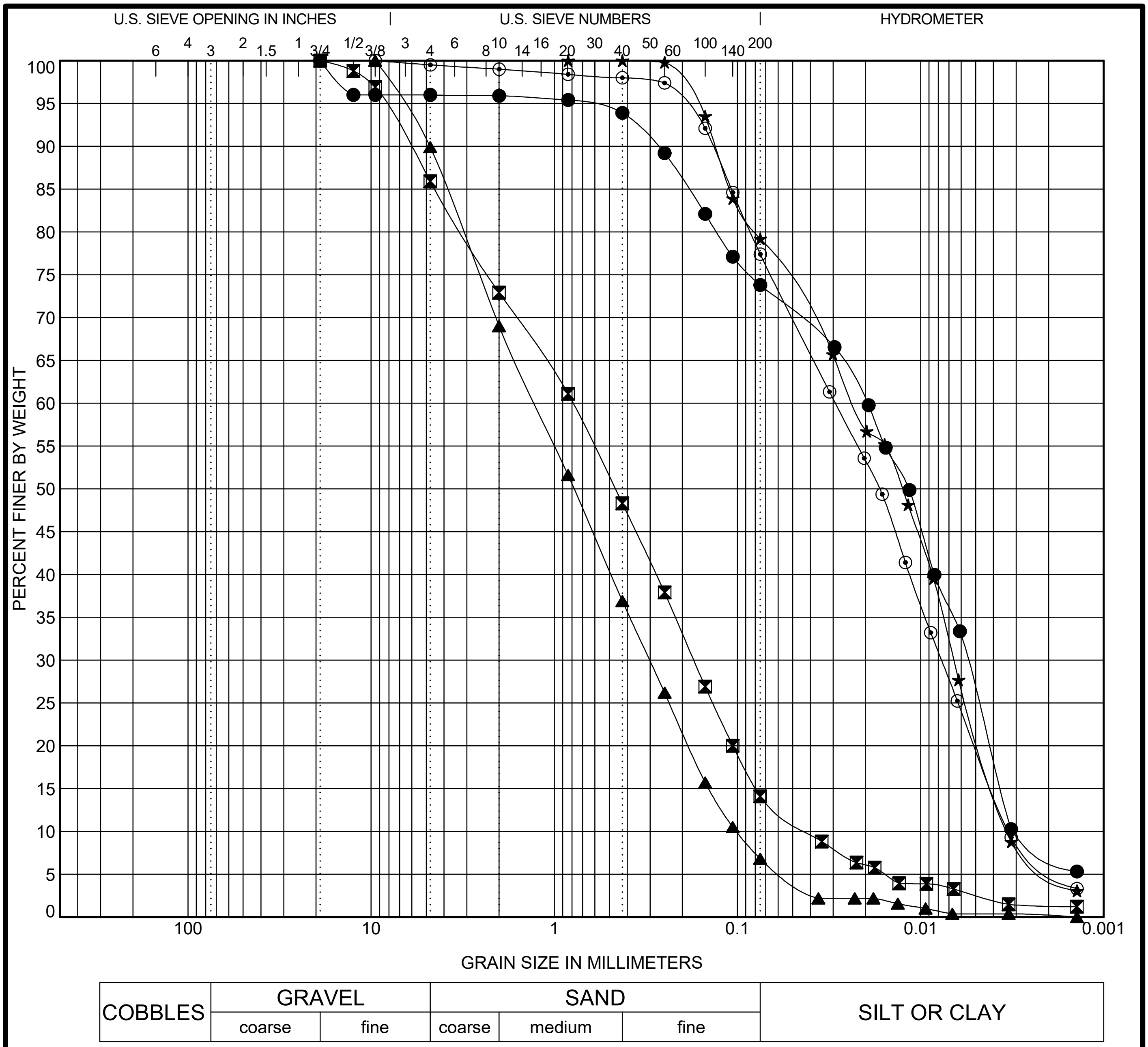
	Boring	Depth (ft.)	Sample Description	LL	PL	PI	Cc	Cu
●	**MW55**	**15.0**	**CLAYEY SAND(SC)**	**32**	**19**	**13**		
⊠	**SB52**	**4.0**	**LEAN CLAY with SAND(CL)**	**32**	**17**	**15**		
▲	**SB53**	**2.0**	**SANDY LEAN CLAY(CL)**	**29**	**16**	**13**		
★	**SB53**	**56.0**					**0.36**	**95.13**
⊙	**SB55**	**50.0**	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**	**21**	**15**	**6**	**10.79**	**862.67**

	Boring	Depth (ft.)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**MW55**	**15.0**	**19**	**0.18**	**0.01**		**12.4**	**39.6**	**26.7**	**21.3**
⊠	**SB52**	**4.0**	**9.5**	**0.02**	**0**		**0.7**	**21.0**	**47.1**	**31.2**
▲	**SB53**	**2.0**	**25**	**0.16**	**0.01**		**9.6**	**39.3**	**31.8**	**19.3**
★	**SB53**	**56.0**	**37.5**	**11.86**	**0.73**	**0.125**	**48.9**	**42.8**	**5.3**	**3.0**
⊙	**SB55**	**50.0**	**50**	**13.39**	**1.5**	**0.016**	**60.0**	**23.2**	**10.7**	**6.1**

GEOTECHNOLOGY INC
FROM THE GROUND UP

GRAIN SIZE DISTRIBUTION

Vistra Energy
Hennepin, Illinois
J037936.01



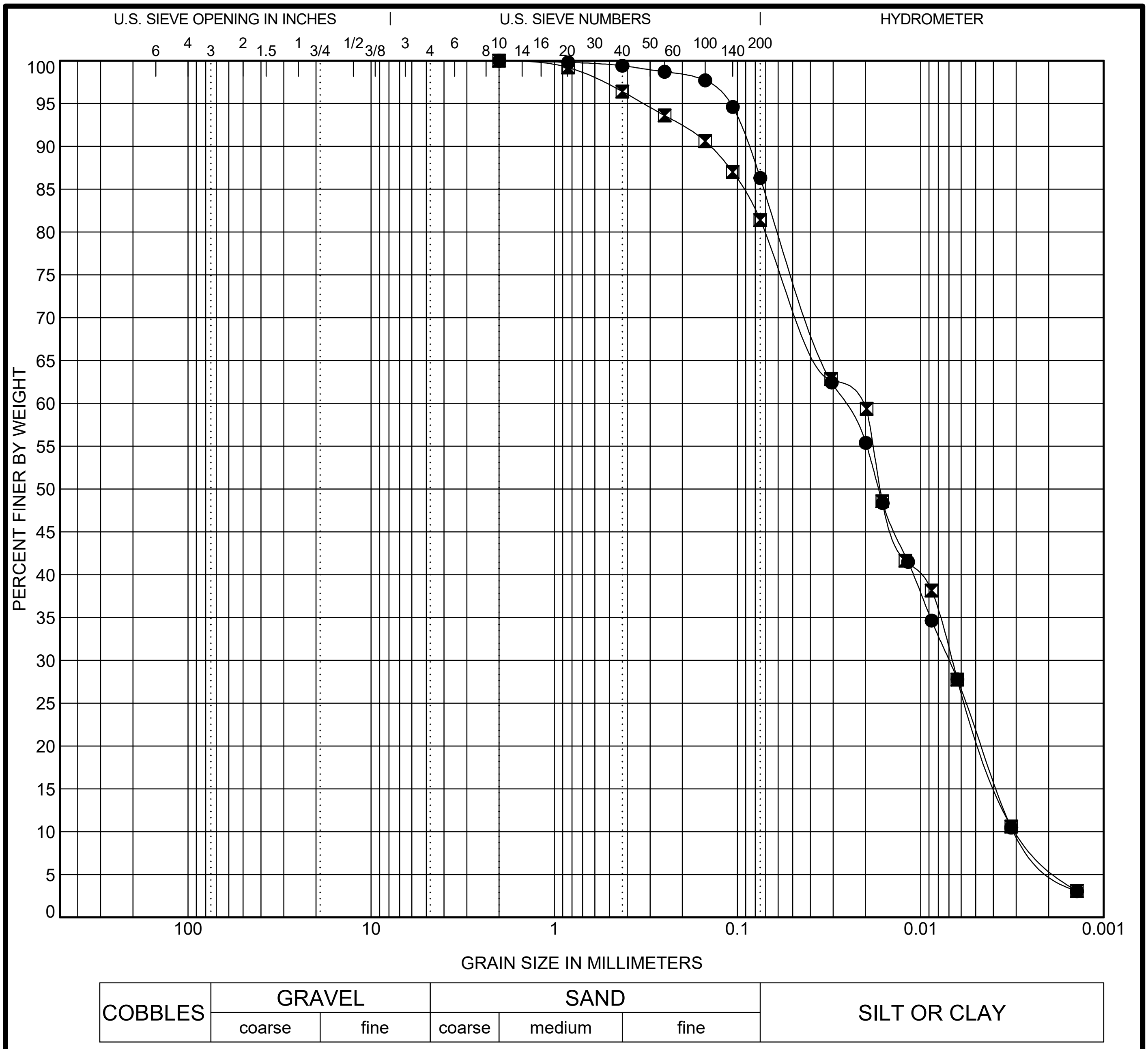
	Boring	Depth (ft.)	Sample Description	LL	PL	PI	Cc	Cu
●	**XPW01**	**10.0**					**0.52**	**6.37**
☒	**XPW01**	**12.0**					**0.92**	**19.28**
▲	**XPW01**	**15.0**					**0.71**	**12.62**
★	**XPW02**	**14.0**	**SILT with SAND(ML)**	**NP**	**NP**	**NP**	**0.57**	**6.89**
⊙	**XPW02**	**16.0**	**SILT with SAND(ML)**	**NP**	**NP**	**NP**	**0.62**	**8.84**

	Boring	Depth (ft.)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**XPW01**	**10.0**	**19**	**0.02**	**0.01**	**0.003**	**4.0**	**22.2**	**47.6**	**26.2**
☒	**XPW01**	**12.0**	**19**	**0.79**	**0.17**	**0.041**	**14.1**	**71.8**	**11.5**	**2.6**
▲	**XPW01**	**15.0**	**9.5**	**1.28**	**0.3**	**0.101**	**10.1**	**83.1**	**6.4**	**0.4**
★	**XPW02**	**14.0**	**0.84**	**0.02**	**0.01**	**0.003**	**0.0**	**20.8**	**57.7**	**21.5**
⊙	**XPW02**	**16.0**	**9.5**	**0.03**	**0.01**	**0.003**	**0.5**	**22.1**	**57.6**	**19.8**

GEOTECHNOLOGY INC
FROM THE GROUND UP

GRAIN SIZE DISTRIBUTION

Vistra Energy
Hennepin, Illinois
J037936.01



	Boring	Depth (ft.)	Sample Description	LL	PL	PI	Cc	Cu
●	**XPW03**	**14.0**	**SILT(ML)**	**NP**	**NP**	**NP**	**0.61**	**8.69**
☒	**XPW03**	**18.0**	**SILT with SAND(ML)**	**NP**	**NP**	**NP**	**0.71**	**7.14**

	Boring	Depth (ft.)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**XPW03**	**14.0**	**2**	**0.03**	**0.01**	**0.003**	**0.0**	**13.7**	**64.4**	**21.9**
☒	**XPW03**	**18.0**	**2**	**0.02**	**0.01**	**0.003**	**0.0**	**18.6**	**59.5**	**21.9**

GEOTECHNOLOGY INC
FROM THE GROUND UP

GRAIN SIZE DISTRIBUTION

Vistra Energy
Hennepin, Illinois
J037936.01

APPENDIX D

Test Report

Geotechnology, Inc.
11816 Lackland Road, Suite 150
St. Louis, MO 63146
314-997-7440

TEST REPORT

Prepared For:
Geosyntec Consultants, Inc.
941 Chatham Lane Suite 103
Columbus, Ohio 43221

Project No.:	**J037936.01**	**March 29, 2021**
Project Name:	**Vistra Energy - Hennepin**	**Page 1 of 1**
Sampled By:	**Geotechnology, Inc.**	
Attention:	**Ms. Allison Kreinberg**	

HYDRAULIC CONDUCTIVITY (PERMEABILITY) TEST
& DENSITY DETERMINATION (UNIT WEIGHT)
ASTM D5084 & D7263

Sample ID	Moisture Content (%)	Initial Wet Density (pcf)	Initial Dry Density (pcf)	Hydraulic Conductivity (cm/s)
MW55-(15-17.5)	14.4	124.5	108.8	1.5×10^{-7}
SB52-(6-8)	24.8	118.8	95.2	7.1×10^{-8}
SB53-(2-4)	13.6	136.4	120.1	2.4×10^{-8}
XPW02-(14-16)	123.3	79.9	35.8	2.9×10^{-4}
XPW03-(14-16)	177.0	76.9	27.8	1.7×10^{-4}
XPW03-(18-20)	138.8	80.4	33.7	2.0×10^{-4}

