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

Bureau of Water ID Number:	For IEPA Use Only
CCR Permit Number:	
Facility Name: Waukegan Generating Station	

SECTION 1: FACILITY, OPERATOR, AND OWNER INFORMATION (35 IAC 845.210(b))

Facility, Operator, and Owner Information

1.1	Facility Name		
	Waukegan Generating Station		
1.2	Illinois EPA CCR Permit Number (if applicable)		
	Initial Permit		
1.3	Facility Contact Information		
	Name (first and last) Mark Wehling	Title Environmental Specialist	Phone Number 847-599-2201
	Email address Mark.Wehling@NRG.com		
1.4	Facility Mailing Address		
	Street or P.O. box 401 E. Greenwood Ave		
	City or town Waukegan	State IL	Zip Code 60087
1.5	Facility Location		
	Street, route number, or other specific identifier 401 E. Greenwood Ave		
	County name Lake	County code (if known)	
	City or town Waukegan	State IL	Zip Code 60087
1.6	Name of Owner/Operator		
	Midwest Generation, LLC		

Facility, Operator, and Owner Info

1.7 Owner/Operator Contact Information

Name (first and last)	Title	Phone Number
Paulo Rocha	Plant Manager	847-599-2212

Email address
Paulo.Rocha@NRG.com

1.8 Owner/Operator Mailing Address

Street or P.O. box
804 Carnegie Center

City or town	State	Zip Code
Princeton	NJ	08540

SECTION 2: LEGAL DESCRIPTION (35 IAC 845.210(c))

Legal Description

2.1 Legal Description of the facility boundary

AN IRREGULAR PARCEL AS DESCRIBED BY DOC 4468499 FRACTIONAL SECTION 15 TOWNSHIP 45 RANGE 12

SECTION 3: PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS (35 IAC 845.810)

Internet Site

3.1 Web Address(es) to publicly accessible internet site(s) (CCR website)

https://midwestgenerationllc.com/illinois-ccr-rule-compliance-data-and-information/

3.2 Is/are the website(s) titled "Illinois CCR Rule Compliance Data and Information"

Yes (circled)   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.

Impoundment ID		
W0971900021-01	☑	Attached written description
W0971900021-02	☑	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 Colum 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
PAULO CRISTIANO ROCHA	PLANT MANAGER
Signature	**Date Signed**
[signature]	01/26/2022

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

Bureau of Water ID Number: **CCR Permit Number:** **Facility Name:**	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).	W0971900021-01
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).	SECTION 15 TOWNSHIP 45 RANGE 12
1.4	State the purpose for which the CCR surface impoundment is being used.	Used as a settling pond for sluiced CCR and other process waters associated with the electrical power generating process.
1.5	How long has the CCR surface impoundment been in operation?	43 years
1.6	List the types of CCR that have been placed in the CCR surface impoundment.	bottom ash, economizer ash, boiler slag

Design and Construction Plans (Continued)

1.7	List the name of the watershed within which the CCR surface impoundment is located.
	Waukegan River - Frontal Lake Michigan watershed
1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?
	31,245
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.
	In 2002, Raymond Professional Group, Inc. (RPG) prepared a report of engineering study to propose repairs to the instabilities observed in the interior embankments of the ponds. During the liner replacements in 2003 and 2005, the recommendation of flattening the interior slopes to 2.5H:1V was completed. In 2002 and 2003, RPG inspected the east and south embankments of the East Ash Pond. The inspections “indicated areas of undercutting and soft soil at the downstream toe of the embankment, observations of some seepage from the embankment, and localized erosion of the perimeter access road east of the East Ash Pond.” These areas were addressed during the 2003 and 2005 liner replacement projects. These areas, as well as the eastern and southeastern slopes of the East Ash Pond, were re-graded in 2016. In 2009, 2014, and 2015, Valdes Engineering, also hired by Midwest Generation, performed inspections of the East and West Ash Ponds and did not document any structural instability. The initial structural stability assessment completed pursuant to 40 CFR Part 257.73(c), dated October 2016, did not identify structural instabilities. Subsequent impoundment periodic inspections (inspections performed through 2020) did not identify any structural deficiencies that would affect the stability of the East Ash Pond and the West Ash Pond. The 2018 inspection identified an area of minor erosion that did not compromise the stability of the East Ash Pond and the station revegetated this area.

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.	
	bottom ash	
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.	
	184,000 cubic yards	
2.4	The rate at which CCR and non-CCR waste streams currently enter the CCR impoundment in gallons per day and dry tons.	
	1,900,000 GPD	dTn
2.5	Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.	
	6 months	
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.

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

Bureau of Water ID Number: **CCR Permit Number:** **Facility Name:**	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.
	West Ash Pond
1.2	Identification number of the CCR surface impoundment (if one has been assigned by the Agency).
	W0971900021-02
1.3	Describe the boundaries of the CCR surface impoundment (35 Ill. Adm. Code 845.210 (c)).
	SECTION 15 TOWNSHIP 45 RANGE 12
1.4	State the purpose for which the CCR surface impoundment is being used.
	The West Ash Pond formerly served as a settling pond for sluiced CCR and other process water associated with the electrical power generating process at the Waukegan Station. As of April 11, 2021, the West Ash Pond is not in service and will not be used in the future for CCR storage.
1.5	How long has the CCR surface impoundment been in operation?
	43 years
1.6	List the types of CCR that have been placed in the CCR surface impoundment.
	All CCR has been removed but previously held bottom ash, economizer ash, and boiler slag.

Design and Construction Plans (Continued)			
	1.7	List the name of the watershed within which the CCR surface impoundment is located.	
		Waukegan River - Frontal Lake Michigan watershed	
	1.8	What is the size in acres of the watershed within which the CCR surface impoundment is located?	
		31,245	
	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.		
		no CCR is expected in the pond. The pond formerly held bottom ash, economizer ash, and boiler slag.		
	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.		
		223,000 cubic yards		
	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	dTn
	2.5	Estimate length of time the CCR surface impoundment will receive CCR and non-CCR waste streams.		
		will no longer receive CCR		
	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.

K P R G

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

APPLICATION FOR INITIAL CONSTRUCTION PERMIT

WAUKEGAN GENERATING STATION
MIDWEST GENERATION, LLC
WAUKEGAN, ILLINOIS

Illinois EPA Site No. 0971905013

January 28, 2022

Submitted To:

Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62702

Prepared For:

Midwest Generation, LLC
401 E Greenwood Ave.
Waukegan, IL 60087

Prepared By:

KPRG and Associates, Inc.
14665 West Lisbon Road, Suite 1A
Brookfield, WI 53005

Table of Contents

TABLES

FIGURES

<u>ATTACHMENTS</u>

Introduction

Midwest Generation, LLC ("Midwest Generation") currently operates the coal-fired generating station, referred to as Waukegan Station, located in Waukegan, Illinois ("site" or "generating station"). As part of generating electricity and managing the coal combustion residuals (CCR), the station operates a set of surface impoundments, the East Ash Pond and the West Ash Pond. As part of complying with the 40 CFR Part 257 (Federal CCR Rule), it was determined that the East Ash Pond and the West Ash Pond did not comply with the liner design requirements of 40 CFR Part 257 Subpart D. As a result, Midwest Generation was required to cease placing CCR in the East Ash Pond and the West Ash Pond as soon as technically feasible but no later than April 11, 2021, unless an alternative deadline could be granted by the US EPA. As stated in the initial operating permit application, Midwest Generation prepared and submitted a Demonstration for a Site-Specific Alternative Deadline to Initiate Closure ("Alternate Closure Demonstration" or "ACD") to the US EPA on November 30, 2020 that requests utilization of the East Pond while alternative disposal capacity to replace the East Ash Pond is established.

Midwest Generation has ceased sending CCR and non-CCR waste streams to the West Ash Pond and initiated closure. An alternative disposal capacity evaluation determined that no on-site or off-site disposal options were available for the East Ash Pond and it was technically infeasible to obtain alternative disposal capacity for the CCR either on-site or off-site by April 11, 2021. In accordance with 845.700(d)(2)(B), the submittal of the ACD has allowed the extended use of the East Ash Pond to receive CCR until the US EPA makes a determination on the ACD. During this time, an alternative disposal solution for the CCR going to East Ash Pond is being determined.

The objective of this submittal is to apply for the initial construction permit for the East Ash Pond and the West Ash Pond at the Waukegan Generating Station. Midwest Generation seeks to receive a construction permit to close the East Ash Pond with the CCR remaining in place and to close the West Ash Pond by removing all the CCR and re-purposing the surface impoundment. The information required for a construction permit application for existing surface impoundments as specified under 35 Ill. Adm. Code 845.220 of the State CCR Rule is provided in the following sections.

This permit application is organized with supporting Tables and Figures that are referenced in the discussions being provided at the end of the full Permit text with the table numbers and figures tied to the Section number within which they are referenced with sequential numbering (e.g., Tables referenced in Section 9 are numbered 9-1, 9-2, etc. Figures referenced in Section 9 are numbered Figure 9-1, 9-2, etc.). Specific Attachments referenced within each Section are provided in a similar fashion (e.g., Attachment 1 information is tied to Section 1 of the Permit text, Attachment 2 information is tied to Section 2 of the Permit text, etc.). It should be noted that if a Section does not reference an Attachment then that Attachment number is not included as part of the permit application. For example, Section 10 does not reference an Attachment; therefore, there is no Attachment 10 in this permit application.

1.0 History of Construction, 845.220(a)(1)

The history of construction of the CCR surface impoundment as specified in Section 845.220(a)(1) is presented below.

1.1 CCR Surface Impoundment Identifying Information

The identifying information associated with the CCR surface impoundments at the generating station are listed in the table below.

Name	Owner/Operator	Impoundment ID Number
East Ash Pond	Midwest Generation 804 Carnegie Center Princeton, NJ 08540	W0971900021-01
West Ash Pond	Midwest Generation 804 Carnegie Center Princeton, NJ 08540	W0971900021-02

1.2 Purpose of CCR Surface Impoundment

1.2.1 East Ash Pond
The East Ash Pond is used as a settling pond for sluiced CCR and other process water associated with the electrical power generating process at the Waukegan Station.

1.2.2 West Ash Pond
The West Ash Pond formerly served as a settling pond for sluiced CCR and other process water associated with the electrical power generating process at the Waukegan Station. As of April 11, 2021, the West Ash Pond is not in service and will not be used in the future for CCR storage.

1.3 CCR Surface Impoundment Length of Operation

1.3.1 East Ash Pond
The exact dates of the construction are unknown, but construction drawings for the East Ash Pond are dated 1977 and 1978. The East Ash Pond has operated since it was constructed per the dates of the drawings. Based on this, the East Ash Pond has been operating for approximately 43 years based on a construction year of 1978.

1.3.2 West Ash Pond
The exact dates of the construction are unknown, but construction drawings for the West Ash Pond are dated 1977 and 1978. The West Ash Pond has operated since it was constructed per the dates of the drawings. Based on this the West Ash Pond has been operating for approximately 43 years based on a construction year of 1978. The notification of Intent to Close the West Ash Pond was posted on April 9, 2021.

1.4 Type of CCR in Surface Impoundment

1.4.1 East Ash Pond

The types of CCR in the East Ash Pond are bottom ash, economizer ash, and boiler slag. The chemical constituents that make up the CCR is explained in further detail in Section 2.

1.4.2 West Ash Pond

Most of the CCR in the West Ash Pond has been removed. The types of CCR that were in the West Ash Pond are bottom ash, economizer ash, and boiler slag. The chemical constituents that make up the CCR is explained in further detail in Section 2.

1.5 Name and Size of the Watershed

The East Ash Pond and the West Ash Pond are located within the Waukegan River – Frontal Lake Michigan watershed, which is approximately 31,245 acres. The East Ash Pond and the West Ash Pond are constructed with elevated embankment crests or run-on diversion berms, which limits any surface water run-on into the ponds to the immediate area within the embankments.

1.6 Description of CCR Surface Impoundment Foundation

The Geosyntec October 2016 Federal CCR Rule History of Construction submittal summarized the foundations for the East Ash Pond and the West Ash Pond as follows:

"The East and West Ash Basins [Ponds] consist of fill embankments on all sides. Because no formational materials provide lateral structural support for the embankments, the basins do not contain abutments. The area west of the West Ash Basin [Pond] is at approximately the same elevation as the west embankment crest, such that there is not a downstream slope of the west embankment. A divider berm separates the two basins [ponds] and acts as the west embankment for the East Ash Basin [Pond] and the east embankment for the West Ash Basin [Pond]."

The following sections discuss the foundation materials' physical and engineering properties. KPRG reviewed the previously developed History of Construction for the East Ash Pond and the West Ash Pond, along with previously completed site investigations and concurred with Geosyntec's observations and conclusions.

1.6.1 Physical Properties of Foundation Materials

The East Ash Pond and the West Ash Pond are located directly above the Henry Formation. The physical properties of the foundation materials in which the East Ash Pond and the West Ash Pond are constructed from consists of dense poorly graded sand with some gravel and silt and silty sand. Beneath the Henry Formation is the Wadsworth formation, which consists of very hard low plasticity clay. This information was obtained from published geologic information and field investigations performed by KPRG (2005 and 2015), Patrick Engineering (2011), and Geosyntec (2015).

1.6.2 Engineering Properties of Foundation Materials

The engineering properties for the foundation materials listed in the following table are from the safety factor assessment performed by Geosyntec for the East Ash Pond and the West Ash Pond. The properties were determined from the site investigation, published correlations, and laboratory testing of samples collected during the site investigations.

Material	Unit Weight (pcf)	Drained friction angle (degrees)	Effective cohesion (psf)
Henry Formation	125	37	0

1.7 Description of the Construction Materials, Methods, and Dates

The descriptions of the construction materials, methods, and dates are based on the construction drawings created by NUS dated 1977 and 1978, the liner replacement drawing dated 2002, and the site investigations. As-built drawings and construction completion reports were not available for review at the time of preparing this operating permit. The drawings discussed in the following sections are located in Attachment 1.

1.7.1 Physical and Engineering Properties of Construction Materials

The East Ash Pond and West Ash Pond physical properties for the construction materials for this section are the same as the physical properties of the foundation materials. As described in Section 1.6.1, the physical properties for the foundation materials were described as poorly graded sand with some gravel and silt and silty sand.

Based on construction documents available from NUS in 1977 and 1978, dikes existed in the area prior to construction. During construction, these dikes were raised and widened with compacted fill material. The interior slopes and pond floor were originally lined with a geomembrane (Hypalon) liner. The Hypalon liner was removed and replaced with a 60-mil smooth high-density polyethylene (HDPE) geomembrane liner in 2003 and 2005 for the East Ash Pond and the West Ash Pond, respectively. Inspections of the liners in the summer of 2005 identified the geomembrane liner overtopped with a warning layer consisting of 12 inches of sand and 6 inches of limestone screenings.

Engineering properties used for the design and construction of the East Ash Pond and the West Ash Pond were not available. Engineering properties were estimated by Geosyntec for use in the factor of safety assessment performed for the East Ash Pond and the West Ash Pond. This estimate was based on site investigations, published correlations and laboratory testing of the embankment materials, which were presented in Geosyntec's soil properties calculations. Those engineering properties are listed below:

Material	Unit Weight (pcf)	Drained friction angle (degrees)	Effective cohesion (psf)
Upper Fill	125	37	25
Lower Fill	115	32	25

To perform the analyses, Geosyntec divided the embankments into two different materials, Upper Fill and Lower Fill. The Upper Fill is defined as the material from the embankment surface to approximately 10 to 12 feet below the embankment top and the Lower Fill is defined as the material from the bottom of the Upper Fill to the foundation material. As identified in Section 1.6.1 above, the foundation material is the Henry Formation.

1.7.2 Construction Methods

Based on construction documents available from NUS, dated 1977 and 1978, dikes existed in the area prior to construction. During construction, these dikes were raised and widened with compacted fill. This compacted fill was required to be placed at 95% relative compaction and any unsuitable material identified within the existing foundations was specified to be removed based on the construction drawings.

The side slopes were designed with 2H:1V (horizontal:vertical) interior slopes and 2H:1V or shallower exterior slopes. During the replacement of the Hypalon liners in 2003 and 2005, the interior slopes were flattened to 2.5H:1V. 2015 aerial photography identified that the existing exterior/downstream slopes ranged from approximately 1.4H:1V to 3H:1V or shallower. In 2016, exterior slopes along the eastern and southeastern side of the East Ash Pond were flattened to 2H:1V.

1.7.3 Construction Dates

The available construction drawings created by NUS were approved in 1977 and 1978, with the East Ash Pond and the West Ash Pond being constructed shortly thereafter. As stated above, the original Hypalon liners were replaced with HDPE liners in 2003 and 2005 for the East and West Ash Ponds, respectively. The eastern and southeastern slopes of the East Ash Pond were modified in 2016 based upon inspections conducted by a third-party consultant. These inspections are discussed later in Section 1.13.

1.8 Detailed Dimensional Drawings

Detailed dimensional drawings for the ponds are provided in Attachment 1. Attachment 1-1 contains construction drawings prepared by NUS, dated 1977 and 1978. The drawing for the liner replacement prepared by Midwest Generation, dated 2002, are included in Attachment 1-2, and Attachment 1-3 contains the 2016 slope modifications construction drawings.

1.9 Instrumentation

Water level monitoring instrumentation was installed in the East and West Ash Ponds in 2016 along the pond (outboard) side of the concrete weir walls. Included in the instrumentation is ultrasonic level detectors with automated remote sensors that notify station operators of the pond water level conditions. Because West Ash Pond is not in service, process wastewater is not directed to it and the water in the pond is either rainfall or runoff.

1.10 Area-Capacity Curve

An area-capacity curve for each pond created by Geosyntec is included as Figure 1-1 and 1-2.

1.11 Spillway and Diversion Capacities and Calculations

The East and West Ash Ponds do not contain spillways.

1.12 Surveillance, Maintenance, and Repair Construction Specifications

Written specifications for the original construction of the ponds were not available for this application, but the original construction drawings are provided in Attachment 1-1. The written specifications for the earthwork and HDPE geomembrane for the liner replacement of the East and West Ash Ponds, performed in 2003 and 2005, respectively, are included in Attachment 1-4 and Attachment 1-5. Warning posts were installed at the toe of interior pond slopes above the geomembrane liner system in 2003 and 2005 as a visual guide to limit potential damage to the liner system. The technical specifications for the slope modification, which included earthwork and geosynthetics, of the East Ash Pond in 2016 are included in Attachment 1-6.

1.13 Record of Structural Instability

In 2002, Raymond Professional Group, Inc. (RPG) prepared a report of engineering study to propose repairs to the instabilities observed in the interior embankments of the ponds. During the liner replacements in 2003 and 2005, the recommendation of flattening the interior slopes to 2.5H:1V was completed.

In 2002 and 2003, RPG inspected the east and south embankments of the East Ash Pond. The inspections "indicated areas of undercutting and soft soil at the downstream toe of the embankment, observations of some seepage from the embankment, and localized erosion of the perimeter access road east of the East Ash Pond." These areas were addressed during the 2003 and 2005 liner replacement projects. These areas, as well as the eastern and southeastern slopes of the East Ash Pond, were re-graded in 2016.

In 2009, 2014, and 2015, Valdes Engineering, also hired by Midwest Generation, performed inspections of the East and West Ash Ponds and did not document any structural instability. The initial structural stability assessment completed pursuant to 40 CFR Part 257.73(c), dated October 2016, did not identify structural instabilities. Subsequent impoundment periodic inspections (inspections performed through 2020) did not identify any structural deficiencies that would affect the stability of the East Ash Pond and the West Ash Pond. The 2018 inspection identified an area of minor erosion that did not compromise the stability of the East Ash Pond and the station revegetated this area.

2.0 Narrative Description of the Facility, 845.220(a)(2)

2.1 CCR Type and CCR Chemical Analysis

The East Ash Pond and the West Ash Pond both contained bottom ash, economizer ash, and boiler slag. This occurs because one pond is used at a time and the ponds' usage are alternated. Once one pond was full, that pond was taken out of service for accumulated ash removal for off-site disposal, and during that time, the other pond was used for CCR accumulation. The CCR in the West Ash Pond has been removed, and CCR is no longer sluiced to it. The CCR in the East Ash Pond and the West Ash Pond were sampled and analyzed and the results are shown in Table 2. The laboratory data package is included in Attachment 2-1.

2.2 Maximum Capacity

The estimate of the maximum capacity of the East Ash Pond is 184,000 cubic yards (CY). The estimate of the maximum capacity of the West Ash Pond is 223,000 CY.

2.3 Waste Streams

Waukegan has not sent CCR or non-CCR waste streams to the West Ash Pond as of April 11, 2021. Midwest Generation has submitted a request to the USEPA to continue sending all CCR and non-CCR waste streams to the East Ash Pond while they develop alternative capacity to replace the East Ash Pond. This request is under USEPA review and in accordance with 845.700(d)(2)(B), the East Ash Pond deadline to stop receiving waste is tolled until the USEPA makes a decision. Currently, the East Ash Pond is receiving the following CCR waste streams:

CCR Waste Streams	Description	Average Flow (gallons per day)
Ash Sluice Water	Sluice water from generating units Unit 7 and Unit 8	1,600,000 (Typical)
Unit 7 Sluice Water Overflow Tank Effluent	Effluent discharged from the Unit 7 ash sluice overflow tank, which collects overflow water from the bottom ash hoppers	300,000 (Intermittent)

Currently, the East Ash Pond is receiving the following non-CCR waste streams:

Non-CCR Waste Streams	Description	Average Flow (gallons per day)
Coal Yard Runoff Basin Overflow	Overflow water from the station’s coal yard runoff basin	1,000,000 (Intermittent)
Main Collection Tank Effluent	Effluent from the main collection tank that collects various wastewaters from the station’s operations	2,000,000 (Typical)

As stated above, the West Ash Pond no longer receives any waste streams as of April 11, 2021. The East Ash Pond will continue to operate until an alternative disposal capacity has been developed, which is expected to be completed by October 11, 2023. The Waukegan Flow Diagram is included in Attachment 2-2 that shows the waste streams that enter the East Ash Pond.

2.4 On-Site Transportation Plan

The Waukegan generating station property is a secure facility. The property boundary is fenced with one main gate that is guarded 24 hours a day, 7 days a week, and 365 days a year. Access to the plant is controlled through the one main gate with visitors required to sign in and out with the guard personnel. Other gates are present at the facility, but they remain locked at all times with access only provided by Midwest Generation personnel.

Upon approval of this permit, the East Pond and the West Pond will be closed and will no longer be used as CCR surface impoundments. The East Pond will be closed with the CCR remaining in place and the construction of a final cover system while the West Pond will be closed by removing the CCR and decontaminating affected areas so the West Pond can be reused as a low volume wastewater and stormwater pond. During the closure activities that main gate access road, mentioned above, will be used to control access to the property.

The ponds will be accessed using the existing roads on the property. There is one main road that leads from the main access gate located in the northeast corner of the property to the ponds that are located on the south side of the property. This road is shown on Figure 2. The ponds are encircled by an access road that allows 360-degree access to the ponds and this road is also shown on Figure 2. The roads shown on Figure 2 will be used to access the East Pond and the West Pond by construction personnel to bring materials and equipment that will be used to execute the closure process. These same roads will be used to haul the material removed from the West Pond off-site as well as bringing off-site fill material and the components of the final cover system to the East Pond. The normal day to day operations of the East Pond and the West Pond does not require access. Midwest Generation personnel use the access roads to perform inspections as needed to ensure that no issues arise. On a quarterly basis, groundwater sampling will be performed at the monitoring wells that surround the East Pond and the Wes Pond and these roads will be used to access the wells. Each sampling event requires 2 to 3 days to perform.

As needed, intersections at the property are traffic controlled with stop signs and the speed limit on the property is 5 miles per hour. The large construction equipment will have either backup alarms or spotters as they are backing up when near the edge of the ponds.

3.0 Site Location Map, 845.220(a)(3)

A site location map on the most recent United States Geological Survey (USGS) quadrangle of the area from the 7 ½ minute topographic series has been included in Attachment/Figure 3. This map includes details regarding the facility and adjacent properties boundaries extending 1000 meters, surface waters, the prevailing wind direction, and the limits of all 100-year floodplains. Alongside this, all natural areas designated as a Dedicated Illinois Nature Preserve under the Natural Areas Preservation Act, all historic and archaeological sites designated by the National Historic Preservation Act and the Illinois Historic Sites Advisory Council Act, and all areas identified as critical habitat under the Endangered Species Protection Act of 1973 and the Illinois Endangered Species Protection Act are also shown on this map.

4.0 Site Plan Map, 845.220(a)(4)

Site plan map(s) in accordance with 845.220(a)(1)(4) are included in Attachment 4. The information required is depicted on multiple maps. Figure 4-1 shows the entire Waukegan Station including the existing groundwater monitoring wells, the existing CCR surface impoundments and the main service corridors, transportation routes, and access roads. Cross-sectional maps showing the boundaries above and below ground level of the facility and CCR surface impoundments are included on Figures 4-2 through 4-5.

5.0 Construction Description, 845.220(a)(5)

Midwest Generation intends to retire the Waukegan Generating Station in June 2022. As a result, both of the CCR surface impoundments, the East Pond and the West Pond, will be closed. The East Pond will be closed in place using a final cover system and the West Pond will be closed by removal and repurposed to manage stormwater and low volume wastewater. The closure of each pond is discussed in the sections below.

5.1 East Pond Closure Description

The East Pond will be taken out of service and closed in place in accordance with 845.750. The existing CCR will be left in place and covered with a final cover system designed in accordance with 845.750(c). The anticipated steps to execute the closure in place of the East Pond are listed below and outlined in the East Pond closure plan:

1. Ceasing all CCR and non-CCR inflows to the pond;

2. Obtaining a construction permit from the Illinois EPA for closing the pond;

3. Drawing down the free surface water in the pond by evaporation and by draining water into the Recycle Water Sump in the northwest corner of the pond;

4. Once the water elevation is below the Recycle Water Sump's overflow weir elevation, promoting additional drainage and dewatering by excavating sumps and trenches within the CCR material, using portable pumps as necessary to remove additional water by pumping water over the weir into the Recycle Water Sump, and/or utilizing earthmoving equipment to move the CCR within the pond;

5. Upon completion of dewatering and stabilization of the impounded CCR, establishing the slopes for the final cover system by grading the stabilized CCR material and placing and grading general fill material over the stabilized CCR to establish the slopes for the final cover system;

6. Installing an engineered final cover system (ClosureTurf®), which consists of a structured geomembrane as the system's low permeability layer and a synthetic turf with sand infill as the system's final protective layer; and

7. Initiating post-closure monitoring of groundwater and the final cover system's integrity.

To ensure the success of the final cover system, the remaining CCR in the East Pond will be graded to direct stormwater runoff towards the low volume pond that the West Pond will be converted in to. After the CCR in the East Pond is graded, general fill material will be placed over the CCR to establish the necessary grades to drain stormwater off the final cover system. The slope of the grades of this general fill will be steep enough to drain stormwater off the final cover system but not so steep as to cause erosion of the final cover system. This will minimize the potential for ponding and infiltration into the CCR below. As the slopes are constructed, measures will be taken to prevent sloughing and movement of the material and final cover system during the post-closure period. The layer of fill material directly below the geomembrane will be free from large, protruding, or sharp objects that could potentially damage the geomembrane.

The proposed final cover system for the East Pond is an engineered final cover system called ClosureTurf that was developed by Watershed Geo, LLC. ClosureTurf consists of a structured geomembrane overlain by engineered synthetic turf infilled with a sand/aggregate mixture. The structured geomembrane will minimize the post-closure infiltration of liquids into the CCR.

Section 845.750(c)(1) requires that the low permeability layer must have a permeability less than or equal to the permeability of any bottom liner system present or a hydraulic conductivity no greater than 1 x 10^{-7} centimeters per second (cm/sec). The East Pond currently has a 60-mil high-density polyethylene (HDPE) geomembrane liner, therefore, the structured geomembrane's permeability for the final cover system must be equal to the permeability of the existing 60-mil liner. As such, the structured geomembrane in the ClosureTurf final cover system will be a 60-mil HDPE structured geomembrane that combines a studded drain surface on the top side and a spiked friction surface on the bottom side into one geomembrane liner.

When using a geomembrane as the low permeability layer, it is required by 845.750(c)(1)(B)(i) to have a hydraulic flux equivalent or superior to a 3-foot layer of soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec. The following table demonstrates that the geomembrane provides a superior performance at reducing the infiltration of liquid when compared to a 3-foot thick layer of earthen material. The following table was obtained from the East Pond closure plan created by Sargent & Lundy and is recreated here to demonstrate the geomembrane that will be used as part of the ClosureTurf final cover system is compliant with 845.750(c)(1)(B)(i).

Table – Liquid Flow Rate Comparison Between Low Permeability Layers Constructed Using Geomembrane & Earthen Material

Parameter	Symbol	Value
Liquid Flow Rate Through Earthen Material		
Hydraulic Conductivity	k	1×10^{-9} m/sec
Hydraulic Head Above Layer	h	0.11 m
Layer Thickness	t	3 ft = 0.91 m
Hydraulic Gradient Through Earthen Material	$i = h / t$	0.12
Liquid Flow Rate Through Layer per Acre of Final Cover System	$q = k \times (i + 1)$	1.12×10^{-9} $m^3/sec/m^2$
Liquid Flow Rate Through Geomembrane		
Hole Area in Geomembrane	a	3.1 mm^2 / 4000 m^2
Acceleration Due to Gravity	g	9.81 m/sec^2
Hydraulic Head Above Layer	h	0.11 m
Liquid Flow Rate Through Layer per Unit Area	$q = 0.6a(2gh)^{0.5}$	6.83×10^{-10} $m^3/sec/m^2$

The explanation and calculations used to determine the values in the above table are located in the closure plan located in Attachment 7-1.

The geomembrane comes in rolls, which will be deployed with the spike side down and the stud side up on top of the graded general fill material. The rolls will be deployed perpendicular to the slope elevation contours and the deployment method will protect the geomembrane as well as the graded general fill material. Adequate anchoring will be used, such as sand bags, to prevent uplift by wind during the deployment of the geomembrane rolls. The edges of each roll are overlapped in the downgrade direction a minimum of three inches to form the seam that is then welded together. Welding is performed by either extrusion welding or hot wedge welding depending on manufacturer's recommendations and as construction of the geomembrane dictates.

The geomembrane will be covered with engineered synthetic turf and sand/aggregate infill which will be the final protective layer. The engineered synthetic turf is green and replaces the need for an erosion layer and vegetation while providing a natural look and feel of grass and protecting the geomembrane from extreme weather. The engineered turf does not require as much maintenance as a vegetated final protective layer which needs to be mowed regularly and may need to be reseeded, refertilized, and/or regraded throughout the post-closure period. The engineered turf will be installed in accordance with the manufacturer's recommendations and equipment used during the installation will not damage the turf or the underlying geomembrane. The engineered synthetic turf also comes in rolls, which will be rolled out on top of the geomembrane starting from the highest slope to the lowest slope. The rolls will be deployed so that the filaments of the engineered turf are pointed upslope and the edges of each roll touch each other so the seams can be joined together. The turf will be laid substantially smooth and it will be secured with sandbags at the top of any slope after it is deployed. The engineered synthetic turf will cover all of the geomembrane and will follow the same slope as the geomembrane. The rolls of the engineered turf are joined together either by sewing with polyester thread or by fusion seaming with a fusion welder. It's important to note that a thicker final protective layer is not needed for frost protection because the freeze-thaw cycle and freezing temperatures does not affect the hydraulic performance of the geomembrane liner that will be used as the final protective layer based on the Geosynthetic Institute's White Paper #28, titled "Cold Temperatures and Free[ze]-Thaw Cycling Behavior of Geomembranes and Their Seams."

A specified sand/aggregate infill will be placed between the blades of the engineered synthetic turf after the turf is in place on top of the geomembrane. The sand infill will be spread with a minimum thickness of 0.5 inches and a maximum thickness of 0.75 inches using conveyor systems and/or express blowers. The infill will be driven into the space between the synthetic blades and the sand/aggregate mixture will meet ASTM C-33-03 for fine aggregates. The infill thickness will be checked at approximately 100-foot grid intervals. The sand infill installation will be done as to not damage or displace previously installed ClosureTurf components and the placement will not occur with snow or ice on the engineered turf.

An anchor trench will be used on the crest of the slope of the graded general fill material to anchor the ClosureTurf system. The anchor trench will bury the top slope edge of the geomembrane and engineered turf beneath two feet of soil to anchor the geomembrane in place. The soil that is placed in the anchor trench will be compacted to prevent the potential pullout of the geomembrane and engineered turf.

QA/QC testing will be performed on the ClosureTurf cover system as part of the installation. Specifications and drawings for the closure of the East Pond are located in Attachment 5.

<u>5.2 West Pond Closure Description</u>

The West Pond will be closed by removal of the existing CCR and decontaminating affected areas in accordance with 845.740(a). Once closed, Midwest Generation intends to repurpose the West Pond as a low volume wastewater pond. The anticipated steps to execute the closure by removal are listed below and are also discussed in the closure plan for the West Pond.

1. Removing the CCR from the pond and transporting the material to a beneficial-use facility or a permitted disposal facility in accordance with current and historic Station maintenance procedures for the pond;

2. Obtaining a construction permit from the Illinois EPA for closing the pond;

3. Removing the protective granular fill layer over the existing geomembrane liner from the pond and transporting the soil materials to a permitted disposal facility;

4. Inspecting and decontaminating the pond's existing geomembrane liner and appurtenant structures (*e.g.*, concrete inlet and outlet structures) for re-use in accordance with the closure

construction permit issued by the Illinois EPA, including submittal of visual inspection documentation and analytical testing results to demonstrate the existing liner and structures are no longer contaminated with CCR constituents;

5. Sampling the groundwater at the pond site to verify the groundwater monitoring concentrations do not exceed the groundwater protection standards established for constituents in accordance with the operating permit issued by the Illinois EPA for the pond; and

6. Certifying (via a qualified professional engineer licensed in the State of Illinois) that the CCR has been removed from the pond and the CCR surface impoundment has been decontaminated in accordance with the closure plan in effect at the time of closure and in accordance with the corresponding construction permit issued by the Illinois EPA

In June of 2020, the West Pond was taken out of service for routine cleaning. Midwest Generation removed the CCR present to reclaim storage capacity needed to return the pond to service to allow for the future routine cleaning of the East Pond, as needed. The CCR was removed in accordance with Midwest Generation's ash pond maintenance program where CCR is periodically removed as part of the pond's normal operation. As of the date of this permit application, most of the CCR that was present in the West Pond had been removed, with only a minimal amount remaining. The remaining CCR in the West Pond will be removed in accordance with Midwest Generation's ash pond maintenance program.

Upon approval of the construction permit application, the closure by removal activities will begin with removing the warning layer. The warning layer consists of 18-inches of granular material that covers the existing 60-mil geomembrane liner. The granular material will be excavated and loaded onto trucks and transported off-site for disposal at a permitted disposal facility. The CCR will be hauled off-site in accordance with 845.740(c), which includes proper manifests for each transported load, a transportation plan, on-site dust controls, signage and public notices, and managing stormwater to prevent contamination of surface and groundwater.

After the granular warning layer material has been removed, the geomembrane, inlet trough, outlet structure, and associated piping, etc. will be decontaminated. Decontamination procedures may include pressure washing, scrubbing, flushing or other generally accepted decontamination methods. After decontamination, the geomembrane liner will be visually inspected for damage and to ensure the liner is free of CCR. If damage is observed, the geomembrane liner will be repaired in accordance with the manufacturer's recommendations. The geomembrane liner will be tested to determine that CCR material is no longer present. The testing will occur based on the steps outlined on Drawing WKG-AP-CSK-004, Note 4 located in Attachment 5.

Specifications and drawings for the closure of the West Pond are located in Attachment 5.

After contractors have been chosen to conduct the closure construction and prior to earth moving activities, the contractor certifications identified on permit form 2CC will be provided to IEPA.

6.0 Facility Component Plans and Specifications, 845.220(a)(6)

The Waukegan Station has generating units that burn coal to generate electricity. The station burns coal in the boilers and the CCR byproducts resulting from burning coal are fly ash and bottom ash. The fly ash is captured before it escapes the boiler exhaust stacks and the bottom ash drops to the bottom of each boiler. The fly ash is collected in the stacks and sent to on-site storage silos using air pressure. The bottom ash is removed from the boilers and sluiced to the East Pond and West Pond for temporary storage. The West Pond was taken out of service in 2021 and is no longer used for temporary storage of CCR. An alternate demonstration to continue re-using the East Pond to manage CCR until the generating units are retired in June of 2022. The bottom ash CCR generated in the boilers is sluiced to the East Pond using an aboveground piping system. Historically, the East Pond and West Pond would alternate service so the CCR would only be sluiced to one pond at a time.

Attachment 1-1 contains the drawings that show the extent of the Waukegan generating station and sections/details for the construction of the East Pond and the West Pond. The generating station is located on the north side of the property near Greenwood Ave and the ponds are located on the south side of the property. Reviewing these documents shows that the piping that sluices CCR to the ponds emanate from the south side of the generating building, crossing aboveground approximately 100 feet over the inlet channel, at which point, the pipes go underground beneath an access road and the railroad yard coal management system for approximately 170 feet. South of the railroad yard coal management system, the pipes run aboveground for approximately 750 feet, where the pipes diverge and then one pipe runs aboveground for approximately 380 feet west to the West Pond inlet trough and the other pipe runs aboveground approximately 500 feet to the East Pond inlet trough. The sluice water enters the West Pond and East Pond through each ponds respective inlet troughs that are on the north side of each pond where the sluice water is evenly distributed into each pond. Once the sluice water enters each pond it disperses into the pond and allows the CCR to settle and remain in the pond. Each pond is constructed with a divider in the center forcing water that enters the pond to travel south around the divider and back north to the discharge structure for a total distance of approximately 1,800 feet. The divider increases the retention time in each pond. The water from each pond is collected in the sump that is located in the northeast corner of the West Pond and the northwest corner of the East Pond. The water from the sump is discharged through piping that returns to the generating station for reuse in the station’s processes. The water is returned to the station via piping that travels along the same path and adjacent to the sluice piping and is aboveground and underground at the same locations the sluice piping is. The return piping enters the generating station on the south side of the building.

7.0 Closure Construction, 845.220(d)

7.1 Closure Prioritization Category

7.1.1 East Ash Pond

In accordance with the requirements of Section 845.700(c), the category designation for the East Ash Pond is Category 3. The Category 3 designation for the East Ash Pond is based on the following:

- The East Ash Pond is an active CCR surface impoundment.

- There are no potable water supply wells or setbacks of existing potable water supply wells downgradient of the East Ash Pond. As such, Midwest Generation is not aware of any imminent threat to human health or the environment.

- Midwest Generation used the Illinois EPA EJ Start tool found at https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c to determine that the Waukegan Generating Station (401 E. Greenwood Ave., Waukegan 60087) East Ash Pond is within one mile of an area of environmental justice concern.

7.1.2 West Ash Pond

In accordance with the requirements of Section 845.700(c), the category designation for the West Ash Pond is Category 3. The Category 3 designation for the West Ash Pond is based on the following:

- The West Ash Pond is an inactive CCR surface impoundment.

- There are no potable water supply wells or setbacks of existing potable water supply wells downgradient of the West Ash Pond. As such, Midwest Generation is not aware of any imminent threat to human health or the environment.

- Midwest Generation used the Illinois EPA EJ Start tool found at https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c to determine that the Waukegan Generating Station (401 E. Greenwood Ave., Waukegan 60087) West Ash Pond is within one mile of an area of environmental justice concern.

7.2 Final Closure Plan

7.2.1 East Pond

The East Ash Pond will be closed with the CCR remaining in place and constructing a final cover system in accordance with Section 845.750. A final cover system will be constructed consisting of a HDPE geomembrane infiltration-control layer and vegetated, earthen erosion-control layer. The written closure plan complies with 845.720 and is included as Attachment 7-1.

7.2.2 West Pond

The West Ash Pond will be closed by removing the CCR in accordance with Section 845.740 and repurposed as a low volume waste pond to hold non-CCR process water. The written closure plan complies with 845.720 and is included as Attachment 7-2.

7.3 Closure Alternatives Analysis

A closure alternatives analysis (CAA) was completed for the East Pond and the West Pond. The CAA evaluated closing the East Pond by leaving the CCR in place in accordance with 845.750 and evaluated the West Pond by removing the CCR in accordance with 845.740 and by leaving the CCR in place in accordance with 845.750. The completed CAA is included in Attachment 7-3.

7.4 Proposed Closure Schedule

7.4.1 East Pond

The following schedule to execute the East Pond closure is reproduced from the East Pond closure plan. The East Pond closure activities are estimated to be completed in 2025. The following table lists the major milestones necessary for closing the East Pond and the expected duration to complete each milestone.

Table – Planning Level Schedule for Closing the East Pond

Activity	Estimated Duration
Prepare Closure Construction Design Documents	8 Months
Obtain Closure Construction Permit from Illinois EPA	12 Months
Hire Contractor to Complete Closure Activities in Accordance with Illinois EPA Permit	4 Months
Draw Down Water & Dewater Impounded Ash	14 Months
Grade Dewatered Ash, Place and Grade General Fill	3 Months
Install Final Cover System	2 Months
Submit Closure Report and Certification to Illinois EPA	2 Weeks
Obtain Approval of Closure Report and Certification from Illinois EPA	3 Months
Complete and Certify Closure of the East Ash Pond	--

7.4.2 West Pond

The following schedule to execute the West Pond closure is reproduced from the West Pond closure plan. The West Pond closure activities are estimated to be completed in 2023. The following table lists the major milestones necessary for closing the West Pond and the expected duration to complete each milestone.