APPENDIX C

Global Slope Stability Analysis Output

Hennepin East Ash Pond
Cross Section SL-10
Long-Term Static

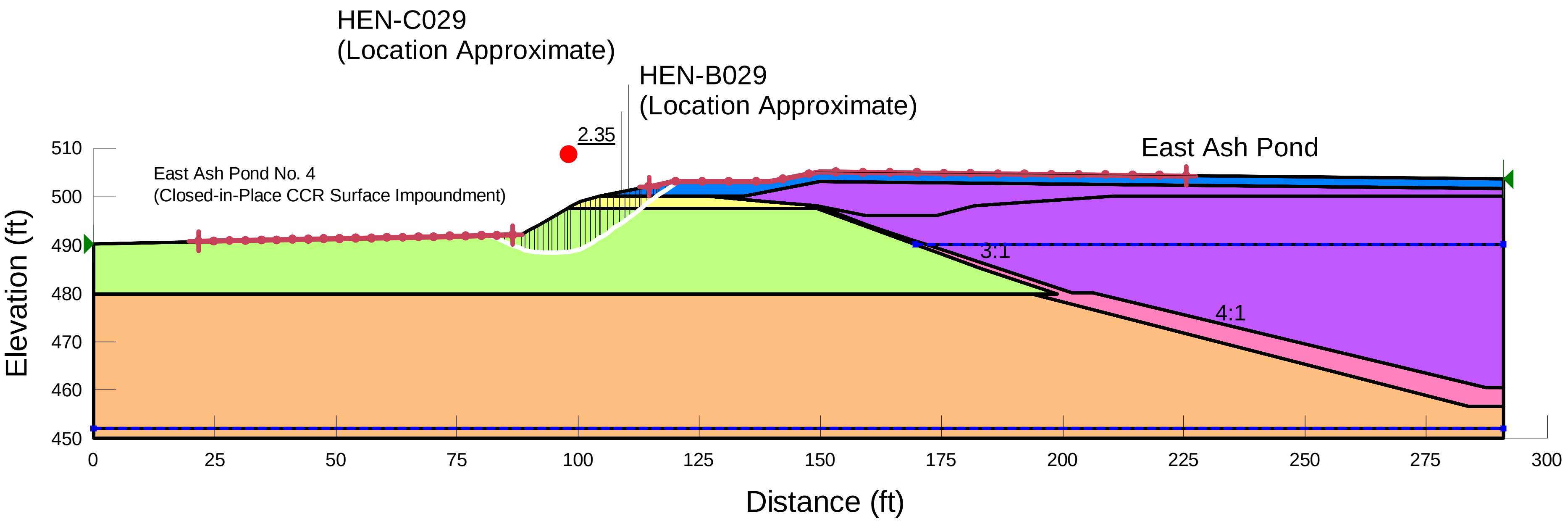
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟥 Liner System (Drained)
🟪 CCR (Drained)
🟩 Embankment Fill (Drained)
🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 2
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 1
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 1



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Hennepin East Ash Pond
Cross Section SL-10
End-of-Construction

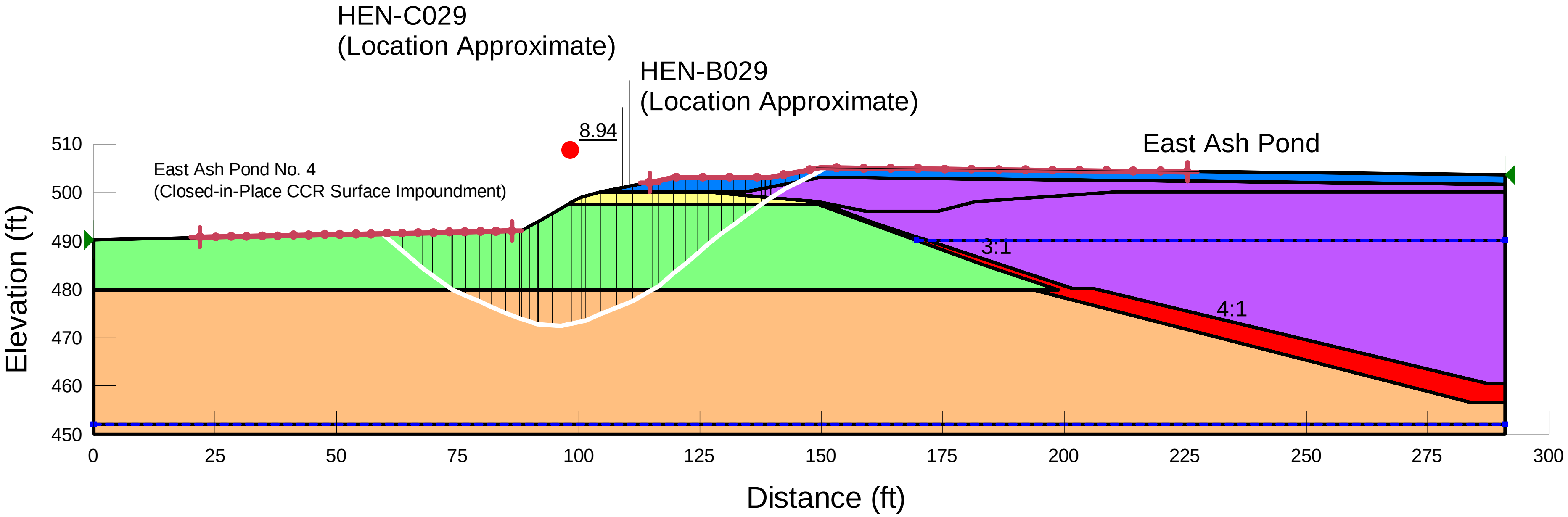
Calculated By: IJV/LPC   Date: 10/27/2021

Checked By: ZJF   Date: 11/1/2021

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟥 Liner System (Undrained)
🟪 CCR (Drained)
🟩 Embankment Fill (Undrained)
🟦 Final Cover System

Name: Road Fill   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °   Piezometric Line: 1
Name: Alluvial Foundation   Unit Weight: 135 pcf   Cohesion': 0 psf   Phi': 38 °   Piezometric Line: 1
Name: Liner System (Undrained)   Unit Weight: 120 pcf   Cohesion': 2,500 psf   Phi': 0 °   Piezometric Line: 2
Name: CCR (Drained)   Unit Weight: 80 pcf   Cohesion': 0 psf   Phi': 30 °   Piezometric Line: 2
Name: Embankment Fill (Undrained)   Unit Weight: 105 pcf   Cohesion': 2,500 psf   Phi': 0 °   Piezometric Line: 1
Name: Final Cover System   Unit Weight: 110 pcf   Cohesion': 0 psf   Phi': 27 °   Piezometric Line: 1



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Hennepin East Ash Pond
Cross Section SL-10
Pseudostatic Seismic - Drained Emb.

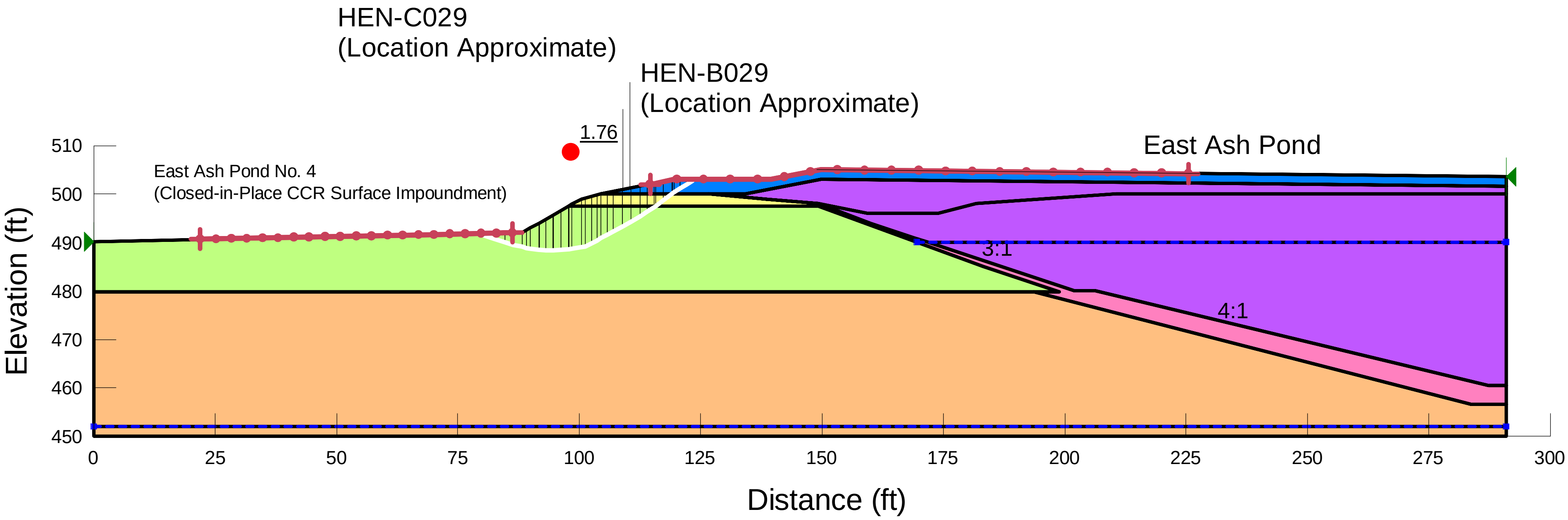
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 Liner System (Drained)
- 🟪 CCR (Drained)
- 🟩 Embankment Fill (Drained)
- 🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 2
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 1
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 1



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Hennepin East Ash Pond
Cross Section SL-10
Pseudostatic Seismic - Undrained Emb.

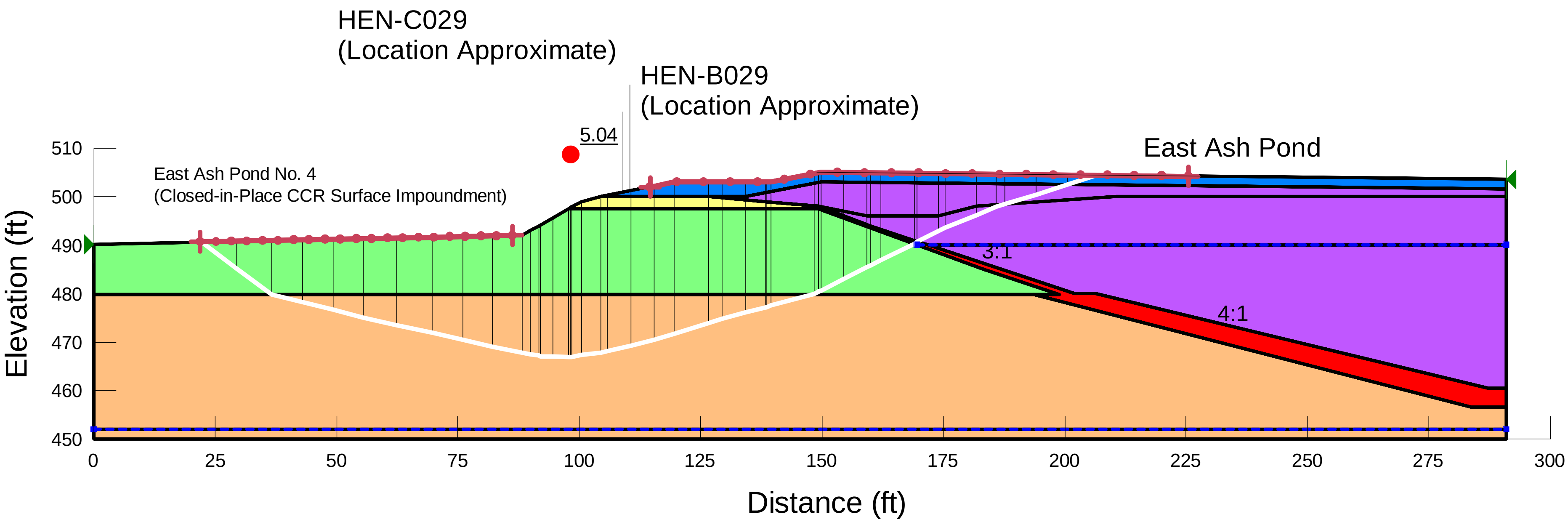
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟥 Liner System (Undrained)
🟪 CCR (Drained)
🟩 Embankment Fill (Undrained)
🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Undrained) Unit Weight: 120 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 2
Name: Embankment Fill (Undrained) Unit Weight: 105 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 1
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 1



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Hennepin East Ash Pond
Cross Section SL-10
Post-Earthquake - Drained Emb.

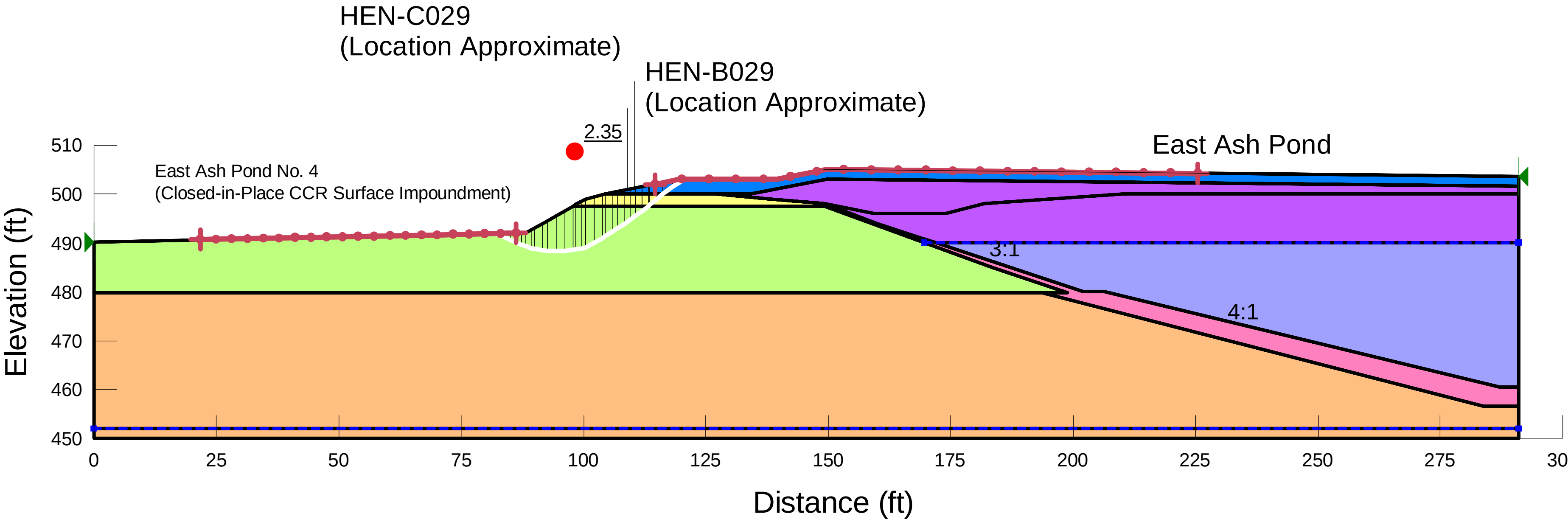
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟥 Liner System (Drained)
- 🟪 CCR (Drained)
- 🟩 Embankment Fill (Drained)
- 🟦 Final Cover System
- 🟪 CCR (Liquefied)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 2
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 1
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 1
Name: CCR (Liquefied) Unit Weight: 80 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf Piezometric Line: 2



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Hennepin East Ash Pond
Cross Section SL-10
Post-Earthquake - Undrained Emb.

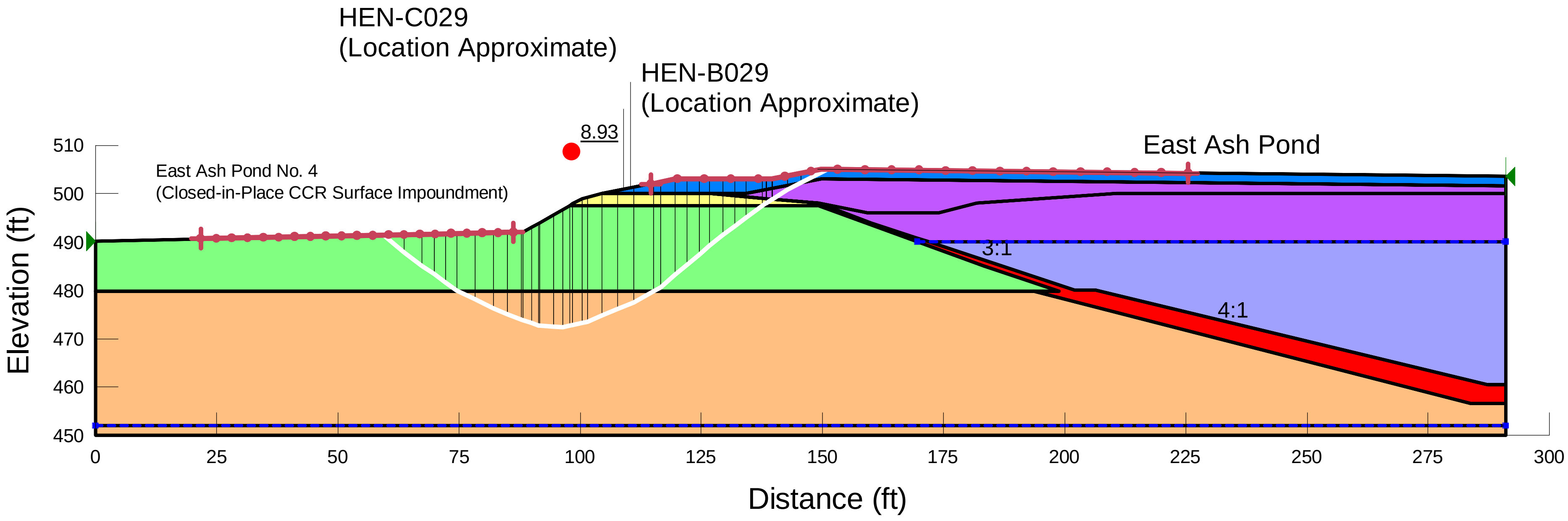
Calculated By: IJV/LPC   Date: 10/27/2021

Checked By: ZJF   Date: 11/1/2021

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟥 Liner System (Undrained)
- 🟪 CCR (Drained)
- 🟩 Embankment Fill (Undrained)
- 🟦 Final Cover System
- ▨ CCR (Liquefied)

Name: Road Fill   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °   Piezometric Line: 1
Name: Alluvial Foundation   Unit Weight: 135 pcf   Cohesion': 0 psf   Phi': 38 °   Piezometric Line: 1
Name: Liner System (Undrained)   Unit Weight: 120 pcf   Cohesion': 2,500 psf   Phi': 0 °   Piezometric Line: 2
Name: CCR (Drained)   Unit Weight: 80 pcf   Cohesion': 0 psf   Phi': 30 °   Piezometric Line: 2
Name: Embankment Fill (Undrained)   Unit Weight: 105 pcf   Cohesion': 2,500 psf   Phi': 0 °   Piezometric Line: 1
Name: Final Cover System   Unit Weight: 110 pcf   Cohesion': 0 psf   Phi': 27 °   Piezometric Line: 1
Name: CCR (Liquefied)   Unit Weight: 80 pcf   Tau/Sigma Ratio: 0.05   Minimum Strength: 0 psf   Piezometric Line: 2



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East Ash Pond
Cross Section SL-12
Long-Term Static

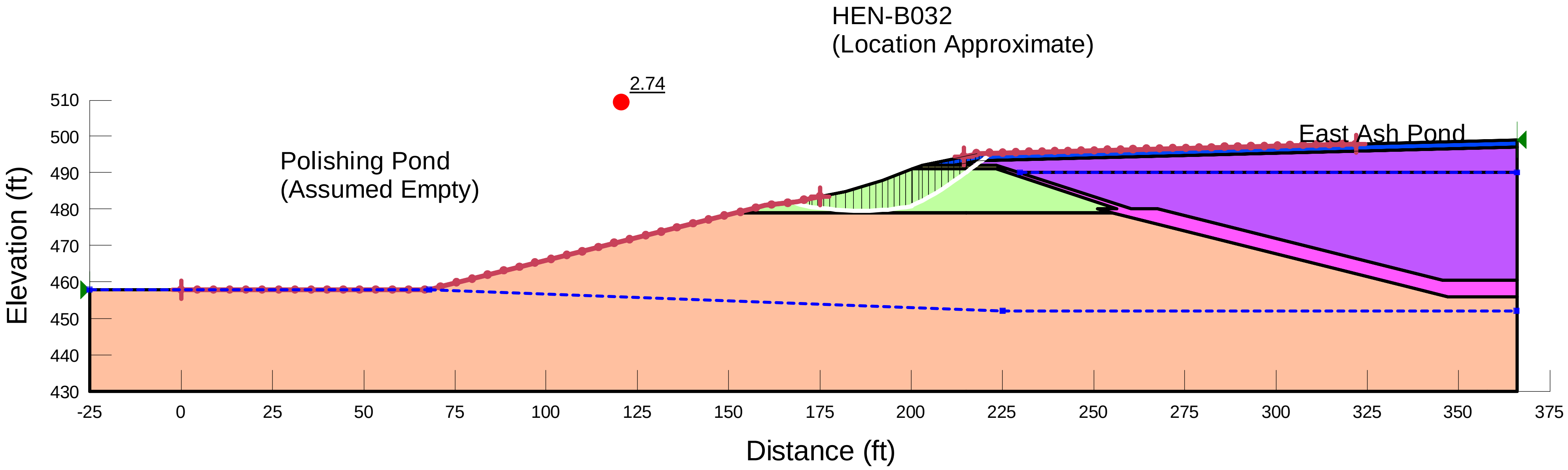
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟪 CCR (Drained)
🟪 Liner System (Drained)
🟩 Embankment Fill (Drained)
🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 1
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 2
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 2



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East Ash Pond
Cross Section SL-12
End-of-Construction

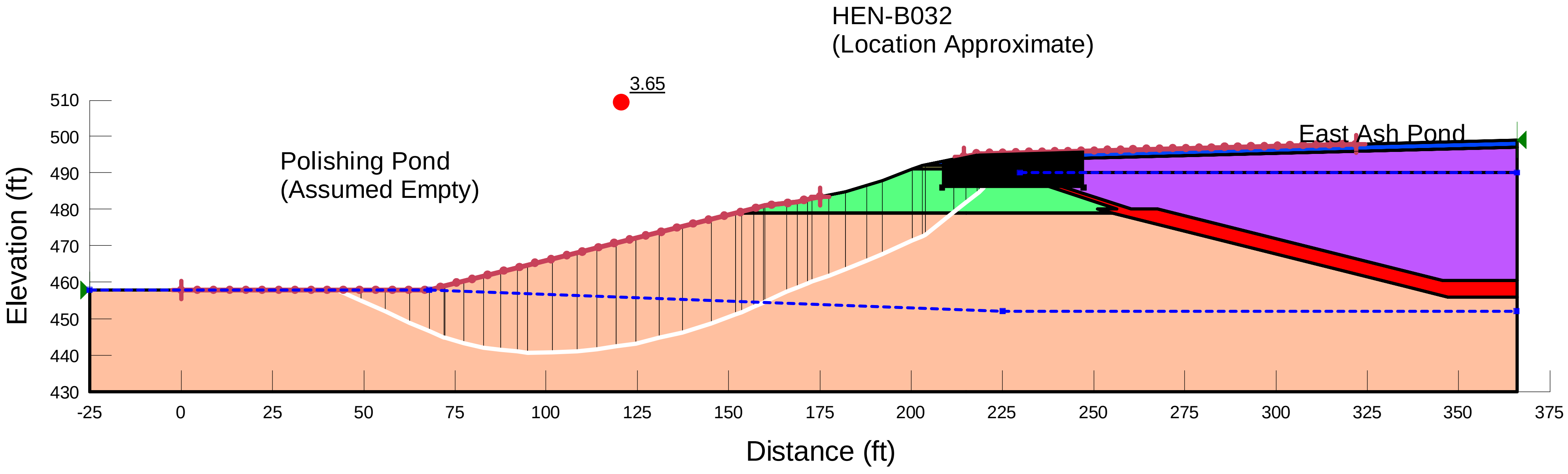
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟪 CCR (Drained)
🟥 Liner System (Undrained)
🟩 Embankment Fill (Undrained)
🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Liner System (Undrained) Unit Weight: 120 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 1
Name: Embankment Fill (Undrained) Unit Weight: 105 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 2
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 2



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East Ash Pond
Cross Section SL-12
Pseudostatic Seismic - Drained Embankment

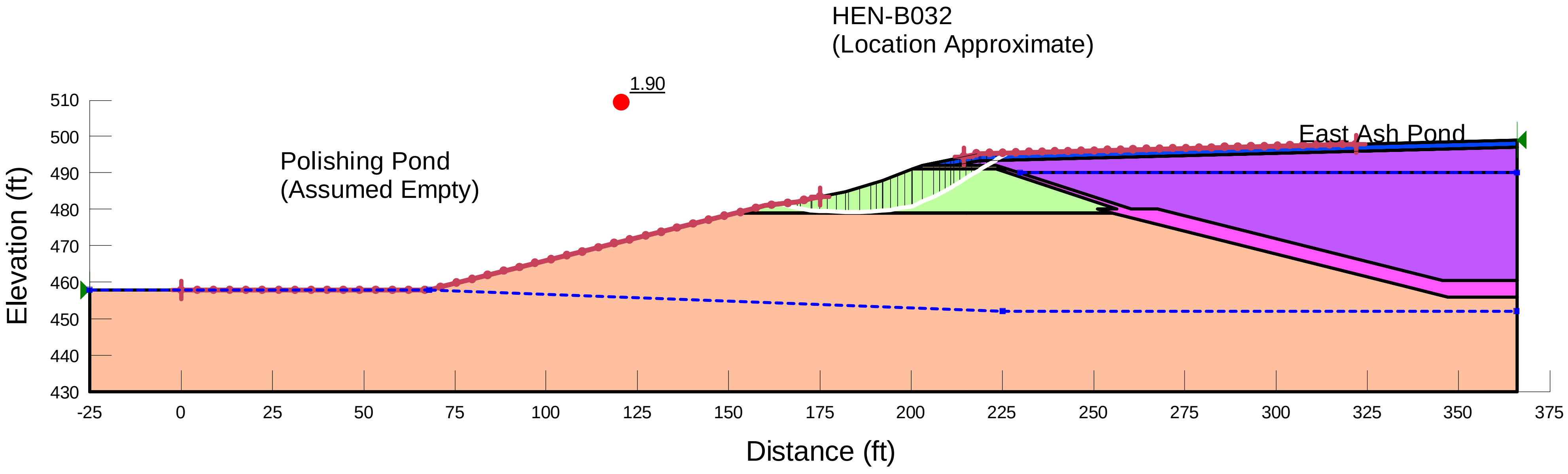
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 CCR (Drained)
- 🟪 Liner System (Drained)
- 🟩 Embankment Fill (Drained)
- 🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 1
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 2
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 2



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East Ash Pond
Cross Section SL-12
Pseudostatic Seismic - Undrained Embankment