Table – Planning Level Schedule for Closing the West Pond

Prepare Closure Construction Design Documents	6 Months
Obtain Closure Construction Permit from Illinois EPA	12 Months
Hire Contractor to Complete Closure Activities in Accordance with Illinois EPA Permit	4 Months
Remove Protective Granular Layers Above Existing Liner	1 Month
Decontaminate Existing Liner and Pond Appurtenances (Including Laboratory Testing)	2 Months
Obtain Approval from Illinois EPA to Re-Use Existing Liner for New Low Volume Waste Pond	3 Months
Submit Completion of CCR Removal and Decontamination Report and Certification to Illinois EPA	2 Weeks
Obtain Approval of Completion of CCR Removal and Decontamination Report from Illinois EPA	3 Months
Complete and Certify Closure of the West Ash Pond	--

7.5 Post-Closure Plan

Closure of the West Pond will be conducted by removing the CCR and decontaminating any areas affected by CCR in accordance with 845.740(a). A post-closure plan is not required for the West Pond based on 845.780(a)(2), but groundwater monitoring around the West Pond will occur for three (3) years in accordance with 845.740(b). Closure of the East Pond will occur by leaving the CCR in place and constructing a compliant final cover system. The Post-Closure Plan for the East Pond is included in Attachment 7-4.

8.0 Groundwater Modeling, 845.220(d)(3)

The groundwater modeling of the CCR surface impoundment as specified in Section 845.220(d)(3) is presented below.

8.1 Modeling Inputs and Parameters

Groundwater monitoring has identified that no statistically significant increases in groundwater concentrations around the East and West Ponds are contributable to the ponds. Therefore, the modeling that was conducted is based on a theoretical distribution of dissolved contaminants beneath the East Pond and the West Pond, assuming a source at the pond. The modeling looks at theoretical, potential contamination from the East and West Ponds, and it assumes the ponds contain CCR and water and that the liner is compromised or non-existent.

To conduct the support modeling a theoretical unit source with a concentration of “1” was established beneath the East Pond and the West Pond and projected forward in time 100 years with advection and dispersion to establish an equilibrated distribution of contaminants in groundwater if the ponds were the source. This equilibrated contaminant mass distribution was established as the initial conditions or base case. The equilibrated distribution (base case) of the mass was then used as the initial concentrations in the groundwater for model runs to simulate the closure alternatives to evaluate corresponding improvement in groundwater quality from the base case scenario.

The groundwater modeling inputs and parameters are discussed further in the groundwater modeling report in Attachment 8.

<u>8.2 Groundwater Modeling Results</u>

Four (4) closure scenarios were modeled involving the East Pond and the West Pond and the scenarios are listed below.

- Scenario 1: Closure by removal of both the East Pond and the West Pond;
- Scenario 2: Closure by removal of the East Pond and closure in place of the West Pond;
- Scenario 3: Closure in place of both the East Pond and the West Pond; and
- Scenario 4: Closure in place of the East Pond and closure by removal and repurposing of the West Pond.

The results of Scenario 1 indicate that removing the theoretical mass source reduces the hypothetical groundwater concentrations beneath the site approximately 20 percent within the first five years following closure. The modeling indicates that the hypothetical groundwater source has moved completely through the groundwater in the area immediately east of the ponds within approximately 30 years. The results for Scenario 2 are similar to the results of Scenario 1. The movement of the hypothetical groundwater source mass follows the same general direction towards Lake Michigan.

The results of Scenario 3 are similar to the results of Scenario 1 and 2. This is accomplished because the source mass is hydraulically isolated in both ponds by dewatering the CCR and the use of a final cover system. As stated in Scenarios 1 and 2, the groundwater source mass follows the same general direction towards Lake Michigan. The results of Scenario 4 are similar to the results of Scenarios 1 through 2 because Scenario 4 simulates a combination of Scenarios 1 through 3 by removing the source mass from the West Pond and hydraulically isolating the source in the East Pond by dewatering the CCR and the use of a final cover system. As with the other three scenarios, the groundwater source mass follows the same general direction towards Lake Michigan.

As the above results indicate, any of the four scenarios are effective at removing the hypothetical source and the hypothetical dissolved groundwater mass is quickly reduced, with the mass being completely flushed through the groundwater system east of the ponds within approximately 30 years. The groundwater modeling results for all four scenarios are discussed further in the groundwater modeling report in Attachment 8.

8.3 Capture Zone Modeling

Capture zone modeling is not applicable based on the selected method of closure.

8.4 Groundwater Modeling Software

The groundwater modeling was completed using standard publically available platforms, which included MODFLOW-NWT and for contaminant transport MT3D-USGS. The graphical user interface is Groundwater Vistas. Both MODFLOW-NWT and MT3D-USGS are publically available programs that can be downloaded from the USGS website at https://water.usgs.gov/water-resources/software/modflow-nwt/ and https://www.usgs.gov/software/mt3d-usgs-groundwater-solute-transport-simulator-modflow, respectively.

9.0 Groundwater Monitoring Program, 845.220(a)(7)

The groundwater monitoring program of the CCR surface impoundment as specified in Section 845.220(a)(7) is presented below.

9.1 Hydrogeologic Site Characterization

The following subsections provide information on the geology and hydrogeology of the site as required under Section 845.620(b). Site geology and hydrogeology are discussed separately below. Referenced Tables and Figures are provided at the end of this report. Other supporting documentation is provided with the referenced Attachment.

9.1.1 Geology

The physiography of Lake County is made up of moraines, outwash plains, lake plains, kames, stream terraces, flood plains, beaches and bogs. It is in the Wheaton Morainal country of the Great Lakes section of the Central Lowland province with the natural topographic relief being primarily associated with differences in deposition thickness resulting from the most recent glaciation. Near surface soils in the general vicinity of the subject impoundments have been grouped as the Orthents loamy, undulating. These soils are well drained with organic content ranging from 0.2 to 2 percent. They have a moderate corrosivity rate and a pH range from slightly acidic to slightly basic (5.6 to 8.4). Surface runoff class is medium (Soil Survey of Lake County Illinois). Based on the Surficial Geology Map of the Chicago Region (ISGS Circular No. 460, 1971) the surficial deposits in the vicinity of the subject surface impoundment are identified as part of the Henry Formation which is generally described as sand and gravel with local beds of silt and/or exposed Silurian dolomite bedrock.

The general stratigraphy in the area of the generating station consists of fill surrounded by Henry Formation Parkland facies sediments intermixed with Grayslake peat, muck, marl and organic rich sediments. Local beach sand deposits include fine to medium, well-sorted sands mixed with organics and may include lenses of clay and peat (Surficial Geology of the Zion Quadrangle, 2009; Surficial Geology of the Waukegan Quadrangle, 2010). These unconsolidated deposits overlay

Silurian dolomite with top of bedrock estimated between 90 and 115 feet below ground surface (bgs). The Silurian dolomite is underlain by the Maquoketa Group, which includes the Scales Shale which is considered a regional aquitard separating the overlying Silurian dolomite from the deeper Cambro-Ordovician sandstone and limestone aquifers.

To evaluate local stratigraphy, logs were obtained for borings in the vicinity of the Waukegan Generation Station (it is noted that all of these log locations are upgradient or side gradient of the Station and include two wells on property [see Section 9.1.2]). The depths of these borings range from 9.5 feet to 1,540 feet. The stratigraphic data from these borings is summarized in Attachment 9-1. In addition, well logs from 10 monitoring wells that were installed in the vicinity of the subject surface impoundment (MW-1 through MW-9 and MW-16; see Figure 9-1) were evaluated, with those borings ranging in depth from 18 feet to 32 feet. This information is also included in Attachment 9-1. Boring logs for these monitoring wells are included in Attachment 9-2. It is noted that monitoring wells MW-10 through MW-15 were installed by another company as part of Environmental Land Use Control (ELUC) definition associated with a site investigation of the former Giess-Pfleger Tannery site investigation/remediation, located immediately west of the Waukegan Generation Station, which extended onto the facility property. Several Freedom of Information Act (FOIA) requests have been submitted to Illinois EPA for the logs for these wells, however, to date those files are not available. Therefore, KPRG completed soil borings to 20 feet bgs at each location to develop the stratigraphic logs for each of these well locations. These boring logs are included in Attachment 9-2.

Based on an evaluation of on-site monitoring well logs, the following general site-specific stratigraphy is defined and geologic cross-sections are provided as Figures 9-2 and 9-5 based on the on-site monitoring well boring logs:

- Fill (9.5’ to 24’ thick) – Consisting of brown and black fine to medium sand with some gravel and silt seams. The fill includes ash, black cinders, slag and occasional coal and wood fragments.

- Organic clayey silts, silty sand and/or peat (0’ to 3.5’ thick) – Localized, discontinuous lenses of organic black to gray clayey silts and silty sands or peat separating the fill from underlying sand.

- Sand (thickness undetermined; borings terminate within unit) – Consisting of generally light brown to brown or gray, well graded, fine to medium sands with some localized more gravelly seams/layers.

Based on a review of three old water well boring logs (1920 vintage) obtained from the Johns-Manville site located immediately to the north of the Waukegan Generating Station (see Attachment 9-1, Well Count Numbers 10, 62 and 63), the above noted sand unit is underlain by 25 to 30 feet of “hard pan”, another 40 to 50 feet of lacustrine clays (blue clay) and 3 to 15 feet of sand/gravel at which point top of bedrock was documented.

Although no specific chemistry information is available for the Henry Formation deposits, the sands in the area tend to be dominated by quartz, feldspars and micas and include whole rock fragments associated with glacially derived erratics (including igneous, metamorphic and sedimentary). With depth, it would be anticipated to see an increase in calcareous fragments associated with the underlying dolomite bedrock.

The underlying Silurian dolomite is estimated at approximately 360 feet thick (Patrick Engineering, 2011). Beneath the Silurian dolomite is the Ordovician age Maquoketa Group including the Scales Shale, which is a recognized regional aquitard which hydraulically isolates the deeper bedrock aquifers from the shallower Silurian dolomite.

Silurian dolomite is a calcium-magnesium carbonate rock that includes horizons of cherty (silica) nodules and is documented both regionally and locally to include mineralization along fractures and within vugs. The mineralization includes, but is not limited to calcite (calcium carbonate) and various sulfide minerals such as pyrite, marcasite, etc. As such, the presence of these minerals and associated weathering products can also be expected within the overlying unconsolidated materials.

There are no underground mines beneath the subject CCR surface impoundment.

9.1.2 Hydrogeology

Based on information from the Soil Survey of Lake County, the average annual precipitation is approximately 34 inches with about 60% of that total falling between May and October of any given year. The average seasonal snowfall is approximately just over 37 inches. More site-proximal precipitation data is provided in Table 9-1.

The nearest surface water body is Lake Michigan located to the east of the subject CCR units (see Figure 9-1). Groundwater beneath the subject unit occurs under water table conditions. Saturated conditions in the immediate vicinity of the subject surface impoundments (wells MW-1 though MW-5, MW-7 and MW-16) range from between approximately 11.75 and 24.61 feet bgs, depending on the well location. Wells to the west along the western property border have shallower groundwater (e.g., well MW-6 located adjacent to a drainage channel). Table 9-2 provides groundwater elevation measurements obtained for the on-site monitoring wells in the vicinity of the subject CCR surface impoundment which includes data for the CCR monitoring wells associated specifically with the subject impoundments (MW-01 though MW-04, MW-09, MW-11, MW-14 and MW-16). A hydrograph of water levels is provided as Figure 9-6. A review of the hydrograph shows some temporal fluctuations with the highest water levels generally occurring in the spring timeframe (April thru June).

Groundwater flow maps for the four quarters from 3rd quarter 2020 through the 2nd quarter 2021 are provided as Figures 9-7 through 9-10. The maps include groundwater elevation data from all 15 wells in the area, including the specific CCR monitoring wells associated with the subject surface impoundment. Based on a review of the maps, groundwater flow is in an east-southeasterly direction. These maps are consistent with historical flow data for the site. Table 9-3 provides a summary of the flow direction, gradient and an estimated rate of groundwater flow for each sampling event. The flow rate was calculated using the following equation:

$$V_s = \frac{\mathrm{K}dh}{n_e dl}$$

Where

V_s = seepage velocity (distance/time)
K = hydraulic conductivity (distance/time)
dh/dl = hydraulic gradient (unitless)
n_e = effective porosity (unitless)

Hydraulic conductivity values were initially estimated for monitor wells MW-1, MW-3 and MW-5 from slug tests completed by Patrick Engineering in 2011. The geometric mean of the data for these wells was approximately 350 feet per day (ft/d; 4.05 $x10^{-3}$ ft/sec) for each well, as calculated by Patrick Engineering (Hydrogeologic Assessment Report – Waukegan Generating Station, February 2011). The slug test data were reviewed as part of the modeling study being completed for the Construction Permit application and the data were reanalyzed using corrected input values for the well casing and borehole dimensions, effective porosity of the sand filter pack material and minor line fitting refinement. The revised geometric mean of the test data for these wells decreased to approximately 155 ft/d ($1.79x10^{-3}$ ft/sec) for each well. This revised value was used in Table 9-3. The estimated effective porosity of the aquifer materials (0.35) was obtained from literature (Applied Hydrogeology, Fetter, 1980).

At this time, based on the geology discussion in Section 9.1.1 and the site-specific hydrogeology discussions above, the groundwater beneath the CCR surface impoundment is considered as Class I Potable Resource Groundwater in accordance with Section 620.210. However, an ELUC is established where the CCR surface impoundments are located as part of a Compliance Commitment Agreement (CCA) between Midwest Generation and Illinois EPA. The ELUC states that the groundwater shall not be used as potable water. The extent of the established and approved ELUC is provided on Figure 9-11.

The Waukegan Station does not have any potable water supply wells on the property. All water used at the Station is obtained from Lake Michigan. A survey of potable water sources within a 2,500 feet radius of the Midwest Generation Waukegan Generating Station was completed by Natural Resources Technology (NRT) in 2009. The following databases and sources of information were utilized in order to determine community water source and water well locations and construction in the vicinity of the ash pond wastewater treatment systems:

- Illinois State Geological Survey (ISGS) -Water Well Database Query;
- Illinois State Water Survey (ISWS) Private Well Database and water well construction report request; and
- Illinois Division of Public Water Supply web-based Geographic System (GIS) files;

As part of this permit preparation, KPRG evaluated the NRT information and reviewed the new Illinois State Geological Survey database and interactive map references as "ILWATER". The survey results are provided on Figure 9-12. There are no potable use water wells downgradient of the subject surface impoundments. Two water wells were identified within a 2,500-foot radius of the Station's subject CCR surface impoundment. The two wells noted to the west (upgradient) of the subject site on Figure 9-12 are former Giess-Pfleger Tannery wells circa 1917 vintage. The tannery and these wells are also no longer present. It is noted that the above-mentioned NRT evaluation identified two water wells to the north-northwest (upgradient), which would be just past the 2,500-foot radius shown on Figure 9-12. Those wells were owned by the Johns-Manville Corporation and were circa 1920 vintage. They are no longer present (entire Johns-Manville site decommissioned as part of a cleanup).

A search of the Illinois Department of Natural Resources dedicated nature preserve database (https://www2.illinois.gov/dnr/INPC/Pages/NaturePreserveDirectory.aspx) was performed to determine whether there may be a nearby-dedicated nature preserve. There were no identified dedicated nature preserves in the immediate vicinity of the subject surface impoundments. Illinois Beach State Park is located approximately three-quarters of a mile to the north.

Based on the geology of the site presented in Section 9.1.1 and the above hydrogeology discussions, the primary contaminant migration pathway for a potential release from the subject CCR surface impoundment would be downward migration to groundwater within the unconsolidated sandy aquifer. Due to its proximity to Lake Michigan, which is a hydrogeologic flow boundary, minimal to no downward vertical flow mixing would be anticipated. There are no other utility or man-made preferential pathway corridors that would act to potentially intercept the flow to move any contamination in a direction other than to east-southeast. There are no potable water wells downgradient of the subject CCR surface impoundment as previously discussed. The City of Waukegan does obtain its drinking water from Lake Michigan. The water utility is located approximately one mile south of the subject surface impoundments. A Freedom of Information Act (FOIA) request was made to the utility for an approximate location of the water intakes within the lake, however, the request was denied due to security reasons.

There is quarterly groundwater quality data associated with the subject CCR surface impoundments dating back to December 2010. However, the parameter list established in 2010 was slightly different from that specified in Section 845.600 and also included analysis of dissolved inorganic parameters rather than total inorganic parameters. That historical water quality data is provided in Attachment 9-3.

The East and West Ponds are subject to the federal requirements under Federal Register, Environmental Protection Agency, 40 CFR Parts 257.94, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule dated April 17, 2015 (Federal CCR Rule). As required under the Federal CCR Rule, eight rounds of background sampling were completed for the monitoring wells within the monitoring network for the subject CCR surface impoundment (MW-01 though MW-04, MW-09, MW-11, MW-14 and MW-16). Wells MW-09, MW-11 and MW-14 are considered upgradient monitoring wells and the remainder of the monitoring points are downgradient wells. This sampling included the full list of Appendix III (detection monitoring) and IV (assessment monitoring) parameters. Subsequently, quarterly groundwater monitoring of these wells was continued for only Appendix III detection monitoring parameters since there were no detections of Appendix III parameters above the established statistical background for those wells and/or an Alternate Source Demonstrations (ASDs) were completed indicating a source of impacts other than the subject surface impoundments. Since the effective date of the State CCR Rule, quarterly groundwater monitoring for the full list of parameters specified in 845.600, which includes all parameters in the Federal CCR Rule Appendix III/IV, has continued. This data is provided in Table 9-4. In addition, it is noted that Illinois EPA added turbidity measurements to the list with a required eight rounds of background of that parameter for each well in the monitoring network for the subject CCR surface impoundment. This data is provided in Table 9-5.

9.2 Groundwater Monitoring System Design and Construction Plans

A comprehensive monitoring well network in the vicinity of the East and West Ponds was established in 2010, the CCA, as well as other work in the area (e.g., the ELUC wells installed as part of Giess-Pfleger Tannery site investigation/remediation located immediately west of the Waukegan Generation Station). The well spacing for the downgradient wells was developed as part of a previous hydrogeologic assessment. The well depths were determined based on depth to groundwater and the base elevations of the ponds being monitored and were approved by Illinois EPA. Groundwater flow in the area is generally to the east-southeast towards Lake Michigan. Monitoring wells MW-09, MW-11 and MW-14 (see Figure 9-1) are the established upgradient water quality monitoring points. Groundwater data from these wells will be evaluated to provide a statistically representative upgradient water quality prior to that water passing beneath the regulated units. Wells MW-01 through, MW-04 and MW-16, which are located essentially at the pond boundaries, will serve as down-gradient monitoring points. This proposed monitoring well network will be utilized for determining whether potential pond leakage may be causing or contributing to groundwater impacts in the vicinity of the units. Other monitoring wells in the area may be used for subsequent supplemental evaluations, as needed.

Monitoring wells MW-01 through MW-04 were installed in 2010 by Patrick Engineering, Inc. and wells MW-09 and MW-16 were installed by KPRG and Associates, Inc. in 2014 and 2015, respectively. The wells were drilled using 4.25-inch hollow stem augers. The wells were completed with standard 2-inch inner-diameter PVC casing with 10-feet of 0.010 slot PVC screen. Filter sand pack around each screen was extended to approximately 2-feet above the top of the well screen. The remainder of the annulus was backfilled with bentonite. Current surface completions include stick-up (above grade two to three feet) locking protector casings set in concrete aprons. The wells are further protected by traffic bollards, as necessary. Boring logs and well construction summaries for these wells are provided in Attachment 9-2. Ground surface and top-of-casing elevations were surveyed by an Illinois licensed surveyor and are included in the previously referenced groundwater elevation table (Table 9-2). As previously stated, monitoring wells MW-11 and MW-14 were installed by another company as part of ELUC definition associated with a site investigation of the former Giess-Pfleger Tannery site investigation/remediation, located immediately west of the Waukegan Generation Station, which extended onto the facility property. Several FOIA requests have been submitted to Illinois EPA for the logs for these wells, however, to date those files are not available. Therefore, KPRG completed soil borings adjacent to the wells at each location to develop the stratigraphic logs for each of these well locations (see Attachment 9-2). Well MW-11 is completed with an above ground protective casing and well MW-14 is completed as a flush-mount well.

Each monitoring well within the sampling network is outfitted with a dedicated sampling system. Specifically, each well has a QED Environmental Systems (QED) Well Wizard Model P1101M dedicated sampling pump with Model No. 37789 intake screens (0.010-inch slot). The screens are set within approximately one foot of the base of the monitoring well.

In accordance with requirements under Section 845.630(g), Attachment 9-4 includes an Illinois licensed Professional Engineer certification of the above-defined monitoring system.

9.3 Groundwater Sampling and Analysis Program

9.3.1 Sample Frequency

The East and West Ponds are regulated under the Federal CCR Rule. As such, all of the above defined monitoring wells (upgradient and down-gradient) have been sampled on a quarterly basis starting the 4th quarter of 2015 for eight consecutive quarters for both Appendix III and Appendix IV parameters specified in the Federal CCR Rule which is the same parameter listing as provided under the State CCR Rule Section 845.600(a). This dataset will facilitate the development of proper statistical evaluation procedures for the site and use in development of applicable GWPSs for each constituent pursuant to Section 845.600(b). Illinois EPA added turbidity as an additional parameter that will require development of a statistical background. Since this parameter was not included within the Federal CCR Rule, eight rounds of turbidity measurements were obtained within the 180-day period since the effective date of the State Rule. However, this restricted period of background data collection does not facilitate evaluation of potential seasonal variations during the development of statistical background for this parameter.

Currently, all wells within this CCR monitoring network are being sampled on a quarterly basis for all parameters specified in Section 845.600(a) plus calcium and turbidity. Between quarterly monitoring events, monthly groundwater level measurements from all designated CCR monitoring wells will be also obtained and recorded. The subject ponds are outfitted with ultra-sonic transducers, which provide for a measure of water within the impoundments. A survey reference point will be established to facilitate conversion of the water level readings to elevations for recording concurrent with monthly water level measurements.

Quarterly groundwater monitoring will continue during the active life of the impoundment and the post-closure care period or, if closure is by removal, then in accordance with monitoring frequency requirements under Section 845.740(b). It is noted that if after 5 years of quarterly monitoring it can be demonstrated that the facility meets the requirements specified in Section 845.650(b)(4), the owner can petition Illinois EPA to shift the monitoring frequency to semi-annual.

9.3.2 Sampling Preparation and Calibrations

Prior to any sampling event, the Station's designated Environmental Specialist shall be notified in advance of sampling crew arrival so that any arrangements can be made, including security clearance and training.

Prior to sampling activities, and at intervals recommended by the manufacturer, all non-dedicated equipment shall be cleaned and calibrated. Specifically, the field parameter water quality meter to be used for pH, specific conductance, turbidity and temperature will be calibrated using standard reference solutions. In addition, an operational check of the electronic water level probe will also be performed by placing the probe into a bucket of water and ensuring that the audio signal is triggered when the sensor meets the water interface. The associated tape measure of the probe will also be checked for wear.

The monitoring network consists of all dedicated sampling equipment (QED Well Wizard P1101M). The controller used to operate individual bladder pumps will be checked and maintained prior to arrival at the site based on manufacturer specifications.

All lab ware shall be obtained directly from an Illinois certified laboratory. Upon arrival to the site, the monitoring wells will be assessed for structural integrity. Each well cover (either stick-up or flush mount) will be inspected for proper labels, locks, any damage and be cleared of any flora or fauna that may be on the well or in the vicinity that would affect the sample or the sampling operation. In addition to any other notable observations, all of the above shall be entered on the sampling sheets. Once the well is uncovered and unlocked, and the well casing inspected, the wellhead shall be inspected for damage and cleanliness. At that point, the well will be considered ready for sampling per procedures described below.

9.3.3 Groundwater Sample Collection

Prior to initiating sampling, a round of groundwater levels will be collected from each monitoring well using an electronic water level probe. The timeframe over which these water levels are collected should be minimized and should not exceed 8 hours. The depth to water will be measured to the nearest one-hundredth of a foot from the top of casing using an electronic water level meter. The water level probe should be properly decontaminated between each reading using procedures specified in Section 9.3.4.

All of the monitoring wells at this Station are equipped with dedicated, down-hole, bladder pumps. At the top of casing for each well is a manifold with air and water quick connects and a port for a water level meter probe to fit so that an undisturbed water level can be obtained. Immediately prior to sampling, the depth to water will be measured again to the nearest one-hundredth of a foot from the top of casing using an electronic water level indicator and recorded onto the sampling sheets. Once recorded, an air compressor and flow controller will be attached to the air-side quick connect and disposable tubing attached to the discharge connection. The discharge tubing will be run to a flow-through cell of the water quality meter. A discharge line from the flow-through cell will be placed into a vessel to allow for the measurement of the volume of groundwater removed. The water quality meter will be attached within the flow-through cell that allows for real time readings of pH, specific conductivity and temperature. It is noted that a calibration check of the water quality meter should be performed at the start and end of each day of sampling and recorded in the field notes. If the meter calibration-check shows drift outside of manufacturer specifications, the meter should be recalibrated in the field using standard solutions per manufacturer requirements.

The air controller will be set to the necessary pressure and to the slowest pumping interval, approximately 50 second refill and 10 second pump (flow rates at this setting tend to be less than 100 milliliters/minute), and the compressor will be started. The intent of the low flow pumping will be to minimize drawdown in the well with an ideal goal of keeping the drawdown to 0.30 feet or less. Once the water has filled the flow-through cell, a reading of the parameters will be recorded. Readings will continue to be recorded until such time as all parameters are deemed stable for three consecutive measurements at which point a sample will be collected from the tubing prior to the flow-through cell. An unfiltered groundwater sample shall be collected directly from the water tubing after it is disconnected from the flow-through cell. The laboratory provided bottles shall be properly filled. Once the sample is collected, the bottles shall be properly labeled and placed on ice as necessary.

If the well would pump dry prior to stabilized field parameter readings, the well will be allowed to recover for up to 24-hours at which point water sample collection will be initiated.

In the event that a dedicated bladder pump fails to work, the following procedures should be implemented:

- Pull the dedicated tubing and pump from the well and ensure that the tubing does not come in contact with the ground.

- Visually inspect the intake of the pump for clogging from sedimentation. If clogging is noted, clean the intake with distilled water. If there is no clogging, dismantle the pump casing and inspect the bladder for any holes, cracks or tears.

- If the bladder is determined to be compromised (i.e., wear has resulted in cracking or tearing), remove the bladder and replace it with a new bladder. Properly clean all parts of the pump using procedures described in Section 9.3.4, reassemble the pump and slowly lower it back down hole. Continue sampling as described above.

- If the entire pump is determined to have failed, a new pump will need to be ordered for replacement and a modified sampling procedure will be implemented as described below.

In the case of bladder pump failure at a specific well during a sampling event, the alternate sampling method will be the use of a portable peristaltic pump (the pump itself does not go down-hole) assuming depth to water is less than 23 feet bgs. Clean disposable polyethylene tubing will be attached to the pump and the tubing will be slowly lowered down hole along with the water level probe. The pump will be operated at the lowest rate possible to achieve the same goals as for sampling described above (generally below 300 milliliters/minute, which is within the range of standard low flow protocols). Water will be collected in a clean glass jar for field parameter readings. Once stable field parameters are recorded, the sample will be collected directly into laboratory prepared containers for analysis. Upon completion of sample collection, the water level meter and tubing should be removed from the well. The polyethylene tubing should be disconnected from the pump and discarded. The water level meter should be properly decontaminated as specified in Section 9.3.4. If depth to water is such that a peristaltic pump cannot be used, a submersible pump will need to be used. The submersible pump must be properly cleaned as specified in Section 9.3.4 prior to placement down the well. All subsequent procedures will be the same as above. The alternate sampling pump use will be recorded on the field data sheet for that well and noted in any subsequent reporting summary.

9.3.4 Equipment Decontamination

Any equipment that is used down-hole at more than one sampling location must be thoroughly decontaminated between uses. Based on procedures described above, only the water level meter is anticipated to be in this category, however, if a submersible pump needs to be used during a particular sampling event due to dedicated pump failure (see Section 9.3.3), these procedures will also apply. The water level meter probe and any measuring tape, or any other non-dedicated equipment that may need to be placed down the well, that extended below the water surface, will need to be cleaned with an Alconox solution, or equivalent, wash followed by a double rinse with distilled water. Any pump tubing that is not dedicated should be discarded and only clean tubing should be used down-hole.

9.3.5 Sample Preservation, Chain-of-Custody and Shipment

Since measurement of total recoverable metals is required by the State CCR Rule, the samples will not be filtered prior to collection. This will facilitate the analysis to capture both the particulate fraction and dissolved fraction of metals in natural groundwater. Groundwater samples will be collected directly into Illinois certified laboratory provided containers. Those containers will be prepared by the laboratory to contain any necessary chemical preservation. The samples shall be stored at temperatures required by the lab following sample collection. Table 9-6 includes a summary of sample bottle requirements, preservatives and holding times

All groundwater samples collected shall be transferred to the laboratory under proper COC procedures. The laboratory provided COC, completed with all pertinent information, shall be maintained from sample collection through receipt by the laboratory. The information shall include, but is not limited to, the following:

- project name and number, state samples collected in, sample name and type, time and date collected, analysis requested, and printed name and signatures of person(s) sampling.

The COC shall be completed and properly relinquished by the field sampler(s) with all samples clearly printed or typed.

All samples will be either delivered directly to the laboratory or be shipped using Federal Express or a similar overnight service. It should be noted that Total Dissolved Solids (TDS) analysis has a 7-day holding time. TDS samples should be shipped to the laboratory within 72 hours after collection. All other holding times for the specified parameters are long enough to facilitate one shipment after the full round of sampling is complete.

9.3.6 Analytical Methods

A list of the analytical methods to be used by the laboratory for each specified parameter is included in the above referenced Table 9-6. Individual detection limits for the parameters may change slightly from sample to sample depending on potential matrix interferences with a sample (e.g., amount of suspended solids/sediment) and/or the concentration of the constituent in the sample. However, the base detection limits will be set below the applicable Illinois Class I Drinking Water Standards as defined in Section 845.600(a)(1) for that compound which are also provided in Table 9-6.

9.3.7 Quality Assurance and Quality Control
Laboratory

Only an Illinois certified analytical laboratory will be used for sample analysis. The laboratory will be conducting their work under their specific approved Quality Assurance and Quality Control (QA/QC) program. A copy of their program can be available upon request. A standard Level II data documentation package will be included in all subsequent reporting, however, the lab will be requested to also provide a Level IV data documentation package (i.e., U.S. EPA Contract Laboratory Protocol equivalent) in the event more detailed data validation/evaluation is deemed necessary.

Field

The QA/QC program for fieldwork will include the collection of blind duplicates and the use of a laboratory supplied trip blank. The blind duplicate will be collected from a random well during every sampling event in which more than three (3) samples are collected. The duplicate will be blind in the manner that there will be no way for the laboratory to determine from which well or point the sample was collected.

Upon receipt of the analytical data, a determination will be made if the duplicate is consistent with the sample collected from the well/point. A generally acceptable range for groundwater samples is +/- 30 percent. If outside the acceptable range, a resample may be determined to be necessary and reanalyzed. The trip blank analytical data will be reviewed for any values other than non-detect. If there are any questions regarding the duplicate, trip blank, or other reported analytical QA/QC runs, the laboratory will be contacted to determine the effect on data quality, if any, and usability. If necessary, a specific well may need to be re-sampled.

9.3.8 Statistical Methods
A proposed statistical evaluation plan meeting the requirements specified in Section 845.640(f) is provided in Attachment 9-5 along with a certification of the plan by an Illinois licensed Professional Engineer.

9.4 Groundwater Monitoring Program Section

The groundwater sample and water level collection frequency is discussed in Section 9.3.1 above.

As previously noted, the monitoring well system for the subject unit consists of following monitoring wells:

- MW-09, MW-11 and MW-14 – Upgradient
- MW-01 through MW-04 and MW-16 – Downgradient

Eight rounds of background sampling for the purposes of statistical evaluation and background determination is available from the initial groundwater sampling which occurred starting in 2015 in compliance with the Federal CCR Rule requirements. Subsequent groundwater sampling has also occurred on a quarterly basis for the seven detection monitoring parameters listed under

Appendix III of the Federal CCR Rule detection monitoring requirements. All available CCR monitoring data through the end of the second quarter 2021 is summarized in Table 9-4 and the eight (8) rounds of turbidity data collected since the enactment of the State CCR Rule in April 2021 in Table 9-5.

Using the currently available data for the subject CCR surface impoundments, site specific Groundwater Protection Standards (GWPSs) have been established in accordance with Section 845.600(b) and are summarized in Table 9-7. The background concentrations noted in Table 9-7 were calculated using the statistical evaluation approach noted in Section 9.3.8 and provided in Attachment 9-5. A presentation of the statistical evaluations which resulted in the background concentration calculations is provided in Attachment 9-6.

Once the proposed GWPSs presented in this permit application are approved by Illinois EPA, these values will be used for all subsequent groundwater monitoring data comparisons. Monitoring will continue on a quarterly basis for all constituents specified in Section 845.600(a)(1) plus calcium and turbidity. In accordance with Section 845.610(b)(3)(D), a data summary report will be submitted to Illinois EPA within 60-days of receipt of all analytical data which will include a groundwater flow map for the quarterly sampling event, summary of water level elevations collected during the reporting period (monthly measurements), and a data summary including summary data tables with a comparison against the established/approved GWPSs. This report must be placed the facility's operating record.

If during a monitoring event, a constituent(s) is/are detected above an established/approved GWPS, that well will be resampled for the specific constituent(s). If the resample data confirms that the constituent(s) concentration(s) is/are above the GWPS then the following will occur:

- Characterize the nature and extent of the potential release and any relevant site conditions that may affect the remedy evaluation/selection. This characterization must meet the requirements set forth under Section 845.650(d)(1).

- If groundwater impacts extend off-site, provide off-site landowner/resident notifications as specified under Section 845.650(d)(2) and place the notifications into the facility's operating record. This must occur within no more than 30-days of determination that a GWPS has been exceeded.

- An Alternate Source Demonstration (ASD) may be initiated and completed for submittal to Illinois EPA review/approval as allowed under Section 845.650(e). Place the ASD into the facility's operating record.

- Within 90-days of determining that a constituent(s) was detected above an established/approved GWPS at a downgradient waste boundary monitoring point, initiate an assessment of corrective measures meeting the requirements specified under Section 845.660 unless an ASD is submitted in accordance with Section 845.650(d)(2) and subsequently approved by the Illinois EPA.

By no later January 31st of each year, an Annual Groundwater Monitoring and Corrective Action Report will be prepared for inclusion as part of an Annual Consolidated Report for the facility. The Annual Groundwater Monitoring and Corrective Action Report will meet the requirements set forth under Section 845.610(e)(1 through 4). The Annual Consolidated Report will be placed into the facility's operating record.

10.0 Professional Engineer Certification, 845.220(a)(8)

This construction permit application has been prepared to meet the requirements of 35 Ill. Adm. Code 845.220(a) and 845.220(d).

1/28/22

Joshua D. Davenport, P.E.
Illinois Professional Engineer

JOSHUA D. DAVENPORT
062-061945
LICENSED
PROFESSIONAL
ENGINEER
STATE OF ILLINOIS

11.0 Owner Certification, 845.220(a)(9)

A certification stating that the owner or operator of the CCR surface impoundment has completed the public notification and public meetings that are required under the Ill. Adm. Code Title 35, Part 845 Section 240 is included in Attachment 11. Also included is a summary of the issues raised by the public and a summary of any revisions, determinations, or other considerations made in response to those issues. A list of interested persons in attendance who would like to be added to the Agent's list for the facility.

OPERATING PERMIT TABLES

Table 2. Waukegan Generating Station
CCR Chemical Constituents Analytical Results

Parameter Name	Bottom Ash Sample 7/1/2021
Antimony	<9.5
Arsenic	4.2 J
Barium	2600
Beryllium	1.9
Boron	170
Cadmium	0.24 J B
Chloride	28
Chromium	20
Cobalt	9.4 J
Fluoride	2.7
Lead	8.1
Lithium	19
Mercury	0.077
Molybdenum	<4.7
Percent Solids (%)	74.6
pH (Standard Unit)	10 H
Selenium	<4.7
Sulfate	1500
Thallium	2.6 J

Notes:

All results are in milligrams per kilogram (mg/kg), unless otherwise noted

B - Compound was found in the blank and sample

J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value

RL - Reporting Limit

MDL - Method Detection Limit

Table 9-1. Summary of Local Precipitation Data - Midwest Generation, LLC, Waukegan Generating Station, Waukegan, Illinois.

Waukegan Station	
Month	**Average Monthly Precipitation* (inches)**
January	1.66
February	1.20
March	2.35
April	3.94
May	3.61
June	3.77
July	3.78
August	3.30
September	3.62
October	2.93
November	2.55
December	2.00

Notes:
* - Historical precipitation data was obtained from the National Oceanic and Atmospheric Administration. Precipitation data was averaged from three stations located within Waukegan, Illinois. Dates of precipitation data range from 1923-2020.

Table 9-2. Groundwater Elevations - Midwest Generation, LLC, Waukegan Station, Waukegan, IL

Well ID	Date	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
MW-01	11/2/2015	603.12	20.75	582.37
	2/29/2016	603.12	20.71	582.41
	5/2/2016	603.12	20.89	582.23
	8/23/2016	603.12	22.01	581.11
	12/2/2016	603.62	22.27	581.35
	2/21/2017	603.62	22.42	581.20
	5/15/2017	603.62	20.52	583.10
	7/5/2017	603.62	21.81	581.81
	9/11/2017	603.62	21.47	582.15
	11/27/2017	603.62	21.82	581.80
	5/29/2018	603.62	19.43	584.19
	11/5/2018	603.62	20.45	583.17
	5/14/2019	603.62	19.81	583.81
	11/18/2019	603.62	19.89	583.73
	4/21/2020	603.62	20.81	582.81
	11/17/2020	603.62	21.51	582.11
	3/1/2021	603.62	21.19	582.43
	3/30/2021	603.62	21.34	582.28
	5/5/2021	603.62	21.76	581.86
MW-02	11/2/2015	603.04	20.71	582.33
	2/29/2016	603.04	20.59	582.45
	5/2/2016	603.04	20.82	582.22
	8/23/2016	603.04	22.04	581.00
	12/2/2016	603.39	22.13	581.26
	2/21/2017	603.39	22.24	581.15
	5/15/2017	603.39	20.25	583.14
	7/5/2017	603.39	21.59	581.80
	9/11/2017	603.39	21.21	582.18
	11/27/2017	603.39	21.63	581.76
	5/29/2018	603.39	19.12	584.27
	11/5/2018	603.39	20.19	583.20
	5/14/2019	603.39	19.55	583.84
	11/18/2019	603.39	19.60	583.79
	4/21/2020	603.39	20.57	582.82
	11/17/2020	603.39	21.32	582.07
	3/1/2021	603.39	21.04	582.35
	3/30/2021	603.39	21.13	582.26
	5/5/2021	603.39	21.56	581.83
MW-03	11/2/2015	602.91	20.37	582.54
	2/29/2016	602.91	20.43	582.48
	5/2/2016	602.91	20.66	582.25
	8/23/2016	602.91	22.12	580.79
	12/2/2016	603.70	22.52	581.18
	2/21/2017	603.70	22.64	581.06
	5/15/2017	603.70	20.55	583.15
	7/5/2017	603.70	21.92	581.78
	9/11/2017	603.70	21.55	582.15
	11/28/2017	603.70	21.96	581.74
	5/29/2018	603.70	19.40	584.30
	11/5/2018	603.70	20.48	583.22
	5/14/2019	603.70	19.80	583.90
	11/18/2019	603.70	20.05	583.65
	4/21/2020	603.70	20.82	582.88
	11/17/2020	603.70	21.60	582.10
	3/1/2021	603.70	21.30	582.40
	3/30/2021	603.70	21.40	582.30
	5/5/2021	603.70	21.83	581.87

Table 9-2. Groundwater Elevations - Midwest Generation, LLC, Waukegan Station, Waukegan, IL

Well ID	Date	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
MW-04	11/2/2015	603.19	20.83	582.36
	2/29/2016	603.19	20.70	582.49
	5/2/2016	603.19	20.94	582.25
	8/23/2016	603.19	22.69	580.50
	12/2/2016	603.17	22.18	580.99
	2/21/2017	603.17	22.36	580.81
	5/15/2017	603.17	20.04	583.13
	7/5/2017	603.17	21.46	581.71
	9/11/2017	603.17	21.05	582.12
	11/28/2017	603.17	21.54	581.63
	5/30/2018	603.17	18.88	584.29
	11/6/2018	603.17	19.96	583.21
	5/14/2019	603.17	19.35	583.82
	11/18/2019	603.17	19.36	583.81
	4/21/2020	603.17	20.40	582.77
	11/18/2020	603.17	21.23	581.94
	3/1/2021	603.17	20.95	582.22
	3/30/2021	603.17	21.02	582.15
	5/5/2021	603.17	21.52	581.65
MW-09	11/2/2015	594.00	9.78	584.22
	2/29/2016	594.00	9.89	584.11
	5/2/2016	594.00	9.59	584.41
	8/23/2016	594.00	10.58	583.42
	12/2/2016	594.00	10.27	583.73
	2/21/2017	594.00	10.21	583.79
	5/15/2017	594.00	9.57	584.43
	7/6/2017	594.00	9.81	584.19
	9/11/2017	594.00	10.25	583.75
	11/29/2017	594.00	9.98	584.02
	5/31/2018	594.00	9.38	584.62
	11/6/2018	594.00	9.52	584.48
	5/14/2019	594.00	9.50	584.50
	11/18/2019	594.00	9.62	584.38
	4/21/2020	594.00	9.84	584.16
	11/18/2020	594.00	10.83	583.17
	3/1/2021	594.00	9.90	584.10
	3/30/2021	594.00	10.46	583.54
	5/5/2021	594.00	10.80	583.20
MW-11	11/2/2015	590.35	5.27	585.08
	2/29/2016	590.35	5.54	584.81
	5/2/2016	590.35	5.17	585.18
	8/23/2016	590.35	6.04	584.31
	12/2/2016	590.35	5.86	584.49
	2/21/2017	590.35	5.87	584.48
	5/15/2017	590.35	5.33	585.02
	7/6/2017	590.35	5.62	584.73
	9/11/2017	590.35	5.61	584.74
	11/30/2017	590.35	5.68	584.67
	5/31/2018	590.35	5.41	584.94
	11/6/2018	590.35	5.29	585.06
	5/14/2019	590.35	5.55	584.80
	11/18/2019	590.35	5.80	584.55
	4/21/2020	590.35	5.85	584.50
	11/19/2020	590.35	6.66	583.69
	3/1/2021	590.35	5.46	584.89
	3/30/2021	590.35	6.54	583.81
	5/5/2021	590.35	6.81	583.54

Table 9-2. Groundwater Elevations - Midwest Generation, LLC, Waukegan Station, Waukegan, IL

Well ID	Date	Top of Casing Elevation (ft above MSL)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (ft above MSL)
MW-14	11/2/2015	590.24	5.17	585.07
	2/29/2016	590.24	5.01	585.23
	5/2/2016	590.24	4.49	585.75
	8/23/2016	590.24	6.07	584.17
	12/2/2016	590.24	5.49	584.75
	2/21/2017	590.24	5.33	584.91
	5/15/2017	590.24	4.67	585.57
	7/6/2017	590.24	5.27	584.97
	9/11/2017	590.24	5.78	584.46
	11/30/2017	590.24	5.19	585.05
	6/1/2018	590.24	4.45	585.79
	11/6/2018	590.24	4.32	585.92
	5/14/2019	590.24	4.20	586.04
	11/18/2019	590.24	4.75	585.49
	4/21/2020	590.24	5.00	585.24
	11/19/2020	590.24	5.98	584.26
	3/1/2021	590.24	4.55	585.69
	3/30/2021	590.24	5.60	584.64
	5/5/2021	590.24	6.20	584.04
MW-16	11/2/2015	607.41	25.13	582.28
	2/29/2016	607.41	24.91	582.50
	5/2/2016	607.41	25.23	582.18
	8/23/2016	607.41	28.33	579.08
	12/2/2016	607.41	28.22	579.19
	2/21/2017	607.41	27.71	579.70
	5/15/2017	607.41	23.99	583.42
	7/6/2017	607.41	27.03	580.38
	9/11/2017	607.41	26.74	580.67
	11/27/2017	607.41	27.49	579.92
	6/1/2018	607.41	23.22	584.19
	11/6/2018	607.41	23.65	583.76
	5/14/2019	607.41	23.40	584.01
	11/18/2019	607.41	23.60	583.81
	4/21/2020	607.41	25.26	582.15
	11/17/2020	607.41	27.50	579.91
	3/1/2021	607.41	27.25	580.16
	3/30/2021	607.41	26.96	580.45
	5/5/2021	607.41	27.50	579.91

MSL - Mean Sea Level
TOC - Top of Casing

Table 9-3. Hydraulic Gradient, Direction and Seepage Velocity. Midwest Generation, LLC, Waukegan Generation Station, Waukegan, IL.