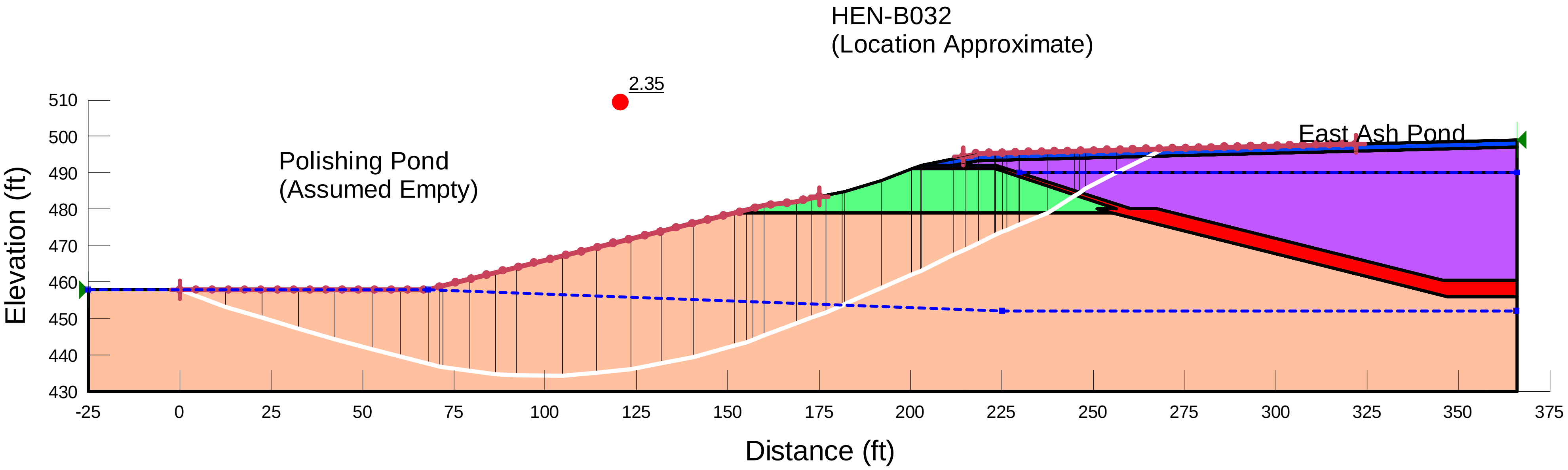
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

🟨 Road Fill
🟧 Alluvial Foundation
🟪 CCR (Drained)
🟥 Liner System (Undrained)
🟩 Embankment Fill (Undrained)
🟦 Final Cover System

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Liner System (Undrained) Unit Weight: 120 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 1
Name: Embankment Fill (Undrained) Unit Weight: 105 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 2
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 2



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East Ash Pond
Cross Section SL-12
Post Earthquake - Drained Embankment

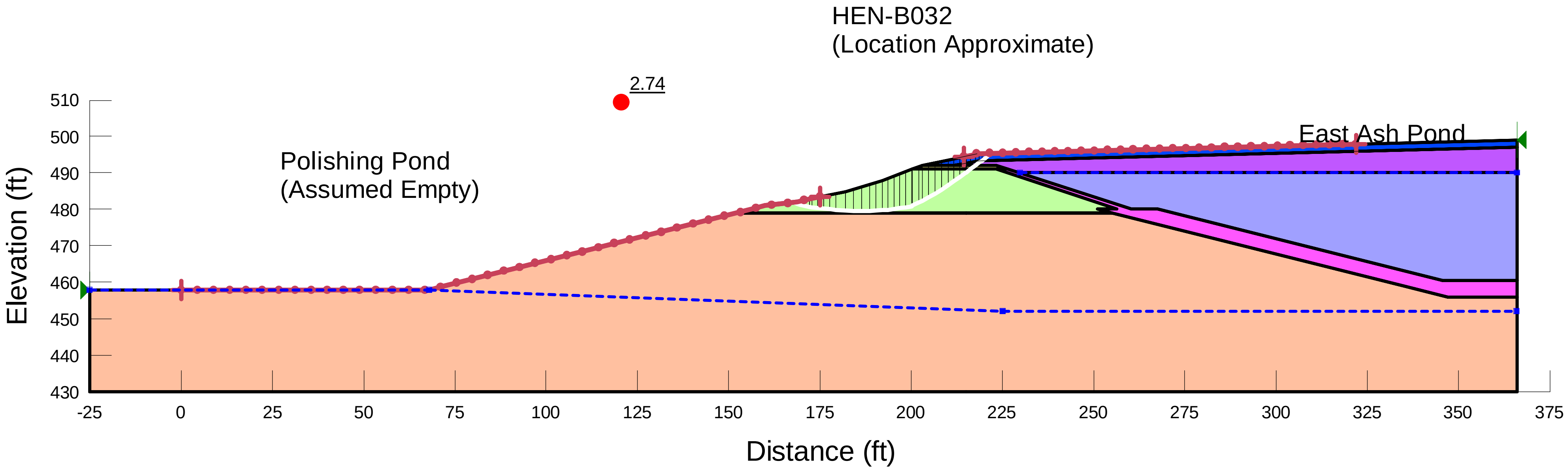
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 CCR (Drained)
- 🟪 Liner System (Drained)
- 🟩 Embankment Fill (Drained)
- 🟦 Final Cover System
- 🟦 CCR (Liquefied)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Liner System (Drained) Unit Weight: 120 pcf Cohesion': 60 psf Phi': 30 ° Piezometric Line: 1
Name: Embankment Fill (Drained) Unit Weight: 105 pcf Cohesion': 30 psf Phi': 32 ° Piezometric Line: 2
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 2
Name: CCR (Liquefied) Unit Weight: 80 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf Piezometric Line: 1



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East Ash Pond
Cross Section SL-12
Post Earthquake - Undrained Embankment

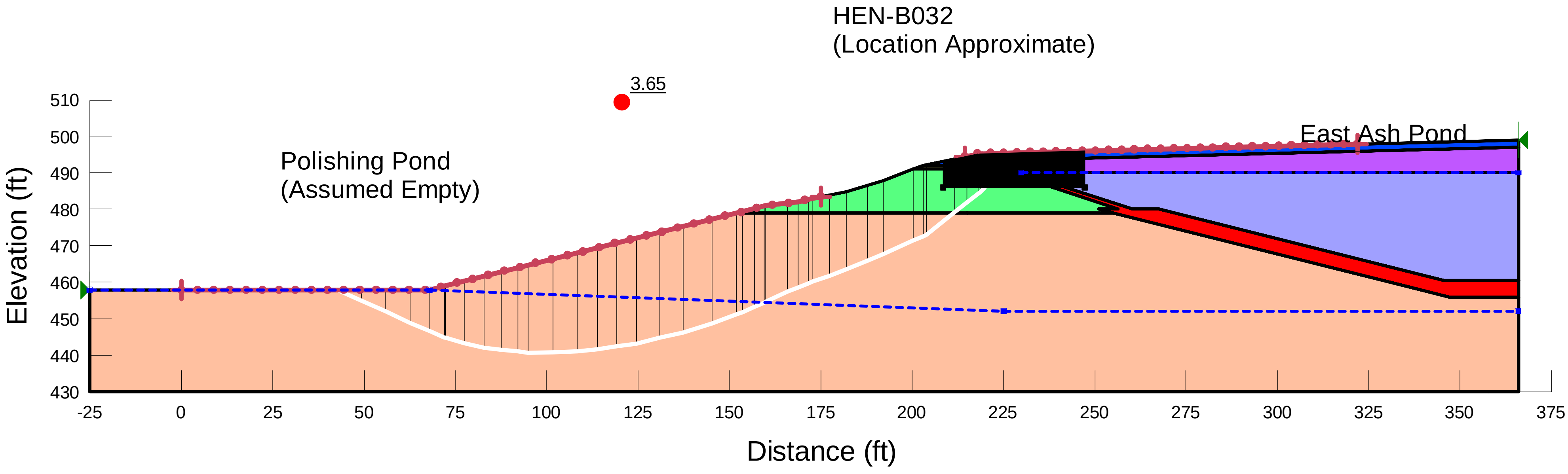
Calculated By: IJV/LPC Date: 10/27/2021

Checked By: ZJF Date: 11/1/2021

Materials

- 🟨 Road Fill
- 🟧 Alluvial Foundation
- 🟪 CCR (Drained)
- 🟥 Liner System (Undrained)
- 🟩 Embankment Fill (Undrained)
- 🟦 Final Cover System
- 🟪 CCR (Liquefied)

Name: Road Fill Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: Alluvial Foundation Unit Weight: 135 pcf Cohesion': 0 psf Phi': 38 ° Piezometric Line: 2
Name: CCR (Drained) Unit Weight: 80 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Liner System (Undrained) Unit Weight: 120 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 1
Name: Embankment Fill (Undrained) Unit Weight: 105 pcf Cohesion': 2,500 psf Phi': 0 ° Piezometric Line: 2
Name: Final Cover System Unit Weight: 110 pcf Cohesion': 0 psf Phi': 27 ° Piezometric Line: 2
Name: CCR (Liquefied) Unit Weight: 80 pcf Tau/Sigma Ratio: 0.05 Minimum Strength: 0 psf Piezometric Line: 1



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APPENDIX D

Interface Friction Testing Data

Table K.1 - Summary of Interface Friction CQA Testing Results

Material	Sample ID	Friction Angle (°)[1]	Adhesion (psf)	Large Displacement Friction Angle (°)[2]	Pass/ Fail[1,2]
Clay Cover Soil	CB-03	23.4	142	17.1*	Pass
Skaps DSGC TN 270-2-10	-				
Skaps 40 mil LLDPE TXGM	-				
CCR	CF-02 (CCR-1)				
Clay Cover Soil	CB-03	27.8	81	21.5*	Pass
Skaps NWGT GE116	-				
Skaps 40 mil LLDPE TXGM	-				
CCR	CF-02 (CCR-1)				
Clay Cover Soil	CB-03	19.0	190	10.8	Pass[3]
Skaps DSGC TN 270-2-10	-				
Skaps 40 mil LLDPE TXGM	-				
Coal	CY-01				
Clay Cover Soil	CB-03	24.9	158	15.0	Pass
Skaps NWGT GE116	-				
Skaps 40 mil LLDPE TXGM	-				
Coal	CY-01				
Sand and Gravel Cover Soil	SCS-03	41.3*	-*	35.5*	Pass
Skaps DSGC TN 270-2-10	-				
Sand and Gravel Cover Soil	SCS-03	26.9	102	27.5	Pass
Skaps NWGT GE116	-				
Sand and Gravel Cover Soil	SCS-03	25.3	51	18.9*	Pass
Skaps 40 mil LLDPE TXGM	-				

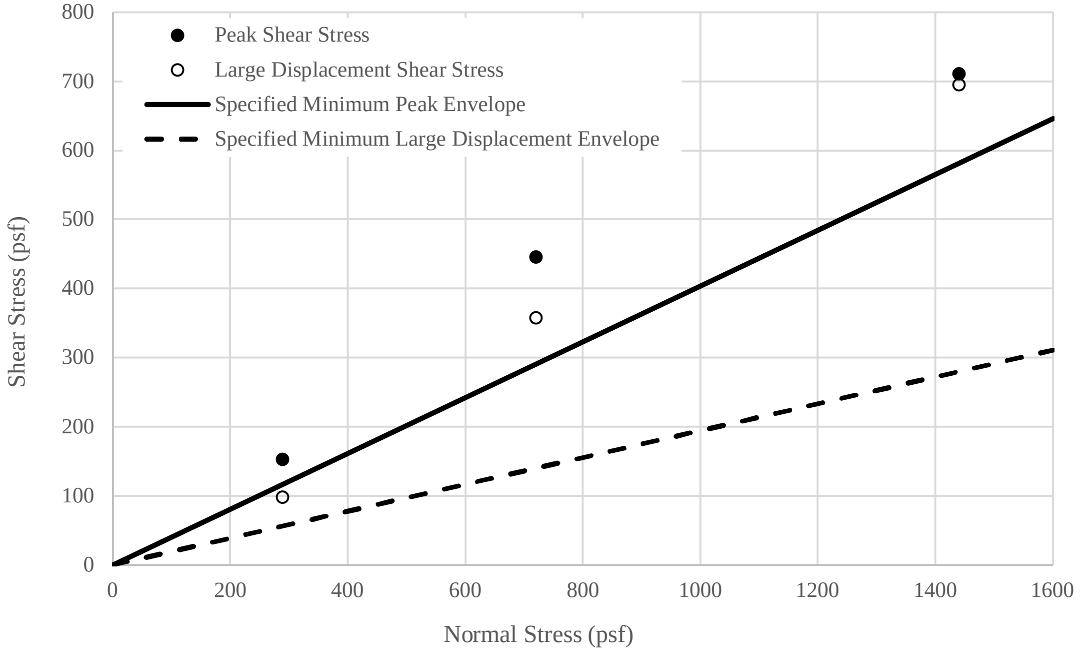
* Minimum Secant Angle results reported.

[1] Minimum Required Friction Angle = 22 degrees per Specification 31 05 19 03.01A

[2] Minimum Required Large Displacement Friction Angle = 11 degrees per Specification 31 05 19 03.01B

[3] Interface shear strength is in excess of specified values when adhesion is considered.