DATE	Groundwater Flow Direction	K_{avg} (ft/sec)*	Average Hydraulic Gradient (ft/ft)	Porosity (unitless)**	Estimated Seepage Velocity (ft/day)
11/2/2015	Southeast	4.040E-03	0.0018	0.35	1.75
2/29/2016	Southeast	4.040E-03	0.0013	0.35	1.30
5/2/2016	Southeast	4.040E-03	0.0015	0.35	1.45
8/23/2016	East-Southeast	4.040E-03	0.0017	0.35	1.65
12/2/2016	East-Southeast	4.040E-03	0.0021	0.35	2.09
2/21/2017	East-Southeast	4.040E-03	0.0022	0.35	2.14
5/15/2017	East-Southeast	4.040E-03	0.0008	0.35	0.80
7/5/2017	East-Southeast	4.040E-03	0.0049	0.35	4.84
9/11/2017	East-Southeast	4.040E-03	0.0018	0.35	1.75
11/27/2017	East-Southeast	4.040E-03	0.0024	0.35	2.39
5/29/2018	East-Southeast	4.040E-03	0.0008	0.35	0.80
11/5/2018	East-Southeast	4.040E-03	0.0014	0.35	1.40
5/14/2019	East-Southeast	4.040E-03	0.0014	0.35	1.40
11/18/2019	East-Southeast	4.040E-03	0.0013	0.35	1.30
4/21/2020	East-Southeast	4.040E-03	0.0013	0.35	1.30
11/17/2020	East-Southeast	4.040E-03	0.0017	0.35	1.70
5/5/2021	East-Southeast	4.040E-03	0.0014	0.35	1.40

* K_{avg} - Average hydraulic conductivity (feet/second) from Hydrogeologic Assessment Report, Patrick Engineering, February 2011.

** - Porosity estimate from Applied Hydrogeology, Fetter, 1980.

Table 9-4. Groundwater Analytical Results - Midwest Generation, LLC, Waukegan Station, Waukegan, IL.

Well	Date	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Radium 226 + 228	Selenium	Thallium
MW-09 up-gradient	11/4/2015	13	210	450	0.14	6.60	370	1700	< 0.003	< 0.001	0.015	^ < 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.081	< 0.0002	0.260	0.1818	< 0.0025	< 0.002
	3/2/2016	35	380	720	0.11	7.02	970	2800	< 0.003	0.06	0.05	< 0.001	< 0.0005	0.043	< 0.001	0.00061	0.094	< 0.0002	0.51	< 0.36	0.025	< 0.002
	5/3/2016	16	310	620	0.12	7.02	740	2500	< 0.003	0.0014	0.025	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.083	< 0.0002	0.63	< 0.512	0.024	< 0.002
	8/25/2016	4.5	130	270	0.21	7.13	190	1100	0.0041	0.042	0.024	< 0.001	0.0011	0.056	0.0027	0.0012	0.049	< 0.0002	0.063	0.482	0.039	< 0.002
	12/8/2016	15	200	330	0.18	7.01	270	1300	< 0.003	0.004	0.016	< 0.001	0.00052	< 0.005	< 0.001	< 0.0005	0.077	< 0.0002	0.24	< 0.72	0.038	< 0.002
	2/23/2017	14	190	290	0.12	7.68	320	1300	< 0.003	0.0027	0.014	< 0.001	< 0.0005	0.059	0.0018	< 0.0005	0.068	< 0.0002	0.26	< 0.461	0.016	< 0.002
	5/16/2017	27	160	67	0.29	8.15	420	970	< 0.003	< 0.001	0.0094	^< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.045	< 0.0002	0.51	< 0.342	0.0085	< 0.002
	7/6/2017	21	220	430	0.13	7.18	610	1800	< 0.003	0.002	0.018	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.089	< 0.0002	0.31	< 0.316	0.021	< 0.002
	9/13/2017	21	250	420	0.14	7.17	520	1800	< 0.003	0.0067	0.019	< 0.001	< 0.0005	0.0052	0.0017	< 0.0005	0.069	< 0.0002	0.33	0.944	0.0041	< 0.002
	11/29/2017	26	200	390	0.13	7.05	390	1600	< 0.003	0.0017	0.015	< ^ 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.086	< 0.0002	0.47	0.625	0.042	< 0.002
	5/31/2018	32	200	29	0.1	6.85	490	1000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/6/2018	30	170	23	0.11	7.33	290	930	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/15/2019	26	120	260	0.13	7.53	31	1000	< 0.003	< 0.001	0.0073	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.035	< 0.0002	0.54	< 0.433	< 0.0025	< 0.002
	11/19/2019	22	160	17	0.16	8.04	300	750	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/22/2020	22	140	9.2	0.18	7.81	360	700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/18/2020	28	250	290	0.18	7.43	420	1700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/6/2021	31	170	35	0.12	7.51	420	910	< 0.003	< 0.001	0.0075	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.04	< 0.0002	0.47	< 0.614	0.023	< 0.002
MW-11 up-gradient	11/5/2015	5.2	140	240	0.13	6.51	190	1100	< 0.003	0.77	0.039	^ < 0.001	< 0.0005	< 0.005	< 0.001	0.001	0.055	< 0.0002	< 0.0050	0.656	< 0.0025	< 0.002
	3/2/2016	4.0	170	240	0.1	7.16	210	1200	< 0.003	0.55	0.048	< 0.001	< 0.0005	0.0058	< 0.001	0.0011	0.049	< 0.0002	< 0.0050	1.09	< 0.0025	< 0.002
	5/5/2016	5.0	140	280	0.11	7.17	160	1000	< 0.003	0.51	0.038	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.057	< 0.0002	< 0.005	1.24	< 0.0025	< 0.002
	8/26/2016	3.5	180	240	0.13	6.97	110	1100	< 0.003	1.1	0.05	< 0.001	< 0.0005	0.0055	< 0.001	0.0005	0.055	< 0.0002	< 0.005	1.04	< 0.0025	< 0.002
	12/7/2016	3.0	170	270	0.12	7.06	110	1200	< 0.003	0.87	0.049	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.038	< 0.0002	< 0.005	1.87	< 0.0025	< 0.002
	2/24/2017	2.4	180	220	4.9	6.61	170	1200	< 0.003	0.58	0.047	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.039	< 0.0002	< 0.005	0.982	< 0.0025	< 0.002
	5/18/2017	1.8	160	170	0.12	7.42	120	1000	< 0.003	0.5	0.047	^< 0.001	< 0.0005	0.0056	< 0.001	< 0.0005	0.036	< 0.0002	< 0.005	1.31	< 0.0025	< 0.002
	7/6/2017	2.4	160	190	0.14	7.33	130	1100	< 0.003	0.69	0.056	< 0.001	< 0.0005	0.0057	< 0.001	< 0.0005	0.041	< 0.0002	< 0.005	0.889	< 0.0025	< 0.002
	9/13/2017	1.9	140	150	0.26	7.16	96	870	< 0.003	0.86	0.036	< 0.001	< 0.0005	0.008	< 0.001	0.00071	0.037	< 0.0002	0.0054	0.718	< 0.0025	< 0.002
	11/30/2017	2.2	170	200	0.14	6.99	93	1100	< 0.003	0.59	0.05	< ^ 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.041	< 0.0002	< 0.005	1.21	< 0.0025	< 0.002
	5/31/2018	1.5	210	160	0.1	6.74	130	1100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/6/2018	2.3	170	150	0.12	7.21	78	990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/15/2019	3.2	120	260	0.13	7.14	31	1000	< 0.003	0.3	0.048	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.038	< 0.0002	< 0.005	1.5	< 0.0025	< 0.002
	11/19/2019	4.1	130	200	0.15	7.51	29	860	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/22/2020	3.2	110	150	0.15	7.16	47	740	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/19/2020	2.3	140	130	0.2	7.00	28	800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/6/2021	2.4	130	120	0.15	7.13	45	770	< 0.003	0.440	0.044	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.038	< 0.0002	< 0.005	1.7	< 0.0025	< 0.002
MW-14 up-gradient	11/5/2015	1.4	150	190	0.19	6.78	140	1000	< 0.003	0.19	0.052	^ < 0.001	< 0.0005	0.01	0.0012	< 0.0005	0.025	< 0.0002	< 0.005	0.7087	< 0.0025	< 0.002
	3/2/2016	0.93	150	110	0.17	7.24	150	870	0.015	4.3	0.12	< 0.001	< 0.0005	1.1	0.0036	0.00068	0.019	< 0.0002	< 0.005	1.36	< 0.0025	< 0.002
	5/5/2016	1.2	170	120	0.18	7.17	190	980	< 0.003	0.35	0.054	< 0.001	< 0.0005	0.017	0.0014	< 0.0005	0.021	< 0.0002	< 0.005	< 0.488	< 0.0025	< 0.002
	8/26/2016	1.5	200	210	0.12	7.00	190	1300	< 0.003	1.0	0.058	< 0.001	< 0.0005	0.021	< 0.001	< 0.0005	0.026	< 0.0002	< 0.005	0.75	< 0.0025	< 0.002
	12/7/2016	0.95	240	340	0.25	6.81	120	1100	0.0096	19	0.42	< 0.001	0.00089	4.6	0.0025	0.00084	0.022	< 0.0002	0.0094	< 0.866	0.014	< 0.002
	2/23/2017	0.73	150	99	0.19	6.88	110	730	0.0061	9.3	0.36	< 0.001	0.001	4.6	0.0070	0.00095	0.017	< 0.0002	< 0.005	< 0.514	0.0031	< 0.002
	5/18/2017	0.81	120	130	0.3	7.62	70	590	0.0035	3.3	0.44	^< 0.001	0.002	4.8	0.0041	0.00054	0.013	0.00043	< 0.005	0.779	< 0.0025	< 0.002
	7/6/2017	1.2	190	180	0.13	7.29	190	1300	< 0.003	0.4	0.071	< 0.001	< 0.0005	0.026	0.0013	< 0.0005	0.034	< 0.0002	< 0.005	0.549	< 0.0025	< 0.002
	9/13/2017	2.3	180	190	0.15	7.20	270	1200	< 0.003	0.52	0.065	< 0.001	< 0.0005	0.0078	< 0.0010	< 0.0005	0.025	< 0.0002	< 0.005	< 0.359	< 0.0025	< 0.002
	11/30/2017	0.85	170	130	0.19	7.33	99	940	0.0093	21	0.27	< ^ 0.001	0.00068	3.2	0.0021	< 0.0005	0.023	< 0.0002	0.0055	1.01	0.0072	< 0.002
	6/1/2018	0.54	100	57	0.28	6.89	42	410	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/6/2018	0.98	160	110	0.24	7.36	53	610	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/15/2019	0.69	110	190	0.23	7.25	35	780	0.0036	2.7	0.091	< 0.001	< 0.0005	0.71	< 0.0010	< 0.0005	0.014	< 0.0002	< 0.005	0.766	< 0.0025	< 0.002
	11/19/2019	0.62	130	68	0.16	7.58	21	630	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/22/2020	0.43	120	20	0.21	7.16	9.5	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/19/2020	0.71	130	40	0.2	7.09	20	520	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/6/2021	0.45	130	41	0.19	7.16	28	390	< 0.003	0.91	0.05	< 0.001	< 0.0005	0.037	< 0.0010	< 0.0005	0.015	< 0.0002	< 0.005	< 0.739	< 0.0025	< 0.002
MW-01 down-gradient	11/2/2015	1.8	64	71	0.46	10.93	310	560	< 0.003	0.074	0.025	^ < 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.04	0.0683	0.0047	< 0.002
	3/1/2016	V 1.9	58	63	0.26	11.13	270	570	< 0.003	0.1	0.026	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.059	< 0.317	< 0.0025	< 0.002
	5/4/2016	2.0	45	60	0.3	11.09	210	490	< 0.003	0.11	0.017	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.069	< 0.40	< 0.0025	< 0.002
	8/23/2016	2.0	42	60	0.26	10.49	240	550	< 0.003	0.074	0.012	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.065	< 0.478	0.0042	< 0.002
	12/5/2016	2.2	55	65	0.34	10.46	180	560	< 0.003	0.13	0.017	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.07	< 0.465	0.0025	< 0.002
	2/21/2017	2.2	50	61	0.29	11.30	250	540	< 0.003	0.15	0.016	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.069	0.516	< 0.0025	< 0.002
	5/15/2017	2.1	52	59	0.37	10.69	330	570	< 0.003	0.14	0.017	^< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.062	< 0.424	0.0036	< 0.002
	7/5/2017	2.3	44	51	0.34	10.83	320	570	< 0.003	0.066	0.014	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.059	< 0.289	0.0095	< 0.002
	9/14/2017	2.4	71	47	0.24	10.45	430	770	< 0.003	0.04	0.033	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.047	< 0.383	0.0096	< 0.002
	11/27/2017	2.7	84	43	0.11	7.85	330	840	< 0.003	0.021	0.055	< ^ 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.034	0.568	0.023	< 0.002
	5/29/2018	2.4	54	58	0.33	8.44	350	610	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/5/2018	2.0	38	43	0.25	8.70	210	630	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/14/2019	2.2	56	45	0.18	9.85	250	560	< 0.003	0.067	0.032	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.053	0.36	< 0.0025	< 0.002
	11/19/2019	2.3	38	39	0.24	10.58	240	530	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2020	2.8	55	25	0.22	9.40	240	470	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/17/2020	3.3	120	95	0.14	7.97	250	640	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/5/2021	< 5.0	66	67	0.22	9.00	180	430	< 0.003	0.025	0.04	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.016	< 0.602	< 0.0025	< 0.002

Notes: All units are in mg/l except pH is in standard units.
V- Serial dilution exceeds the control limits.
R- Resampling event
NA - Not analyzed.

H - Sample preped or analyzed beyond specific holding time.
^ - Denotes instrument related QC exceeds the control limits

Table 9-4. Groundwater Analytical Results - Midwest Generation, LLC, Waukegan Station, Waukegan, IL.

Well	Date	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Radium 226 + 228	Selenium	Thallium
MW-02 down-gradient	11/2/2015	3.0	32	47	0.78	8.27	230	460	< 0.003	0.014	0.016	^ < 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.0630	0.4628	< 0.0025	< 0.002
	3/1/2016	4.1	39	47	1.3	8.57	220	510	< 0.003	0.011	0.02	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.078	0.529	< 0.0025	< 0.002
	5/4/2016	3.3	34	51	1.5	8.19	180	440	< 0.003	0.0081	0.018	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.069	< 0.425	< 0.0025	< 0.002
	8/23/2016	3.1	42	59	1.3	7.52	250	500	< 0.003	0.0082	0.016	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.056	< 0.439	< 0.0025	< 0.002
	12/5/2016	3.1	28	56	1.0	8.62	160	430	< 0.003	0.018	0.015	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.071	0.509	< 0.0025	< 0.002
	2/21/2017	3.3	31	52	0.76	8.75	190	420	< 0.003	0.028	0.012	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.051	< 0.416	0.0038	< 0.002
	5/15/2017	3.6	85	48	0.64	8.33	320	640	< 0.003	0.02	0.029	^< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.047	0.425	0.023	< 0.002
	7/5/2017	4.2	100	52	0.42	7.92	300	710	< 0.003	0.0094	0.031	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.047	< 0.295	0.017	< 0.002
	9/14/2017	2.5	87	54	0.44	8.19	340	780	< 0.003	0.012	0.035	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.049	0.769	0.0052	< 0.002
	11/27/2017	3.4	69	57	0.62	7.34	200	570	< 0.003	0.011	0.022	< ^ 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.048	< 0.442	< 0.0025	< 0.002
	5/29/2018	4.5	160	43	0.40	6.85	420	990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/5/2018	3.1	77	59	0.61	8.06	180	610	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/14/2019	2.9	47	49	1.0	8.30	140	430	< 0.003	0.0094	0.013	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.069	0.37	< 0.0025	< 0.002
	11/19/2019	4.7	140	43	0.7	7.37	270	900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2020	3.4	86	48	1.0	8.02	250	580	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/17/2020	4.0	79	20	0.8	7.67	310	610	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/5/2021	4.6	70	37	0.72	8.39	190	420	< 0.003	0.008	0.03	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.023	0.97	< 0.0025	< 0.002
MW-03 down-gradient	11/2/2015	2.3	72	87	0.51	9.26	270	570	< 0.003	0.0068	0.011	^ < 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.0370	0.071	< 0.0025	< 0.002
	3/1/2016	2.9	61	70	0.33	7.33	220	530	< 0.003	0.0069	0.015	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.0560	< 0.332	0.0043	< 0.002
	5/4/2016	2.4	42	74	0.56	7.25	170	470	< 0.003	0.007	0.011	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.058	< 0.48	< 0.0025	< 0.002
	8/24/2016	2.0	70	59	0.3	9.13	200	430	< 0.003	0.010	0.0069	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.042	< 0.428	< 0.0025	< 0.002
	12/5/2016	2.4	57	60	0.41	7.62	120	440	< 0.003	0.0065	0.0094	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.044	< 0.526	< 0.0025	< 0.002
	2/21/2017	2.2	56	65	0.33	7.56	180	460	< 0.003	0.011	0.0067	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.043	0.437	< 0.0025	< 0.002
	5/16/2017	3.9	110	61	0.27	7.90	320	820	< 0.003	0.0087	0.039	^< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.041	< 0.461	0.014	< 0.002
	7/5/2017	3.0	60	60	0.28	7.46	200	470	< 0.003	0.0029	0.017	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.058	< 0.304	0.0045	< 0.002
	9/14/2017	2.1	86	57	0.26	7.53	260	680	< 0.003	0.0024	0.026	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.056	0.462	0.0081	< 0.002
	11/28/2017	2.6	69	63	0.56	6.96	120	500	< 0.003	0.0025	0.016	< ^ 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.057	1.17	< 0.0025	< 0.002
	5/29/2018	2.4	67	61	0.38	6.84	190	480	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/5/2018	2.4	54	54	0.5	8.99	150	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/14/2019	4.2	86	17	0.59	7.21	270	660	< 0.003	0.0059	0.022	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.053	0.657	0.0061	< 0.002
	11/19/2019	4.2	130	15	0.25	7.47	300	740	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2020	3.8	120	23	0.29	6.87	270	660	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/17/2020	3.8	120	53	0.29	7.05	240	650	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/5/2021	3.3	110	43	0.23	7.18	210	550	< 0.003	0.0066	0.035	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.010	< 0.0002	0.016	0.689	0.0065	< 0.002
MW-04 down-gradient	11/3/2015	1.8	66	62	0.51	6.68	240	480	< 0.003	0.0066	0.032	^ < 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.031	0.2732	< 0.0025	< 0.002
	3/1/2016	2.0	58	51	0.5	7.17	170	450	< 0.003	0.0083	0.033	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.048	0.478	< 0.0025	< 0.002
	5/4/2016	1.6	44	49	0.61	6.92	140	340	< 0.003	0.0083	0.017	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.046	< 0.542	< 0.0025	< 0.002
	8/24/2016	2.0	46	58	0.56	7.01	120	370	< 0.003	0.0099	0.019	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.049	< 0.461	< 0.0025	< 0.002
	12/5/2016	3.4	200	60	0.21	7.40	300	1000	< 0.003	0.019	0.13	< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.0097	1.04	0.02	< 0.002
	2/22/2017	2.4	150	41	0.17	7.44	290	850	< 0.003	0.036	0.093	< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.015	0.886	0.0042	< 0.002
	5/16/2017	2.5	170	29	0.32	7.94	400	970	< 0.003	0.024	0.072	^< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.017	0.55	0.032	< 0.002
	7/5/2017	3.6	200	51	0.29	7.09	520	1100	< 0.003	0.0034	0.076	< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.017	0.515	0.062	< 0.002
	9/14/2017	2.5	180	45	0.28	7.04	480	1100	< 0.003	0.0028	0.076	< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.021	0.794	0.026	< 0.002
	11/28/2017	2.3	110	32	0.28	7.04	130	560	< 0.003	0.0027	0.053	< ^ 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.032	0.872	0.0069	< 0.002
	5/30/2018	3.0	150	21	0.38	6.57	200	700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/6/2018	2.5	150	58	0.37	6.83	240	900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/14/2019	3.3	100	58	0.64	7.30	200	730	< 0.003	0.0026	0.039	< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.07	0.69	0.004	< 0.002
	11/19/2019	2.9	120	44	0.75	7.27	270	680	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2020	2.9	100	33	0.9	7.18	290	670	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/18/2020	3.1	100	18	1.1	7.17	250	690	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/5/2021	3.3	75	17	0.91	7.46	190	530	< 0.003	0.0069	0.032	< 0.001	< 0.0005	< 0.005	< 0.0010	< 0.0005	< 0.01	< 0.0002	0.056	< 0.781	0.0041	< 0.002
MW-16 down-gradient	11/3/2015	4.1	230	87	0.43	6.24	610	1400	< 0.003	0.001	0.047	^ < 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.071	< 0.0002	0.021	0.865	0.0074	< 0.002
	3/2/2016	3.1	360	130	0.35	6.76	990	1700	< 0.003	0.0015	0.035	< 0.001	0.001	< 0.005	< 0.001	< 0.0005	0.13	< 0.0002	0.013	< 0.396	0.0052	0.002
	5/2/2016	4.9	250	150	0.49	6.99	620	1600	< 0.003	0.0011	0.052	< 0.001	0.00053	< 0.005	< 0.001	< 0.0005	0.024	< 0.0002	0.014	0.70	< 0.0025	< 0.002
	8/24/2016	3.6	130	53	0.71	7.00	330	830	< 0.003	< 0.001	0.028	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.014	< 0.0002	0.022	< 0.462	< 0.0025	< 0.002
	12/5/2016	3.8	160	52	0.51	7.03	280	920	< 0.003	0.036	0.062	< 0.001	< 0.0005	< 0.005	0.0012	0.00054	0.011	< 0.0002	0.021	0.791	< 0.0025	< 0.002
	2/24/2017	6.5	200	67	0.2	5.76	570	1100	< 0.003	0.027	0.067	< 0.001	< 0.0005	0.005	0.0011	< 0.0005	0.012	< 0.0002	0.023	0.54	0.0037	< 0.002
	5/16/2017	2.6	340	130	0.15	7.57	760	1700	< 0.003	0.043	0.045	^< 0.001	0.0043	0.0076	< 0.001	0.00057	0.13	< 0.0002	0.016	0.441	0.016	0.0021
	7/6/2017	9.5	190	70	0.57	7.35	480	1100	< 0.003	0.0029	0.029	< 0.001	0.00069	< 0.005	< 0.001	< 0.0005	0.017	< 0.0002	0.017	< 0.382	< 0.0025	< 0.002
	9/13/2017	2.8	190	55	0.61	7.33	460	970	< 0.003	< 0.001	0.024	< 0.001	0.0005	< 0.005	< 0.001	< 0.0005	< 0.01	< 0.0002	0.024	< 0.335	< 0.0025	< 0.002
	11/27/2017	4.2	140	58	0.71	7.16	270	760	< 0.003	0.0031	0.026	< ^ 0.001	0.00097	< 0.005	< 0.001	< 0.0005	0.01	< 0.0002	0.026	0.557	< 0.0025	< 0.002
	6/1/2018	3	380	130	0.32	6.53	890	1900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	8/22/2018 (R)	NA	190	NA	NA	NA	NA	1200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/6/2018	3.9	380	150	0.39	6.78	550	1900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/4/2018 (R)	NA	320	NA	NA	NA	NA	1600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/15/2019	2.9	400	65	0.31	6.67	990	2000	< 0.003	0.0011	0.029	< 0.001	0.003	< 0.005	< 0.001	< 0.0005	0.15	< 0.0002	0.0086	< 0.491	0.0039	< 0.002
	11/19/2019	7.2	410	480	0.46	6.89	680	3100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	12/27/2019 (R)	NA	NA	NA	NA	NA	NA	2800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4/21/2020	7.7	420	200	0.5	6.79	1100	2400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	11/17/2020	3.2	130	54	0.71	7.22	320	990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5/6/2021	3.1	120	55	0.68	7.33	300	740	< 0.003	< 0.001	0.024	< 0.001	< 0.0005	< 0.005	< 0.001	< 0.0005	0.014	< 0.0002	0.019	< 0.919	< 0.0025	< 0.002

Notes: All units are in mg/l except pH is in standard units.
V- Serial dilution exceeds the control limits.
R- Resampling event
NA - Not analyzed.

H - Sample preped or analyzed beyond specific holding time.
^ - Denotes instrument related QC exceeds the control limits

Table 9-5 Turbidity Measurement Data - Midwest Generation, LLC, Waukegan Station

Well	Date	Turbidity (NTU)
MW-09	3/3/2021	4.70
	3/30/2021	10.15
	5/6/2021	3.44
	5/27/2021	12.41
	6/18/2021	27.7
	7/8/2021	28.77
	8/19/2021	77.36
	9/29/2021	18.41
MW-11	3/2/2021	2.20
	3/30/2021	6.08
	5/6/2021	2.34
	5/27/2021	2.69
	6/18/2021	13.7
	7/8/2021	4.71
	8/19/2021	139.34
	9/29/2021	402.9
MW-14	3/2/2021	2035
	3/30/2021	151.5
	5/6/2021	901.4
	5/27/2021	2385.61
	6/18/2021	69.25
	7/8/2021	73.18
	8/19/2021	77.04
	9/29/2021	8.42
MW-01	3/1/2021	0.59
	3/30/2021	5.72
	5/5/2021	1.42
	5/27/2021	2.02
	6/18/2021	2.33
	7/8/2021	3.6
	8/18/2021	2.33
	9/29/2021	3.03
MW-02	3/1/2021	0.69
	3/30/2021	5.66
	5/5/2021	1.65
	5/27/2021	2.95
	6/18/2021	2.71
	7/8/2021	4.2
	8/18/2021	9.03
	9/29/2021	3.42
MW-03	3/1/2021	0.75
	3/30/2021	5.73
	5/5/2021	1.71
	5/27/2021	2.02
	6/18/2021	2.56
	7/8/2021	3.74
	8/18/2021	2.6
	9/29/2021	2.82
MW-04	3/1/2021	1.30
	3/30/2021	6.21
	5/5/2021	1.77
	5/27/2021	2.73
	6/18/2021	3.69
	7/8/2021	5.36
	8/18/2021	40.61
	9/29/2021	3.48
MW-16	3/1/2021	0.77
	3/30/2021	6.07
	5/6/2021	1.63
	5/27/2021	2.00
	6/18/2021	2.59
	7/8/2021	3.58
	8/18/2021	3.22
	9/29/2021	6.05

Table 9-6. Summary of Sample Bottles, Preservation Holding Time, and Analytical Methods. Midwest Generation, LLC, Waukegan Generating Station, Waukegan, IL.

PARAMETER	ANALYTICAL METHOD	CONTAINER	PRESERVATION	HOLD TIME	METHOD DETECTION LIMIT (MG/L)	Section 845.600(a) Standards
Boron	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.0245	2
Calcium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.106	NS
Chloride	SM4500 Cl-E	1 L plastic	None, < 6 °C	28 days	1.22	200
Fluoride	SM4500 F-C	1 L plastic	None, < 6 °C	28 days	0.019	4
pH	SM4500 H^+ -B	1 L plastic	None, < 6 °C	immediate *	Field Parameter	6.5 - 9.0 (secondary standard)
Sulfate	SM4500 SO_4 -E	1 L plastic	None, < 6 °C	28 days	2	400
Total Dissolved Solids	SM2400 C	1 L plastic	None, < 6 °C	7 days	6.1	1200
Antimony	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.00101	0.006
Arsenic	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000439	0.01
Barium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000841	2
Beryllium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000237	0.004
Cadmium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.00019	0.005
Chromium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000608	0.1
Cobalt	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000189	0.006
Lead	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000141	0.0075
Lithium	6010 C	250 mL plastic	HNO_3, < 6 °C	6 months	0.00215	0.04
Mercury	7470 A	250 mL plastic	HNO_3, < 6 °C	28 days	0.0000611	0.002
Molybdenum	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.00162	0.1
Selenium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000834	0.05
Thallium	6020 A	250 mL plastic	HNO_3, < 6 °C	6 months	0.000591	0.002
Radium 226	903.0	1 L plastic	HNO_3	180 days	1 pCi/L	5 pCi/L **
Radium 228	904.0	2 L plastic	HNO_3	180 days	1 pCi/L	5 pCi/L **

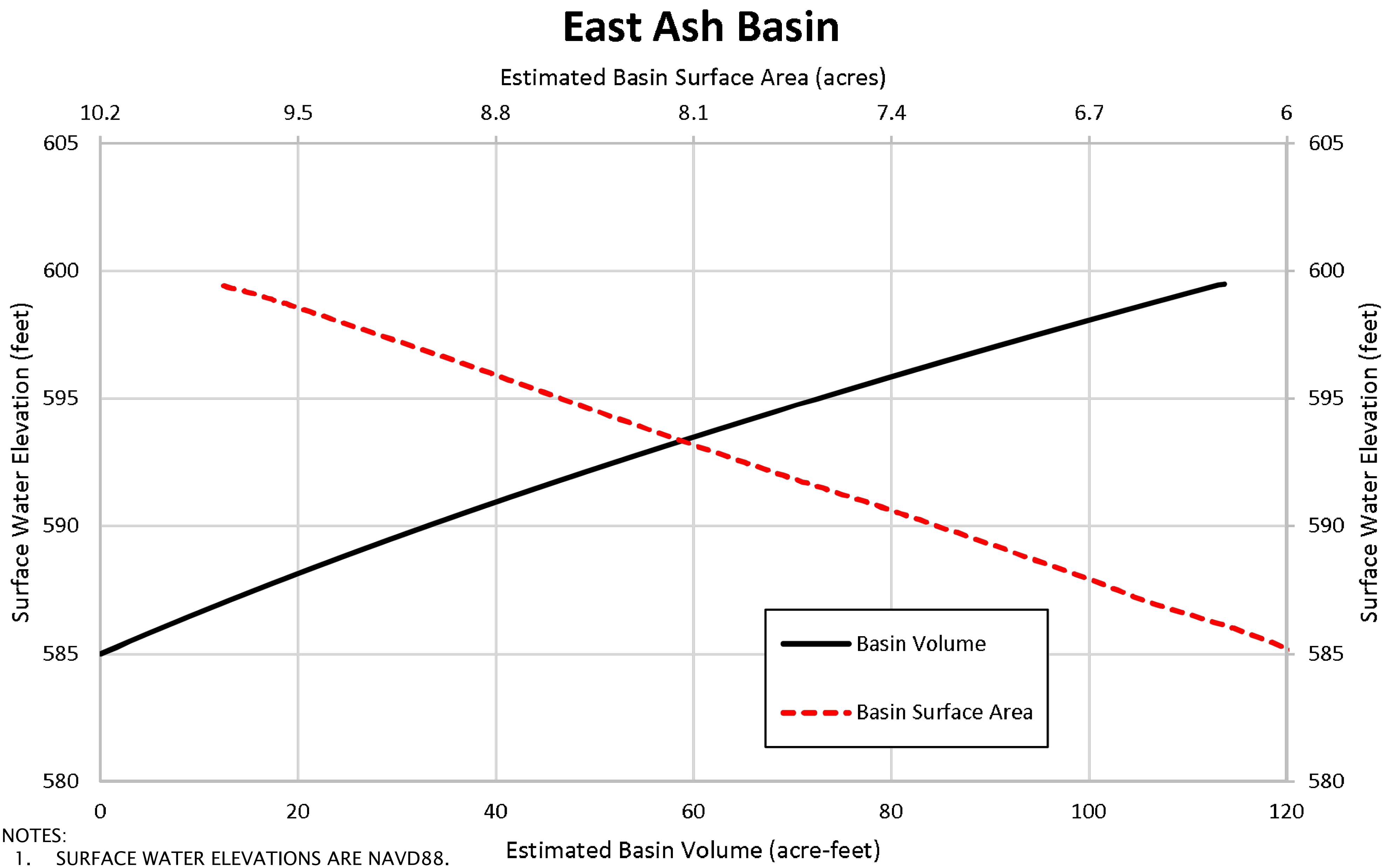
Notes: It is noted that some parameters may be combined with others within the same container.
* - The result for pH is obtained in the field and is not submitted to the laboratory.
** - Combined Radium 226/228
mL - milliliters
L - liters
°C - degrees Celsius
HNO_3 - Nitric Acid
NS- No Standard

Table 9-7. Proposed Site-Specific Groundwater Protection Standards - Waukegan Generating Station

Upgradient Well(s)	Parameter	Section 845.600 Standards	Interwell Background Prediction Limit	**Proposed GWPS**
MW-14	Antimony	0.006	0.015	**0.015**
MW-11/MW-14 Pooled	Arsenic	0.01	21	**21**
MW-11	Barium	2	0.064	**2**
MW-9/MW-11/MW-14 Pooled	Beryllium	0.004	0.001	**0.004**
MW-11	Boron	2.0	5.965	**5.965**
MW-14	Cadmium	0.005	0.002	**0.005**
MW-11/MW-14 Pooled*	Chloride	200	389	**389**
MW-14	Chromium	0.1	4.8	**4.8**
MW-14	Cobalt	0.006	0.007	**0.007**
MW-14	Combined Radium 226 + 228 (pCi/L)	5.0	1.566	**5.0**
MW-14	Fluoride	4.0	0.334	**4.0**
MW-9/MW-11/MW-14 Pooled	Lead	0.0075	0.0011	**0.0075**
MW-14	Lithium	0.04	0.040	**0.040**
MW-14	Mercury	0.002	0.0004	**0.002**
MW-11/MW-14 Pooled	Molybdenum	0.10	0.009	**0.100**
MW-11/MW-14 Pooled	pH (standard units)	6.5-9.0	6.51-7.74	**6.5-9.0**
MW-11/MW-14 Pooled	Selenium	0.05	0.014	**0.050**
MW-11/MW-14 Pooled*	Sulfate	400	259.1	**400**
MW-9/MW-11/MW-14 Pooled	Thallium	0.002	0.002	**0.002**
MW-11/MW-14 Pooled*	Total Dissolved Solids	1200	1589	**1589**
MW-11	Calcium	NE	225.1	**225.1**
MW-14	Turbidity (NTU)	NE	12,436	**12,436**

All values are in mg/L (ppm) unless otherwise noted.
* - Limited to original 8 background samples.
NE - Not Established
Bold - Site-specific Groundwater Protection Standard based on Section 845.600(a)(2)

<u>OPERATING PERMIT FIGURES</u>



NOTES:
1. SURFACE WATER ELEVATIONS ARE NAVD88.
2. BASIN VOLUMES ARE ESTIMATED BASED ON AS-BUILT INFORMATION AND 2015 SITE TOPOGRAPHY.
3. AREA-CAPACITY CURVE CREATED BY GEOSYNTEC AS PART OF COMPLETING THE HISTORY OF CONSTRUCTION IN ACCORDANCE WITH 40 CFR PART 257.

ENVIRONMENTAL CONSULTATION & REMEDIATION
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KPRG and Associates, inc.
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414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

EAST ASH BASIN AREA-CAPACITY CURVE

WAUKEGAN GENERATING STATION
WAUKEGAN, ILLINOIS

Scale: NTS	Date: September 15, 2021
KPRG Project No. 19520.2	FIGURE 1-1

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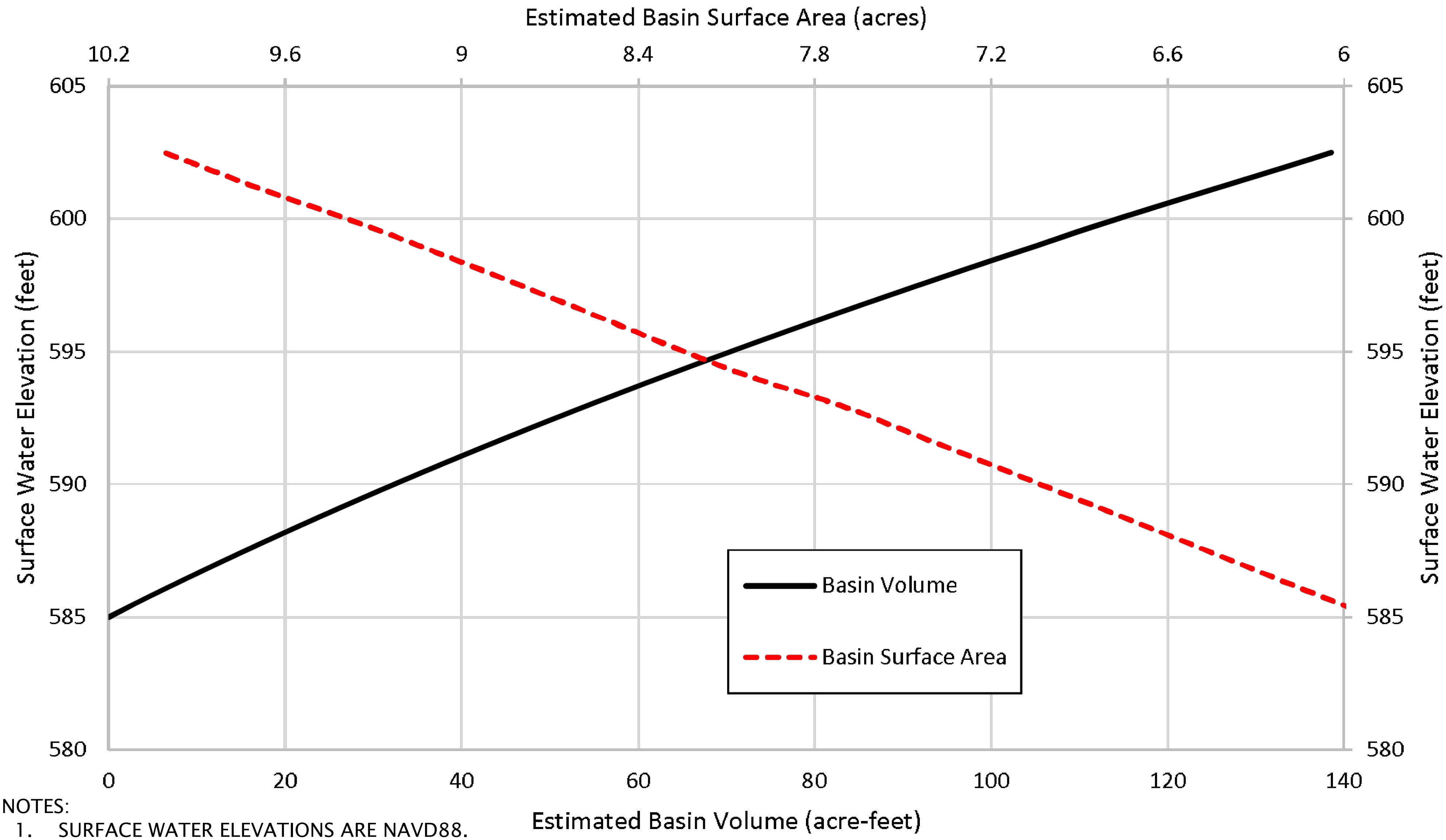
West Ash Basin



NOTES:

1. SURFACE WATER ELEVATIONS ARE NAVD88.
2. BASIN VOLUMES ARE ESTIMATED BASED ON AS-BUILT INFORMATION AND 2015 SITE TOPOGRAPHY.
3. AREA-CAPACITY CURVE CREATED BY GEOSYNTEC AS PART OF COMPLETING THE HISTORY OF CONSTRUCTION IN ACCORDANCE WITH 40 CFR PART 257.

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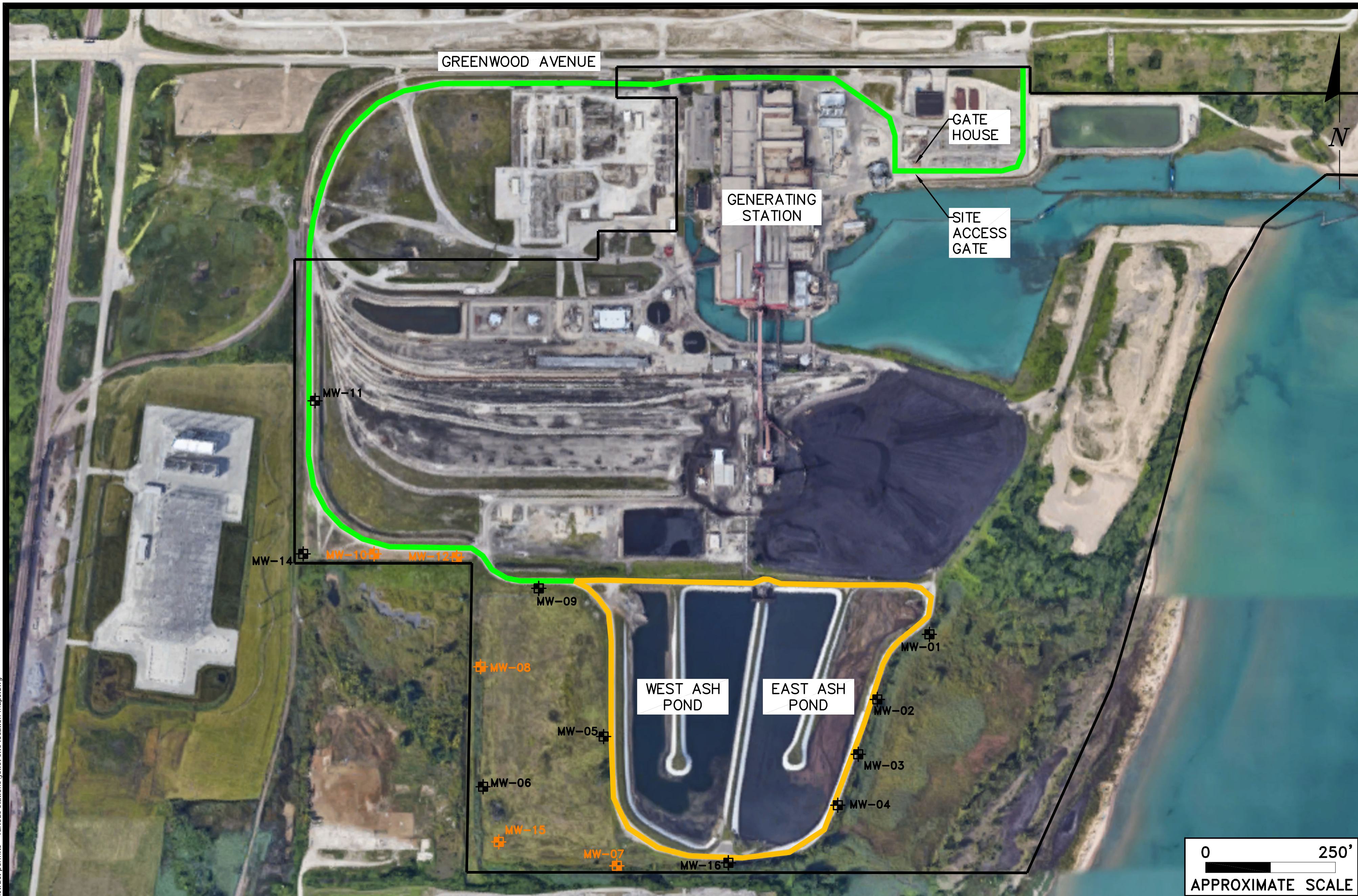
WEST ASH BASIN AREA-CAPACITY CURVE

WAUKEGAN GENERATING STATION
WAUKEGAN, ILLINOIS

Scale: NTS	Date: September 15, 2021
KPRG Project No. 19520.2	FIGURE 1-2



W:\projects\midwest gen\operating and construct permits - various stations\joliet site location maps.dwg

LEGEND

FACILITY BOUNDARY

TYPICAL VEHICLE ACCESS TO POND 2

LARGE VEHICLE ACCESS TO POND 2

FACILITY FENCE

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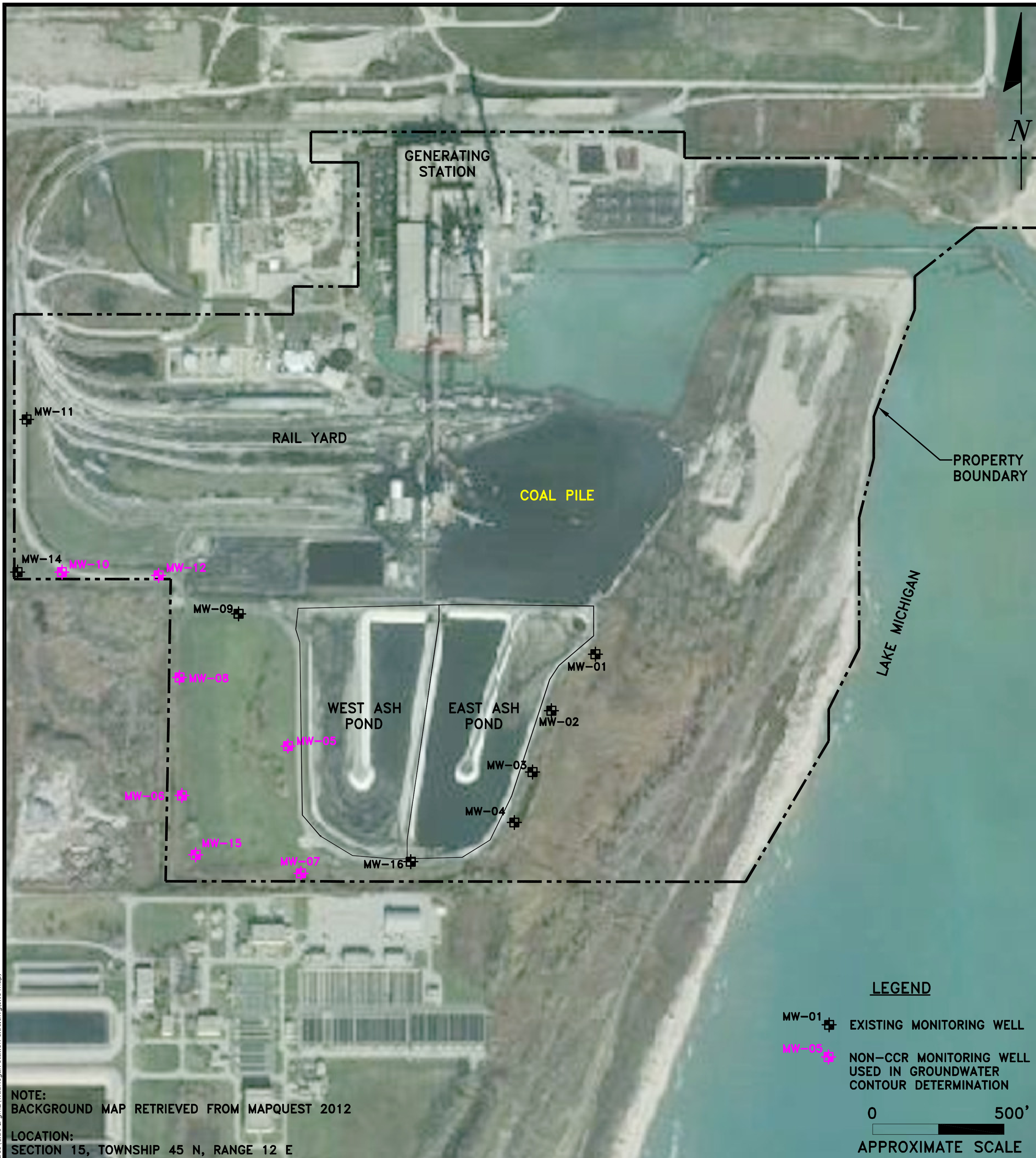
SITE TRANSPORTATION MAP

JOLIET #29 GENERATING STATION
JOLIET, ILLINOIS

Scale: 1" = 250'	Date: January 4, 2022
KPRG Project No. 19620	FIGURE 2



W:\c-p&p\projects\midwest generation\ash pond issues\eluc & gmz\waukegan station eluc.dwg(site map)

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MONITORING WELL MAP

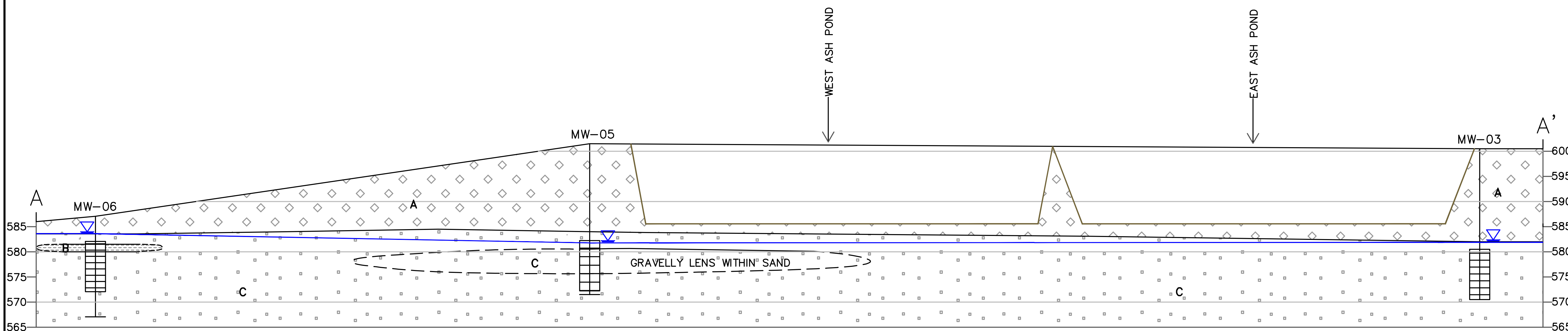
WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 500'

Date: August 31, 2021

KPRG Project No. 19520.2

FIGURE 9-1



FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS.

ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND.

SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS.

WATER LEVEL (5/21)

POND OUTLINE

20'
0
100'
APPROXIMATE SCALE

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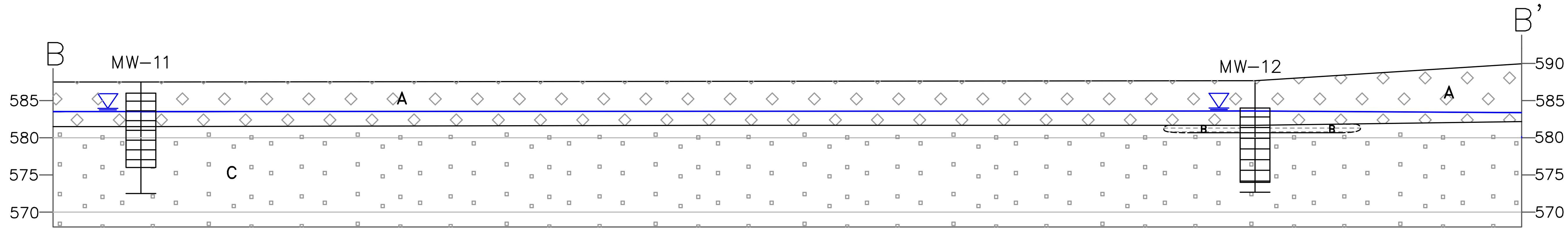
CROSS SECTION A-A'	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 9-2



FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS. (A)

ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND. (B)

SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS. (C)

WATER LEVEL (5/21)

15'
0
80'
APPROXIMATE SCALE

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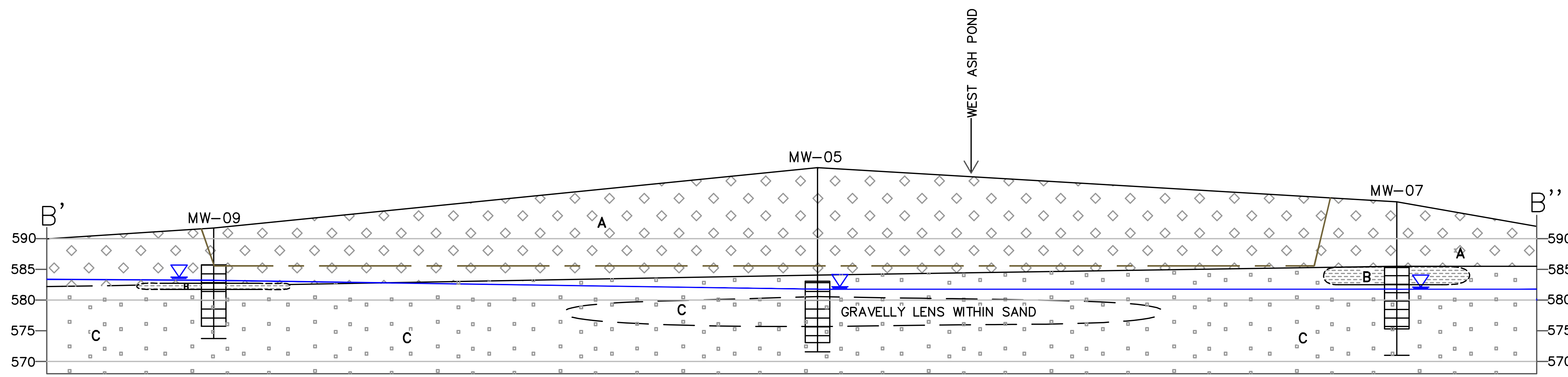
CROSS SECTION B–B'	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 9–3



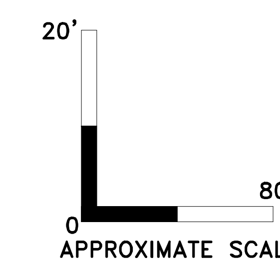
A — FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS.

B — ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND.

C — SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS.

WATER LEVEL (5/21)

PROJECTED POND OUTLINE



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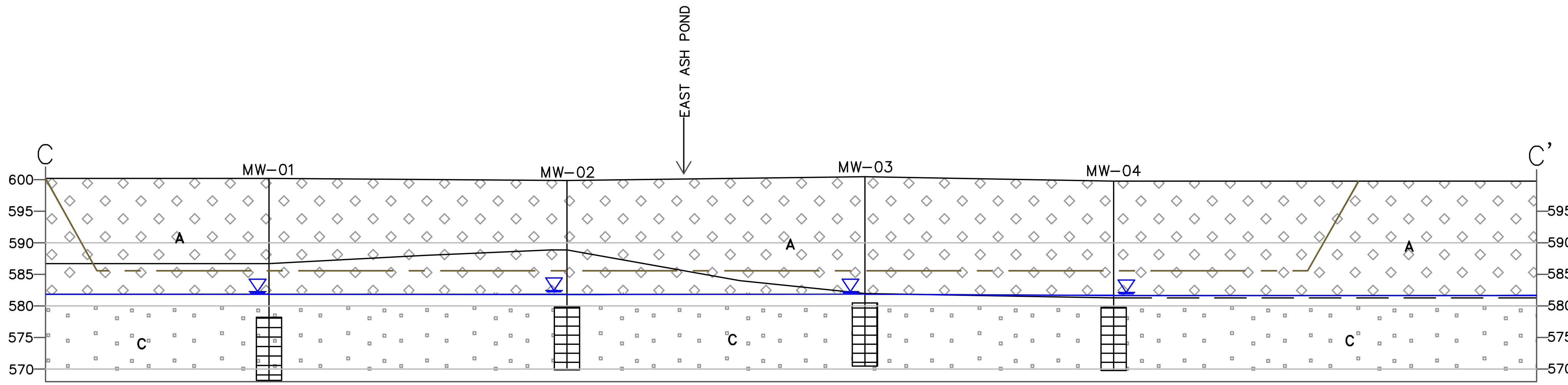
CROSS SECTION B'–B''	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 9-4



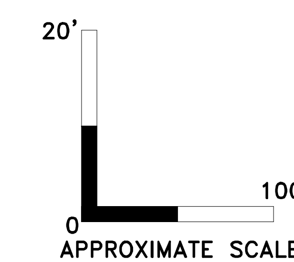
A — FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS.

B — ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND.

C — SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS.

WATER LEVEL (5/21)

PROJECTED POND OUTLINE



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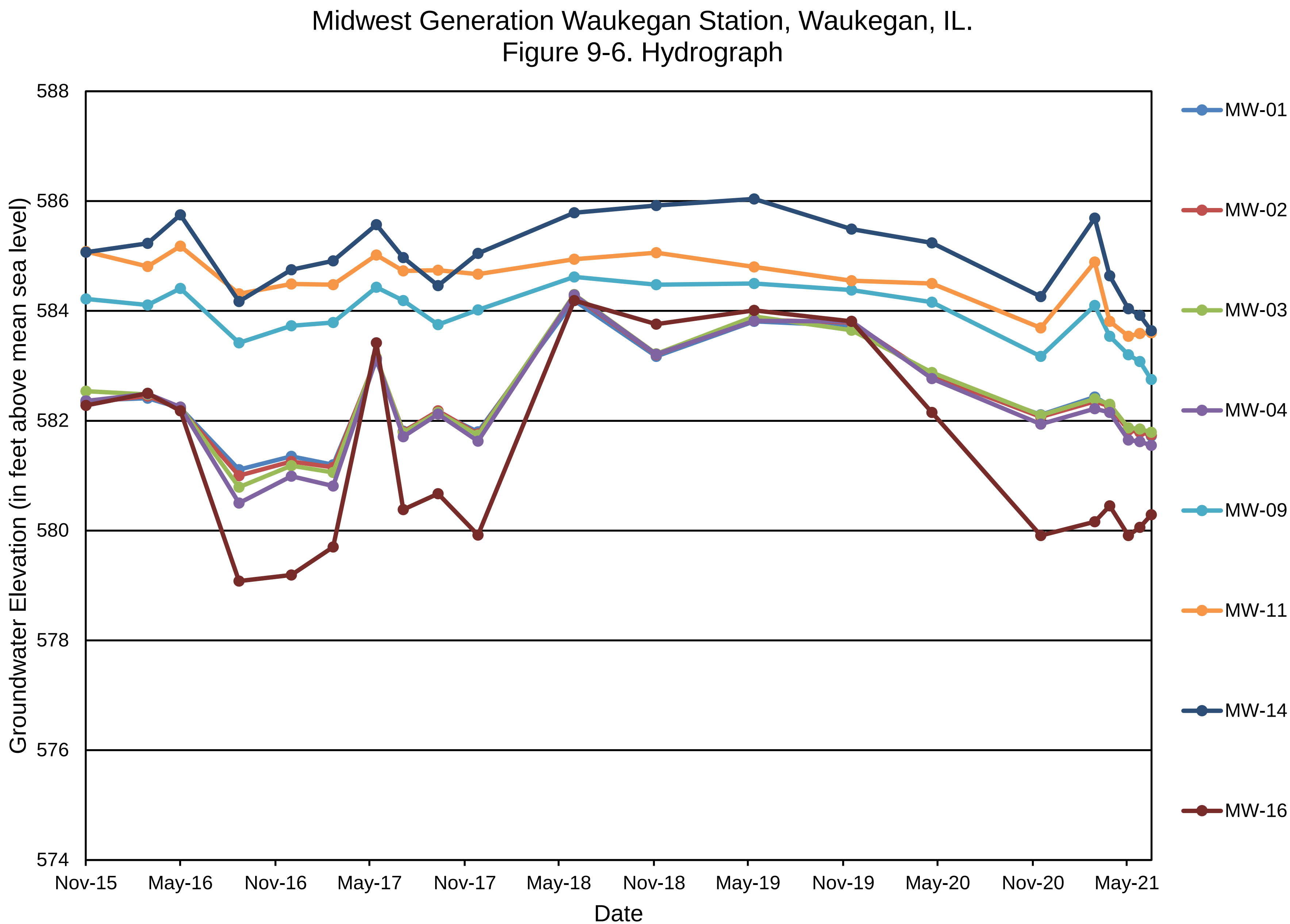
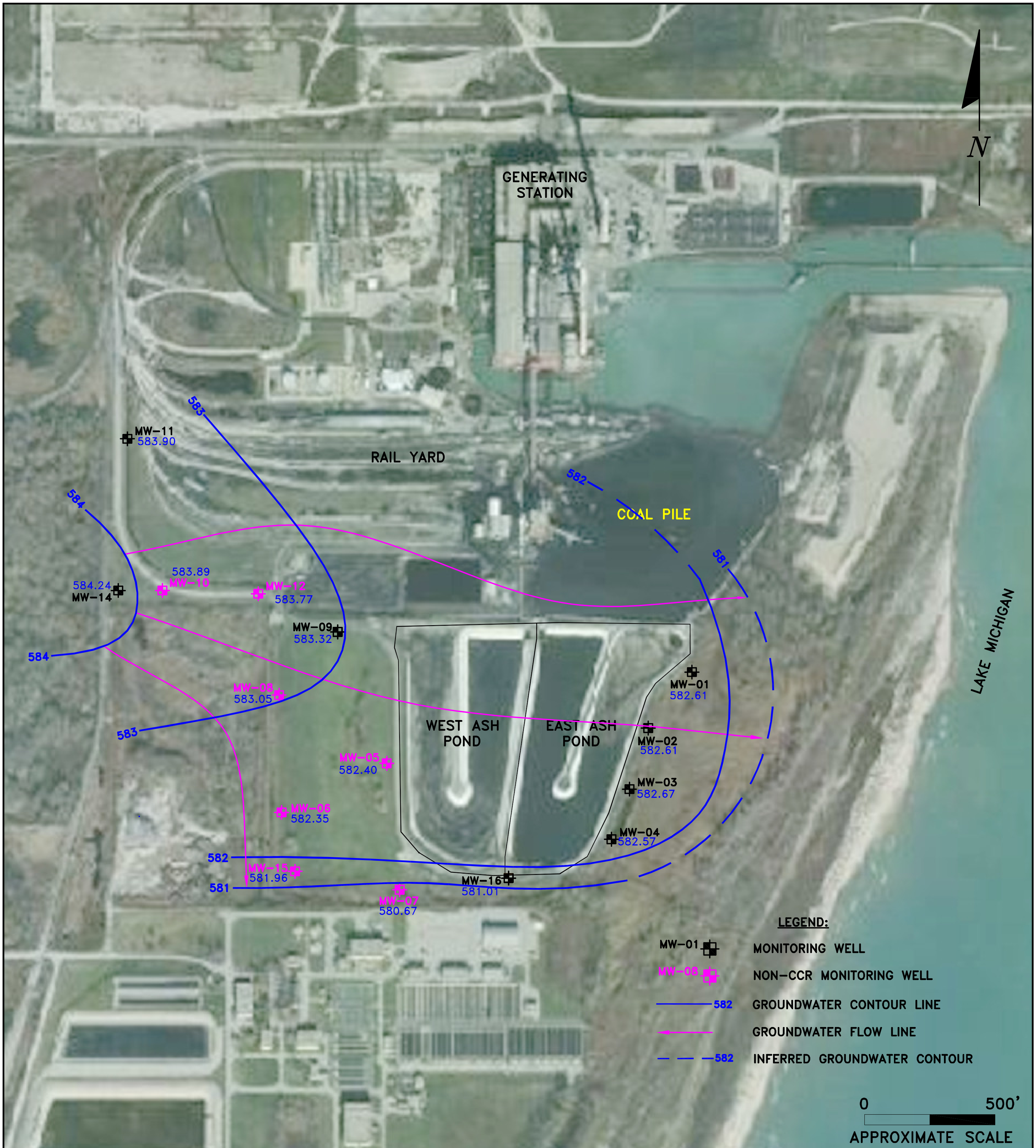
CROSS SECTION C–C'	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 9-5


Midwest Generation Waukegan Station, Waukegan, IL.
Figure 9-6. Hydrograph
Groundwater Elevation (in feet above mean sea level)
588
586
584
582
580
578
576
574
Nov-15
May-16
Nov-16
May-17
Nov-17
May-18
Nov-18
May-19
Nov-19
May-20
Nov-20
May-21
Date
MW-01
MW-02
MW-03
MW-04
MW-09
MW-11
MW-14
MW-16



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GROUNDWATER CONTOUR MAP 08/2020

WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 500'	Date: August 31, 2021
KPRG Project No. 19520.2	FIGURE 9-7

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414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

GROUNDWATER CONTOUR MAP 11/2020

WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 500'	Date: August 31, 2021
KPRG Project No. 19520.2	FIGURE 9-8

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

KPRG and Associates, inc.

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414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

GROUNDWATER CONTOUR MAP 03/2021

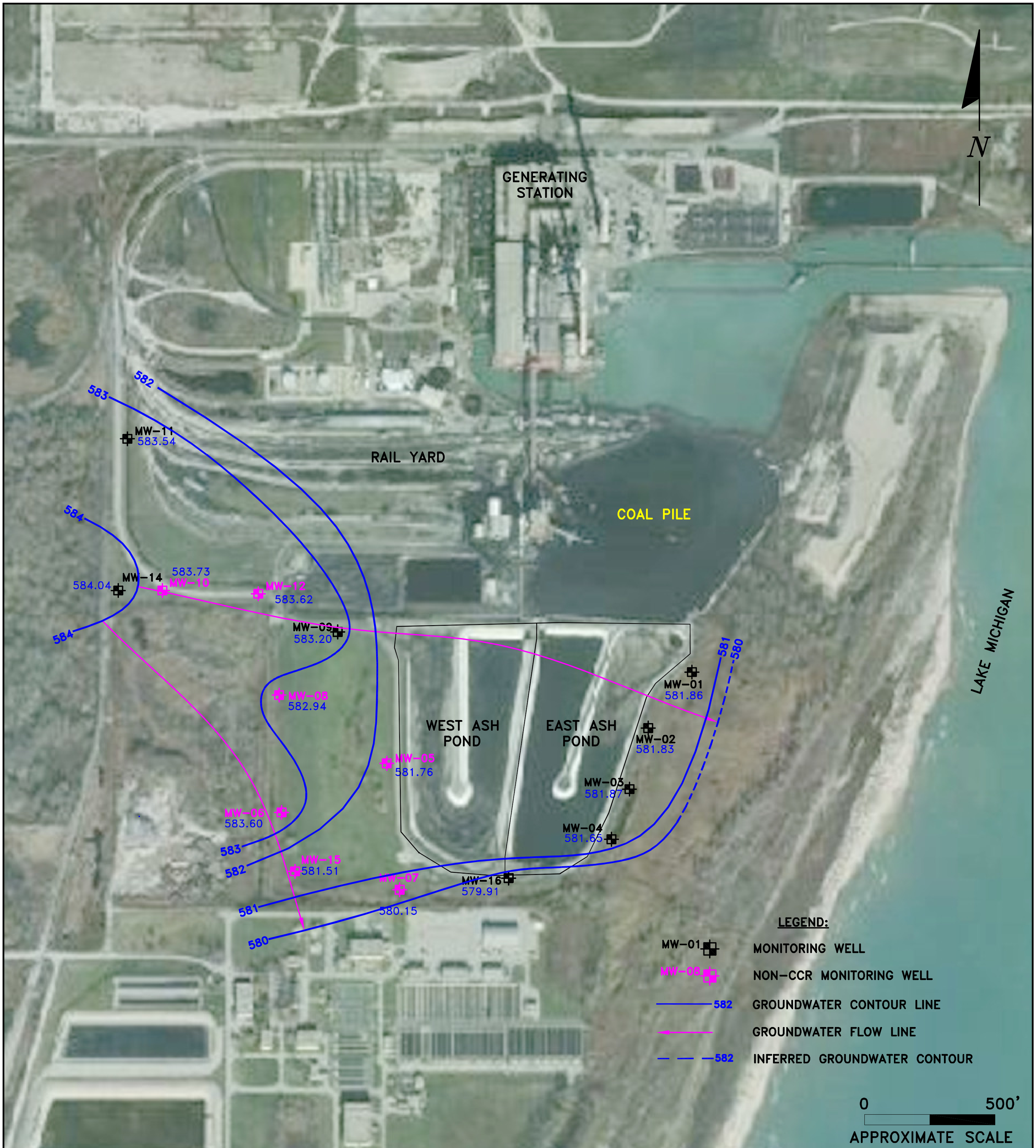
WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 500'

Date: August 31, 2021

KPRG Project No. 19520.2

FIGURE 9-9



E N V I R O N M E N T A L C O N S U L T A T I O N & R E M E D I A T I O N

K P R G

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

GROUNDWATER CONTOUR MAP 05/2021

WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 500' | Date: August 31, 2021

KPRG Project No. 19520.2 | FIGURE 9-10

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

ELUC BOUNDARY EXTENSION	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
Scale: 1" = 500'	Date: September 17, 2021
KPRG Project No. 19520.2	FIGURE 9-11

W:\projects\midwest generation\ash pond issues\eluc & gmz\waukegan station eluc.dwg(eluc site map)

LEGEND

● WATER WELL

41204 SHORT API WELL ID

1540 TOTAL WELL DEPTH

0 800'

APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

2500' RADIUS POTABLE WELL MAP

WAUKEGAN GENERATING STATION
WAUKEGAN, ILLINOIS

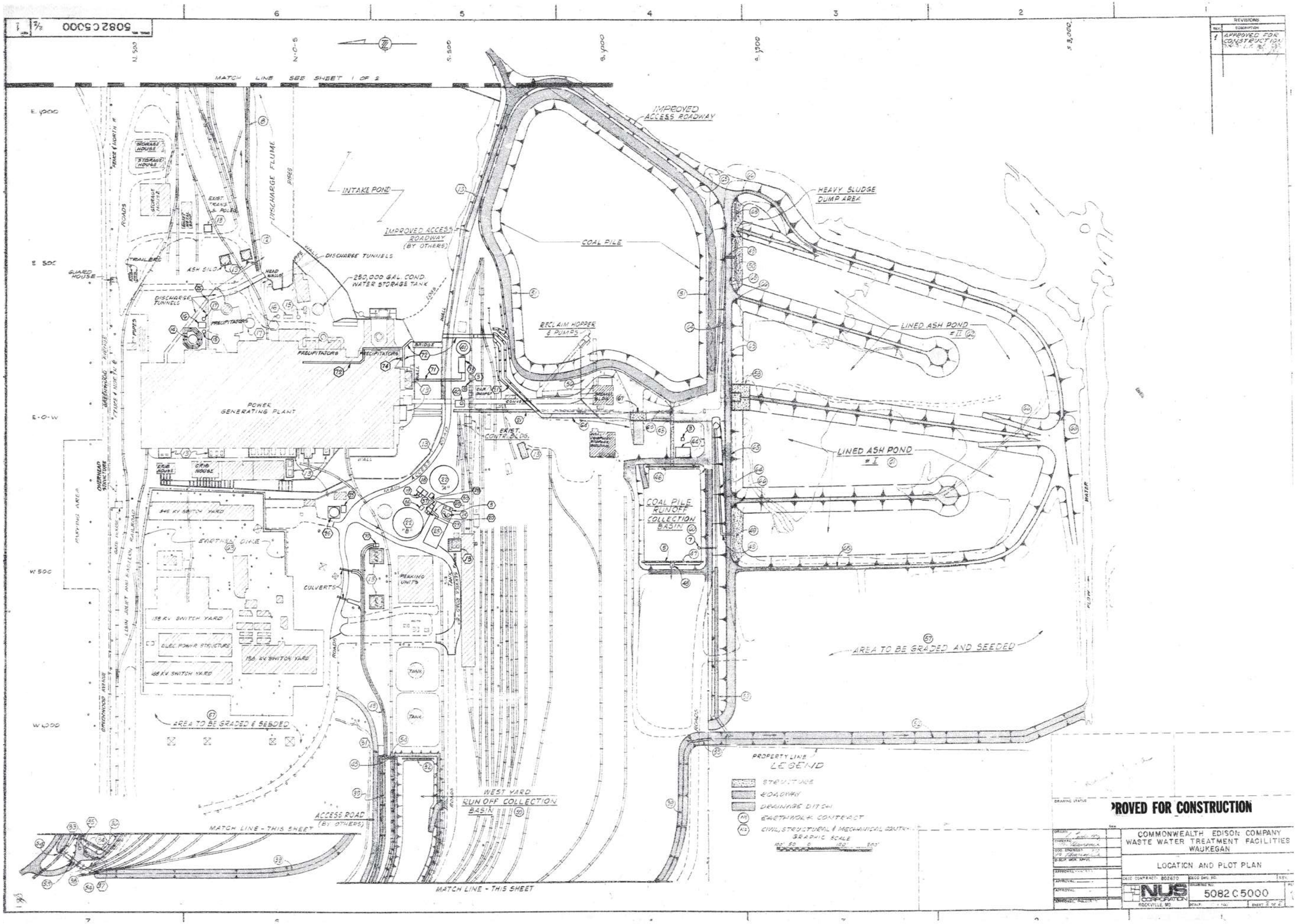
Scale: 1" = 800'	Date: August 25, 2021
KPRG Project No. 19520.2	FIGURE 9-12

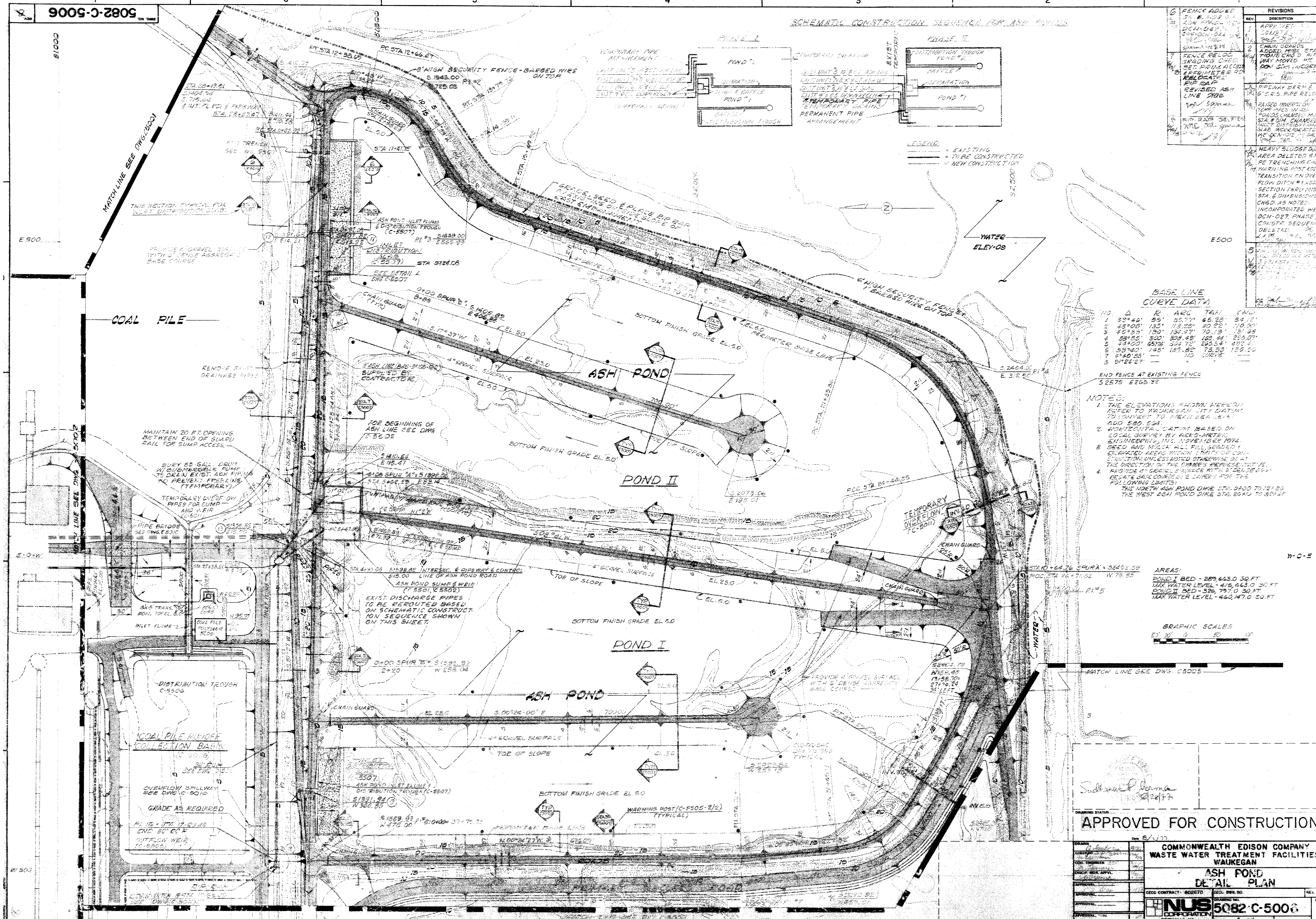
W:\projects\midwest generation\operating and constr permit\waukegan\waukegan station.dwg