Figure K.1 - Interface Friction Testing Results Plot



TRI ENVIRONMENTAL

TESTING, RESEARCH, CONSULTING AND FIELD SERVICES

Austin, TX - USA | CA - USA | SC - USA | Gold Coast - Australia | Suzhou - China | Sao Paulo, Brazil | Johannesburg - Africa

Multi-Layered Interface Friction Test (ASTM D5321 Modified)

Client: Geosyntec Consultants

Project: Dynegy Energy

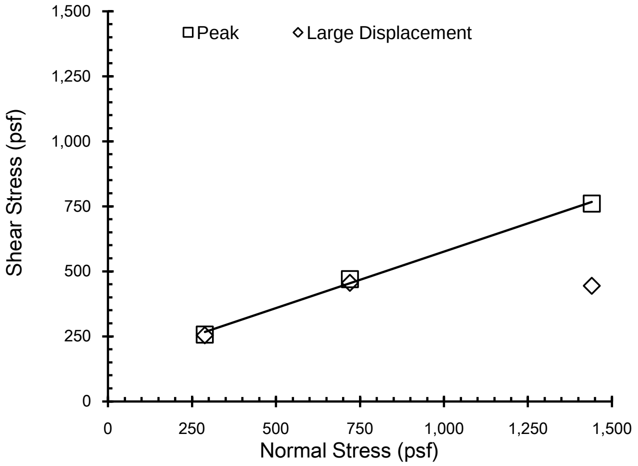
Hennepin West Ash Pond System Closure

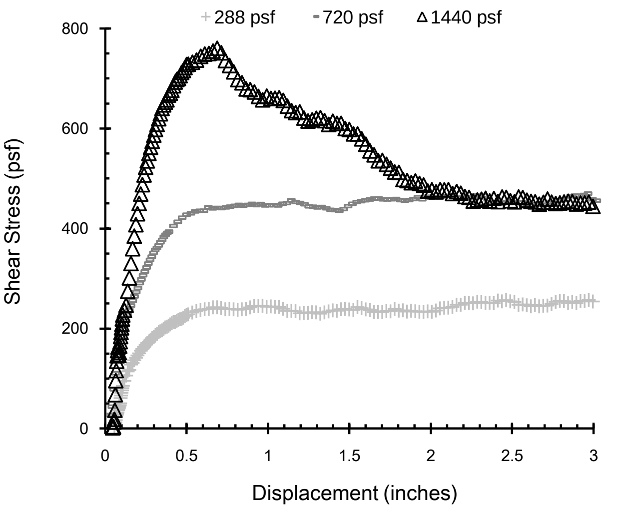
TRI Log #: 53888-3

Richard S. Lacey, P.E. 3/9/2020

Analysis & Quality Review/Date

CB-03 (Clay) vs. Skaps DSGC TN 270-2-10 (95161010001) vs. Skaps 40 mil LLDPE TXGM (3111002301) vs. CCR-1(coal ash) - Tamp





Test Results, Linear Regression

Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	23.4	Various failure modes *Refer to per normal stress secant friction angles*
Y-intercept or Adhesion	psf	142	
Minimum Secant Angle	Degrees	27.8	17.1

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions

Upper Box	CB-03 (Clay) ω = 17.0 % γ_d = 104.0 pcf	
Floating	Skaps DSGC TN 270-2-10 (95161010001)	
	Skaps 40 mil LLDPE TXGM (3111002301)	
Lower Box	CCR-1(coal ash) Tamped in place	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 16 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

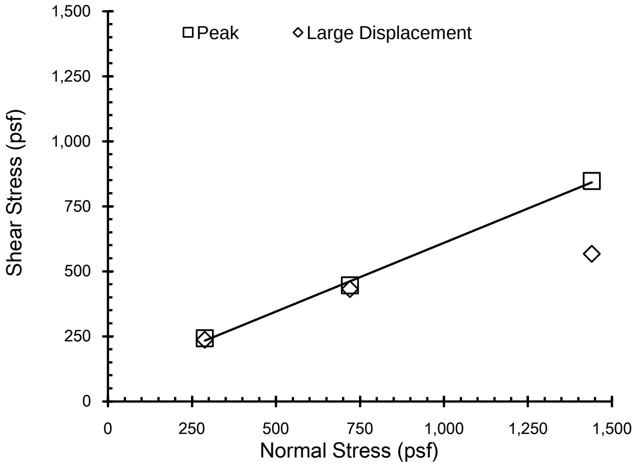
Shearing occurred at the TXGM vs Ash interface at 288 psf and 720 psf, and at the NWGT vs. TXGM interface at 1,440 psf.

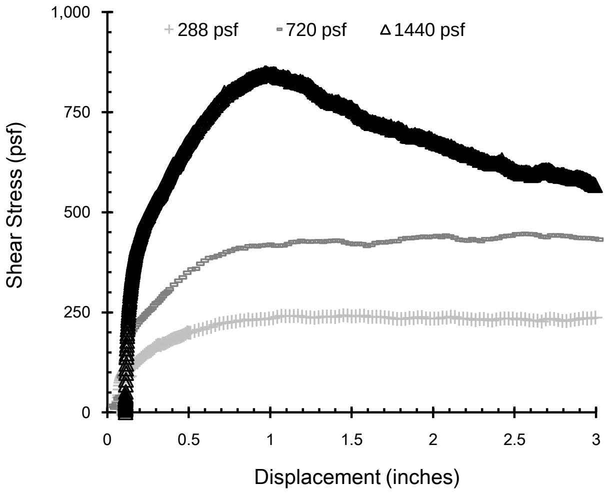
Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	257	470	760
	Secant Angle	deg.	41.7	33.1	27.8
Large Displacement	Shear Stress	psf	254	456	444
	Secant Angle	deg.	41.4	32.3	17.1
Asperity Height, Avg. of 5 Meas.		mils	32	33	32

Multi-Layered Interface Friction Test (ASTM D5321 Modified)

Client:	Geosyntec Consultants	TRI Log #:	53888-1
Project:	Dynegy Energy	Richard S. Lacey, P.E.	3/10/2020
	Hennepin West Ash Pond System Closure	Analysis & Quality Review/Date	

CB-03 (Clay) vs. Skaps NWGT GE116 (60771.1) vs. Skaps 40 mil LLDPE TXGM (3111002301) vs. CCR-1(coal ash) - Tamp





Test Results, Linear Regression			
Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	27.8	Various failure modes *Refer to per normal stress secant friction angles*
Y-intercept or Adhesion	psf	81	
Minimum Secant Angle	Degrees	30.5	21.5

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions		
Upper Box	CB-03 (Clay) ω = 17.0 % γ_d = 104.0 pcf	
Floating	Skaps NWGT GE116 (60771.1) Skaps 40 mil LLDPE TXGM (3111002301)	
Lower Box	CCR-1(coal ash) Tamped in place	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 16 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the TXGM vs Ash interface at 288 psf and 720 psf, and at the NWGT vs. TXGM interface at 1,440 psf.

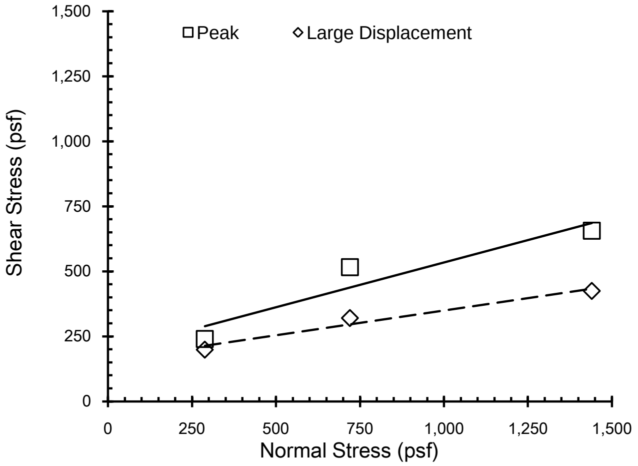
Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	243	446	847
	Secant Angle	deg.	40.1	31.8	30.5
Large Displacement	Shear Stress	psf	237	432	567
	Secant Angle	deg.	39.4	30.9	21.5
Asperity Height, Avg. of 5 Meas.		mils	32	32	31

Multi-Layered Interface Friction Test (ASTM D5321 Modified)

Client: Geosyntec Consultants
Project: Dynegy Energy - Hennepin West Ash Pond System C

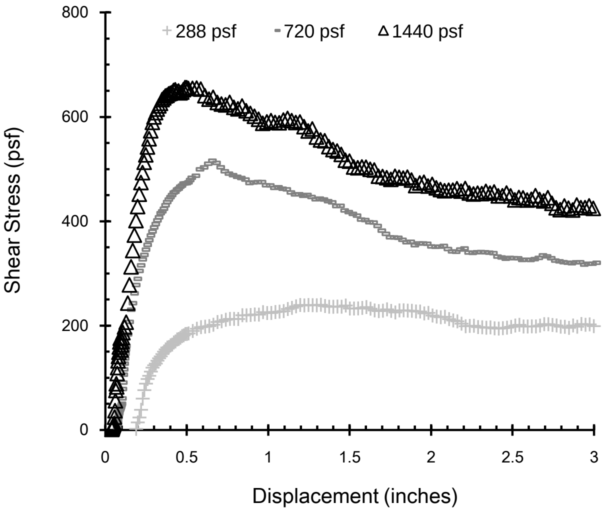
TRI Log #: 53888-4
Richard S. Lacey, P.E. 3/10/2020
Analysis & Quality Review/Date

CB-03 (Clay) vs. Skaps DSGC TN 270-2-10 (95161010001) vs. Skaps 40 mil LLDPE TXGM (3111002301) vs. CY-01 (Coal) - Tamp



Test Results, Linear Regression			
Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	19.0	10.8
Y-intercept or Adhesion	psf	190	159
Minimum Secant Angle	Degrees	24.5	16.4

Note - Large Displacement Values Reported for 3.0 inches of Displacement



Test Conditions		
Upper Box	CB-03 (Clay) ω = 17.0 % γ_d = 104.0 pcf	
FLOATING	Skaps DSGC TN 270-2-10 (95161010001) Skaps 40 mil LLDPE TXGM (3111002301)	
Lower Box	CY-01 (Coal) Tamped in place	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 16 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

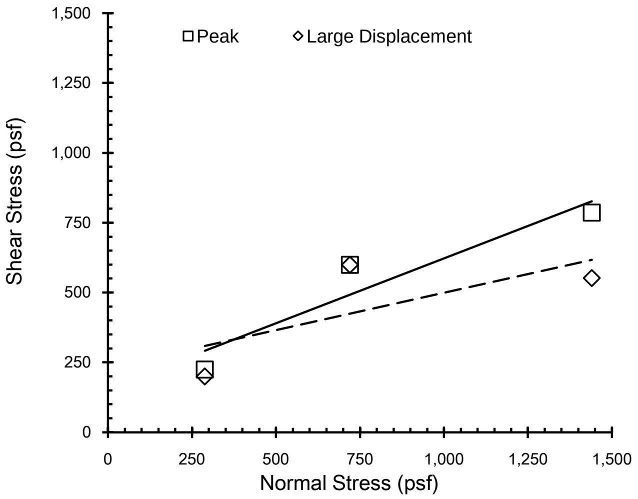
Shearing occurred at the DSGC vs. TXGM interface at all stresses.

Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	240	516	656
	Secant Angle	deg.	39.8	35.6	24.5
Large Displacement	Shear Stress	psf	199	320	425
	Secant Angle	deg.	34.6	24.0	16.4
Asperity Height, Avg. of 5 Meas.		mils	33	33	34

Multi-Layered Interface Friction Test (ASTM D5321 Modified)

Client:	Geosyntec Consultants	TRI Log #:	53888-2
Project:	Dynegy Energy	Richard S. Lacey, P.E.	3/3/2020
	Hennepin West Ash Pond System Closure	Analysis & Quality Review/Date	

CB-03 (Clay) vs. Skaps NWGT GE116 (60771.1) vs. Skaps 40 mil LLDPE TXGM (3111002301) vs. CY-01 (Coal)



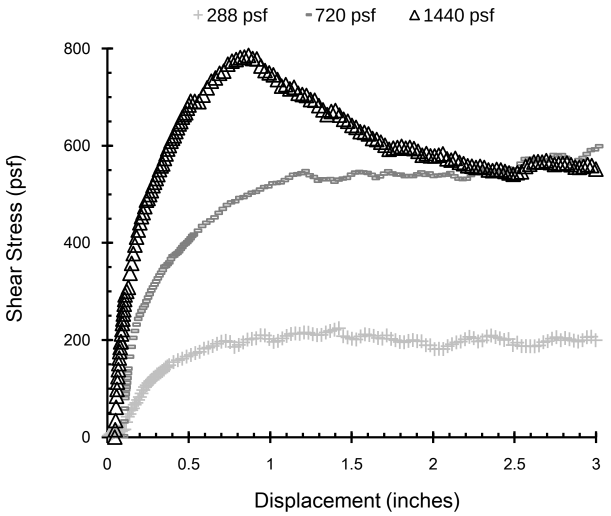
Test Results, Linear Regression

Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	24.9	15.0
Y-intercept or Adhesion	psf	158	232
Minimum Secant Angle	Degrees	28.6	21.0

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions

Upper Box	CB-03 (Clay) ω = 17.0 % γ_d = 104.0 pcf	
Floating	Skaps NWGT GE116 (60771.1) Skaps 40 mil LLDPE TXGM (3111002301)	
Lower Box	CY-01 (Coal) Tamped in place	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 16 hours prior to shear.	
Shearing Rate	inches/minute	0.04



Test Notes

Shearing occurred at the Clay vs. NWGT interface at all stresses.

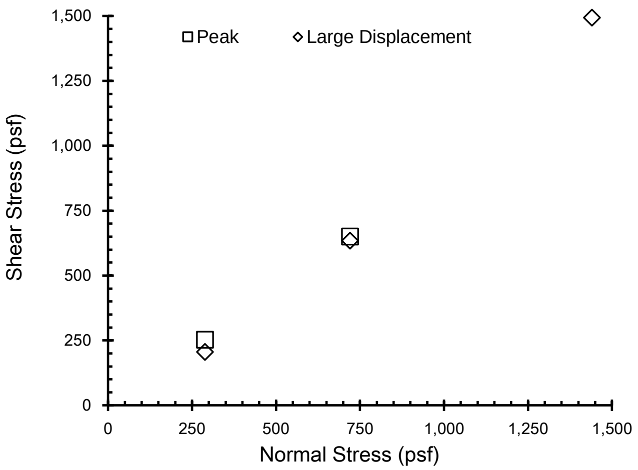
Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	224	599	786
	Secant Angle	deg.	37.9	39.8	28.6
Large Displacement	Shear Stress	psf	200	599	552
	Secant Angle	deg.	34.7	39.8	21.0
Asperity Height, Avg. of 5 Meas.		mils	32	33	31

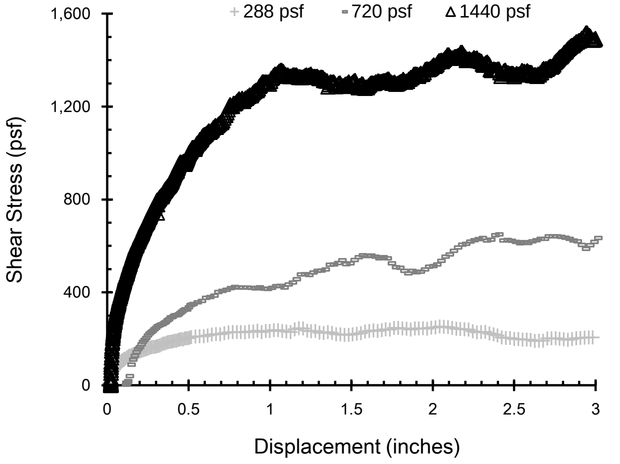
Shear Strength of Geosynthetic-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Geosyntec Consultants
Project: Dynegy Energy - Hennepin
West Ash Pond System Closure

TRI Log #: 53888-7
Richard S. Lacey, P.E. 5/26/2020
Analysis & Quality Review/Date

SCS-03 vs.
Skaps DSGC TN 270-2-10 (95161010001)





Test Results, Linear Regression

Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	Negative Intercept *Refer to per-normal-stress secant angles*	
Y-intercept or Adhesion	psf		
Minimum Secant Angle	Degrees	41.3	35.5

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions

Upper Box	SCS-03 Tamped in place	
Lower Box	Skaps DSGC TN 270-2-10 (95161010001)	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the interface at all stresses.