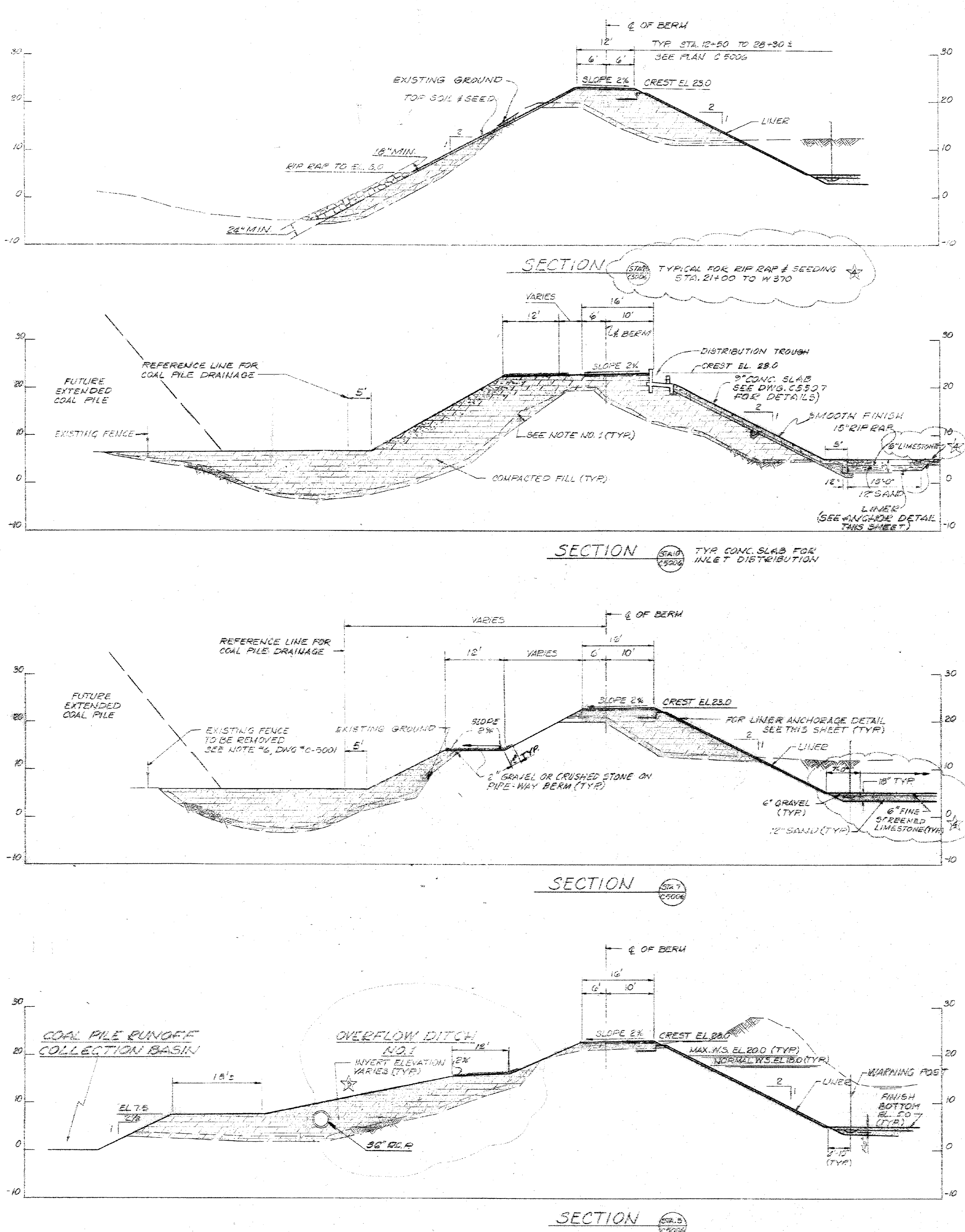
OPERATING PERMIT ATTACHMENTS

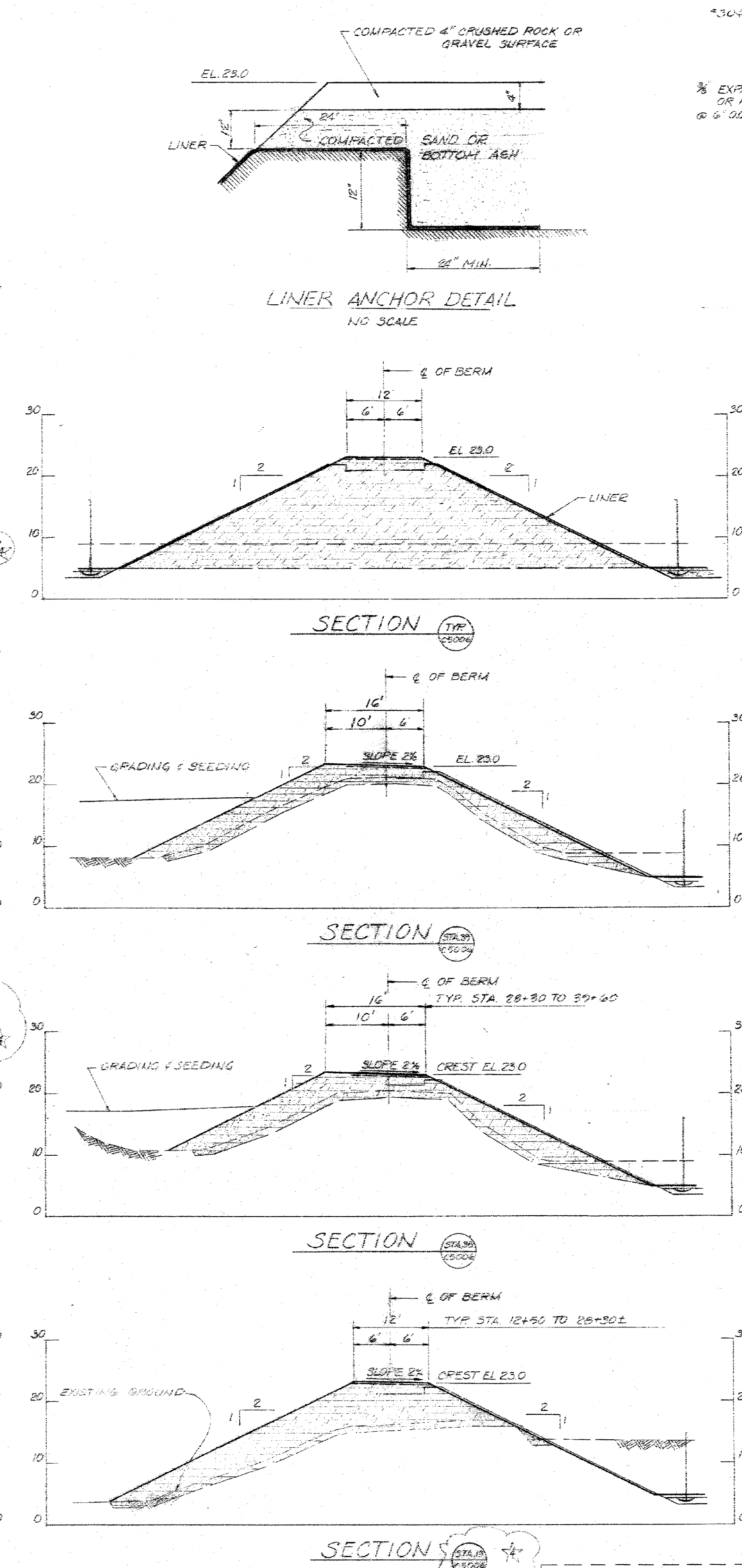
ATTACHMENT 1
HISTORY OF CONSTRUCTION

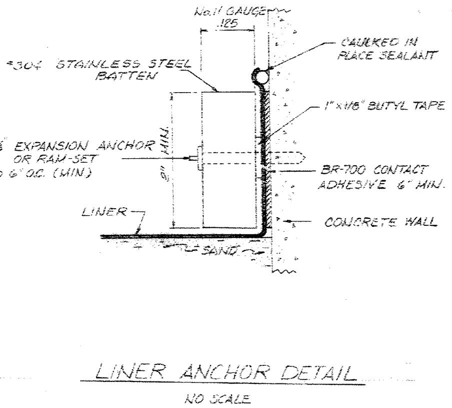
Attachment 1-1 – NUS Construction Drawings

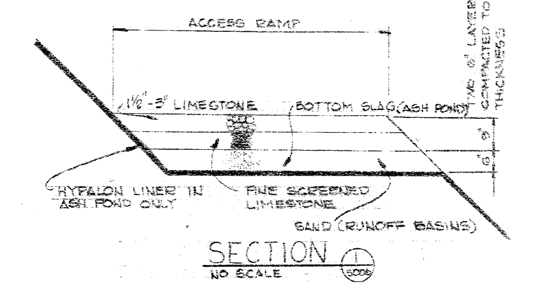

5082 C 5000
MATCH LINE SEE SHEET 1 OF 2
IMPROVED ACCESS ROADWAY
INTAKE POND
DISCHARGE FLUME
IMPROVED ACCESS ROADWAY (BY OTHERS)
DISCHARGE TUNNELS
250,000 GAL. COND. WATER STORAGE TANK
COAL PILE
HEAVY SLUDGE DUMP AREA
RECLAIM HOPPER & PUMPS
LINED ASH POND #II
LINED ASH POND #I
PRECIPITATORS
POWER GENERATING PLANT
EXIST. CONTR. BLDG.
COAL PILE RUNOFF COLLECTION BASIN
345 KV SWITCH YARD
EARTHEN DIKE
CULVERTS
PEAKING UNITS
138 KV SWITCH YARD
ELEC. POWER STRUCTURE
TANK
AREA TO BE GRADED AND SEEDED
AREA TO BE GRADED & SEEDED
WEST YARD RUN OFF COLLECTION BASIN
ACCESS ROAD (BY OTHERS)
MATCH LINE - THIS SHEET
PROPERTY LINE
LEGEND
STRUCTURE
ROADWAY
DRAINAGE DITCH
EARTHWORK CONTRACT
CIVIL, STRUCTURAL & MECHANICAL CONTRACT
GRAPHIC SCALE
APPROVED FOR CONSTRUCTION
COMMONWEALTH EDISON COMPANY
WASTE WATER TREATMENT FACILITIES
WAUKEGAN
LOCATION AND PLOT PLAN
NUS CORPORATION
ROCKVILLE, MD
5082 C 5000


5082-C-5006
SCHEMATIC CONSTRUCTION SEQUENCE FOR ASH PONDS
PHASE I
PHASE II
LEGEND
EXISTING
TO BE CONSTRUCTED
NEW CONSTRUCTION
COAL PILE
ASH POND
POND II
POND I
BOTTOM FINISH GRADE EL. 5.0
COAL PILE RUNOFF COLLECTION BASIN
DISTRIBUTION TROUGH
WATER ELEV.-0.9
BASE LINE CURVE DATA
END FENCE AT EXISTING FENCE
S 2575 E265.32
NOTES:
1. THE ELEVATIONS SHOWN HEREON REFER TO WAUKEGAN CITY DATUM. TO CONVERT TO MEAN SEA LEVEL ADD 580.564.
2. HORIZONTAL DATUM BASED ON LOCAL SURVEY BY AERO-METRIC ENGINEERING, INC. NOVEMBER 1974.
3. SEED AND MULCH ALL FILL, GRADED & EXCAVATED AREAS WITHIN LIMITS OF CONSTRUCTION, UNLESS NOTED OTHERWISE OR AT THE DIRECTION OF THE OWNER'S REPRESENTATIVE.
4. PROVIDE 4" GRAVEL SURFACE WITH 6" DENSE AGGREGATE BASE COURSE IN 2 LAYERS FOR THE FOLLOWING LIMITS:
THE NORTH ASH POND DIKE STA. 0+00 TO 12+80
THE WEST ASH POND DIKE STA. 26+10 TO 39+48
AREAS:
POND I BED - 289,663.0 SQ.FT.
MAX. WATER LEVEL - 415,663.0 SQ.FT.
POND II BED - 326,797.0 SQ.FT.
MAX. WATER LEVEL - 460,147.0 SQ.FT.
GRAPHIC SCALES
MATCH LINE SEE DWG. C-5005
REVISIONS
DRAWING STATUS
APPROVED FOR CONSTRUCTION
COMMONWEALTH EDISON COMPANY
WASTE WATER TREATMENT FACILITIES
WAUKEGAN
ASH POND
DETAIL PLAN
CECO CONTRACT: 802670
NUS CORPORATION
ROCKVILLE, MD.
DRAWING NO. 5082-C-5006
SCALE: 1" = 30'









NOTES:

1. ALL ORGANIC MATERIAL, DEBRIS AND LOOSE BOTTOM SLAG OR FLY-ASH SHALL BE STRIPPED FROM THE EXISTING DIKE FOUNDATION AREA. THE EXPOSED FOUNDATION SOILS SHALL BE PROOF ROLLED WITH A PNEUMATIC SMALL TIRE COMPACTOR OF 10 TONS WEIGHT.
2. THE FOUNDATION MATERIAL FOR ALL NEW (INTERIOR) DIKES SHALL BE PLACED BELOW ORGANIC SOILS, DEBRIS, LOOSE FILL MATERIAL IN THE STRATUM OF NATURAL BROWN GRAY SAND.
3. ALL EARTHWORK, FILL, BACKFILL AND EXCAVATION SHALL BE DONE AS PER NUS SPECIFICATION C519. ALL FILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 9 INCHES IN LOOSE THICKNESS AND COMPACTED TO A MINIMUM OF 95 % OF THE MAXIMUM DENSITY AS PER A.S.T.M. D1557-70, METHOD A.
4. DIKE CONSTRUCTION SHALL UTILIZE BOILER BOTTOM SLAG OF ACCEPTABLE FLY ASH CONTENT, TO THE EXTENT THAT MATERIAL IS READILY AVAILABLE. OTHER MATERIAL IF ANALYSED & APPROVED BY THE OWNER'S REPRESENTATIVE, WILL BE ACCEPTABLE.
5. EXISTING WET BOTTOM SLAG REMOVED FROM INTERIOR OF ASH POND AREA MAY BE DRIED AND REUSED FOR DIKE CONSTRUCTION IF FREE OF ORGANIC MATERIAL & WITH ACCEPTABLE FLY ASH CONTENT. UNSUITABLE MATERIAL, AS DETERMINED BY THE OWNER'S REPRESENTATIVE, SHALL NOT BE USED FOR DIKE CONSTRUCTION.

7. BEDDING BLANKET FOR FILTER MATERIAL AND IMPERVIOUS BASIN LINERS SHALL BE PROVIDED TO THE DEPTH, GRADE AND DIMENSIONS AS SHOWN. SAND, CRUSHED STONE OR LOCALLY AVAILABLE BOTTOM ASH CONFORMING TO NUS STANDARD SPECIFICATION C613 AND C515 MAY BE USED.
8. FILL SHALL HAVE SUFFICIENT BEARING CAPACITY FOR SUPPORTING TRAFFIC.

Sudhakar P. Verma 9-29-77

DRAWING STATUS
APPROVED FOR CONSTRUCTION
Date 8/1/77

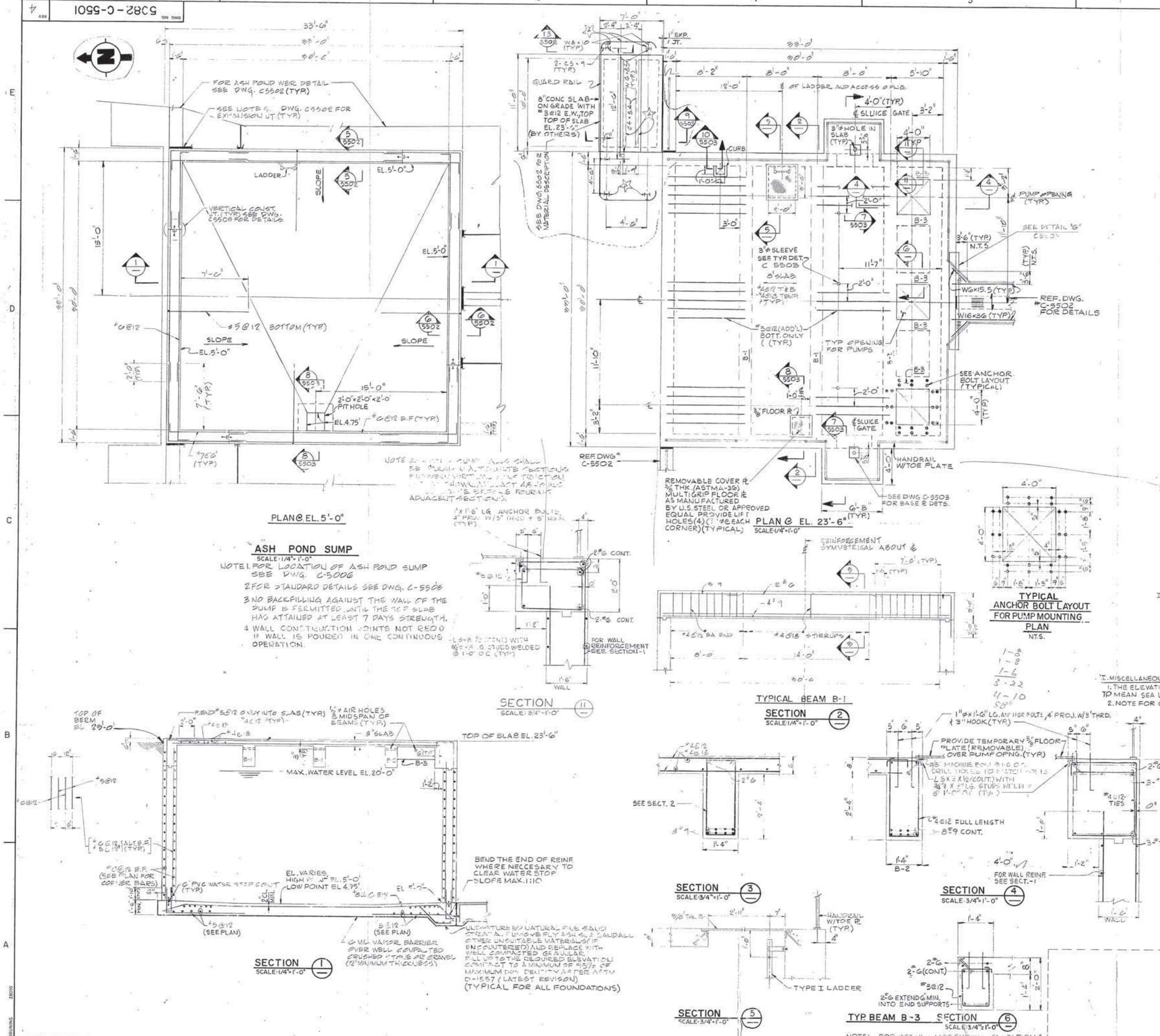
DRAWN J. Tkac	COMMONWEALTH EDISON COMPANY WASTE WATER TREATMENT FACILITIES WAUKEGAN
CHECKED	ASH POND SECTIONS & DETAILS
CDG. ENGINEER	CECO CONTRACT: 802670 — CECO DWG NO. — REV.
DISCIP. MGR. APPVL.	NUS CORPORATION ROCKVILLE, MD. — DRAWING NO. 5082-C-5007 — REV. 4
APPROVAL	SCALE: 1" = 10' — SHEET OF

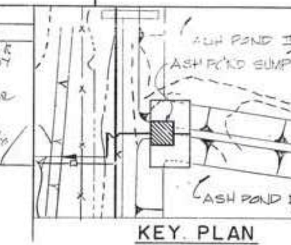
GRAPHIC SCALE HOR. 1"=10' VERT. 1"=10'

REVISIONS

REV.	DESCRIPTION
1	APPROVED FOR CONSTRUCTION
2	NOTE NO. 8 ADDED LINER ANCHOR DETAIL
3	CHANGED DISTANCE OF WARNING POST FROM TOE
4	REVISED SECTS.

6/9/78





REV	DESCRIPTION
	APPROVED FOR CONSTRUCTION
	REVISE ... ADDED & CHANGED NOTES
3	ADDED SECTION 11 & NOTES

GENERAL NOTES

THESE NOTES SHALL BE USED AS A SUPPLEMENT TO THE NOTES SHOWN ON INDIVIDUAL DRAWINGS

I. FOUNDATION

1. THE BOTTOM OF ALL EXCAVATIONS SHALL BE INSPECTED AND APPROVED BY THE OWNER OR HIS AUTHORIZED REPRESENTATIVE
2. THE DESIGN BEARING CAPACITY OF SOIL IS ASSUMED TO BE 3000 P.S.F.
3. ALL SLABS ON GRADE INCLUDING FOUNDATION PADS FOR EQUIPMENT SHALL BE PLACED ON 6 MIL POLYETHYLENE VAPOR BARRIER PLACED OVER WELL COMPACTED CRUSHED STONE OR GRAVEL (8" MINIMUM). UNLESS OTHERWISE NOTED ON DRAWING
4. ALL FOUNDATIONS SHALL BEAR UPON UNDISTURBED SOIL AND WELL PREPARED COMPACTED SOIL

II. CONCRETE

1. ALL STRUCTURAL CONCRETE SHALL BE STONE CONCRETE AND SHALL DEVELOP A MINIMUM COMPRESSIVE STRENGTH OF 4000 P.S.I. AT 28 DAYS
2. ALL REINFORCING BARS SHALL BE DEFORMED BARS OF NEW BILLET STEEL CONFORMING TO A.S.T.M. A-615 GRADE 40 AND SHALL HAVE A MINIMUM YIELD STRESS OF 40,000 P.S.I.
3. UNLESS OTHERWISE NOTED, ALL DOWELS SHALL BE SAME IN NUMBER AND SIZE AS THE VERTICAL BARS TO WHICH THEY ARE SPLICED.
4. MINIMUM CONCRETE PROTECTION FOR REINFORCING BARS SHALL BE AS INDICATED BELOW. PLACING OF ALL REINFORCING BARS SHALL CONFORM TO ACI 381-71, SECTION 7.3.

Cast-In-Place Concrete	Min. Cover, In
Cast against and permanently exposed to earth	3
Not exposed to weather or in contact with the ground:	
Slabs, walls, joists:	
No.14 and No.18 Bars	1-1/2
No.11 and smaller	3/4

Cast-In-Place Concrete	Min. Cover, In
Exposed to earth or weather:	
No 6 through No.18 Bars	2
No 5 Bars, 5/8 In. wire, and smaller	1-1/2
Beams, girders, columns:	
Principal reinforcement, ties, stirrups or spirals	1-1/2

5. UNLESS OTHERWISE NOTED ALL SPLICES, BENDS, STANDARD HOOKS AND OTHER DETAILING OF REINFORCING BARS SHALL BE DONE AS RECOMMENDED IN THE "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES" (ACI 315-74).
6. CONTRACTOR SHALL VERIFY DIMENSIONS & LOCATIONS OF ALL OPENINGS, PIPE SLEEVES, ANCHOR BOLTS, ETC., AS REQUIRED BY OTHER TRADES BEFORE PLACING ANY CONCRETE
7. CONSTRUCTION JOINTS OF LIQUID CONTAINING STRUCTURES SHALL HAVE 6" P.V.C. CONTINUOUS WATER STOP UNLESS NOTED OTHERWISE ON THE CONTRACT DRAWINGS
8. W.W.F. SHALL CONFORM TO REQUIREMENTS OF ASTM 185

III. STRUCTURAL STEEL

1. ALL STRUCTURAL STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A-36
2. THE DESIGN, FABRICATION AND ERECTION OF ALL STRUCTURAL STEEL SHALL BE DONE IN ACCORDANCE WITH THE AISC MANUAL OF STEEL CONSTRUCTION (SEVENTH EDITION)
3. ALL STRUCTURAL BOLTS SHALL BE 3/4" Ø HIGH STRENGTH TYPE ASTM A 325-X.
4. UNLESS OTHERWISE NOTED, ALL CONNECTIONS SHALL BE SELECTED TO SUPPORT HALF THE TOTAL UNIFORM LOAD CAPACITY SHOWN IN "TABLES FOR ALLOWABLE LOADS ON BEAMS" (AISC MANUAL OF STEEL CONSTRUCTION – SEVENTH EDITION) + 5 KIPS FOR THE SHAPE AND SPAN SHOWN ON DRAWINGS
5. ALL WELDING SHALL BE DONE IN ACCORDANCE WITH THE REQUIREMENTS OF "STRUCTURAL WELDING CODE, AWS D1.1–REV. 1-73" WELDING ELECTRODES SHALL BE E70XX

IV. EARTHWORK.

1. ONE FOOT OF POROUS BACKFILL SHALL BE PLACED ALONG ALL WALLS FROM TOP OF FOUNDATION TO 1'-0" BELOW FINISHED GRADE WHERE SHOWN ON CONTRACT DRAWINGS
2. BACKFILLING SHALL NOT BE DONE UNTIL ALL CONCRETE HAS ATTAINED ITS' FULL DESIGN COMPRESSIVE STRENGTH
3. BACKFILLING SHALL BE DONE AND COMPACTED IN EQUAL LAYERS ALONG ALL SIDES OF STRUCTURE
4. CONTRACTOR SHALL ADEQUATELY PROTECT ALL WALLS DURING BACKFILLING OPERATIONS

V. MISCELLANEOUS

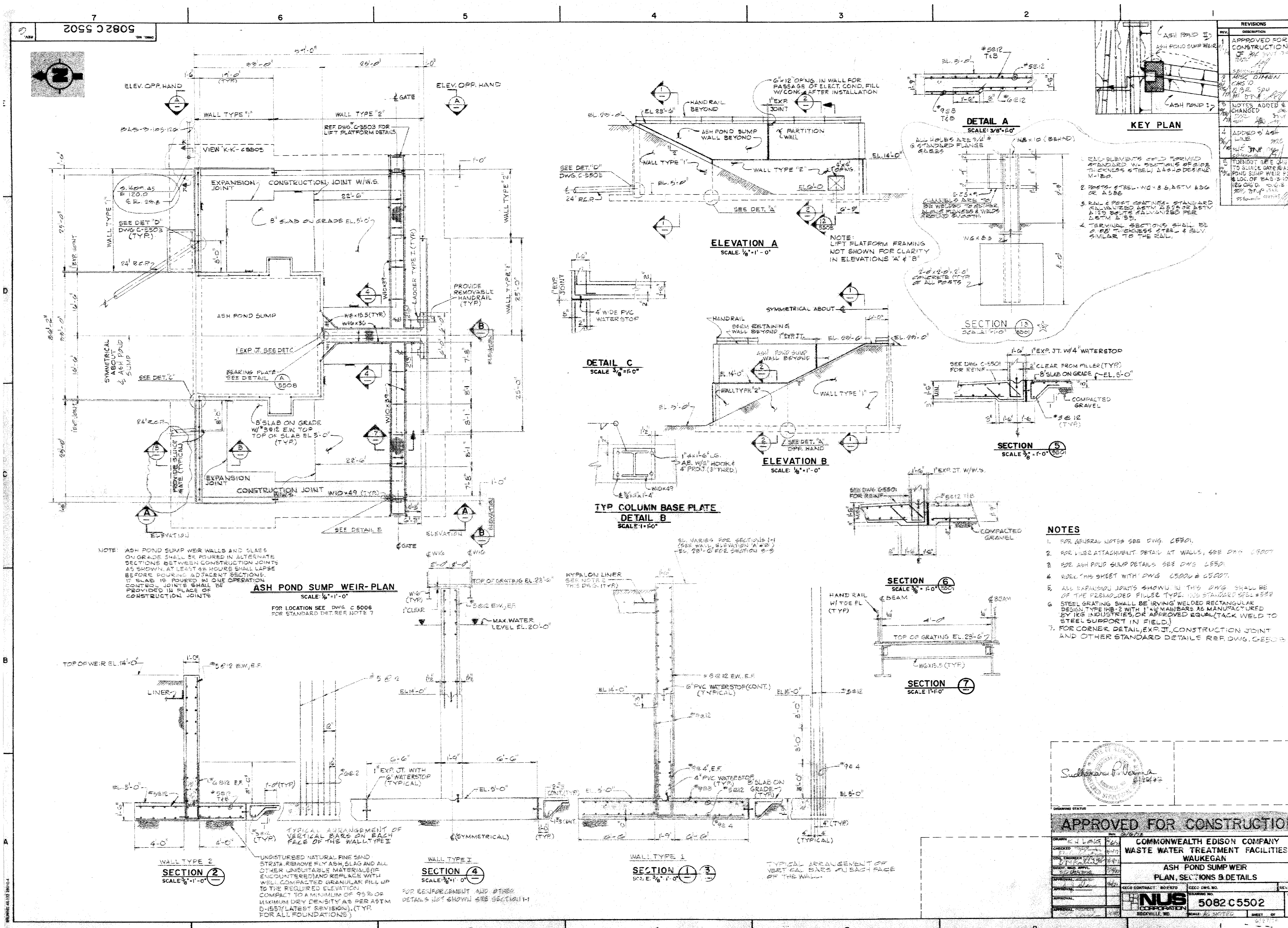
1. THE ELEVATIONS SHOWN ON THESE DRAWINGS REFER TO WAUKEGAN CITY DATUM; TO CONVERT TO MEAN SEA LEVEL, ADD 580.564
2. NOTE FOR COVER SLAB, DESIGN LIVE LOAD = 200 PSF, DESIGN PUMP WT. ... K.

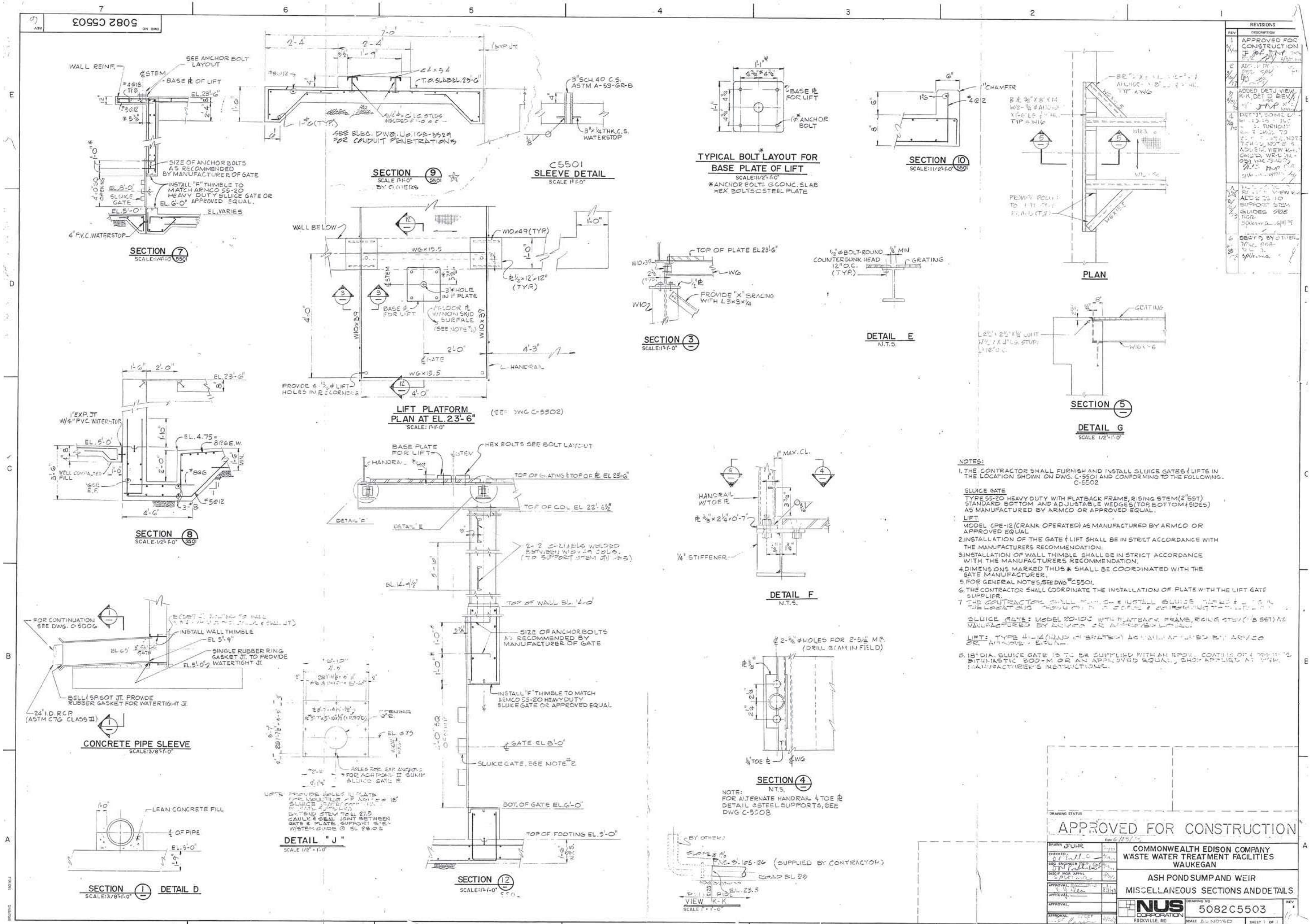
DRAWING STATUS

APPROVED FOR CONSTRUCTION

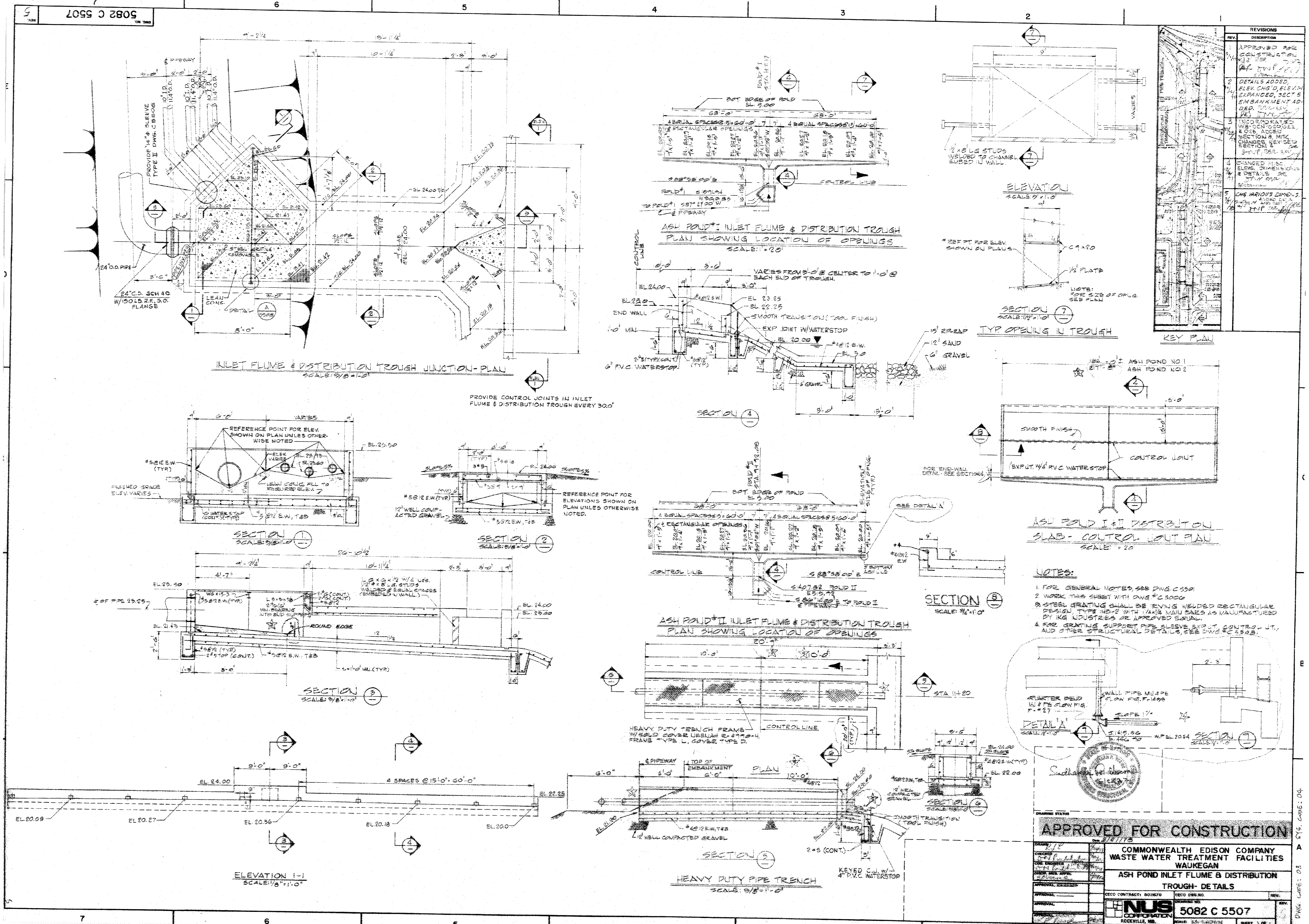
Date 6/28/78

DRAWN		COMMONWEALTH EDISON COMPANY WASTE WATER TREATMENT FACILITIES WAUKEGAN
CHECKED		
COG. ENGINEER		ASH POND SUMP PLAN, SECTIONS AND DETAILS
DISCIP. MGR. APPVL.	3/4/72	
APPROVAL		CECO CONTRACT #02670 / CECO DWG NO
APPROVAL		NUS CORPORATION, ROCKVILLE, MD / DRAWING NO 5082 C 5501 / REV
APPROVAL		SCALE AS NOTED / SHEET 1 OF 1


5082 C 5502
ASH POND SUMP WEIR-PLAN
SCALE: 1/8" = 1'-0"
FOR LOCATION SEE DWG. C 5006
NOTE: ASH POND SUMP WEIR WALLS AND SLABS ON GRADE SHALL BE POURED IN ALTERNATE SECTIONS BETWEEN CONSTRUCTION JOINTS AS SHOWN. AT LEAST 48 HOURS SHALL LAPSE BEFORE POURING ADJACENT SECTIONS. IF SLAB IS POURED IN ONE OPERATION CONTROL JOINTS SHALL BE PROVIDED IN PLACE OF CONSTRUCTION JOINTS
ELEVATION A
SCALE: 1/8" = 1'-0"
NOTE: LIFT PLATFORM FRAMING NOT SHOWN FOR CLARITY IN ELEVATIONS "A" & "B"
ELEVATION B
SCALE: 1/8" = 1'-0"
DETAIL A
SCALE: 3/8" = 1'-0"
DETAIL C
SCALE 3/8" = 1'-0"
TYP COLUMN BASE PLATE DETAIL B
SCALE: 1" = 1'-0"
KEY PLAN
SECTION 5
SECTION 6
SECTION 7
SCALE 1" = 1'-0"
SECTION 2
SCALE 3/8" = 1'-0"
SECTION 4
SCALE: 3/8" = 1'-0"
SECTION 1 / 3
SCALE: 3/8" = 1'-0"
NOTES
1. FOR GENERAL NOTES SEE DWG. C5501.
2. FOR LINER ATTACHMENT DETAIL AT WALLS, SEE DWG. C5507.
3. FOR ASH POND SUMP DETAILS SEE DWG. C5503.
4. WORK THIS SHEET WITH DWG. C5006 & C5507.
5. ALL EXPANSION JOINTS SHOWN IN THIS DWG. SHALL BE OF THE PREMOLDED FILLER TYPE.
6. STEEL GRATING SHALL BE 'IRVING' WELDED RECTANGULAR DESIGN TYPE IHB-2 WITH 1"x3/16" MAINBARS AS MANUFACTURED BY IKG INDUSTRIES, OR APPROVED EQUAL (TACK WELD TO STEEL SUPPORT IN FIELD.)
7. FOR CORNER DETAIL, EXP. JT., CONSTRUCTION JOINT AND OTHER STANDARD DETAILS REF. DWG. C5508.
REVISIONS
1 APPROVED FOR CONSTRUCTION
2 MISC. DIMEN CHG'D
3 NOTES ADDED & CHANGED
4 ADDED 5' ASH LINE
5 TURNOUT REF. DWG TO SLUICE GATE ASH POND SUMP WEIR PL. LOC. OF BAS-3-105
APPROVED FOR CONSTRUCTION
COMMONWEALTH EDISON COMPANY
WASTE WATER TREATMENT FACILITIES
WAUKEGAN
ASH POND SUMP WEIR
PLAN, SECTIONS & DETAILS
NUS CORPORATION
ROCKVILLE, MD.
5082 C5502
5

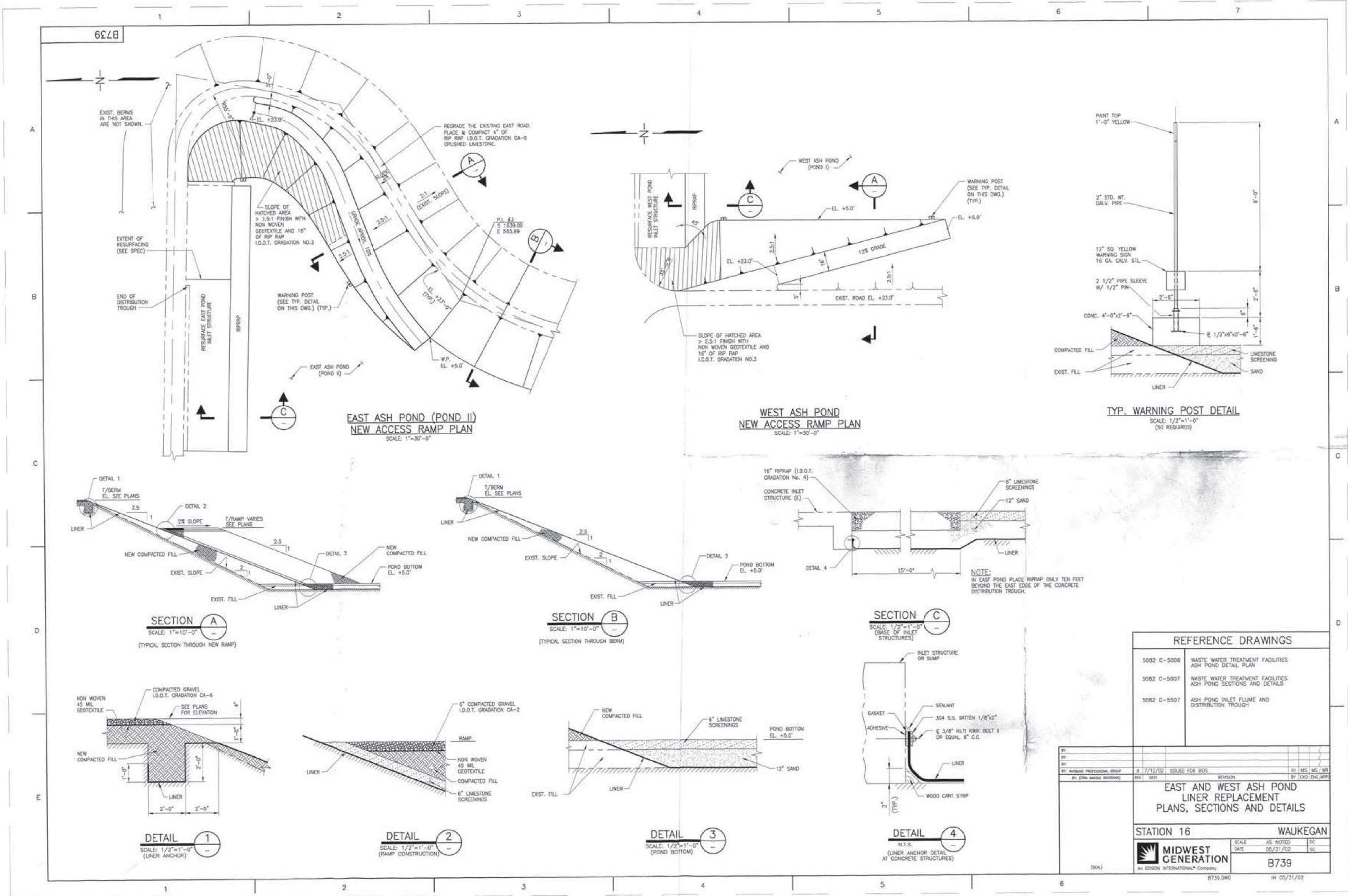


SECTION 7
SCALE: 1/4"=1'-0"
SECTION 9
SCALE 1"=1'-0"
SEE ELEC. DWG. NO. 105-3529 FOR CONDUIT PENETRATIONS
C5501
SLEEVE DETAIL
SCALE 1"=1'-0"
TYPICAL BOLT LAYOUT FOR BASE PLATE OF LIFT
SCALE: 1 1/2"=1'-0"
*ANCHOR BOLTS @ CONC. SLAB HEX BOLTS @ STEEL PLATE
SECTION 10
PLAN
LIFT PLATFORM PLAN AT EL. 23'-6"
SCALE: 1"=1'-0"
SECTION 3
SCALE: 1"=1'-0"
DETAIL E
N.T.S.
SECTION 5
DETAIL G
SCALE 1/2"=1'-0"
SECTION 8
SCALE: 1/2"=1'-0"
DETAIL F
N.T.S.
CONCRETE PIPE SLEEVE
SCALE: 3/8"=1'-0"
DETAIL "J"
SCALE 1/2"=1'-0"
SECTION 4
N.T.S.
NOTE: FOR ALTERNATE HANDRAIL & TOE PL DETAIL @ STEEL SUPPORTS, SEE DWG C-5508
SECTION 1 DETAIL D
SCALE: 3/8"=1'-0"
SECTION 12
SCALE: 1"=1'-0"
VIEW K-K
NOTES:
1. THE CONTRACTOR SHALL FURNISH AND INSTALL SLUICE GATES & LIFTS IN THE LOCATION SHOWN ON DWG. C-5501 AND CONFORMING TO THE FOLLOWING. C-5502
SLUICE GATE
TYPE 55-20 HEAVY DUTY WITH FLATBACK FRAME, RISING STEM (2" SST) STANDARD BOTTOM AND ADJUSTABLE WEDGES (TOP, BOTTOM & SIDES) AS MANUFACTURED BY ARMCO OR APPROVED EQUAL.
LIFT
MODEL CPE-12 (CRANK OPERATED) AS MANUFACTURED BY ARMCO OR APPROVED EQUAL
2. INSTALLATION OF THE GATE & LIFT SHALL BE IN STRICT ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATION.
3. INSTALLATION OF WALL THIMBLE SHALL BE IN STRICT ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATION.
4. DIMENSIONS MARKED THUS * SHALL BE COORDINATED WITH THE GATE MANUFACTURER.
5. FOR GENERAL NOTES, SEE DWG # C5501.
6. THE CONTRACTOR SHALL COORDINATE THE INSTALLATION OF PLATE WITH THE LIFT GATE SUPPLIER.
7. THE CONTRACTOR SHALL
SLUICE GATE: MODEL 20-10C WITH FLATBACK FRAME,
LIFT: TYPE
8. 18" DIA. SLUICE GATE IS TO BE SUPPLIED WITH AN EPOXY COATING
APPROVED FOR CONSTRUCTION
DRAWN FUHR
COMMONWEALTH EDISON COMPANY
WASTE WATER TREATMENT FACILITIES
WAUKEGAN
ASH POND SUMP AND WEIR
MISCELLANEOUS SECTIONS AND DETAILS
NUS CORPORATION
ROCKVILLE, MD
DRAWING NO 5082C5503
SCALE AS NOTED
SHEET 1 OF 1