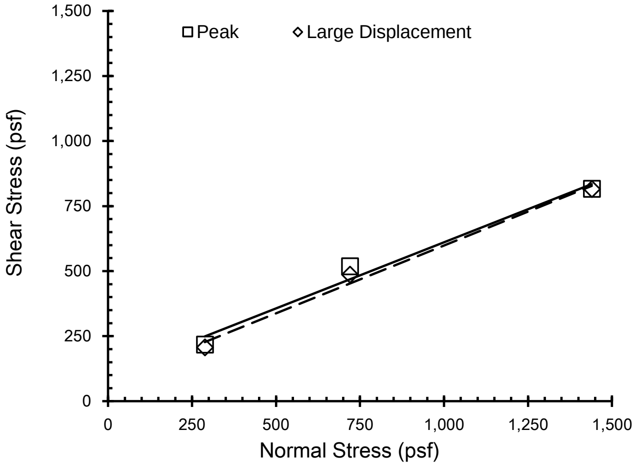
Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	253	649	1,517
	Secant Angle	deg.	41.3	42.1	46.5
Large Displacement	Shear Stress	psf	206	634	1,493
	Secant Angle	deg.	35.5	41.4	46.0

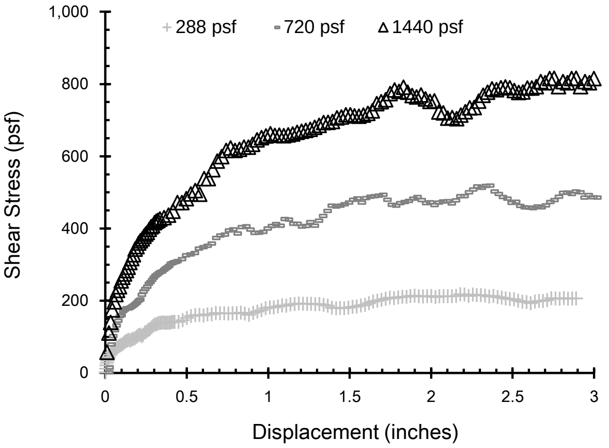
Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Geosyntec Consultants
Project: Dynegy Energy - Hennepin
West Ash Pond System Closure

TRI Log #: 53888-5
Richard S. Lacey, P.E. 5/26/2020
Analysis & Quality Review/Date

SCS-03 vs.
Skaps NWGT GE116 (60771.30)





Test Results, Linear Regression

Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	26.9	27.5
Y-intercept or Adhesion	psf	102	77
Minimum Secant Angle	Degrees	29.5	29.5

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions

Upper Box	SCS-03 Tamped in place	
Lower Box	Skaps NWGT GE116 (60771.30)	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the interface at all stresses.

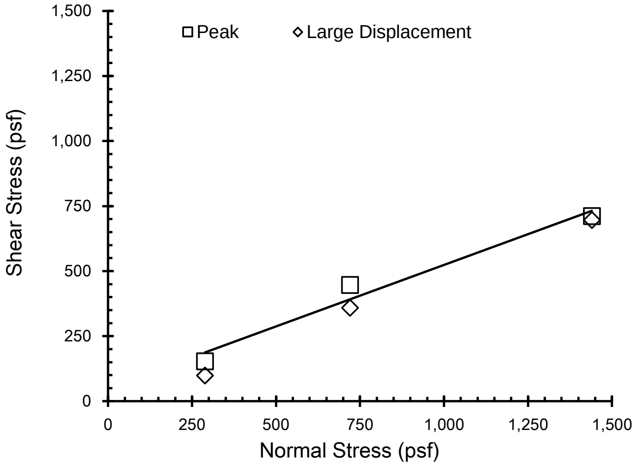
Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	218	518	816
	Secant Angle	deg.	37.1	35.8	29.5
Large Displacement	Shear Stress	psf	206	486	815
	Secant Angle	deg.	35.6	34.0	29.5

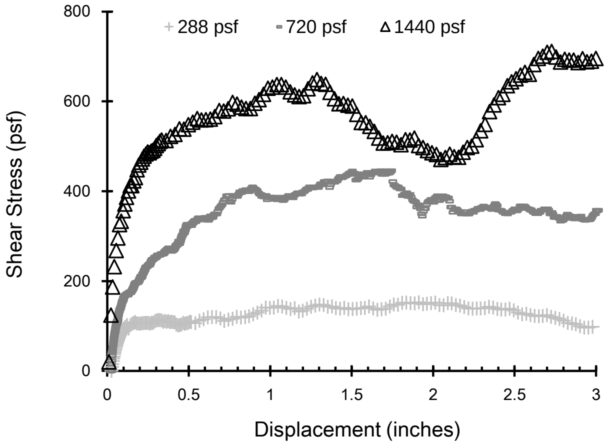
Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Geosyntec Consultants
Project: Dynegy Energy - Hennepin
West Ash Pond System Closure

TRI Log #: 53888-6
Richard S. Lacey, P.E. 5/28/2020
Analysis & Quality Review/Date

SCS-03 vs.
Skaps 40 mil LLDPE TXGM (3111002301) - shiny side up





Test Results, Linear Regression

Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	25.3	Negative Intercept *Refer to per-normal-stress secant angles*
Y-intercept or Adhesion	psf	51	
Minimum Secant Angle	Degrees	26.3	18.9

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions

Upper Box	SCS-03 Tamped in place	
Lower Box	Skaps 40 mil LLDPE TXGM (3111002301) - shiny side up	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the interface at all stresses.

Specimen No.		-	1	2	3
Normal Stress		psf	288	720	1,440
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	11	15	22
Peak	Shear Stress	psf	153	446	711
	Secant Angle	deg.	27.9	31.8	26.3
Large Displacement	Shear Stress	psf	98	358	695
	Secant Angle	deg.	18.9	26.4	25.8
Asperity Height, Avg. of 5 Meas.		mils	29	32	32

APPENDIX E

Veneer Stability Analysis Output

VENEER SLOPE STABILITY CALCULATIONS - 40H:1V SLOPE

Inputs in purple.

Internal Slope Failure (Unsaturated Static)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

2.5% (40H:1V slope) β =	1.43	degrees =	*0.02 radians*
Interface Friction, δ =	**25.30**	**degrees =**	*0.44 radians*
Interface Adhesion, a =	**51.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_{w} =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	6.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	***B***	***C***	
[γ_t x (t-t_w) + γ_b x t_w]	**[γ_t x (t-t_w) + γ_{sat} x t_w]**	**tanδ/tanβ**	**[A/B] x C**
218.900	220.210	18.908	18.795

D	
[a/sinβ]	**D/B**
2040.637	**9.266778986**

E	***F***	***G***	
γ_t x (t-t_w*) + γ_b x t_w*]/B	**[tanϕ/(2sinβcos$^2\beta$)]/(1-tanβtanϕ)**	**t/h**	**E x F x G**
0.994	10.332	0.333	3.423

H	***I***	***J***	
1/B	**[1/(sinβcosβ)]/[1-tanβtanϕ]**	**ct/h**	**H x I x J**
0.005	40.541	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
a/[γ_t x t x cos^2(β)]	**tanϕ x [1-(γ_w x t_w)/(γ_t x t)]**	**n_q x tanβ x tanϕ**	**n_q + tanβ**	28.074
0.232	0.470	0.000	0.025	

FS (Static)
31.486

VENEER SLOPE STABILITY CALCULATIONS - 40:1V SLOPE

Inputs in purple.

Internal Slope Failure (Unsaturated Seismic)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

2.5% (40H:1V slope) β =	1.43	degrees =	*0.02 radians*
Interface Friction, δ =	**25.30**	**degrees =**	*0.44 radians*
Interface Adhesion, a =	**51.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_w =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	6.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.078	g	

A	***B***	***C***	
$[\gamma_t$ x $(t-t_w) + \gamma_b$ x $t_w]$	**$[\gamma_t$ x $(t-t_w) + \gamma_{sat}$ x $t_w]$**	**$\tan\delta/\tan\beta$**	**[A/B] x C**
218.900	220.210	18.908	18.795

D	
$[a/\sin\beta]$	**D/B**
2040.637	**9.266778986**

E	***F***	***G***	
γ_t x $(t-t_w^*) + \gamma_b$ x $t_w^*]/B$	**$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$**	**t/h**	**E x F x G**
0.994	10.332	0.333	3.423

H	***I***	***J***	
1/B	**$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$**	**ct/h**	**H x I x J**
0.005	40.541	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
$a/[\gamma_t$ x t x $\cos^2(\beta)]$	**$\tan\phi$ x $[1-(\gamma_w$ x $t_w)/(\gamma_t$ x t)]**	**n_q x $\tan\beta$ x $\tan\phi$**	**$n_q + \tan\beta$**	6.805
0.232	0.470	0.001	0.103	

FS (Seismic)
6.805

VENEER SLOPE STABILITY CALCULATIONS - 40H:1V SLOPE

Internal Slope Failure (Saturated Static)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

Inputs in purple.

2.5% (40H:1V slope) β =	1.43	degrees =	*0.02 radians*
Interface Friction, δ =	**25.30**	**degrees =**	*0.44 radians*
Interface Adhesion, a =	**51.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_w =	2.000	ft	
t_w* =	2.000	ft	
Height of slope, h =	6.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	***B***	***C***	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	**$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$**	**$\tan\delta/\tan\beta$**	**[A/B] x C**
115.200	240.000	18.908	9.076

D			***E***	***F***	***G***	
$[a/\sin\beta]$	**D/B**		**$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$**	**$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$**	**t/h**	**E x F x G**
2040.637	**8.502655835**		0.480	10.332	0.333	1.653

H	***I***	***J***	
1/B	**$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$**	**ct/h**	**H x I x J**
0.004	40.541	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
$a/[\gamma_t \times t \times \cos^2(\beta)]$	**$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$**	**$n_q \times \tan\beta \times \tan\phi$**	**$n_q + \tan\beta$**	17.460
0.232	0.205	0.000	0.025	

FS (Static)
19.232

VENEER SLOPE STABILITY CALCULATIONS - 40H:1V SLOPE

Inputs in purple.

Internal Slope Failure (Unsaturated Post-EQ)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

2.5% (40H:1V slope) β =	1.43	degrees =	*0.02 radians*
Interface Friction, δ =	**17.10**	**degrees =**	*0.30 radians*
Interface Adhesion, a =	**0.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_w =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	6.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	***B***	***C***	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	**$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$**	**$\tan\delta/\tan\beta$**	**[A/B] x C**
218.900	220.210	12.306	12.232

D	
$[a/\sin\beta]$	**D/B**
0.000	**0**

E	***F***	***G***	
$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$	**$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$**	**t/h**	**E x F x G**
0.994	10.332	0.333	3.423

H	***I***	***J***	
1/B	**$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$**	**ct/h**	**H x I x J**
0.005	40.541	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
$a/[\gamma_t \times t \times \cos^2(\beta)]$	**$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$**	**$n_q \times \tan\beta \times \tan\phi$**	**$n_q + \tan\beta$**	12.232
0.000	0.306	0.000	0.025	

FS (Post-EQ)
15.656

VENEER SLOPE STABILITY CALCULATIONS - 5H:1V SLOPE

Purple highlighted parameters are inputted

Internal Slope Failure (Unsaturated Static)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

20% (5H:1V slope) β =	11.31	degrees =	*0.20 radians*
Interface Friction, δ =	**25.30**	**degrees =**	*0.44 radians*
Interface Adhesion, a =	**51.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_{w} =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	10.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	***B***	***C***	
[γ_t x (t-t_w) + γ_b x t_w]	**[γ_t x (t-t_w) + γ_{sat} x t_w]**	**tanδ/tanβ**	**[A/B] x C**
218.900	220.210	2.363	2.349

D	
[a/sinβ]	**D/B**
260.050	**1.180918193**

E	***F***	***G***	
γ_t x (t-t_w*) + γ_b x t_w*]/B	**[tanϕ/(2sinβcos^{2}β)]/(1-tanβtanϕ)**	**t/h**	**E x F x G**
0.994	1.504	0.200	0.299

H	***I***	***J***	
1/B	**[1/(sinβcosβ)]/[1-tanβtanϕ]**	**ct/h**	**H x I x J**
0.005	5.790	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
a/[γ_t x t x cos^2(β)]	**tanϕ x [1-(γ_w x t_w)/(γ_t x t)]**	**n_q x tanβ x tanϕ**	**n_q + tanβ**	3.555
0.241	0.470	0.000	0.200	

FS (Static)
3.829

VENEER SLOPE STABILITY CALCULATIONS - 5H:1V SLOPE

Purple highlighted parameters are inputted

Internal Slope Failure (Saturated Static)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