5082 C 5507
INLET FLUME & DISTRIBUTION TROUGH JUNCTION-PLAN
SCALE: 3/8"=1'-0"
PROVIDE CONTROL JOINTS IN INLET FLUME & DISTRIBUTION TROUGH EVERY 30.0'
ASH POND #1 INLET FLUME & DISTRIBUTION TROUGH
PLAN SHOWING LOCATION OF OPENINGS
SCALE: 1"=20'
SECTION 4
ELEVATION
SECTION 7
TYP. OPENING IN TROUGH
KEY PLAN
REVISIONS
1 APPROVED FOR CONSTRUCTION
2 DETAILS ADDED, ELEV. CHG'D, ELEV. EXPANDED, SECT 5 EMBANKMENT ADDED
3 INCORPORATED
4 CHANGED MISC. ELEVS., DIMENSIONS & DETAILS
5 CHG VARIOUS DIMEN.
SECTION 1
SECTION 2
ASH POND II INLET FLUME & DISTRIBUTION TROUGH
PLAN SHOWING LOCATION OF OPENINGS
SECTION 8
ASH POND I & II DISTRIBUTION SLAB - CONTROL JOINT PLAN
SCALE: 1"=20'
NOTES:
1. FOR GENERAL NOTES, SEE DWG. C 5501
2. WORK THIS SHEET WITH DWG. # C 5006
3. STEEL GRATING SHALL BE IRVING WELDED RECTANGULAR DESIGN, TYPE WD-2 WITH 1 1/4x3/16 MAIN BARS AS MANUFACTURED BY IKG INDUSTRIES OR APPROVED EQUAL.
4. FOR GRATING SUPPORT, PIPE SLEEVE, EXP. JT., CONTROL JT., AND OTHER STRUCTURAL DETAILS, SEE DWG. # C 5505.
SECTION 3
DETAIL 'A'
SECTION 9
PLAN
SECTION 6
SECTION 5
HEAVY DUTY PIPE TRENCH
SCALE: 3/8"=1'-0"
ELEVATION 1-1
SCALE: 1/8"=1'-0"
APPROVED FOR CONSTRUCTION
COMMONWEALTH EDISON COMPANY
WASTE WATER TREATMENT FACILITIES
WAUKEGAN
ASH POND INLET FLUME & DISTRIBUTION TROUGH - DETAILS
NUS CORPORATION
ROCKVILLE, MD.
5082 C 5507

Attachment 1-2 – Liner Replacement Drawing



REFERENCE DRAWINGS

5082 C-5006	WASTE WATER TREATMENT FACILITIES ASH POND DETAIL PLAN
5082 C-5007	WASTE WATER TREATMENT FACILITIES ASH POND SECTIONS AND DETAILS
5082 C-5507	ASH POND INLET FLUME AND DISTRIBUTION TROUGH

REV	DATE	REVISION	BY	CKD	ENG	APP
A	7/12/02	ISSUED FOR BIDS	IH	MS	MS	WR

EAST AND WEST ASH POND
LINER REPLACEMENT
PLANS, SECTIONS AND DETAILS

STATION 16 WAUKEGAN

MIDWEST GENERATION
An EDISON INTERNATIONAL Company

SCALE: AS NOTED
DATE: 05/31/02

B739

B739.DWG IH 05/31/02

Attachment 1-3 – Slope Modifications Construction Drawings

PLANS FOR THE CONSTRUCTION OF:

EAST ASH BASIN SLOPE MODIFICATION

JULY 2016

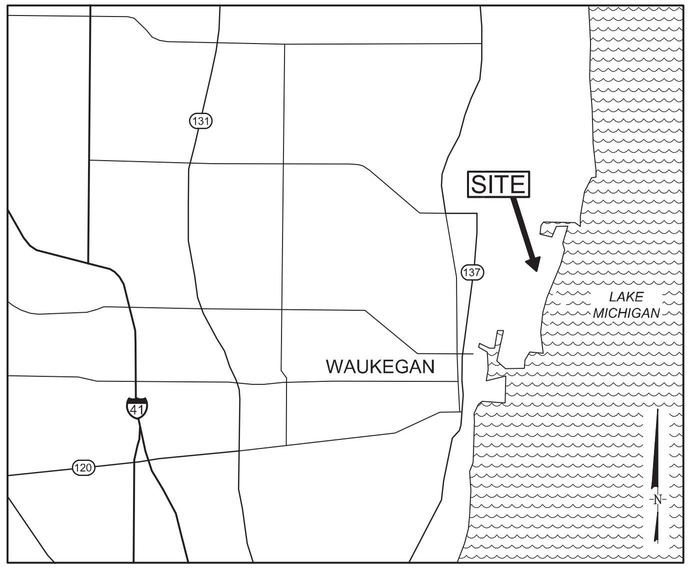
WAUKEGAN GENERATING STATION LAKE COUNTY, ILLINOIS

PREPARED FOR:

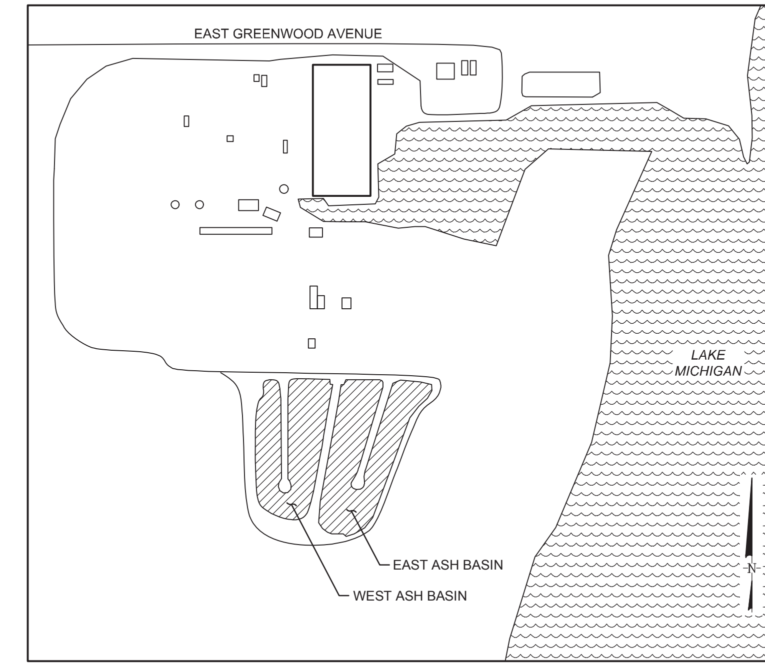
MIDWEST GENERATION, LLC

PREPARED BY:

Geosyntec Consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CALIFORNIA 92110
(619) 810-4000
www.geosyntec.com



VICINITY MAP
NOT TO SCALE



SITE LOCATION MAP
NOT TO SCALE

DETAIL IDENTIFICATION LEGEND

DETAIL IDENTIFICATION
2
5
SHEET ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER
2
3
DETAIL
TITLE OF DETAIL
SCALE: 1" = 1'
SHEET ON WHICH ABOVE DETAIL WAS REFERENCED

EXAMPLE: DETAIL NUMBER 2 PRESENTED ON SHEET NO. 5 WAS REFERENCED ON SHEET NO. 3.

NOTE: ABOVE REFERENCING SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DRAWING INDEX

DRAWING NO.	DRAWING TITLE	FILE NAME
1	TITLE INDEX AND LEGEND	SW0251-11-01
2	SITE PLAN	SW0251-11-02
3	GRADING PLAN	SW0251-11-03
4	CROSS SECTIONS	SW0251-11-04
5	DETAILS	SW0251-11-05
6	SWPPP	SW0251-11-06
7	SURVEY CONTROL POINTS	SW0251-11-07

GENERAL NOTES

1. THE WORK UNDERTAKEN BY THIS DOCUMENT IS FOR MIDWEST GENERATION, LLC, HEREAFTER REFERRED TO AS OWNER. GEOSYNTEC CONSULTANTS, HEREAFTER REFERRED TO AS ENGINEER, PERFORMED DESIGN.
2. THE PLANS AND OTHER DOCUMENTS SHALL GOVERN THE WORK AND SHALL BE CONSIDERED COMPLIMENTARY. ANYTHING FOUND IN THE PLANS AND NOT IN ANOTHER DOCUMENT OR FOUND IN ANOTHER DOCUMENT AND NOT IN THE PLANS SHALL BE CONSIDERED TO BE IN BOTH.
3. CONTRACTOR SHALL, UPON DISCOVERING ANY ERROR OR OMISSION IN THE PLANS, IMMEDIATELY BRING IT TO THE ATTENTION OF ENGINEER.
4. CONSTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF PUBLIC AND PRIVATE PROPERTY ADJACENT TO THE WORK, AND EXERCISE DUE CAUTION TO AVOID DAMAGE TO SUCH PROPERTY. CONTRACTOR SHALL NOT PERFORM ANY WORK OR DISTURBANCE OUTSIDE OF THE WORK ZONE AND APPROVED SITE ACCESS ROUTES WITHOUT PREAPPROVAL BY THE OWNER.
5. THROUGHOUT ALL PHASES OF CONSTRUCTION, INCLUDING SUSPENSION OF WORK, AND UNTIL FINAL ACCEPTANCE OF THE PROJECT, CONTRACTOR SHALL KEEP THE WORK SITE CLEAN AND FREE FROM RUBBISH AND DEBRIS.
6. THE WORK SHALL BE CONDUCTED TO MINIMIZE DISTURBANCE TO ONGOING PLANT OPERATIONS. WORK THAT IMPACTS PLANT OPERATIONS SHALL BE COORDINATED THROUGH THE OWNER.
7. CONTRACTOR SHALL KEEP A COPY OF THE PLANS AND OTHER DOCUMENTS AT THE WORK SITE, TO WHICH THE OWNER SHALL HAVE ACCESS UPON REQUEST.
8. CONTRACTOR SHALL ASCERTAIN THE EXISTENCE OF ANY CONDITIONS AFFECTING THE COST OF THE WORK WHICH WOULD HAVE BEEN DISCLOSED BY REASONABLE EXAMINATION OF THE SITE.
9. EXISTING IMPROVEMENT VISIBLE AT THE JOB SITE, FOR WHICH NO SPECIFIC DISPOSITION IS MADE ON THE PLANS, BUT WHICH COULD REASONABLY BE ASSUMED TO INTERFERE WITH SATISFACTORY COMPLETION OF THE WORK, SHALL BE BROUGHT TO THE ATTENTION OF OWNER.
10. ALL MATERIALS, PARTS, AND EQUIPMENT FURNISHED BY CONTRACTOR SHALL BE NEW, HIGH GRADE, AND FREE OF DEFECTS. QUALITY OF WORK SHALL BE IN ACCORDANCE WITH GENERALLY ACCEPTED STANDARDS. MATERIALS AND WORK QUALITY SHALL BE SUBJECT TO APPROVAL BY ENGINEER.
11. DEFECTIVE WORK OR MATERIAL SHALL BE REMOVED IMMEDIATELY FROM THE SITE BY CONTRACTOR, AT CONTRACTOR'S EXPENSE, WHEN SO DIRECTED.
12. SOIL AND ROCK MATERIALS, REQURIED FOR THE WORK, SHALL BE STOCKPILED AT LOCATIONS DESIGNATED BY THE OWNER AND APPROVED BY ENGINEER.
13. CONTRACTOR SHALL PROVIDE AND MAINTAIN FACILITIES TO PROTECT ALL WORK AND EQUIPMENT WHETHER IN PLACE OR NOT.
14. CONTRACTOR MAY SUPPLY EQUIVALENT REPLACEMENTS FOR ANY MATERIALS REQUIRED FOR COMPLETION FO THE WORK, SUBJECT TO APPROVAL BY ENGINEER.
15. CONTRACTOR SHALL NOT INTERRUPT THE SERVICE FUNCTION OR DISTURB THE SUPPORT OF ANY UTILITY WITHOUT AUTHORIZATION FROM OWNER.
16. UPON LEARNING OF THE EXISTENCE OF ANY UTILITY OMITTED FROM OR SHOWN INCORRECTLY ON THE PLANS, CONTRACTOR SHALL IMMEDIATELY NOTIFY ENGINEER IN WRITING.
17. DRAWINGS ARE SCALED TO SIZE 22X34 INCH SHEETS. REPRODUCTION OF SHEETS MAY DISTORT DRAWINGS AND SCALE.

LEGEND

- PROOF ROLLED SUBGRADE
- SELECT FILL
- EXISTING GRADE
- AGGREGATE BASE
- GEOTEXTILE
- GEOMEMBRANE
- ×125 PROPOSED GRADE POINT

GENERAL LINES

- 600 PROPOSED GRADING CONTOUR (10')
- PROPOSED GRADING CONTOUR (2')
- 600 EXISTING GRADE CONTOUR (10')
- EXISTING GRADE CONTOUR (2')
- LIMITS OF PROPOSED GRADING
- FLOW LINE

ABBREVIATIONS

AC	ASPHALT CONCRETE	L	LENGTH
APPROX.	APPROXIMATE	LF	LINEAL FEET
C	CENTER LINE	MH	MANHOLE
CF	CUBIC FOOT	MIN.	MINIMUM
DIA.	DIAMETER	N	NORTHING
DIM.	DIMENSION	NTS	NOT TO SCALE
E	EASTING	NO.	NUMBER
EL.	ELEVATION	OC	ON CENTER
EW	EACH WAY	oz.	OUNCE
FG	FINISH GRADE	OD	OUTSIDE DIAMETER
F	FLOW LINE	R	RADIUS
GALV.	GALVANIZED	SCH.	SCHEDULE
HDPE	HIGH DENSITY POLYETHYLENE	STD.	STANDARD
INV.	INVERT	TYP.	TYPICAL

(1in) (2in) (3in) (4in)
SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

ISSUED FOR BID

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: TITLE, INDEX, AND LEGEND

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

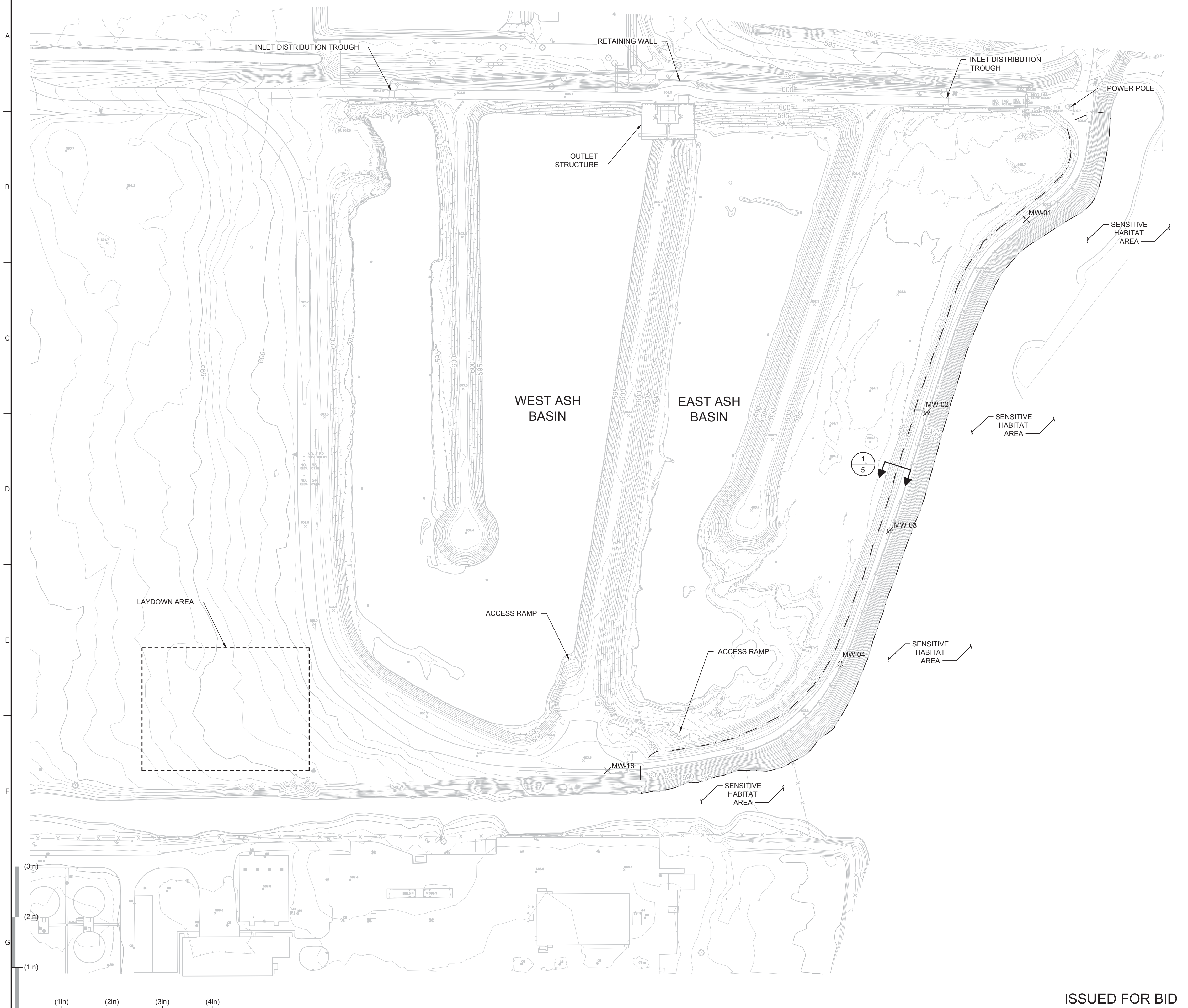
SITE: WAUKEGAN GENERATING STATION LAKE COUNTY, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Jane Soule
SIGNATURE
7/1/16
DATE

JANE W. SOULE 062-067766 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

DESIGN BY: JG	DATE: JULY 2016
DRAWN BY: JA	PROJECT NO.: SW0251-11
CHECKED BY: GC	FILE: SW0251-11-01
REVIEWED BY: JS	DRAWING NO.:
APPROVED BY: JS	1 OF 7



LEGEND

1400 EXISTING GROUND MAJOR CONTOUR (10') [NOTE 2]

EXISTING GROUND MINOR CONTOUR (2') [NOTE 2]

EXISTING FENCE

MW-01 MONITORING WELL

LIMITS OF GRADING

NOTES

1. ALL PLANS IN THIS PLAN SET WERE DRAWN BASED ON THE FOLLOWING DATUM SOURCE:
   HORIZONTAL CONTROL - NAD83 ILLINOIS STATE PLANE EAST, U.S. feet
   VERTICAL CONTROL - NAVD 88., U.S. feet
2. EXISTING PHOTOGRAMMETRIC SURVEY DATA PROVIDED BY GEO TERRA. FLIGHT DATE: 4 DECEMBER 2015.
3. BASINS ARE CURRENTLY LINED WITH A SMOOTH HDPE GEOMEMBRANE ANCHORED NEAR THE INTERIOR CREST OF THE EMBANKMENT.
4. EXISTING TOPOGRAPHY ABOVE APPROXIMATE ELEVATION OF 587 FT REPRESENTS APPROXIMATE CCR DEPOSITS WITHIN EASTERN ASH BASIN.
5. SENSITIVE HABITAT IS PRESENT AT THE DOWNSTREAM TOE OF THE EASTERN AND SOUTHERN EMBANKMENTS.

N

0 80' 160'
SCALE IN FEET

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

ISSUED FOR BID

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: SITE PLAN

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

SITE: WAUKEGAN GENERATING STATION
LAKE COUNTY, ILLINOIS

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Jane Soule
SIGNATURE

7/1/16
DATE

JANE W. SOULE 062-067766 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

DESIGN BY: JG		DATE:	JULY 2016
DRAWN BY: JA		PROJECT NO.:	SW0251-11
CHECKED BY: GC		FILE:	SW0251-11-02
REVIEWED BY: JS		DRAWING NO.:	
APPROVED BY: JS		2	OF 7

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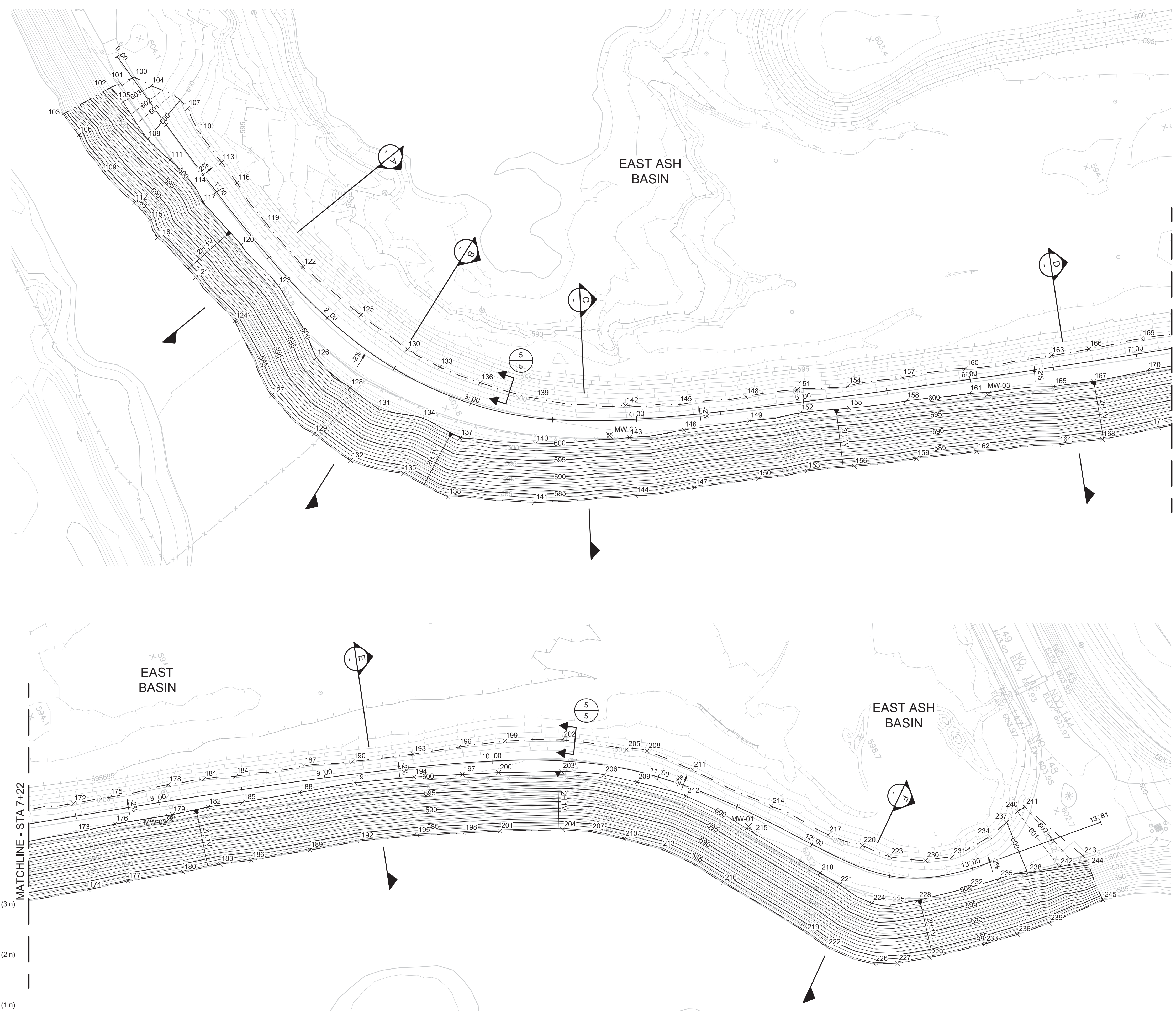


LEGEND

- EXISTING GROUND MAJOR CONTOUR (10') [NOTE 2]
- EXISTING GROUND MINOR CONTOUR (2') [NOTE 2]
- EXISTING FENCE
- PROPOSED GRADE MAJOR CONTOUR (10')
- PROPOSED GRADE MINOR CONTOUR (2')
- LIMITS OF GRADING
- MW-01 MONITORING WELL
- CROSS SECTION LOCATION
- 125 SURVEY CONTROL POINT

NOTES

1. ALL PLANS IN THIS PLAN SET WERE DRAWN BASED ON THE FOLLOWING DATUM SOURCE:
   HORIZONTAL CONTROL - NAD83 ILLINOIS STATE PLANE EAST, U.S. feet
   VERTICAL CONTROL - NAVD 88., U.S. feet
2. EXISTING PHOTOGRAMMETRIC SURVEY DATA PROVIDED BY GEO TERRA. FLIGHT DATE: 4 DECEMBER 2015.
3. CONTRACTOR SHALL REMOVE EXISTING FENCE AND GATES WITHIN WORK AREA AND PROPERLY DISPOSE OF OFFSITE.
4. CONTRACTOR SHALL INSTALL AND MAINTAIN 4-FT HIGH ORANGE BARRIER FENCING AT THE TOE OF THE SLOPE DURING THE DURATION OF THE WORK.
5. GRADING ELEVATIONS AT CREST OF EMBANKMENT REPRESENT TOP OF ROAD SURFACING LAYER.

0 30' 60'
SCALE IN FEET

ISSUED FOR BID

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: GRADING PLAN

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

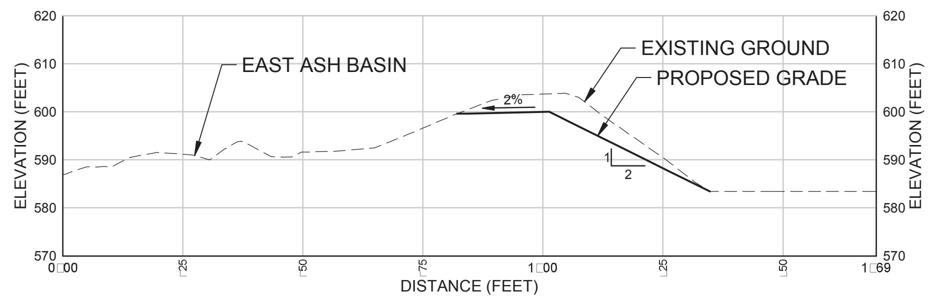
SITE: WAUKEGAN GENERATING STATION
LAKE COUNTY, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

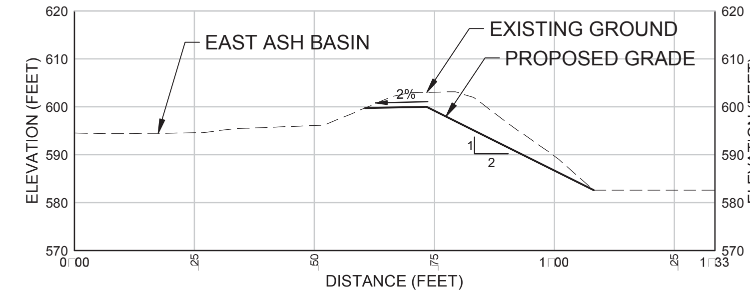
SIGNATURE: Jane Soule
7/1/16
DATE

JANE W. SOULE 062-067766 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

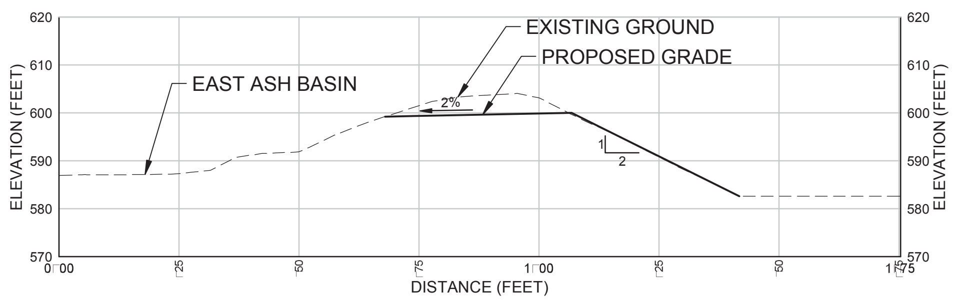
DESIGN BY:	JG	DATE:	JULY 2016
DRAWN BY:	JA	PROJECT NO.:	SW0251-11
CHECKED BY:	GC	FILE:	SW0251-11-03
REVIEWED BY:	JS	DRAWING NO.:	
APPROVED BY:	JS	3 OF 7	



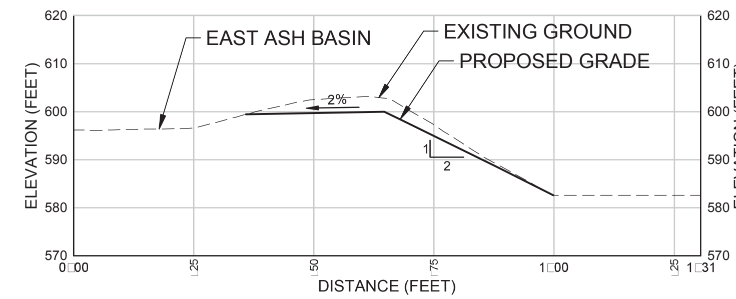
SECTION A
(STA. 1+49)



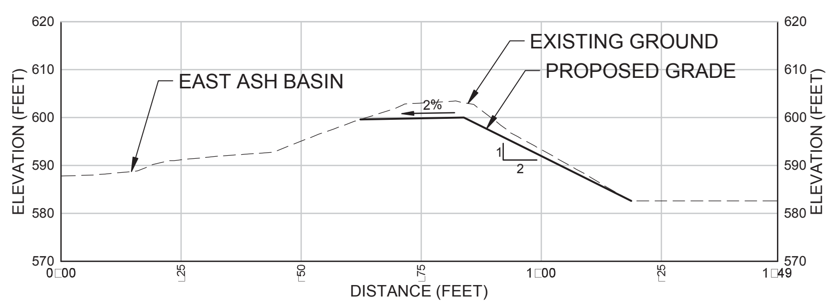
SECTION E
(STA. 9+29)



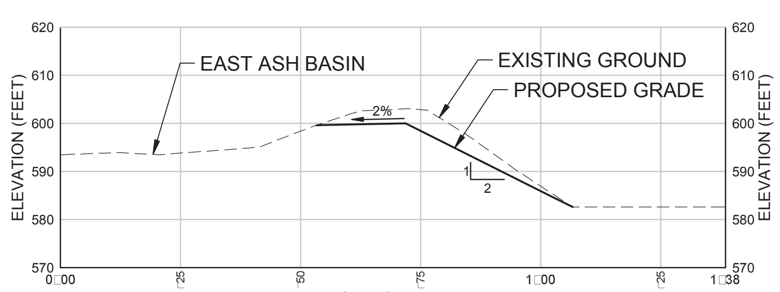
SECTION B
(STA. 2+50)



SECTION F
(STA. 12+35)



SECTION C
(STA. 3+70)



SECTION D
(STA. 6+58)

LEGEND

- - - - EXISTING GROUND
——— PROPOSED GRADE

NOTES

1. ALL PLANS IN THIS PLAN SET WERE DRAWN BASED ON THE FOLLOWING DATUM SOURCE:
   HORIZONTAL CONTROL - NAD83 ILLINOIS STATE PLANE EAST, U.S. feet
   VERTICAL CONTROL - NAVD 88., U.S. feet
2. EXISTING PHOTOGRAMMETRIC SURVEY DATA PROVIDED BY GEO TERRA. FLIGHT DATE: 4 DECEMBER 2015.
3. FOR SECTION LOCATIONS, SEE SHT 3.

0 20' 40'
SCALE IN FEET

ISSUED FOR BID

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: CROSS SECTIONS

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

SITE: WAUKEGAN GENERATING STATION
LAKE COUNTY, ILLINOIS

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Jane Soule
SIGNATURE
7/1/16
DATE

JANE W. SOULE 062-067766 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

DESIGN BY:	JG	DATE:	JULY 2016
DRAWN BY:	JA	PROJECT NO.:	SW0251-11
CHECKED BY:	GC	FILE:	SW0251-11-04
REVIEWED BY:	JS	DRAWING NO.:	
APPROVED BY:	JS	4 OF 7	

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

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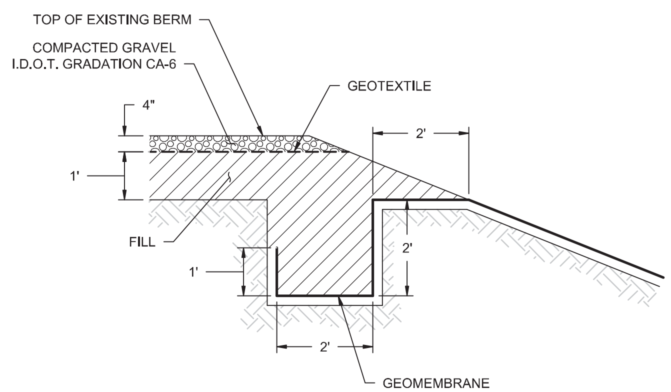
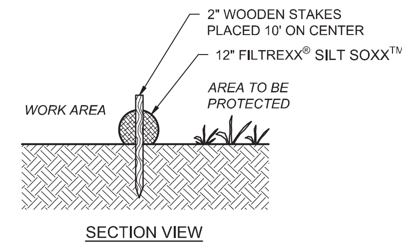
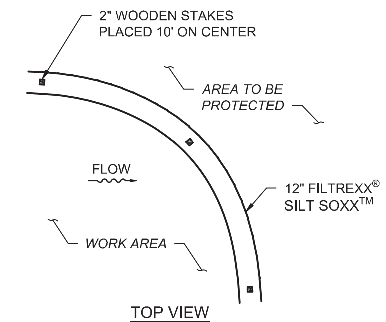
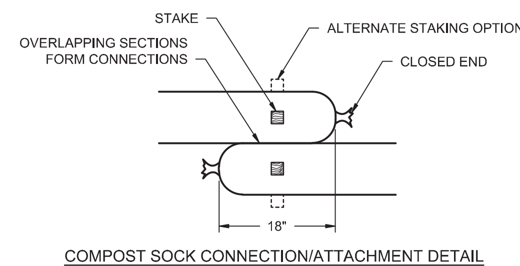


1 / 2 DETAIL
EXISTING ANCHOR TRENCH
SCALE: NTS

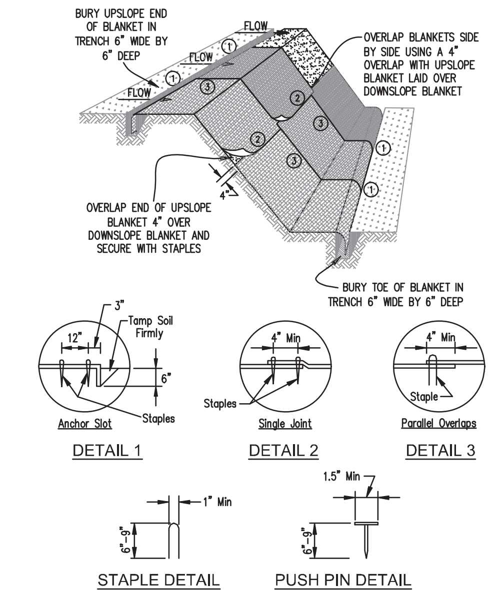






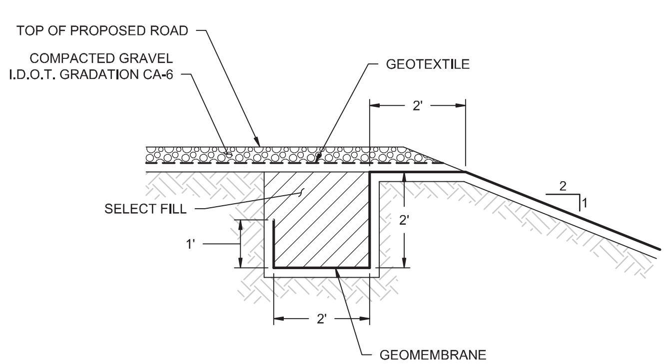
NOTES:
1. ALL MATERIAL TO MEET FILTREXX® SPECIFICATIONS.
2. SILT SOXX™ FILL TO MEET APPLICATION REQUIREMENTS.
3. COMPOST MATERIAL TO BE DISPERSED ON SITE, AS DETERMINED BY ENGINEER.

2 / 6 DETAIL
COMPOST SOCK
SCALE: NTS



NOTES:
1. Staples shall be placed in a diamond pattern at 2 per s.y. for stitched blankets. Non-stiched shall use 4 staples per s.y. of material. This equates to 200 staples with stitched blanket and 400 staples with non-stitched blanket per 100 s.y. of material.
2. Staple or push pin lengths shall be selected based on soil type and conditions. (minimum staple length is 6").
3. Erosion control material shall be placed in contact with the soil over a prepared seedbed.
4. All anchor slots shall be stapled at approximately 12" intervals.
5. Erosion Control Blanket shall be BioNet™ SC150BN® Erosion Control Blanket or approved equivalent. Blanket must be made of 100% biodegradable materials (i.e. no plastic netting).
6. Anchor trench shall be 2' from top of slope.

3 / 6 DETAIL
EROSION CONTROL BLANKET
INSTALLATION
SCALE: NTS



NOTES:
1. Grading shown on Sheet 3 represents the top of the road surfacing layer.
2. Geotextile shall be Propex 200ST or equivalent.

4 / 3 DETAIL
ANCHOR TRENCH
SCALE: NTS

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: DETAILS

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

SITE: WAUKEGAN GENERATING STATION
LAKE COUNTY, ILLINOIS

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Jane Soule
SIGNATURE

7/1/16
DATE

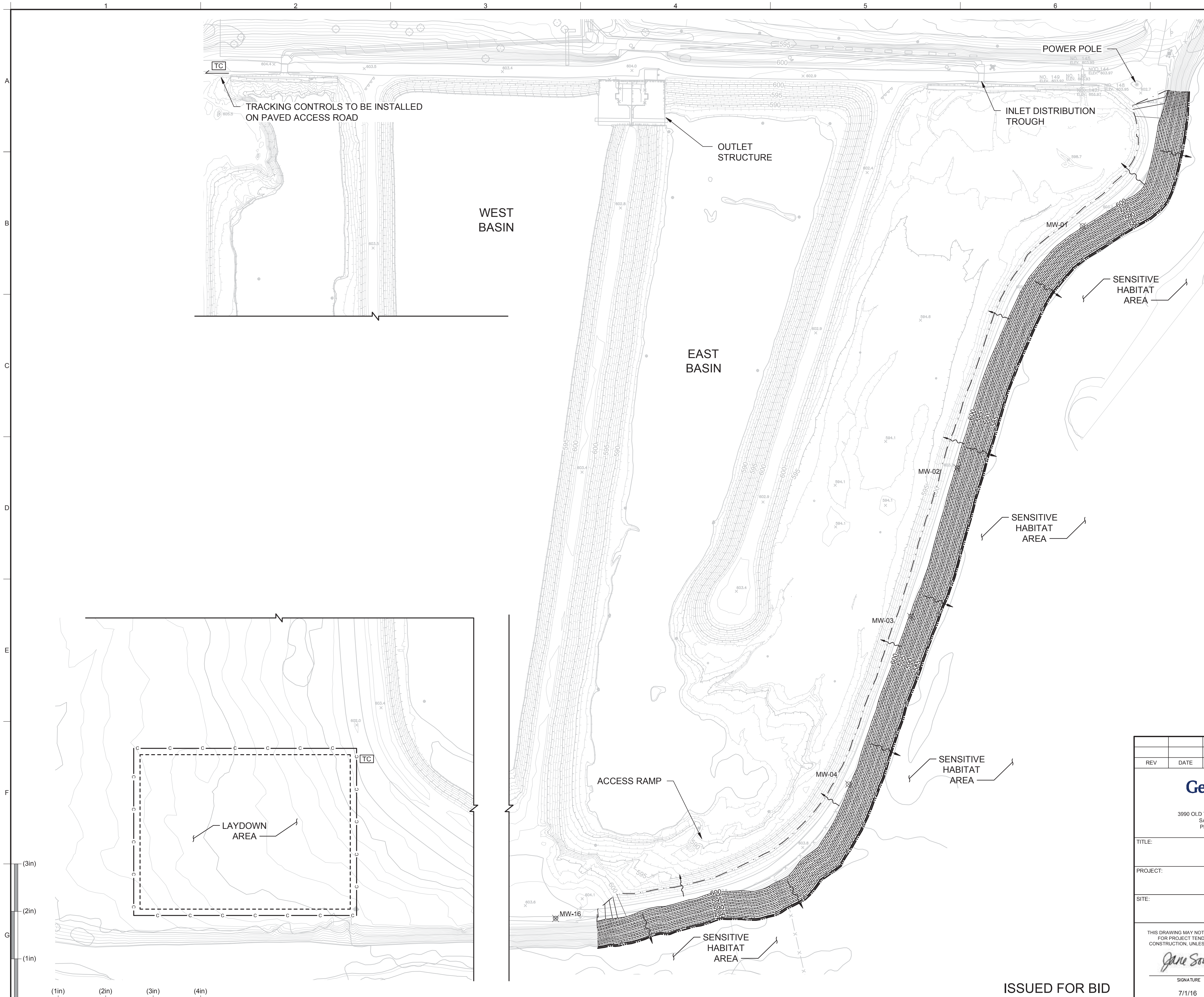
JANE W. SOULE 062-067766 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

DESIGN BY:	JG	DATE:	JULY 2016
DRAWN BY:	JA	PROJECT NO.:	SW0251-11
CHECKED BY:	GC	FILE:	SW0251-11-05
REVIEWED BY:	JS	DRAWING NO.:	5 OF 7
APPROVED BY:	JS		

ISSUED FOR BID

(1in) (2in) (3in) (4in)
(1in) (2in) (3in)
SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

Z:\CADD\Plansets\SW0251-11 Slope Adjust_Current Set\SW0251-11-05.dwg Last Edited by: jamos on 7/6/2016 3:28 PM



LEGEND

- 1400 — EXISTING GROUND MAJOR CONTOUR (10') [NOTE 2]
- EXISTING GROUND MINOR CONTOUR (2') [NOTE 2]
- 1400 — PROPOSED GRADE MAJOR CONTOUR (10')
- PROPOSED GRADE MINOR CONTOUR (2')
- LIMITS OF GRADING
- MW-01 — MONITORING WELL
- FLOW DIRECTION
- C — COMPOST SOCK (2/5)
- HABITAT SENSITIVE AREA BOUNDARY (NOTE 3)
- STABILIZATION (SEE NOTE 6) (3/5)
- TC — TRACKING CONTROLS (SEE NOTE 7)

NOTES

1. ALL PLANS IN THIS PLAN SET WERE DRAWN BASED ON THE FOLLOWING DATUM SOURCE:
   HORIZONTAL CONTROL - NAD83 ILLINOIS STATE PLANE EAST, U.S. feet
   VERTICAL CONTROL - NAVD 88., U.S. feet
2. EXISTING PHOTOGRAMMETRIC SURVEY DATA PROVIDED BY GEO TERRA. FLIGHT DATE: 4 DECEMBER 2015.
3. EARTH DISTURBING ACTIVITIES ARE PROHIBITED OUTSIDE OF THE LIMITS OF DISTURBANCE.
4. DOWNGRADIENT PROTECTIVE MEASURES MUST BE IN PLACE PRIOR TO EARTH DISTURBANCES.
5. CONSTRUCTION SHOULD BE SEQUENCED SUCH THAT EXPOSED AREAS ARE LIMITED TO WHAT CAN BE STABILIZED PRIOR TO FORECAST RAIN.
6. STABILIZATION MEASURE MUST BE IMPLEMENTED WITHIN 1 WORKING DAY OF CESSATION OF EARTH DISTURBING ACTIVITIES. FOR PORTIONS OF THE SITE THAT HAVE REACHED FINAL GRADE OR WHERE CONSTRUCTION ACTIVITIES HAVE PERMANENTLY CEASED, AND COMPLETED WITHIN 14 DAYS.
7. STREET SWEEPING SHALL BE IMPLEMENTED AS NEEDED AT THE NEAREST PAVED SURFACE, APPROXIMATELY 1300-FT FROM CONSTRUCTION ACTIVITY.
8. CONTRACTOR SHALL COMPLY WITH REQUIREMENTS OF 'STORMWATER POLLUTION PREVENTION PLAN, EAST ASH BASIN SLOPE MODIFICATION' BY GEOSYNTEC, JULY 2016.

N

0 60' 120'
SCALE IN FEET

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: SWPPP

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

SITE: WAUKEGAN GENERATING STATION
LAKE COUNTY, ILLINOIS

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Jane Soule
SIGNATURE

7/1/16
DATE

JANE W. SOULE 062-067766 LICENSED PROFESSIONAL ENGINEER STATE OF ILLINOIS

DESIGN BY:	JG	DATE:	JULY 2016
DRAWN BY:	JA	PROJECT NO.:	SW0251-11
CHECKED BY:	GC	FILE:	SW0251-11-06
REVIEWED BY:	JS	DRAWING NO.:	
APPROVED BY:	JS	6 OF 7	

ISSUED FOR BID

(1in) (2in) (3in) (4in)
SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

SURVEY CONTROL POINTS

PT NO.	NORTHING	EASTING	ELEV
100	2080081.36	1124398.00	604.00
101	2080072.25	1124397.50	604.19
102	2080066.08	1124397.19	603.33
103	2080033.65	1124398.72	583.40
104	2080087.98	1124407.11	603.00
105	2080068.79	1124408.21	603.00
106	2080036.43	1124414.03	583.40
107	2080101.42	1124428.72	599.40
108	2080071.84	1124434.52	600.00
109	2080039.57	1124440.76	583.40
110	2080101.02	1124444.16	599.52
111	2080078.27	1124451.51	600.00
112	2080047.90	1124464.91	583.40
113	2080105.13	1124466.59	599.57
114	2080083.99	1124471.13	600.00
115	2080051.53	1124478.09	583.40
116	2080107.88	1124481.58	599.55
117	2080084.37	1124483.01	600.00
118	2080051.09	1124489.55	583.40
119	2080112.86	1124510.84	599.60
120	2080093.64	1124515.78	600.00
121	2080060.84	1124520.90	583.40
122	2080120.84	1124543.90	599.63
123	2080102.49	1124547.18	600.00
124	2080070.12	1124554.54	583.40
125	2080138.95	1124584.79	599.31
126	2080103.78	1124595.75	600.00
127	2080069.83	1124603.94	582.60
128	2080113.78	1124620.67	600.00
129	2080082.40	1124635.73	582.60
130	2080154.39	1124615.57	599.23
131	2080122.89	1124638.85	600.00
132	2080094.66	1124659.61	582.60
133	2080167.03	1124633.47	599.36
134	2080144.24	1124656.14	600.00
135	2080119.32	1124680.43	582.60
136	2080184.50	1124652.60	599.33
137	2080159.01	1124676.65	600.00
138	2080137.02	1124704.92	582.60
139	2080209.88	1124675.70	599.46
140	2080197.56	1124699.83	600.00
141	2080181.73	1124730.88	582.60
142	2080255.71	1124703.37	599.62
143	2080249.34	1124721.36	600.00
144	2080237.38	1124754.04	582.60
145	2080284.53	1124717.03	599.69
146	2080280.35	1124731.84	600.00
147	2080270.89	1124765.33	582.60
148	2080322.19	1124730.64	599.71
149	2080317.74	1124744.37	600.00
150	2080307.02	1124777.48	582.60
151	2080351.75	1124740.47	599.72
152	2080346.98	1124753.72	600.00
153	2080335.21	1124786.47	582.60
154	2080379.65	1124752.08	599.74
155	2080374.25	1124764.16	600.00
156	2080361.52	1124796.55	582.60
157	2080410.64	1124761.84	599.72
158	2080406.61	1124775.44	600.00
159	2080396.74	1124808.81	582.60
160	2080446.96	1124773.99	599.70
161	2080442.02	1124788.33	600.00
162	2080430.67	1124821.23	582.60
163	2080495.87	1124789.90	599.63
164	2080476.01	1124839.43	582.60
165	2080488.99	1124807.05	600.00
166	2080517.66	1124796.42	599.61
167	2080511.62	1124814.96	600.00
168	2080500.83	1124848.07	582.60
169	2080548.62	1124804.88	599.61
170	2080543.36	1124823.44	600.00
171	2080533.87	1124856.92	582.60
172	2080591.08	1124819.10	599.65
173	2080585.43	1124835.48	600.00
174	2080576.30	1124869.06	582.60
175	2080612.22	1124825.36	599.67
176	2080608.01	1124841.09	600.00
177	2080599.61	1124874.87	582.60
178	2080646.78	1124834.29	599.64
179	2080640.97	1124851.38	600.00
180	2080631.45	1124884.87	582.60
181	2080667.10	1124840.80	599.67
182	2080662.01	1124856.75	600.00
183	2080653.40	1124890.47	582.60
184	2080684.90	1124847.68	599.68
185	2080681.74	1124863.52	600.00
186	2080671.00	1124896.63	582.60
187	2080723.78	1124860.22	599.70
188	2080714.72	1124873.38	600.00
189	2080704.88	1124906.76	582.60
190	2080751.18	1124870.99	599.75
191	2080746.65	1124882.79	600.00
192	2080734.17	1124915.27	582.60
193	2080785.20	1124883.14	599.73
194	2080779.79	1124895.56	600.00
195	2080765.90	1124927.46	582.60
196	2080811.48	1124891.47	599.67
197	2080806.25	1124907.08	600.00
198	2080791.67	1124938.69	582.60
199	2080837.64	1124900.56	599.63
200	2080825.88	1124915.65	600.00
201	2080811.02	1124947.12	582.60
202	2080868.55	1124915.15	599.63
203	2080859.71	1124931.63	600.00
204	2080844.85	1124963.10	582.60
205	2080900.45	1124937.39	599.65
206	2080881.52	1124944.75	600.00
207	2080859.48	1124971.68	582.60
208	2080910.75	1124943.66	599.61
209	2080897.09	1124957.50	600.00
210	2080875.04	1124984.43	582.60
211	2080929.94	1124965.68	599.68
212	2080919.62	1124977.96	600.00
213	2080892.35	1124999.58	582.60
214	2080962.13	1125005.97	599.62
215	2080945.99	1125015.91	600.00
216	2080916.36	1125034.16	582.60
217	2080984.92	1125036.30	599.56
218	2080970.60	1125054.50	600.00
219	2080947.16	1125082.42	582.60
220	2081000.35	1125051.10	599.46
221	2080977.71	1125065.76	600.00
222	2080954.57	1125096.01	582.60
223	2081011.89	1125064.39	599.43
224	2080990.03	1125084.39	600.00
225	2081000.04	1125090.47	600.00
226	2080975.23	1125117.45	582.60
227	2080987.80	1125123.13	582.60
228	2081015.31	1125095.09	600.00
229	2081006.42	1125128.75	582.60
230	2081030.06	1125075.92	599.56
231	2081045.21	1125080.97	599.59
232	2081046.14	1125101.99	600.00
233	2081039.38	1125136.13	582.60
234	2081070.37	1125080.32	599.49
235	2081064.50	1125105.23	600.00
236	2081059.28	1125139.65	582.60
237	2081083.36	1125077.08	600.00
238	2081081.49	1125109.79	600.02
239	2081079.32	1125142.19	582.60
240	2081091.91	1125074.28	601.00
241	2081097.13	1125073.74	602.00
242	2081099.55	1125114.69	601.00
243	2081115.13	1125115.22	603.00
244	2081116.09	1125119.17	601.90
245	2081114.11	1125144.19	582.60

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
3990 OLD TOWN AVENUE, SUITE A-101
SAN DIEGO, CA 92110
PHONE: 619.810.4000

TITLE: SURVEY CONTROL POINTS

PROJECT: EAST ASH BASIN SLOPE MODIFICATION

SITE: WAUKEGAN GENERATING STATION
LAKE COUNTY, ILLINOIS

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

Jane Soule
SIGNATURE

7/1/16
DATE

JANE W. SOULE
062-067766
LICENSED PROFESSIONAL ENGINEER
STATE OF ILLINOIS

DESIGN BY:	JG	DATE:	JULY 2016
DRAWN BY:	JA	PROJECT NO.:	SW0251-11
CHECKED BY:	GC	FILE:	SW0251-11-07
REVIEWED BY:	JS	DRAWING NO.:	
APPROVED BY:	JS	7 OF 7	

ISSUED FOR BID

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE (BORDER = 21" X 32")

(1in) (2in) (3in) (4in)

Attachment 1-4 – East Ash Pond HDPE Liner Replacement Specifications

1.0 WORK INCLUDED

1.1 This work includes furnishing materials, tools, equipment, and labor to perform bulk and structural excavation, grading, dewatering and place and compact fill, backfill, and bedding materials.

1.2 Excavation includes, sheeting and bracing required for proper execution of the work, loosening, digging, wedging, ripping, loading, hauling, stockpiling, dumping, and disposal of excavated materials in legal disposal areas approved by Owner's Representative.

1.3 Excavation is unclassified and includes, but is not limited to soil, ash and rock materials, abandoned underground conduits or pipes, and buried concrete and masonry structures.

2.0 QUALITY CONTROL

2.1 Existing and new materials to be used as fill, backfill or bedding are subject to the approval of Owner's Representative.

2.2 Bottom ash from the site may be incorporated in the fill material if the Contractor provides tests results and a statement from a geotechnical engineer that use of the bottom ash in conjunction with the other proposed fill materials will not compromise the stability of the 2.5:1 slope.

2.3 To obtain approval of fill, backfill, and bedding materials, designate the proposed borrow area and notify the Owner's Site Representative for a visual inspection prior to placing the material.

3.0 REFERENCES

3.1 Occupational Safety and Health Administration (OSHA)

A. OSHA 2206 General Industry Standards

B. OSHA 2207 Construction Industry Standards

3.2 Illinois Department of Transportation (IDOT) - Standard Specifications for Road and Bridge Construction.

3.3 American Society for Testing and Materials (ASTM)

A. ASTM D 1556- Test for Density of Soil in place by Sand Cone Method

B. ASTM D 1557- Tests for Moisture-Density Relations of Soils Using 10 lb. Hammer and 18 inch drop.

C. ASTM D 2167- Test for Density of Soil in place by Rubber Balloon Method

3.4 The above references shall be the current revision for each.

4.0 SUBMITTALS

4.1 With Contractors' Proposals

A. Submit product data sheets for the chosen liner material.

B. Submit the estimated quantities of materials required to complete the work.

4.2 Two weeks prior to the start of the work, submit to the Owner's Engineer for review, procedures for placing and compacting fill on top of the new liner without damaging the liner material. Include a statement from the liner manufacture that says the procedure is acceptable.

5.0 SITE CONDITIONS

5.1 Prior to start of work become thoroughly familiar with the site, site access, the site conditions, and all portions of the work.

5.2 One pond will be operational while the work on the second pond is being performed.

6.0 MATERIALS

6.1 Make maximum use of suitable on site material for fill when building the pond slopes and entrance ramps. Suitable on site fill material is granular soil or soil/rock mixture that is free from organic matter and other deleterious substances. Material containing rocks or lumps over 1½" in greatest dimension, or containing 15% rocks or lumps larger than ½" in greatest dimension is not acceptable. The material shall have an angle of repose of 30° or greater.

6.2 Imported fill and backfill material shall meet the requirements of Item 6.1 above and, in addition, shall contain predominantly granular material with a maximum particle size of 2".

6.3 Sand used as the protective layer for the pond liners shall be approved by the liner manufacturer.

6.4 Rip rap, coarse aggregate and limestone screenings shall comply with I.D.O.T. specifications.

7.0 BULK AND STRUCTURAL EXCAVATION

7.1 Perform bulk and structural excavation in accordance with the most recent revision of the OSHA General Industry Standards (OSHA 2206) and the OSHA Construction Industry Standards (OSHA 2207).

7.2 Provide temporary grading, ditches and other means as required to drain the areas of the work.

7.3 Perform excavation to lines and grades shown on the contract drawings and as directed by Owner's Representative.

7.4 When the sides of an excavation are five feet or more in depth or when employees are required to enter the excavated area where danger from moving ground exists, perform excavation by open cut to a stable slope or by sheeting and bracing.

7.5 Remove unstable subsoil material, where encountered at the bottom of excavation, to a depth required to obtain satisfactory bearing conditions. Contractor is responsible for bringing the excavation back to the proper elevation by installing compacted bedding material as specified in this section.

7.6 Remove spoil from areas of excavation and stockpile for later use at locations no closer than 2'-0" from edge of excavation unless otherwise approved by Owner's Representative. Remove excess spoil and excavated materials not specifically approved by Owner's Representative for fill, backfill or stockpiling from the site and dispose of these materials at locations and in a manner approved by Federal, State and Local Authorities.

7.7 Properly grade bottom of bulk and structural excavations, remove loose materials, and maintain excavations in good condition, keeping them dry in accordance with Article 8.0 Dewatering, of this section, and free from debris, ice, and frost until completion of the work.

8.0 DEWATERING

8.1 Provide and maintain in operation adequate pumping capacity from sumps, deep wells, or well point installation and perform all other work necessary to keep excavations dry and free of groundwater or surface water during the progress of the work.

8.2 Construction is not permitted in flowing or standing water.

8.3 Dispose of water pumped or drained from the work area in a manner satisfactory to the Owner's Representative, without damage to adjacent property or to other work under construction.

8.4 Take necessary precautions to protect the work against flooding.

9.0 COMPACTION

9.1 Determine the types of equipment and the number of passes required to obtain the required compaction. A pass is defined as one complete coverage of the area by the compaction equipment being used.

9.2 Compact fill and backfill materials to a minimum of 90% of maximum dry density in all areas except in road areas where a minimum of 95% of maximum dry density is required.

9.3 Compact surfaces that are scarified along with and as part of the first lift of fill material that is spread thereon.

9.4 Maximum dry density is defined as the maximum density that can be produced when the same material is compacted in the laboratory in accordance with ASTM D 698 (Standard Proctor).

10.0 INSTALLATION OF FILL AND BACKFILL

10.1 Install fill and backfill material by placing fill and backfill material in uniform layers not to exceed 6" loose measurement unless otherwise noted on the contract drawings or elsewhere in this specification. Compact to minimum specified compaction as set forth in Article 9.2 of this Section.

10.2 Install the 12" protective sand layer on top of the liner material in a single layer.

10.3 Moisten and scarify surfaces to a depth of 4", against which new fill or roadway material is to be placed.

10.4 Remove shoring as backfill progresses only when banks are safe from caving or collapse.

10.5 Water or aerate the material as necessary, and thoroughly mix to obtain a moisture content that will permit proper compaction.

10.6 Do not place fill or backfill materials on a frozen surface. Do not incorporate snow, ice or frozen earth with the fill. Distribute and grade fill and backfill materials throughout the work such that fill will be free from lenses, pockets, streaks or layers of materials differing in texture or gradation from the surrounding material. Do not place successive layers until the layer under construction has been satisfactorily compacted. Place materials in horizontal lifts.

10.7 Remove, dispose and replace any material that Owner's Representative considers objectionable without additional cost to Owner.

10.8 Bring subgrades to a plus or minus tolerance of 0.10 feet.

11.0 FIELD QUALITY CONTROL

11.1 Do not allow or cause any of the work performed or installed to be covered up or enclosed prior to required inspections, tests, and approvals.

11.2 Should any of the work be enclosed or covered up before it has been approved, uncover such work at no additional cost to Owner.

11.3 After the work has been completed, tested, inspected, and approved, make repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, at no additional cost to the Owner.

11.4 Owner may engage (at his own expense), a testing laboratory to inspect and perform tests on all fill, backfill, and bedding materials.

A. The testing laboratory shall conduct and interpret the following ASTM tests to determine the degree of compaction achieved by compaction operations:

1. ASTM D 1556 Test for Density of Soil in place by Sand Cone Method

2. ASTM D 2167 Test for Density of Soil in place by Rubber Balloon Method

3. ASTM D 2922 Test for Density of Soil in place by Nuclear Methods

B. The testing laboratory shall prepare a test report stating whether the test specimens comply with the work requirements, and specifically state any deviations therefrom.

C. Contractor shall provide access for Owner's testing personnel to all required areas so that required inspection and testing can be accomplished.

D. The Owner shall have the right to reject any materials or work not complying with the requirements of the Specification.

E. Contractor shall be responsible for all costs associated with the removal and replacement of all materials determined by Owner's testing personnel to have failed the testing acceptance standards.

END OF SECTION

1.0 WORK INCLUDED

This work includes furnishing materials, tools, equipment, and labor to install a 60-mil thick, high-density polyethylene liner with a reflective white coating.

2.0 REFERENCES

2.1 American Society for Testing and Materials (ASTM)

D 638 Standard Test Method for Tensile Properties of Plastics

D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting

D 1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique

D 1603 Test Method for Carbon Black in Olefin Plastics

D 3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

D 5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

D 6392 Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

2.2 Geosynthetic Research Institute

GM9 Cold Weather Seaming of Geomembranes

GM13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

3.0 DEFINITIONS

3.1 Lot - A quantity of resin (usually the capacity of one rail car) used in the manufacture of polyethylene geomembrane rolls. The finished roll will be identified by a roll number traceable to the resin lot used.

3.2 Construction Quality Assurance Consultant (consultant) - Party, independent from manufacturer and installer that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

3.3 Engineer - The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

3.4 Geomembrane Manufacturer (manufacturer) - The party responsible for manufacturing the geomembrane rolls.

3.5 Geosynthetic Quality Assurance Laboratory (testing laboratory) - Party, independent from the owner, manufacturer and installer, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the owner.

3.6 Installer - Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.

3.7 Panel - Unit area of a geomembrane that will be seamed in the field that is larger than 100 square feet.

3.8 Patch - Unit area of a geomembrane that will be seamed in the field that is less than 100 square feet.

3.9 Subgrade Surface - Soil layer surface which immediately underlies the geosynthetic material.

4.0 SUBMITTALS POST-AWARD

4.1 Furnish the following product data, in writing, to engineer prior to installation of the geomembrane material:

A. Resin Data shall include certification stating that the resin meets the specification requirements (see Section 8.0).

B. Statement certifying no more than 10% reclaimed polymer (of the same type) is added to the resin (product run may be recycled) per GRI GM 13.

4.2 The installer shall furnish the following information to the engineer and owner prior to installation:

A. Installation layout drawings

1. Must show proposed panel layout including field seams and details

2. Must be approved prior to installing the geomembrane (Approved drawings will be for concept only and actual panel placement will be determined by site conditions).

B. Installer's Geosynthetic Field Installation Quality Assurance Plan

4.3 The installer will submit the following to the engineer upon completion of installation:

A. Certificate stating the geomembrane has been installed in accordance with the Contract Documents

B. Material and installation warranties

C. As-built drawings showing actual geomembrane placement and seams including typical anchor trench detail/

5.0 QUALITY ASSURANCE

5.1 The Owner may engage and pay for the services of a Quality Assurance Consultant to monitor geomembrane installation.

5.2 Qualifications

A. Manufacturer

1. Geomembrane shall be manufactured by GSE Lining Technology, Inc. or an approved equal.

2. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane during the last year.

B. Installer

1. The liner manufacturer shall install the liner.

2. Installer shall have installed a minimum of 3,000,000 square feet of HDPE geomembrane during the last five years.

3. Installer shall have worked in a similar capacity on at least three projects similar in complexity to the project described in the contract documents.

4. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

5. The installer shall provide a minimum of one Master Seamer for work on the project.

6. Must have completed a minimum of 1,000,000 square feet of geomembrane seaming work using the type of seaming apparatus proposed for the use on this Project.

6.0 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

6.1 Labeling - Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label will identify:

A. Manufacturer's name

B. Product identification

C. Roll number

6.2 Delivery - Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

6.3 Storage - The on-site storage location for geomembrane material, provided by the contractor to protect the geomembrane from punctures, abrasions and excessive dirt and moisture for should have the following characteristics:

A. Level (no wooden pallets)

B. Smooth

C. Dry

D. Protected from theft and vandalism

E. Adjacent to the area being lined

6.4 Handling - Materials are to be handled so as to prevent damage.

7.0 WARRANTY

7.1 Material shall be warranted, on a pro-rata basis against Manufacturer's defects for a period of five years from the date of geomembrane installation.

7.2 Installation shall be warranted against defects in workmanship for a period of one year from the date of geomembrane completion.

8.0 GEOMEMBRANE

8.1 Material shall be smooth/textured polyethylene geomembrane as shown on the drawings.

8.2 Resin

A. Resin shall be new, first quality, compounded and manufactured specifically for producing geomembrane.

B. Natural resin (without carbon black) shall meet the following additional minimum requirements:

Property	**Test Method**(1)	**HDPE**
Density [g/cm^3]	ASTM D 1505	0.932
Melt Flow Index [g/10 min.]	ASTM D 1238 (190/2.16)	≤ 1.0
OIT [minutes]	ASTM D 3895 (1 atm/200°C)	100

8.3 Geomembrane Rolls

A. Do not exceed a combined maximum total of one percent by weight of additives other than carbon black.

B. Geomembrane shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

C. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating both number, thickness, length, width and manufacturer.

D. All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in Section 8.2, and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

8.4 Smooth, white surfaced geomembrane shall meet the requirements shown in Table 1.2

The geomembrane shall be a white-surfaced, coextruded geomembrane. The white surface shall be installed upwards.

8.5 Extrudate Rod or Bead

A. Extrudate material shall be made from same type resin as the geomembrane.

B. Additives shall be thoroughly dispersed.

C. Materials shall be free of contamination by moisture or foreign matter.

9.0 EQUIPMENT

Welding equipment and accessories shall meet the following requirements:

9.1 Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.

9.2 An adequate number of welding apparatus shall be available to avoid delaying work.

9.3 Power source capable of providing constant voltage under combined line load shall be used.

10.0 DEPLOYMENT

10.1 Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.

10.2 Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

10.3 Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:

A. Unroll geomembrane panels using methods that will not damage geomembrane and will protect underlying surface from damage (i.e., spreader bar, protected equipment bucket).

B. Place ballast (commonly sandbags) on geomembrane that will not damage geomembrane to prevent wind uplift.

C. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage the geomembrane. Smoking will not be permitted on the geomembrane.

D. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than six psi.

E. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.

10.4 Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

11.0 FIELD SEAMING

11.1 Seams shall meet the following requirements:

A. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope.

B. Minimize number of field seams in corners, odd shaped geometric locations and outside corners.

C. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.

D. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the consultant and installer.

E. Align seam overlaps consistent with the requirements of the welding equipment being used. A six-inch overlap is commonly suggested.

11.2 During Welding Operations provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

11.3 Extrusion Welding

A. Hot-air tack adjacent pieces together using procedures that do not damage geomembrane.

B. Clean geomembrane surfaces by disc grinder or equivalent.

C. Purge welding apparatus of heat degraded extrudate before welding.

11.4 Hot Wedge Welding

A. Welding apparatus shall be a self-propelled device equipped with an electronic controller that displays applicable temperatures.

B. Clean seam area of dust, mud, moisture and debris immediately ahead of the hot wedge welder.

C. Protect against moisture build up between sheets.

12.0 Trial Welds

A. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.

B. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

C. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.

D. Cut four, one-inch wide by six-inch long test strips from the trial weld.

E. Quantitatively test specimens for peel adhesion, and then for bonded seam strength (shear).

F. Trial weld specimens shall pass when the results shown in Table 3 are achieved in both peel and shear test.

1. The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).

2. The break is ductile.

G. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.

H. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.

12.2 Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Installer shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

12.3 Defects and Repairs

A. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

B. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

13.0 FIELD QUALITY ASSURANCE

13.1 Manufacturer/installer shall participate in and conform to all terms and requirements of the Owner's quality assurance program. Contractor shall be responsible for assuring this participation.

13.2 Field Testing

A. Non-destructive testing shall be carried out as the seaming progresses.

1. Vacuum Testing - Shall be performed in accordance with ASTM D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

2. Air Pressure Testing - Shall be performed in accordance with ASTM D 5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

13.3 Destructive Testing (performed by the installer witnessed by the consultant)

A. Location and Frequency of Testing

1. Collect destructive test samples at a frequency of one per every 1500 lineal feet of seam length.

2. Test locations will be determined after seaming.

3. Exercise Method of Attributes as described by GRI GM-14 (Geosynthetics Institute, http://www.geosynthetic-institute.org) to minimize test samples taken.

B. Sampling Procedures are performed as follows:

1. Installer shall cut samples at locations designated by the consultant as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.

2. Consultant will number each sample, and the location will be noted on the installation as built.

3. Samples shall be twelve inches wide by minimal length with the seam centered lengthwise.

4. Cut a two-inch wide strip from each end of the sample for field-testing.

5. Cut the remaining sample into two parts for distribution as follows:

   a. One portion for installer, twelve -inches by twelve inches

   b. One portion for the third party laboratory, 12-inches by 18-inches

   c. Additional samples may be archived if required.

C. Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

D. Installer shall repair all holes in the geomembrane resulting from destructive sampling.

E. Repair and test the continuity of the repair in accordance with these Specifications.

13.4 Failed Seam Procedures

A. If the seam fails, installer shall follow one of two options:

1. Reconstruct the seam between any two passed test locations.

2. Trace the weld to an intermediate location at least ten feet minimum or to where the seam ends in both directions from the location of the failed test.

B. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than ten feet long.

C. If sample passes, then the seam shall be reconstructed or capped between the test sample locations.

D. If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

14.0 REPAIR PROCEDURES

14.1 Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

14.2 Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.

14.3 Installer shall be responsible for repair of defective areas.

14.4 Agreement upon the appropriate repair method shall be decided between consultant and installer by using one of the following repair methods:

A. Patching - Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

B. Abrading and Rewelding - Used to repair short section of a seam.

C. Spot Welding - Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

D. Capping - Used to repair long lengths of failed seams.

E. Flap Welding - Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

F. Remove the unacceptable seam and replace with new material.

14.5 The following procedures shall be observed when a repair method is used:

A. All geomembrane surfaces shall be clean and dry at the time of repair.

B. Surfaces of the polyethylene that are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.

C. Extend patches or caps at least six inches for extrusion welds and four inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

14.6 Repair Verification

A. Number and log each patch repair (performed by consultant).

B. Non-destructively test each repair using methods specified in this Specification.

Table 3.1: Minimum Weld Values for Smooth HDPE Geomembranes

Property	**Test Method**	**60 (1.5)**
Peel Strength (fusion), ppi (kN/m)	ASTM D 6392	98 (17)
Peel Strength (extrusion), ppi (kN/m)	ASTM D 6392	78 (14)
Shear Strength (fusion & ext.), ppi (kN/m)	ASTM D 6392	121 (21)

Table 1.2: Minimum Values for Smooth White-Surfaced HDPE Geomembranes

Property	**Test Method**	
Thickness, mil (mm)	ASTM D 5199	
Minimum Average		60 (1.5)
Lowest Individual Reading		54 (1.4)
Density, g/cm^3	ASTM D 1505	0.94
Carbon Black Content(2), %	ASTM D 1603	2.0
Carbon Black Dispersion	ASTM D 5596	*Note 3*
Tensile Properties:	ASTM D 638	
(each direction)	Type IV, 2 ipm	
Strength at Yield, lb/in (kN/m)		130 (23)
Strength at Break, lb/in (kN/m)		243 (43)
Elongation at Yield, %	(1.3" gauge length)	13
Elongation at Break, %	(2.0" gauge length)	700
Tear Resistance, lb (N)	ASTM D 1004	42 (187)
Puncture Resistance, lb (N)	ASTM D 4833	119 (530)
Notched Constant Tensile Load, hours	ASTM D 5397,	400
Oxidative Induction Time, min.	ASTM D 3895	100

Geomenbrane may have an overall ash content greater than 3.0% due to the white layer.

The OIT values apply to the black layer only.

Only near spherical agglomerates are considered. 9 of 10 views shall be Category 1 or 2. No more than one view Category 3.

END OF SECTION

1.0 SCOPE OF WORK

1.1 The work to be performed under this section of the specification shall consist of furnishing all necessary supervision, materials, labor, and equipment to design a shotcrete mix, prepare the surface and install the repair/wear layer on the ash pond inlet structures as specified herein.

1.2 Shotcrete Mix: The shotcrete mix selected by the contractor shall be designed to minimize shrinkage cracking and to provide an abrasion resistant surface.

A. Option 1: Use a mix design of Portland cement, hard natural aggregates and admixtures that data and references show to be abrasion resistant.

B. Option 2: Incorporate silica fume into the mix design at a rate of not less than 4%.

2.0 REFERENCES

2.1 American Concrete Institute

A. ACI 308 Standard Practice for Curing Concrete

B. ACU 506R Guide to Shotcreting

C. ACI 506.2 Specification for Shotcrete

2.2 American Society for Testing and Materials

A. ASTM C33 Standard Specification for Concrete Aggregates

B. ASTM C150 Standard Specification for Portland Cement

C. ASTM C309 Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete

D. ASTM C685 Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing

E. ASTM C1116 Standard Specification for Fiber Reinforced Concrete and Shotcrete

3.0 MATERIALS

3.1 Cement: Portland Cement conforming to ASTM C150 Type I.

3.2 Aggregate: Shall conform to ASTM C33.

3.3 Mixing Water: Shall conform to the requirements of ASTM C-94.

3.4 Silica Fume: "Force 10,000D" microsilica as manufactured by W.R. Grace or an approved equal.

3.5 Synthetic Reinforcing Fibers: "Strux 85/50" fibers as manufactured by W.R. Grace or an approved equal.

3.6 Curing Compounds: Wax based (Type I) or water emulsified, resin base (Type II)

4.0 SUBMITTALS

4.1 The contractors shall submit the proposed mix designs and test data with their proposal. If test data is not available prior to award, the contractor shall be responsible for performing preconstruction testing of the mix after award. The mix shall have a 28-day strength of not less than 6,000 psi.

4.2 Two weeks before starting the shotcreting work, the contractor shall submit the qualifications of the nozzlemen who will be performing the work. Every nozzelman shall be certified and have a minimum of 3000 hours of experience as a nozzleman.

5.0 SURFACE PREPARATION

5.1 Inspect surfaces and conditions where shotcrete is to be placed. Notify the Owner's Representative immediately of any unsatisfactory conditions and do not proceed until those unsatisfactory conditions have been corrected.

5.2 Remove previously applied patching materials.

5.3 Chip or scarify the edges of the eroded areas of the concrete slab such that the change in thickness of the shotcrete application will be no greater than ... per linear foot. Scarify the remainder of the existing structure to allow for a minimum shotcrete application of —". Taper edges to leave no square shoulders at the perimeter of a cavity. Perform these procedures with equipment and in a manner that leaves the maximum reveal to insure excellent bonding.

5.4 Inspect the surface upon completing the scarifying to insure no residual fractured fragments from the scarifying process remain.

5.5 Thoroughly clean the surfaces to be repaired by water blasting to remove any traces of dirt, dust, grease, oil or other substances that could effect the bond of the shotcrete to the existing concrete.

5.6 Adequately saturate the repair surface before beginning the shotcreting process.

6.0 INSTALLATION

6.1 Shotcrete shall be applied using the dry mix process.

6.2 Batching and Mixing:

A. Materials shall be volume proportioned by a calibrated screw conveyor or other approved methods.

B. Batching tolerances shall not exceed 1% for water, 1 | % for cementitious materials, 2% for sand and coarse aggregates and 3% for reinforcing fibers.

C. The percentage of surface moisture in the sand shall be maintained within 3% to 6% by weight.

D. Shotcrete batches that have been in contact with damp aggregate or other moisture for more than two hours shall be wasted at the contractor's expense.

E. Mixers for the mixing the dry ingredients shall be capable of mixing and discharging a uniform product without segregation of ingredients.

F. The discharge nozzle of the applicator shall be equipped with a manual water injection system capable of ready adjustment and convenient to the nozzleman.

6.3 Placing of Shotcrete:

A. Shotcrete shall be placed, starting at the bottom of the Work and proceeding upward, using nozzles and air compressors capable of supplying clean and dry air adequate for maintaining uniform and sufficient nozzle velocity for the Work.

B. The minimum thickness of shotcrete shall be — in. per layer. The maximum total thickness shall not exceed 3" per layer, unless otherwise indicated on the Contract Drawings.

C. The surface of freshly placed shotcrete shall be broomed or cleaned to remove laitance. Shotcrete shall be placed in one layer; where shotcrete is placed over existing cementitious surfaces, such surfaces shall be dampened prior to application of the new shotcrete.

D. The finished repair surface shall not very from smooth by more than +/- ..." within any ten feet.

E. Fill corners filled first with sound material so as to prevent rebound collecting therein. Corners, or any area where rebound cannot easily escape or be blown out, are the most likely places for "sand pockets" to develop.

F. If placement results in sagging or sloughing off of materials, shotcreting shall be halted until causes have been determined and corrections have been made. If wind or air currents cause separation of nozzle stream during placement, or if rain occurs and it may wash cement out of the freshly placed material, shotcreting shall be discontinued or suitable means shall be provided to eliminate the problem. Shotcreting shall not be performed when ambient temperature is below 40°F at the pump or at the placement area.

G. The contractor shall provide and maintain sufficient standby equipment to assure continuous production and application of shotcrete.

6.4 All construction, placement and other joints shall be tapered with a height of at least twice the shotcrete thickness.

6.5 Any placed shotcrete which is damaged, or lacks uniformity, exhibits segregation, honeycomb or lamination, or contains dry patches, slugs, voids or sand pockets, shall be removed and replaced with dry mixed mortar.

6.6 Under no circumstances shall any rebound or previously expended material be used in the shotcrete mix.

6.7 Curing:

A. Curing shall commence immediately after the concrete has attained enough set to prevent damage to the concrete surface. Water curing shall be continued for seven days after shotcreting. During this curing period, the shotcrete work shall be maintained above 50°F.

B. After water curing, final curing may be performed by apply curing compounds. The rate of application shall be at least twice that recommended by the manufacturer for smooth concrete surfaces.

7.0 INSPECTION AND TESTING

7.1 Contractor shall be responsible for all inspection and testing work as required or as needed, unless otherwise indicated. Owner's Representative may, during the course of the Work, observe the various phases of the Work for full compliance with all requirements of this Specification and the Contract Drawings. Any work failing to meet the specified requirements shall be rectified or replaced by Contractor at his expense at no additional cost to Owner.

7.2 Test Specimens:

A. Test specimens shall be made by each shotcrete application crew using the materials, equipment, and mix proportions used for the subject work.

B. A test panel of at least 30" x 30" shall be made with suitable backing material for each mix design being considered, and also for each shooting position to be encountered in the Work (i.e., horizontal, vertical and overhead positions). At least half of each panel to be tested for proper embedment of reinforcement shall contain the same reinforcement as the structure. The thickness of test panels shall be the same as the structure.

C. At least five cores shall be taken from each test panel for testing. All cored surfaces shall be dense and free from laminations and sand pockets. Embedment of reinforcement shall be examined in each panel.

7.3 Test specimens shall be obtained and tested in accordance with ASTM C42 and C39 for compressive strength only.

END OF SECTION

Attachment 1-5 – West Ash Pond HDPE Liner Replacement Specifications

1.0 WORK INCLUDED

1.1 This work includes furnishing materials, tools, equipment, and labor to perform bulk and structural excavation, grading, dewatering and place and compact fill, backfill, and bedding materials.

1.2 Excavation includes, sheeting and bracing required for proper execution of the work, loosening, digging, wedging, ripping, loading, hauling, stockpiling, dumping, and disposal of excavated materials in legal disposal areas approved by Owner's Representative.

1.3 Excavation is unclassified and includes, but is not limited to soil, ash and rock materials, abandoned underground conduits or pipes, and buried concrete and masonry structures.

2.0 QUALITY CONTROL

2.1 Existing and new materials to be used as fill, backfill or bedding are subject to the approval of Owner's Representative.