20% (5H:1V slope) β =	11.31	degrees =	*0.20 radians*
Interface Friction, δ =	**25.30**	**degrees =**	*0.44 radians*
Interface Adhesion, a =	**51.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_{w} =	2.000	ft	
t_{w}* =	2.000	ft	
Height of slope, h =	10.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	***B***	***C***	
[γ_t x (t-t_w) + γ_b x t_w]	**[γ_t x (t-t_w) + γ_{sat} x t_w]**	**tanδ/tanβ**	**[A/B] x C**
115.200	240.000	2.363	1.134

D	
[a/sinβ]	**D/B**
260.050	**1.083541647**

E	***F***	***G***	
γ_t x (t-t_w*) + γ_b x t_w*]/B	**[tanϕ/(2sinβcos$^2\beta$)]/(1-tanβtanϕ)**	**t/h**	**E x F x G**
0.480	1.504	0.200	0.144

H	***I***	***J***	
1/B	**[1/(sinβcosβ)]/[1-tanβtanϕ]**	**ct/h**	**H x I x J**
0.004	5.790	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
a/[γ_t x t x cos^2(β)]	**tanϕ x [1-(γ_w x t_w)/(γ_t x t)]**	**n_q x tanβ x tanϕ**	**n_q + tanβ**	2.228
0.241	0.205	0.000	0.200	

FS (Static)
2.362

VENEER SLOPE STABILITY CALCULATIONS - 5H:1V SLOPE

Purple highlighted parameters are inputted

Internal Slope Failure (Unsaturated Seismic)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

20% (5H:1V slope) β =	11.31	degrees =	*0.20 radians*
Interface Friction, δ =	**25.30**	**degrees =**	*0.44 radians*
Interface Adhesion, a =	**51.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_w =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	10.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.078	g	

A	***B***	***C***	
$[\gamma_t \times (t-t_w) + \gamma_b \times t_w]$	**$[\gamma_t \times (t-t_w) + \gamma_{sat} \times t_w]$**	**tanδ/tanβ**	**[A/B] x C**
218.900	220.210	2.363	2.349

D	
[a/sinβ]	**D/B**
260.050	**1.180918193**

E	***F***	***G***	
$\gamma_t \times (t-t_w^*) + \gamma_b \times t_w^*]/B$	**$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$**	**t/h**	**E x F x G**
0.994	1.504	0.200	0.299

H	***I***	***J***	
1/B	**[1/(sinβcosβ)]/[1-tanβtanϕ]**	**ct/h**	**H x I x J**
0.005	5.790	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
$a/[\gamma_t \times t \times \cos^2(\beta)]$	**$\tan\phi \times [1-(\gamma_w \times t_w)/(\gamma_t \times t)]$**	**$n_q \times \tan\beta \times \tan\phi$**	**$n_q + \tan\beta$**	2.531
0.241	0.470	0.007	0.278	

FS (Seismic)
2.531

VENEER SLOPE STABILITY CALCULATIONS - 5H:1V SLOPE

Purple highlighted parameters are inputted

Internal Slope Failure (Unsaturated Post-EQ)

Analysis of all lower interfaces (subgrade-to-geomembrane, geomembrane-to-geocomposite, geocomposite-to-cover soil)

(Conversion of degrees to radians are performed for Excel spread sheet calculations)

20% (5H:1V slope) β =	11.31	degrees =	*0.20 radians*
Interface Friction, δ =	**17.10**	**degrees =**	*0.30 radians*
Interface Adhesion, a =	**0.00**	**psf**	
Thickness of soil above geomembrane, t =	**2.00**	**ft**	
Thickness of Saturation (water) t_{w} =	0.021	ft	
t_w* =	0.021	ft	
Height of slope, h =	10.0	ft	
Total Unit Weight of Soil Above Geomembrane, γ_t =	**110.00**	**pcf**	
Effective Unit Weight, γ_b =	57.60	pcf	
Saturated Unit Weight of Soil Above Geomembrane, γ_{sat} =	120.00	pcf	
Friction Angle of Soil Above Geomembrane, ϕ =	**27.00**	**degrees =**	*0.47 radians*
Cohesion of Soil Above Geomembrane, c =	**0.00**	**psf**	
Seismic Coeffecient, k_s =	0.000	g	

A	***B***	***C***	
$[\gamma_t$ x $(t-t_w) + \gamma_b$ x $t_w]$	**$[\gamma_t$ x $(t-t_w) + \gamma_{sat}$ x $t_w]$**	**$\tan\delta/\tan\beta$**	**[A/B] x C**
218.900	220.210	1.538	1.529

D	
$[a/\sin\beta]$	**D/B**
0.000	**0**

E	***F***	***G***	
γ_t x $(t-t_w^*) + \gamma_b$ x $t_w^*]/B$	**$[\tan\phi/(2\sin\beta\cos^2\beta)]/(1-\tan\beta\tan\phi)$**	**t/h**	**E x F x G**
0.994	1.504	0.200	0.299

H	***I***	***J***	
1/B	**$[1/(\sin\beta\cos\beta)]/[1-\tan\beta\tan\phi]$**	**ct/h**	**H x I x J**
0.005	5.790	0.000	0.000

A'	***B'***	***C'***	***D'***	**[A'+B'-C']/D'**
$a/[\gamma_t$ x t x $\cos^2(\beta)]$	**$\tan\phi$ x $[1-(\gamma_w$ x $t_w)/(\gamma_t$ x t)]**	**n_q x $\tan\beta$ x $\tan\phi$**	**$n_q + \tan\beta$**	1.529
0.000	0.306	0.000	0.200	

FS (Post-EQ)
1.828

ATTACHMENT H

Public Notification and Public Meeting Certification

845.220(a)(9)

Luminant

Dianna Tickner
Dynegy Midwest Generation, 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
Hennepin Power Plant East Ash Pond (IEPA ID # W1550100002-05)

Dear Mr. Darin LeCrone:

For the above-refenced CCR surface impoundment and in accordance with 35 IAC 845.220(a)(9), Dynegy Midwest Generation, 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,
Dynegy Midwest Generation, LLC

Dianna Tickner

Dianna Tickner
Director, Decommissioning & Demolition

Hennepin Public Meeting Issues Summary, December 8, 2021

On Sunday, November 7, 2021, Dynegy Midwest Generation, LLC made available to the public its plans to close the East Ash Pond (EAP) CCR surface impoundment located at Hennepin Power Plant. On Wednesday, December 8, 2021, Dynegy Midwest Generation, LLC held in-person and virtual public meetings at 3:00 pm and 5:30pm 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 relating to the closure and the company provided answers.

As required by Section 845.240(g), Dynegy Midwest Generation, 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 issued raised by the public and a summary of any revisions, changes and considerations made to the closure plans on December 22, 2021.

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
1.	Engineered Final Cover System at the EAP	Final cover system consists of a geomembrane and 2 feet of soil on top of the geomembrane to protect the membrane from the sun. Vegetative grass with a shallow root system will be planted on the final cover system. The geomembrane will be rolled out in sections. Each section will be heat sealed to each other and to the existing liner beneath the gypsum. Final cover system will be monitored for 30 years. Groundwater data will continue to be collected to monitor system performance. Groundwater data will be publicly available. During construction, the only anticipated impact would be in the vicinity of the outfall structure. Those impacts would be associated with general construction activities and are anticipated to be minimal and temporary.	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 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 a 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 East Ash Pond is at least 30 years.
2.	Groundwater Monitoring and Modeling	A January 2012 IEPA study concluded that there are no off-site wells that can be_impacted from CCR units and there are no risks to current groundwater users. In 2020, DMG performed a supplemental study, which was submitted to the Illinois Pollution Control Board and IEPA that confirmed the IEPA findings. Maps and tables showing well locations and depths have been provided in the on-line, publicly available materials. Groundwater monitoring is required for at least the next 30 years. Follow-up actions are required if Groundwater Protection Standards (GWPS) exceedances are detected. No exceedances were currently identified that were associated with the EAP. Groundwater at the site discharges towards the Illinois River and so will not affect upgradient water wells. Long-term data shows that the groundwater elevation beneath the EAP is consistently more than five feet below the base of the EAP and there is never flooding in the vicinity of the unit. The EAP is outside of both the 100- and 500-year flood plains for the Illinois River. Concentrations of boron are currently below the GWPS, and no exceedances are identified, boron concentrations are expected to remain at or below approximately 0.2 mg/L over a 30-year	Figure 1, attached to this document, shows the location of water wells (from publicly available data sources) within one mile of the Hennepin Power Plant. As stated at the meeting, and shown on this figure, there are no potable water supply wells that can be impacted by groundwater from the EAP, or any other impoundment located on the Hennepin Power Plant property. Normal water table is encountered approximately 10 to 14 feet below the base of the clay liner of the East Ash Pond. The final cover elevation of the east ash pond will be at least 26 feet above the 500-year and 29 feet above the 100-year flood plain. Chloride, in addition to other Part 845 groundwater monitoring parameters, measured at background monitoring wells for the East Ash Pond are above their respective Part 845 GWPSs. Alternate source demonstrations (ASDs) have not been submitted to the State of Illinois specifically for the East Ash Pond, nor have they been required. No statistically significant levels (SSLs) of 40 C.F.R. Part 257 Appendix IV parameters have been determined at the East Ash Pond. No ASDs have been required and the East Ash Pond remains in the Assessment Monitoring Program. ASDs for any Part 845 parameter, if required, will be submitted to the State of Illinois after the Part 845 groundwater monitoring plan is approved. The landfill (which is not subject to Part 845 but is subject to 40 C.F.R Part 257) does have SSLs and ASDs have been attached to the annual groundwater monitoring and corrective action reports required by §

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
		time period under both closure in place or closure by removal scenarios. Alternative source demonstrations for exceedances of chloride at background wells to the south have been submitted to IEPA. IEPA has not yet finished their review of the ASDs. Information regarding acreages of site features is provided in the on-line, publicly available materials.	257.90(e) which are located on the publicly available website.
3.	Material Handling	Closure by removal for off-site disposal would only consist of ash. There is a three-step process to off-site disposal: unwater the impoundment, dewater CCR, and then excavate. The unwater and dewater liquids are discharged through a permitted outfall. For off-site disposal, the ash has to be dryer than on-site disposal because no liquids can leak from the truck during transport to the off-site landfill. Material transport by barge is not feasible, as we would need to construct new handling facilities at both the Hennepin Power Plant and Ottawa Landfill facilities. The permitting required to build these facilities would extend the closure timeline. There is a greater potential for release into the water body when loading onto a barge than via truck. Handling ash via truck is a known process. DMG is looking at beneficial reuse at all sites in accordance with existing IEPA guidance/regulations on beneficial reuse.	Prior to hauling the CCR off-site, ponded water in the impoundment will be removed and discharged through a National Pollutant Discharge Elimination System (NPDES) outfall, in accordance with permitted discharge criteria. The depth of the ash in the EAP can be identified in hydrogeologic report dated Oct 25, 2021, and is estimated to be <30’.
4.	Risk Assessment	We will provide a written response to this question.	The Hennepin 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 East Ash Basin (EAB).

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			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 that people or animals may 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". For the Hennepin risk assessment, we followed US EPA processes and protocols 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

Issue/Topic		Summary of Response Provided at Meeting	Additional Written Response
			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 the EAB 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.	Other Hennepin CCR Units/Groundwater Impacts	The West Ash Pond System (WAPS) and East Ash Pond No. 2 and No. 4 are unlined, with construction completed in the 1950s/1960s. The other units at the site have been capped in place and are being monitored under other permit programs. They will be monitored under Part 845 also. These caps were completed with the approval of IEPA and in accordance with USEPA's CCR Rule requirements. If an exceedance is detected at either of these units in the future under Part 845, a corrective action plan will be developed.	The final cover systems at the WAPS and East Ash Pond No. 2 and No. 4 were completed under plans approved by the IEPA. The IEPA, in their approval letters to DMG dated June 19, 2018, and March 5, 2020, found that the closure and post-closure care plans presented by DMG were an adequate corrective action.

In accordance with 845.240(f)(4), a list people who requested to be added to the IEPA Listserv for the Hennepin is as follows:

Hennepin Listserv	
Name	email
Ellen Starr	flowergirl62902@yahoo.com
Roy Mahnesith	roymahnesmith@yahoo.com
Bob and Judy Haggenjas	rjhaggenjos@gmail.com
Joyce Blumenshine	joblumen@yahoo.com
Rick Wilkin	wilkin.rick@gmail.com
David Urnikis	durnikis@gmail
Dawn Neubaun	dawn.neubaum@yahoo.com
Bob Hamann	roberthamann@sbcglobal.net
Andrew Rehn	arehn@prairierivers.org

ATTACHMENT I

Closure Prioritization Category Letter

845.220(d)(1)

Luminant

Phil Morris
Dynegy Midwest Generation, LLC
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 Dynegy Midwest Generation, LLC

Dear Mr. LeCrone:

Pursuant to 35 I.A.C. 845.700(c), Dynegy Midwest Generation, LLC submits the information necessary to categorize the CCR surface impoundments located at the Baldwin Power Plant and the retired Hennepin and Vermilion Power Plants. 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 Baldwin, Hennepin and Vermilion 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 3.

- 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)**
Baldwin	Bottom Ash Pond	Existing	No	No	No	No	7
Hennepin	East New Primary Pond	Inactive	No	No	Yes	NA[3]	3
Vermilion	North Pond Cell 1 & 2	Inactive	No	No	No	Yes	4
	Old East Pond	Inactive	No	No	No	Yes	4
	New East Pond Cell 1 & 2	Inactive	No	No	No	Yes	4

[1] See Attachment 3 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.

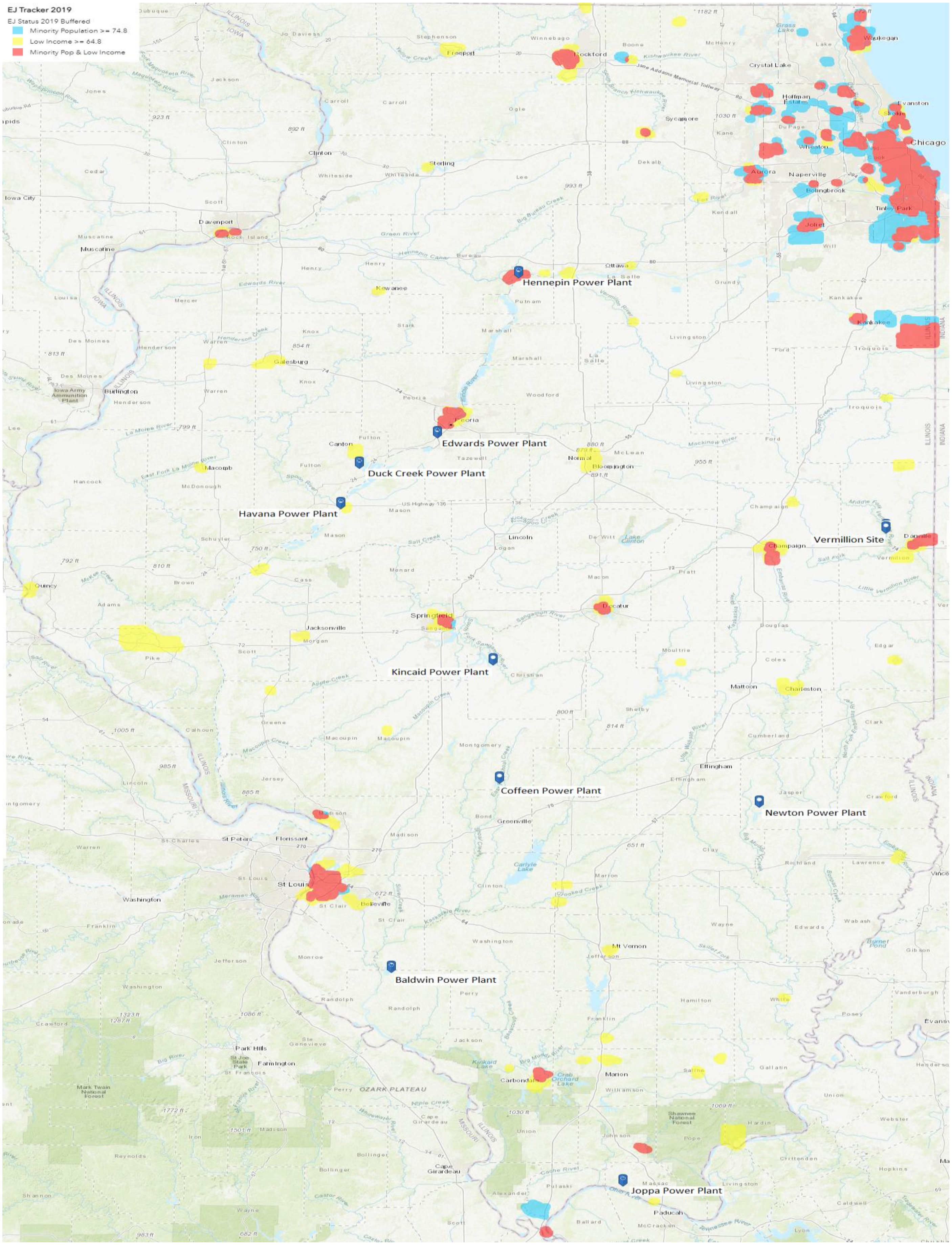
[3] NA for this determination since the CCR surface impoundment was assign a highest priority category

Attachment 2

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
Baldwin	**Present, but not at risk** Twenty-two (22) water wells were identified and eight (8) are located potentially downgradient of the site. Based on Ramboll's review of groundwater data, these wells are unlikely to be impacted by releases from the site.	Absent	Absent	**Present, but not at risk** Two (2) active CWS wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant.	**Present, but not at risk** One (1) CWS surface water intake was identified potentially downgradient of the site. Based on Ramboll's review of available information, this CWS surface water intake is unlikely to be impacted by releases from the site.
Hennepin	**Present, but not at risk** Sixteen (16) water wells were identified and one (1) is located potentially downgradient of the site. However, this well is unlikely to be present/in use based on its remote floodplain location and installation date (1884).	**Present, but not at risk** Three (3) non-CWS wells were identified; however, they are unlikely to be at risk because of their relative hydrogeologic position or inactive status.	Absent	Absent	Absent
Vermilion	**Present, but not at risk** Seventy-nine (79) water wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant, they are abandoned, they do not appear to be used for potable purposes, and/or they are unlikely to be present based on the mapped location. None of the off-site wells are located in a downgradient direction.	**Present, but not at risk** Two CWS wells were identified; however, they are unlikely to be at risk because of their hydrogeologic location relative to the power plant and/or their inactive status.	**Present, but inactive** One non-CWS surface water intake was identified; however, it is unlikely to be at risk because it is listed with inactive status.	Absent	Absent

Attachment 3: EJ Mapping Denoting Facilities with Impoundments



ATTACHMENT J

Post-Closure Care Plan

845.220(d)(5)

POST-CLOSURE PLAN FOR EXISTING CCR SURFACE IMPOUNDMENT
40 C.F.R. § 257.104 and 35 I.A.C. 845.780
REV 0 – 10/30/2021

SITE INFORMATION

Site Name / Address	Hennepin Power Plant / 13498 East 800th Street, Hennepin, IL 61327		
Owner Name / Address	Dynegy Midwest Generation, LLC / 6555 Sierra Drive Irving, Texas 75039		
CCR Unit	East Ash Pond	Closure Method and Final Cover Type	Close In-Place Geomembrane with Soil and Vegetation Cover

POST-CLOSURE PLAN DESCRIPTION

40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1) – Length of post-closure care period.	Post-closure care will be conducted for a period of 30 years as required by 40 C.F.R. § 257.104(c)(1) and 35 I.A.C. 845.780(c)(1), except as provided by 40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2).
40 C.F.R. § 257.104(c)(2) and 35 I.A.C. 845.780(c)(2) – Circumstances extending the post closure care period.	If at the end of the post-closure care period the CCR unit is operating under assessment monitoring in accordance with §257.95, the post-closure care as described in this plan will continue until returning to detection monitoring in accordance with §257.95. Under 35 I.A.C. 845.780(c)(2), the post-closure care period will be extended until groundwater monitoring data demonstrate that concentrations are below the groundwater protection standards in Section 845.600 and are not increasing for those constituents 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 concentrations are protective of human health and the environment.
40 C.F.R. § 257.104(d)(1)(i) and 35 I.A.C. 845.780(d)(1)(A) – A description of the monitoring and maintenance activities required in 40 C.F.R. § 257.104(b) and 35 I.A.C. 845.780(b), and the frequency at which these activities will be performed, to maintain the integrity and effectiveness of the final cover system, maintain the groundwater monitoring system and monitor the groundwater.	Pursuant to § 257.104(b)(1) and 35 I.A.C. 845.780(b)(1), throughout the post-closure care period, periodic visual observations of the final cover system and stormwater management system will be performed at least annually for evidence of settlement, subsidence, erosion, or other damage that may adversely affect the integrity and effectiveness of the final cover system. When practical, visual observations of the final cover will be made concurrent with groundwater monitoring activities. Noted evidence of damage, such as rills, surface cracks and settlement, will be repaired to maintain the integrity and effectiveness of the final cover system. Vegetation will be established and maintained on the final cover system, including storm drainage areas, where appropriate, to provide long-term erosion control. Established vegetation and the slope design of the final cover system will prevent potential erosion and damage that may be caused by run-on and run-off. Repair activities may include, but are not limited to, replacing and

	compacting soil cover, repairing drainage channels that have been eroded, filling in depressions with soil, regrading, and reseeding areas of failed vegetation, as necessary. Pursuant to § 257.104(b)(3) and 35 I.A.C. 845.780(b)(3), the groundwater monitoring system will be maintained, and groundwater will be monitored as required by 40 C.F.R. § 257.90 through 40 C.F.R. § 257.98 and 35 I.A.C. 845.600 through 845.680. Monitoring wells will be inspected during each groundwater sampling event. Monitoring wells and associated instrumentation will be maintained so that they perform to the design specifications throughout the life of the monitoring program. Groundwater monitoring frequency will be at least quarterly, except as provided in 40 C.F.R. § 257.94(d) and 35 I.A.C. 845.650(b)(4).
40 C.F.R. § 257.104(d)(1)(ii) and 35 I.A.C. 845.780(d)(1)(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.	Dynegy Midwest Generation, LLC 6555 Sierra Drive Irving, Texas 75039 800.633.4704 ccr@dynegy.com
40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) – A description of the planned uses of the property during the post-closure period.	The CCR unit is located at a retired electric generation facility. Planned uses of the property during the post-closure period are currently unknown, except for post-closure care of the CCR unit. Post-closure use of the property will not disturb the integrity of the final cover system or other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements of 40 C.F.R. Part § 257, Subpart D and 35 I.A.C. Part 845. Any other disturbance will be conducted following a demonstration that it will not increase the potential threat to human health or the environment, as required by 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780 (d)(1)(C). The demonstration will be certified by a qualified professional engineer and submitted to the Illinois Environmental Protection Agency (IEPA). Per 40 C.F.R. § 257.104(d)(1)(iii) notification shall be provided to the State Director that the demonstration has been placed in the operating record and on the owners or operator's publicly accessible internet site. Following closure of the CCR unit, a notation on the deed to the property, or some other instrument that is normally examined during title search, will be recorded in accordance with 40 C.F.R. § 257.102(i) and 35 I.A.C. 845.760(h). The notation will notify potential purchasers of the property that the land has been used as a CCR unit and its use is restricted under the post-closure care requirements in 40 C.F.R. § 257.104(d)(1)(iii) and 35 I.A.C. 845.780(d)(1)(C) or groundwater monitoring requirements per 35 I.A.C. 845.740(b). Within 30 days of recording the deed notation, a notification stating that the notation has been recorded will be submitted to the IEPA and placed in the facility's operating record per 35 I.A.C. 845.760(h)(3). The notification will be placed on the owner or operator's publicly accessible CCR Web site in accordance with 40 C.F.R. § 257.107(i)(9) and 35 I.A.C. 845.810(e) and placed in the facility's operating record as required by 35 I.A.C. 845.800(d)(26) and §257.105(i)(9).

40 C.F.R. § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3)- Amendments to the initial or subsequent written post-closure plan.	Pursuant to 40 C.F.R. § 257.104(d), the initial post closure care plan for the Hennepin East Ash Pond was prepared on October 17, 2016. That plan is being amended pursuant to 40 C.F.R. § 257.104(d)(3)(i). This plan also serves as the initial post-closure care plan, prepared in accordance with 35 I.A.C. 845.780(d). Pursuant to § 257.104(d)(3) and 35 I.A.C. 845.780(d)(3), an operating permit modification application to amend the initial or any subsequent written post-closure care plan developed under 35 I.A.C. 845.780 (d)(1) and § 257.104(d)(1) will be submitted to IEPA. The written post-closure care plan will be amended whenever there is a change in the operation of the CCR surface impoundment that would substantially affect the written post-closure care plan in effect; or unanticipated events necessitate a revision of the written post-closure care plan, after post-closure activities have started. The written post-closure care plan will be amended at least 60 days before a planned change in the operation of the facility or CCR surface impoundment, or within 60 days after an unanticipated event requires the need to revise the existing plan. If the plan is revised after post-closure activities have started, a request to modify the operating permit, including an amended written post-closure care plan, will be submitted to the IEPA within 30 days following the triggering event.
40 C.F.R. § 257.104(d)(4) and 35 I.A.C. 845.780(d)(4) – Qualified professional engineering certification.	Certification by a qualified professional engineer will be appended to this plan and any amendment of this plan.
35 I.A.C. 845.780(e) – Termination of post-closure care.	Upon completion of the post-closure period, a request to terminate post-closure care will be submitted to the IEPA. The request will include a certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the post-closure care plan specified in 35 I.A.C. 845.780(d) and the requirements of 35 I.A.C. 845.780.
40 C.F.R. § 257.104(e) and 35 I.A.C. 845.780(f) – Notification of completion of the post-closure care period.	A notification of completion of post-closure care will be prepared and placed in the facility's operating record within 30 days after IEPA approval of the request to terminate post-closure care. The notification will be placed in the facility's operating record in accordance with 35 I.A.C. 845.800(d)(31) and § 257.105(i)(13). The notification will be placed on the owner or operator's publicly accessible CCR Internet site in accordance with the requirements of § 257.107(i)(13) and 35 I.A.C. 845.810(e). The IEPA will be notified when the notification has been placed in the operating record and on the owner or operator's publicly accessible Internet site in accordance with the requirements of § 257.106(i)(13).

Certification Statement 40 C.F.R. § 257.104 (d)(4) and 35 I.A.C. 845.780(d)(4) – Amended/Initial Written Post Closure Plan for a CCR Surface Impoundment

CCR Unit: Dynegy Midwest Generation, LLC; Hennepin Power Plant; East Ash Pond

I, John R. Hesemann, being a Registered Professional Engineer in good standing in the State of Illinois, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above referenced CCR Unit, that the information contained in the amended/initial written post closure plan, dated October 30, 2021, meets the requirements of 40 C.F.R. § 257.104 and 35 I.A.C. 845.780.

John R. Hesemann

Printed Name

9/28/2021

Date

JOHN ROBERT HESEMANN
062-058523

John R. Hesemann

Exp.: 11/30/2021

ATTACHMENT K

Contractor Training Certification

45 ILCS 5/22.59(b)(4)

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