2.2 To obtain approval of fill, backfill, and bedding materials, designate the proposed borrow area and notify the Owner's Site Representative for a visual inspection prior to placing the material.

3.0 REFERENCES

3.1 Occupational Safety and Health Administration (OSHA)

A. OSHA 2206 General Industry Standards

B. OSHA 2207 Construction Industry Standards

3.2 Illinois Department of Transportation (IDOT) - Standard Specifications for Road and Bridge Construction.

3.3 American Society for Testing and Materials (ASTM)

A. ASTM D 1556- Test for Density of Soil in place by Sand Cone Method

B. ASTM D 1557- Tests for Moisture-Density Relations of Soils Using 10 lb. Hammer and 18 inch drop.

C. ASTM D 2167- Test for Density of Soil in place by Rubber Balloon Method

3.4 The above references shall be the current revision for each.

4.0 SUBMITTALS

4.1 With Contractors' Proposals

A. Submit product data sheets for the chosen liner material.

B. Submit the estimated quantities of materials required to complete the work.

4.2 Two weeks prior to the start of the work, submit to the Owner's Engineer for review, procedures for placing and compacting fill on top of the new liner without damaging the liner material. Include a statement from the liner manufacture that says the procedure is acceptable.

5.0 SITE CONDITIONS

5.1 Prior to start of work become thoroughly familiar with the site, site access, the site conditions, and all portions of the work.

5.2 One pond will be operational while the work on the second pond is being performed.

6.0 MATERIALS

6.1 Make maximum use of suitable on site material for fill when building the pond slopes and entrance ramps. Suitable on site fill material is granular soil or soil/rock mixture that is free from organic matter and other deleterious substances. Material containing rocks or lumps over 1½" in greatest dimension, or containing 15% rocks or lumps larger than ½" in greatest dimension is not acceptable. The material shall have an angle of repose of 30° or greater.

6.2 Imported fill and backfill material shall meet the requirements of Item 6.1 above and, in addition, shall contain predominantly granular material with a maximum particle size of 2".

6.3 Sand used as the protective layer for the pond liners shall be approved by the liner manufacturer.

6.4 Rip rap, coarse aggregate and limestone screenings shall comply with I.D.O.T. specifications.

7.0 BULK AND STRUCTURAL EXCAVATION

7.1 Perform bulk and structural excavation in accordance with the most recent revision of the OSHA General Industry Standards (OSHA 2206) and the OSHA Construction Industry Standards (OSHA 2207).

7.2 Provide temporary grading, ditches and other means as required to drain the areas of the work.

7.3 Perform excavation to lines and grades shown on the contract drawings and as directed by Owner's Representative.

7.4 When the sides of an excavation are five feet or more in depth or when employees are required to enter the excavated area where danger from moving ground exists, perform excavation by open cut to a stable slope or by sheeting and bracing.

7.5 Remove unstable subsoil material, where encountered at the bottom of excavation, to a depth required to obtain satisfactory bearing conditions. Contractor is responsible for bringing the excavation back to the proper elevation by installing compacted bedding material as specified in this section.

7.6 Remove spoil from areas of excavation and stockpile for later use at locations no closer than 2'-0" from edge of excavation unless otherwise approved by Owner's Representative. Remove excess spoil and excavated materials not specifically approved by Owner's Representative for fill, backfill or stockpiling from the site and dispose of these materials at locations and in a manner approved by Federal, State and Local Authorities.

7.7 Properly grade bottom of bulk and structural excavations, remove loose materials, and maintain excavations in good condition, keeping them dry in accordance with Article 8.0 Dewatering, of this section, and free from debris, ice, and frost until completion of the work.

8.0 DEWATERING

8.1 Provide and maintain in operation adequate pumping capacity from sumps, deep wells, or well point installation and perform all other work necessary to keep excavations dry and free of groundwater or surface water during the progress of the work.

8.2 Construction is not permitted in flowing or standing water.

8.3 Dispose of water pumped or drained from the work area in a manner satisfactory to the Owner's Representative, without damage to adjacent property or to other work under construction.

8.4 Take necessary precautions to protect the work against flooding.

9.0 COMPACTION

9.1 Determine the types of equipment and the number of passes required to obtain the required compaction. A pass is defined as one complete coverage of the area by the compaction equipment being used.

9.2 Compact fill and backfill materials to a minimum of 90% of maximum dry density in all areas except in road areas where a minimum of 95% of maximum dry density is required.

9.3 Compact surfaces that are scarified along with and as part of the first lift of fill material that is spread thereon.

9.4 Maximum dry density is defined as the maximum density that can be produced when the same material is compacted in the laboratory in accordance with ASTM D 698 (Standard Proctor).

10.0 INSTALLATION OF FILL AND BACKFILL

10.1 Install fill and backfill material by placing fill and backfill material in uniform layers not to exceed 6" loose measurement unless otherwise noted on the contract drawings or elsewhere in this specification. Compact to minimum specified compaction as set forth in Article 9.2 of this Section.

10.2 Install the 12" protective sand layer on top of the liner material in a single layer.

10.3 Moisten and scarify surfaces to a depth of 4", against which new fill or roadway material is to be placed.

10.4 Remove shoring as backfill progresses only when banks are safe from caving or collapse.

10.5 Water or aerate the material as necessary, and thoroughly mix to obtain a moisture content that will permit proper compaction.

10.6 Do not place fill or backfill materials on a frozen surface. Do not incorporate snow, ice or frozen earth with the fill. Distribute and grade fill and backfill materials throughout the work such that fill will be free from lenses, pockets, streaks or layers of materials differing in texture or gradation from the surrounding material. Do not place successive layers until the layer under construction has been satisfactorily compacted. Place materials in horizontal lifts.

10.7 Remove, dispose and replace any material that Owner's Representative considers objectionable without additional cost to Owner.

10.8 Bring subgrades to a plus or minus tolerance of 0.10 feet.

11.0 FIELD QUALITY CONTROL

11.1 Do not allow or cause any of the work performed or installed to be covered up or enclosed prior to required inspections, tests, and approvals.

11.2 Should any of the work be enclosed or covered up before it has been approved, uncover such work at no additional cost to Owner.

11.3 After the work has been completed, tested, inspected, and approved, make repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, at no additional cost to the Owner.

11.4 Contractor shall engage a testing laboratory to inspect and perform tests on all fill, backfill, and bedding materials.

A. The testing laboratory shall conduct and interpret the following ASTM tests to determine the degree of compaction achieved by compaction operations:

1. ASTM D 1556 Test for Density of Soil in place by Sand Cone Method

2. ASTM D 2167 Test for Density of Soil in place by Rubber Balloon Method

3. ASTM D 2922 Test for Density of Soil in place by Nuclear Methods

B. The testing laboratory shall prepare a test report stating whether the test specimens comply with the work requirements, and specifically state any deviations therefrom.

C. The Owner shall have the right to reject any materials or work not complying with the requirements of the Specification.

D. Contractor shall be responsible for all costs associated with the removal and replacement of all materials determined by testing personnel to have failed the testing acceptance standards.

END OF SECTION

1.0 WORK INCLUDED

This work includes furnishing materials, tools, equipment, and labor to install a 60-mil thick. high-density polyethylene liner with a reflective white coating.

2.0 REFERENCES

2.1 American Society for Testing and Materials (ASTM)

D 638	Standard Test Method for Tensile Properties of Plastics
D 1004	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
D 1603	Test Method for Carbon Black in Olefin Plastics
D 3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 6392	Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

2.2 Geosynthetic Research Institute

GM9	Cold Weather Seaming of Geomembranes
GM13	Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GM19	Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

3.0 DEFINITIONS

3.1 Lot - A quantity of resin (usually the capacity of one rail car) used in the manufacture of polyethylene geomembrane rolls. The finished roll will be identified by a roll number traceable to the resin lot used.

3.2 Construction Quality Assurance Consultant (consultant) - Party, independent from manufacturer and installer that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

3.3 Engineer - The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

3.4 Geomembrane Manufacturer (manufacturer) - The party responsible for manufacturing the geomembrane rolls.

3.5 Geosynthetic Quality Assurance Laboratory (testing laboratory) - Party, independent from the owner, manufacturer and installer, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the owner.

3.6 Installer - Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.

3.7 Panel - Unit area of a geomembrane that will be seamed in the field that is larger than 100 square feet.

3.8 Patch - Unit area of a geomembrane that will be seamed in the field that is less than 100 square feet.

3.9 Subgrade Surface - Soil layer surface which immediately underlies the geosynthetic material.

4.0 SUBMITTALS POST-AWARD

4.1 Furnish the following product data, in writing, to engineer prior to installation of the geomembrane material:

A. Resin Data shall include certification stating that the resin meets the specification requirements (see Section 8.0).

B. Statement certifying no more than 10% reclaimed polymer (of the same type) is added to the resin (product run may be recycled) per GRI GM 13.

4.2 The installer shall furnish the following information to the engineer and owner prior to installation:

A. Installation layout drawings

1. Must show proposed panel layout including field seams and details

2. Must be approved prior to installing the geomembrane (Approved drawings will be for concept only and actual panel placement will be determined by site conditions).

B. Installer's Geosynthetic Field Installation Quality Assurance Plan

4.3 The installer will submit the following to the engineer upon completion of installation:

A. Certificate stating the geomembrane has been installed in accordance with the Contract Documents

B. Material and installation warranties

C. As-built drawings showing actual geomembrane placement and seams including typical anchor trench detail/

5.0 QUALITY ASSURANCE

5.1 The Contractor shall engage and pay for the services of a Quality Assurance Consultant to monitor geomembrane installation.

5.2 Qualifications

A. Manufacturer

1. Geomembrane shall be manufactured by GSE Lining Technology, Inc. or an approved equal.

2. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane during the last year.

B. Installer

1. The liner manufacturer shall install the liner.

2. Installer shall have installed a minimum of 3,000,000 square feet of HDPE geomembrane during the last five years.

3. Installer shall have worked in a similar capacity on at least three projects similar in complexity to the project described in the contract documents.

4. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

5. The installer shall provide a minimum of one Master Seamer for work on the project.

6. Must have completed a minimum of 1,000,000 square feet of geomembrane seaming work using the type of seaming apparatus proposed for the use on this Project.

6.0 <u>MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING</u>

6.1 Labeling - Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label will identify:

A. Manufacturer's name

B. Product identification

C. Roll number

6.2 Delivery - Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

6.3 Storage - The on-site storage location for geomembrane material, provided by the contractor to protect the geomembrane from punctures, abrasions and excessive dirt and moisture for should have the following characteristics:

A. Level (no wooden pallets)

B. Smooth

C. Dry

D. Protected from theft and vandalism

E. Adjacent to the area being lined

6.4 Handling - Materials are to be handled so as to prevent damage.

7.0 <u>WARRANTY</u>

7.1 Material shall be warranted, on a pro-rata basis against Manufacturer's defects for a period of five years from the date of geomembrane installation.

7.2 Installation shall be warranted against defects in workmanship for a period of one year from the date of geomembrane completion.

8.0 <u>GEOMEMBRANE</u>

8.1 Material shall be smooth/textured polyethylene geomembrane as shown on the drawings.

8.2 Resin

A. Resin shall be new, first quality, compounded and manufactured specifically for producing geomembrane.

B. Natural resin (without carbon black) shall meet the following additional minimum requirements:

Property	**Test Method**[1]	**HDPE**
Density [g/cm^3]	ASTM D 1505	0.932
Melt Flow Index [g/10 min.]	ASTM D 1238 (190/2.16)	≤ 1.0
OIT [minutes]	ASTM D 3895 (1 atm/200°C)	100

8.3 Geomembrane Rolls

A. Do not exceed a combined maximum total of one percent by weight of additives other than carbon black.

B. Geomembrane shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

C. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating both number, thickness, length, width and manufacturer.

D. All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in Section 8.2, and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

8.4 Smooth, white surfaced geomembrane shall meet the requirements shown in Table 1.2

The geomembrane shall be a white-surfaced, coextruded geomembrane. The white surface shall be installed upwards.

8.5 Extrudate Rod or Bead

A. Extrudate material shall be made from same type resin as the geomembrane.

B. Additives shall be thoroughly dispersed.

C. Materials shall be free of contamination by moisture or foreign matter.

9.0 EQUIPMENT

Welding equipment and accessories shall meet the following requirements:

9.1 Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.

9.2 An adequate number of welding apparatus shall be available to avoid delaying work.

9.3 Power source capable of providing constant voltage under combined line load shall be used.

10.0 DEPLOYMENT

10.1 Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.

10.2 Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

10.3 Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:

A. Unroll geomembrane panels using methods that will not damage geomembrane and will protect underlying surface from damage (i.e., spreader bar, protected equipment bucket).

B. Place ballast (commonly sandbags) on geomembrane that will not damage geomembrane to prevent wind uplift.

C. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage the geomembrane. Smoking will not be permitted on the geomembrane.

D. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than six psi.

E. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.

10.4 Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

11.0 FIELD SEAMING

11.1 Seams shall meet the following requirements:

A. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope.

B. Minimize number of field seams in corners, odd shaped geometric locations and outside corners.

C. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.

D. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the consultant and installer.

E. Align seam overlaps consistent with the requirements of the welding equipment being used. A six-inch overlap is commonly suggested.

11.2 During Welding Operations provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

11.3 Extrusion Welding

A. Hot-air tack adjacent pieces together using procedures that do not damage geomembrane.

B. Clean geomembrane surfaces by disc grinder or equivalent.

C. Purge welding apparatus of heat degraded extrudate before welding.

11.4 Hot Wedge Welding

A. Welding apparatus shall be a self-propelled device equipped with an electronic controller that displays applicable temperatures.

B. Clean seam area of dust, mud, moisture and debris immediately ahead of the hot wedge welder.

C. Protect against moisture build up between sheets.

12.0 Trial Welds

A. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.

B. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

C. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.

D. Cut four, one-inch wide by six-inch long test strips from the trial weld.

E. Quantitatively test specimens for peel adhesion, and then for bonded seam strength (shear).

F. Trial weld specimens shall pass when the results shown in Table 3 are achieved in both peel and shear test.

1. The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).

2. The break is ductile.

G. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.

H. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.

12.2 Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Installer shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

12.3 Defects and Repairs

A. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

B. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

13.0 FIELD QUALITY ASSURANCE

13.1 Manufacturer/installer shall participate in and conform to all terms and requirements of the Owner's quality assurance program. Contractor shall be responsible for assuring this participation.

13.2 Field Testing

A. Non-destructive testing shall be carried out as the seaming progresses.

1. Vacuum Testing - Shall be performed in accordance with ASTM D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

2. Air Pressure Testing - Shall be performed in accordance with ASTM D 5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

13.3 Destructive Testing (performed by the installer witnessed by the consultant)

A. Location and Frequency of Testing

1. Collect destructive test samples at a frequency of one per every 1500 lineal feet of seam length.

2. Test locations will be determined after seaming.

3. Exercise Method of Attributes as described by GRI GM-14 (Geosynthetics Institute, http://www.geosynthetic-institute.org) to minimize test samples taken.

B. Sampling Procedures are performed as follows:

1. Installer shall cut samples at locations designated by the consultant as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.

2. Consultant will number each sample, and the location will be noted on the installation as built.

3. Samples shall be twelve inches wide by minimal length with the seam centered lengthwise.
4. Cut a two-inch wide strip from each end of the sample for field-testing.
5. Cut the remaining sample into two parts for distribution as follows:
   a. One portion for installer, twelve -inches by twelve inches
   b. One portion for the third party laboratory, 12-inches by 18-inches
   c. Additional samples may be archived if required.

C. Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

D. Installer shall repair all holes in the geomembrane resulting from destructive sampling.

E. Repair and test the continuity of the repair in accordance with these Specifications.

13.4 Failed Seam Procedures

A. If the seam fails, installer shall follow one of two options:
   1. Reconstruct the seam between any two passed test locations.
   2. Trace the weld to an intermediate location at least ten feet minimum or to where the seam ends in both directions from the location of the failed test.

B. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than ten feet long.

C. If sample passes, then the seam shall be reconstructed or capped between the test sample locations.

D. If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

14.0 REPAIR PROCEDURES

14.1 Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

14.2 Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.

14.3 Installer shall be responsible for repair of defective areas.

14.4 Agreement upon the appropriate repair method shall be decided between consultant and installer by using one of the following repair methods:

A. Patching - Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

B. Abrading and Rewelding - Used to repair short section of a seam.

C. Spot Welding - Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

D. Capping - Used to repair long lengths of failed seams.

E. Flap Welding - Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

F. Remove the unacceptable seam and replace with new material.

14.5 The following procedures shall be observed when a repair method is used:

A. All geomembrane surfaces shall be clean and dry at the time of repair.

B. Surfaces of the polyethylene that are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.

C. Extend patches or caps at least six inches for extrusion welds and four inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

14.6 Repair Verification

A. Number and log each patch repair (performed by consultant).

B. Non-destructively test each repair using methods specified in this Specification.

Table 3.1: Minimum Weld Values for Smooth HDPE Geomembranes

Property	Test Method	60 (1.5)
Peel Strength (fusion), ppi (kN/m)	ASTM D 6392	98 (17)
Peel Strength (extrusion), ppi (kN/m)	ASTM D 6392	78 (14)
Shear Strength (fusion & ext.), ppi (kN/m)	ASTM D 6392	121 (21)

Table 1.2: Minimum Values for Smooth White-Surfaced HDPE Geomembranes

Property	Test Method	
Thickness, mil (mm)	ASTM D 5199	
Minimum Average		60 (1.5)
Lowest Individual Reading		54 (1.4)
Density, g/cm^3	ASTM D 1505	0.94
Carbon Black Content$^{(2)}$, %	ASTM D 1603	2.0
Carbon Black Dispersion	ASTM D 5596	*Note 3*
Tensile Properties:	ASTM D 638	
(each direction)	Type IV, 2 ipm	
Strength at Yield, lb/in (kN/m)		130 (23)
Strength at Break, lb/in (kN/m)		243 (43)
Elongation at Yield, %	(1.3" gauge length)	13
Elongation at Break, %	(2.0" gauge length)	700
Tear Resistance, lb (N)	ASTM D 1004	42 (187)
Puncture Resistance, lb (N)	ASTM D 4833	119 (530)
Notched Constant Tensile Load, hours	ASTM D 5397,	400
Oxidative Induction Time, min.	ASTM D 3895	100

Geomenbrane may have an overall ash content greater than 3.0% due to the white layer.

The OIT values apply to the black layer only.

Only near spherical agglomerates are considered. 9 of 10 views shall be Category 1 or 2. No more than one view Category 3.

END OF SECTION

1.0 SCOPE OF WORK

1.1 The work to be performed under this section of the specification shall consist of furnishing all necessary supervision, materials, labor, and equipment to design a shotcrete mix, prepare the surface and install the repair/wear layer on the ash pond inlet structures as specified herein.

1.2 Shotcrete Mix: The shotcrete mix selected by the contractor shall be designed to minimize shrinkage cracking and to provide an abrasion resistant surface.

A. Option 1: Use a mix design of Portland cement, hard natural aggregates and admixtures that data and references show to be abrasion resistant.

B. Option 2: Incorporate silica fume into the mix design at a rate of not less than 4%.

2.0 REFERENCES

2.1 American Concrete Institute

A. ACI 308 Standard Practice for Curing Concrete

B. ACU 506R Guide to Shotcreting

C. ACI 506.2 Specification for Shotcrete

2.2 American Society for Testing and Materials

A. ASTM C33 Standard Specification for Concrete Aggregates

B. ASTM C150 Standard Specification for Portland Cement

C. ASTM C309 Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete

D. ASTM C685 Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing

E. ASTM C1116 Standard Specification for Fiber Reinforced Concrete and Shotcrete

3.0 MATERIALS

3.1 Cement: Portland Cement conforming to ASTM C150 Type I.

3.2 Aggregate: Shall conform to ASTM C33.

3.3 Mixing Water: Shall conform to the requirements of ASTM C-94.

3.4 Silica Fume: "Force 10,000D" microsilica as manufactured by W.R. Grace or an approved equal.

3.5 Synthetic Reinforcing Fibers: "Strux 85/50" fibers as manufactured by W.R. Grace or an approved equal.

3.6 Curing Compounds: Wax based (Type I) or water emulsified, resin base (Type II)

4.0 SUBMITTALS

4.1 The contractors shall submit the proposed mix designs and test data with their proposal. If test data is not available prior to award, the contractor shall be responsible for performing preconstruction testing of the mix after award. The mix shall have a 28-day strength of not less than 6,000 psi.

4.2 Two weeks before starting the shotcreting work, the contractor shall submit the qualifications of the nozzlemen who will be performing the work. Every nozzelman shall be certified and have a minimum of 3000 hours of experience as a nozzleman.

5.0 SURFACE PREPARATION

5.1 Inspect surfaces and conditions where shotcrete is to be placed. Notify the Owner's Representative immediately of any unsatisfactory conditions and do not proceed until those unsatisfactory conditions have been corrected.

5.2 Remove previously applied patching materials.

5.3 Chip or scarify the edges of the eroded areas of the concrete slab such that the change in thickness of the shotcrete application will be no greater than ¼" per linear foot. Scarify the remainder of the existing structure to allow for a minimum shotcrete application of ¾". Taper edges to leave no square shoulders at the perimeter of a cavity. Perform these procedures with equipment and in a manner that leaves the maximum reveal to insure excellent bonding.

5.4 Inspect the surface upon completing the scarifying to insure no residual fractured fragments from the scarifying process remain.

5.5 Thoroughly clean the surfaces to be repaired by water blasting to remove any traces of dirt, dust, grease, oil or other substances that could effect the bond of the shotcrete to the existing concrete.

5.6 Adequately saturate the repair surface before beginning the shotcreting process.

6.0 INSTALLATION

6.1 Shotcrete shall be applied using the dry mix process.

6.2 Batching and Mixing:

A. Materials shall be volume proportioned by a calibrated screw conveyor or other approved methods.

B. Batching tolerances shall not exceed 1% for water, 1 1/2% for cementitious materials, 2% for sand and coarse aggregates and 3% for reinforcing fibers.

C. The percentage of surface moisture in the sand shall be maintained within 3% to 6% by weight.

D. Shotcrete batches that have been in contact with damp aggregate or other moisture for more than two hours shall be wasted at the contractor's expense.

E. Mixers for the mixing the dry ingredients shall be capable of mixing and discharging a uniform product without segregation of ingredients.

F. The discharge nozzle of the applicator shall be equipped with a manual water injection system capable of ready adjustment and convenient to the nozzleman.

6.3 Placing of Shotcrete:

A. Shotcrete shall be placed, starting at the bottom of the Work and proceeding upward, using nozzles and air compressors capable of supplying clean and dry air adequate for maintaining uniform and sufficient nozzle velocity for the Work.

B. The minimum thickness of shotcrete shall be ¾" per layer. The maximum total thickness shall not exceed 3" per layer, unless otherwise indicated on the Contract Drawings.

C. The surface of freshly placed shotcrete shall be broomed or cleaned to remove laitance. Shotcrete shall be placed in one layer; where shotcrete is placed over existing cementitious surfaces, such surfaces shall be dampened prior to application of the new shotcrete.

D. The finished repair surface shall not very from smooth by more than +/- ¼" within any ten feet.

E. Fill corners filled first with sound material so as to prevent rebound collecting therein. Corners, or any area where rebound cannot easily escape or be blown out, are the most likely places for "sand pockets" to develop.

F. If placement results in sagging or sloughing off of materials, shotcreting shall be halted until causes have been determined and corrections have been made. If wind or air currents cause separation of nozzle stream during placement, or if rain occurs and it may wash cement out of the freshly placed material, shotcreting shall be discontinued or suitable means shall be provided to eliminate the problem. Shotcreting shall not be performed when ambient temperature is below 40°F at the pump or at the placement area.

G. The contractor shall provide and maintain sufficient standby equipment to assure continuous production and application of shotcrete.

6.4 All construction, placement and other joints shall be tapered with a height of at least twice the shotcrete thickness.

6.5 Any placed shotcrete which is damaged, or lacks uniformity, exhibits segregation, honeycomb or lamination, or contains dry patches, slugs, voids or sand pockets, shall be removed and replaced with dry mixed mortar.

6.6 Under no circumstances shall any rebound or previously expended material be used in the shotcrete mix.

6.7 Curing:

A. Curing shall commence immediately after the concrete has attained enough set to prevent damage to the concrete surface. Water curing shall be continued for seven days after shotcreting. During this curing period, the shotcrete work shall be maintained above 50°F.

B. After water curing, final curing may be performed by apply curing compounds. The rate of application shall be at least twice that recommended by the manufacturer for smooth concrete surfaces.

7.0 INSPECTION AND TESTING

7.1 Contractor shall be responsible for all inspection and testing work as required or as needed, unless otherwise indicated. Owner's Representative may, during the course of the Work, observe the various phases of the Work for full compliance with all requirements of this Specification and the Contract Drawings. Any work failing to meet the specified requirements shall be rectified or replaced by Contractor at his expense at no additional cost to Owner.

7.2 Test Specimens:

A. Test specimens shall be made by each shotcrete application crew using the materials, equipment, and mix proportions used for the subject work.

B. A test panel of at least 30" x 30" shall be made with suitable backing material for each mix design being considered, and also for each shooting position to be encountered in the Work (i.e., horizontal, vertical and overhead positions). At least half of each panel to be tested for proper embedment of reinforcement shall contain the same reinforcement as the structure. The thickness of test panels shall be the same as the structure.

C. At least five cores shall be taken from each test panel for testing. All cored surfaces shall be dense and free from laminations and sand pockets. Embedment of reinforcement shall be examined in each panel.

7.3 Test specimens shall be obtained and tested in accordance with ASTM C42 and C39 for compressive strength only.

END OF SECTION

Attachment 1-6 – East Ash Pond Technical Specifications

SECTION 02200

EARTHWORK

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary to perform all Earthwork. The Work shall be carried out as specified herein and in accordance with the Construction Drawings.

B. The Work shall include, but not be limited to clearing and grubbing, excavating, hauling, placing, moisture conditioning, backfilling, compacting, grading, and subgrade preparation. Earthwork shall conform to the dimensions, lines, grades and sections shown on the Construction Drawings or as directed by the Construction Manager.

1.02 RELATED SECTIONS

A. Section 02770 – Geosynthetics

1.03 REFERENCES

A. Construction Drawings

B. Latest version of the Occupational Safety and Health Administration (OSHA) rules and regulations.

C. "Stormwater Pollution Prevention Plan, East Ash Basin Slope Modification", Geosyntec, July 2016.

D. 2015 Standard Specifications for Public Works Construction "Greenbook" (Greenbook)

E. "Construction Quality Assurance (CQA) Plan, East Ash Basin Slope Modification, Waukegan Generating Station" by Geosyntec, dated June 2016

F. Illinois Department of Transportation (IDOT), Standard Specifications for Road and Bridge Construction, January 2012.

G. Latest version of the American Society for Testing and Materials (ASTM) standards:

ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D422	Standard Method for Particle-Size Analysis of Soils
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D2487	Standard Test Method for Classification of Soils for Engineering Purposes
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)

H. Submittals

I. The Contractor shall submit to the Construction Manager a description of equipment and methods proposed for all earthwork components including excavation, ash relocation, select and engineered fill placement, moisture conditioning, and compaction, stockpiling, road subgrade preparation and road surfacing placement and compaction at least 5 days prior to the start of activities covered by this Section.

J. The Contractor shall submit copies of all permits obtained for site work. The permits shall be provided prior to initiating the applicable site activities.

K. The Contractor shall submit as-built Record Drawing electronic files and data, to the Construction Manager, within 7 days of project substantial completion, in accordance with this Section. The Record Drawings shall be submitted in AutoCAD version 2015 format or newer, or in a DXF format that can be converted to AutoCAD.

1.04 QUALITY ASSURANCE

A. The Contractor shall ensure that the materials and methods used for Earthwork meet the requirements of the Construction Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Construction Manager will be rejected and shall be repaired or replaced by the Contractor at the Contractor's expense.

B. The Contractor shall be aware of and accommodate all monitoring and field/laboratory conformance testing required by the CQA Plan. This monitoring and testing, including random conformance testing of construction materials and completed Work, will be performed by the CQA Consultant. If nonconformances or other deficiencies are found in the materials or completed Work, the Contractor will be required to repair the deficiency or replace the deficient materials at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Engineered Fill – Engineered Fill shall consist of relatively homogeneous soils that contain no debris, foreign objects, large rock fragments (greater than 6 inches in maximum dimension), roots, and organics. No materials larger than 6 inches shall be allowed within the Engineered Fill. The Engineered Fill shall be classified according to the Unified Soil Classification System (per ASTM D2487) as, ML, CL, CL-ML, SM, SC, SW, SP, GW, GP, GM, GC, or combinations of these materials. The Contractor may propose the use of other soil types as Engineered Fill, but such use shall be at the sole discretion of the Engineer.

B. Select Soil – Select Soil shall have at least 40 percent material smaller than ¼-inch in size, no particles larger than 3 inches, and not having any sharp, angular pieces greater than ¼-inch or perishable, spongy, deleterious, or otherwise unsuitable material. Select soil shall be utilized to backfill geomembrane anchor trenches.

C. Aggregate Base – Aggregate Base shall meet the requirements of Illinois Department of Transportation Gradation CA 6.

D. CCR – CCR (Coal Combustion Residuals) are materials located within the geomembrane lined areas of the West and East Ash Basins.

2.02 EQUIPMENT

A. The Contractor shall furnish, operate, and maintain compaction equipment as necessary to produce the required in-place soil density and moisture content.

B. The Contractor shall furnish, operate and maintain tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable surface widths.

C. The Contractor shall furnish, operate, and maintain miscellaneous equipment such as scarifiers or disks, earth excavating equipment, earth hauling equipment, and other equipment, as necessary for Earthwork construction.

D. When relocating CCR Deposits or placing excavated material within the basin in areas lined with a geomembrane, the Contractor shall use equipment which will not damage the underlying geomembrane in accordance with the Geomembrane Manufacturer's recommendations.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor shall not disturb or impact areas outside of the limits of work as defined on the Construction Drawings without prior approval from the Construction Manager. If work outside of the limit cannot be avoided, the Contractor shall notify the Construction Manager a minimum of 3 days prior to disturbance outside of the limits for approval prior to starting the work.

B. Prior to initiating earthwork activities, the Contractor shall have implemented the site SWPPP.

C. The Contractor shall obtain all applicable grading permits, or other applicable work permits, prior to initiating the work covered by the permit.

D. When hauling is done over roadways or city streets, the loads shall comply with legal load requirements, all material shall be removed from shelf areas of vehicles in order to eliminate spilling of material, and loads shall be watered or covered to eliminate dust.

E. Under this Work, the Contractor shall apply water for dust control, for compaction purposes, and for such other purposes (not provided for in other Sections) called for on the Construction Drawings or as directed by the Construction Manager. Contractor shall coordinate with Owner for access to onsite water source. Contractor shall not waste water or allow water application to create erosion or other deleterious conditions to the work area or adjacent areas.

F. Well heads for existing groundwater wells within the work area will removed by others and wells will be capped prior to work. The Contractor shall provide protection to existing groundwater monitoring wells throughout construction. Any damage to these items shall be repaired or replaced to the Construction Manager's satisfaction at the Contractor's sole expense.

3.02 FAMILIARIZATION

A. Prior to implementing any of the Work in this Section, the Contractor shall become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this and other related Sections.

3.03 CLEARING AND GRUBBING

A. Prior to Site clearing, Contractor shall have implemented the SWPPP.

B. The Contractor shall remove and properly dispose of all vegetation, debris, organic and deleterious material that exist along the crest of the embankment and eastern and southern facing slopes of the embankment within the work area.

C. No burning of combustible materials shall be allowed.

D. Clearing and grubbing shall include, but not be limited to removal and disposal of trees, plants and shrubs and vegetation as well as rocks, and surficial and shallow debris.

E. Vegetation, debris and organic matter shall be properly disposed of offsite.

F. Remove all tree root balls associated with trees with a diameter greater than 4-inches. Tree root ball holes in non-excavation areas shall be backfilled in accordance with Section 3.07.

3.04 EXCAVATION

A. CCR located on top of the geomembrane along the slope area within the East Ash Basin shall be relocated, as necessary, to accommodate grading of the embankment. Excavated CCR materials shall be placed within the western portion of the East Ash Basin. CCR shall not be placed at inclinations greater than 5H:1V (Horizontal:Vertical). Excavation of CCR shall be performed with care to ensure no damage to the underlying geomembrane. Damage to the underlying geomembrane shall be repaired to the Construction Manager’s satisfaction at the Contractor’s expense.

B. Perform all excavations, regardless of the type, nature, or condition of material encountered, as specified, shown, required or implied to accomplish the construction. Excavated soil shall be placed within the western portion of the East Ash Basin at inclinations no greater than 5H:1V.

C. Allow for working space, overlying materials, and finish grades as shown or required. Do not carry excavations deeper than the elevation shown, unless soft or wet materials are encountered. Excavation carried below the grade lines in areas of unsuitable materials, including root balls, shall be replaced with over excavated material compacted to at least 90% relative compaction and to -3 percent to +1 percent of optimum moisture. Cuts below grade shall be corrected by filling and compacting soil material to at least 90% relative compaction and -3 percent to +1 percent of optimum moisture, and creating a smooth transition. All overexcavation in areas of suitable materials will be filled and compacted at the Contractor's expense.

D. After completion of excavation, and prior to placement of aggregate base on the embankment crest (Section 3.06), proof-roll the berm crest to detect soft, wet, or loose materials. Notify the Owner or Owner's Representative prior to commencement of proof rolling. If soft, wet, or loose materials are found, excavate the soft or loose material to a depth accepted by the Engineer, then fill and compact in accordance with Section 3.07.

E. Perform all earthwork to the lines and grades as shown and/or established by the Owner or Owner's Representative. Make slopes free of all exposed roots and stones exceeding 3-inch diameter which are loose and liable to fall. Neatly blend all new grading into surrounding, existing terrain. The Owner or Owner’s Representative shall review finished site grading.

F. After excavating existing aggregate base materials on the embankment crest within the work area, Contractor shall remove existing geotextile and properly dispose of offsite.

3.05 ANCHOR TRENCH EXCAVATION AND BACKFILL

A. The Contractor shall excavate 2 ft by 2 ft anchor trenches to secure the geomembrane prior to placement of the geotextile and aggregate base material.

B. Anchor trenches shall be backfilled with select fill and compacted in accordance with Subpart 3.07, below.

3.06 ACCESS ROAD SURFACING

A. The Contractor shall grade access road along the crest of the embankment to the widths and minimum slope inclinations as shown on the Construction Drawings.

B. Prior to placing aggregate base, the Contractor shall moisten the area to be covered. The area shall be kept moist, but not wet (i.e. no ponding water or saturated soils), until the geotextile and overlying aggregate base is installed.

C. Geotextile shall be placed prior to aggregate base placement in accordance with Section 02770.

D. The access road shall be surfaced with 4 inches of aggregate base to the lines and grades shown on the Construction Drawings. Aggregate base shall be as described in Section 2.01 and in locations indicated on the Construction Drawings.

E. The aggregate base shall be compacted to a minimum of 95 percent relative compaction and within ± 2 percent of the optimum moisture content as determined by ASTM D1557.

F. After initial compaction, the Contractor shall trim off high spots to within tolerance wherever the finished surface is higher than the specified tolerance. Following trimming, the Contractor shall compact trimmed areas with one complete coverage so the entire layer complies with compaction requirements. Loose material at the surface and tear marks shall not be permitted.

3.07 ENGINEERED AND SELECT FILL

A. Prior to placing engineered fill, the soil subgrade shall be scarified to a depth of 6 inches and recompacted.

B. Engineered fill and select fill shall be compacted to a minimum of 90 percent relative compaction and -3 percent to +1 percent of optimum moisture percent as measured in accordance with ASTM D1557.

3.08 STOCKPILING

A. If deemed acceptable for reuse, existing aggregate base material may be stockpiled within the laydown area or an area approved by the Owner. Stockpiles shall be no steeper than 2.5H:1V (Horizontal:Vertical), unless stockpiles are to be created within the East Ash Basin in which case the stockpiles shall be no steeper than 5H:1V, or other slope approved by the Engineer, graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the Construction Manager, and dressed daily during periods when fill is taken from the stockpile. The Contractor shall employ temporary erosion and sediment control measures (i.e. silt fence) around stockpile areas in accordance with Construction Drawings.

B. There are no compaction requirements for temporary stockpiled materials.

3.09 FIELD TESTING

A. The minimum frequency and details of quality control testing are provided below. This testing will be performed by the CQA Consultant. Additional testing may be performed at the discretion of the CQA Consultant, Construction Manager or Owner. The Contractor shall consider this testing frequency when preparing the construction schedule.

1. The CQA Consultant will perform conformance tests on placed and compacted engineered fill, select soil and aggregate base to evaluate compliance with these Specifications. These tests will include in-situ moisture content and dry density. The frequency and procedures for moisture-density testing are provided in the CQA Plan. At a minimum, the dry density and moisture content of the soil will be measured in-situ in accordance with ASTM D6938. The CQA Consultant shall approve the material prior to placement of overlying materials.

2. Increased testing frequencies may be used by the CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing will be considered when:

   a. The rollers slip during rolling operation

   b. The lift thickness is greater than specified

   c. The fill is at improper and/or variable moisture content

   d. Fewer than the specified number of roller passes are made

   e. Dirt-clogged rollers are used to compact the material

   f. The rollers do not have optimum ballast

   g. The degree of compaction is doubtful

3. During construction, the frequency of testing will be increased by the CQA Consultant in the following situations:

   a. Adverse weather conditions

   b. Breakdown of equipment

   c. At the start and finish of grading

   d. If the material fails to meet specifications

   e. The Work area is reduced

B. Defective Areas:

1. If a defective area is discovered in the Earthwork, the CQA Consultant will evaluate the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse Site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the

defect. The CQA Consultant shall notify the Construction Manager within 1 day of defective area discovery.

2. Once the extent and nature of a defect is determined, the Contractor shall correct the deficiency to the satisfaction of the CQA Consultant and Construction Manager. The Contractor shall not perform additional Work in the area until the CQA Consultant and Construction Manager approve the correction of the defect.

3. Additional testing may be performed by the CQA Consultant to verify that the defect has been corrected. This additional testing will be performed before any additional Work is allowed in the area of deficiency. The cost of the additional testing shall be borne by the Contractor.

3.10 SURVEY CONTROL

A. The Contractor shall perform all surveys necessary for construction layout and control.

1. At a minimum, all surfaces should be surveyed on a square grid not wider spaced than 50 ft and shall include additional points for grade breaks (top and toe of slope).

3.11 CONSTRUCTION TOLERANCE

A. Tolerances for designed thicknesses shown on Construction Drawings and for elevations shown on Construction Drawings are ±0.10 foot unless otherwise specified.

3.12 AS-BUILT SURVEY

A. The Contractor shall produce complete electronic as-built Record Drawings in conformance with the requirements set forth in this Section. This electronic file shall be provided to the Construction Manager for verification. Surveys shall be submitted for the following:

1. Existing topography;

2. Anchor trench;

3. Finish grade and limits of the access road;

4. Final topography.

A. Record survey shall be performed, at a minimum, at all grade breaks, flow lines, and on a 50-foot grid.

3.13 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect completed Work of this Section.

B. At the end of each day, the Contractor shall verify that the entire Work area is left in a state that promotes drainage of surface water away from the area and from finished Work. If threatening weather conditions are forecast, at a minimum, compacted surfaces shall be seal-rolled to protect finished Work.

C. In the event of damage to prior Work, the Contractor shall make repairs and replacements to the satisfaction of the Construction Manager, at the expense of the Contractor.

[END OF SECTION]

SECTION 02770
GEOSYNTHETICS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for the repair of the existing geomembrane and installation of geotextile. The Work shall be carried out as specified herein and in accordance with the Drawings.

B. The Work shall include, but not be limited to, delivery, storage, and placement of the various geosynthetic components of the project.

C. The intent is for the Contractor to re-use existing geomembrane by cutting the existing geomembrane in sections to facilitate folding the geomembrane down the slope to allow excavation of the underlying soils. Contractor shall exercise caution while folding geomembrane and excavating soil to not damage the existing geomembrane. Once excavation is complete and the new anchor trench has been excavated, the intent is to pull the sections of geomembrane back up the slope, cut the geomembrane to the appropriate length, and place the geomembrane into the new anchor trench. Vertical cuts in the existing geomembrane, along with other damage, will be repaired with new geomembrane, in accordance with this section.

D. Geotextile shall be placed beneath the aggregate base surfacing on the embankment crest.

E. Existing geomembrane shall be repaired/patched as necessary to achieve the lines and grades shown on the Drawings.

1.02 RELATED SECTIONS

Section 02200 – Earthwork

1.03 REFERENCES

A. Drawings

B. "Construction Quality Assurance (CQA) Plan, East Ash Basin Slope Modification, Waukegan Generating Station" by Geosyntec, dated June 2016

C. Latest version of ASTM International (ASTM) standards:

ASTM D792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D1004	Standard Test Method for Initial Tear Resistance (Graves Tear) of Plastic Film and Sheeting
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique

ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics

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

ASTM D4439 Terminology for Geosynthetics

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

ASTM D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

ASTM D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

ASTM D5641 Practice for Geomembrane Seam Evaluation by Vacuum Chamber

ASTM D5820 Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

ASTM D6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products using a 50-mm Probe

ASTM D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced using Thermo-Fusion Methods.

ASTM D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

D. GRI GM9 Cold Weather Seaming of Geomembranes

E. GRI GM10 The Stress Crack Resistance of HDPE Geomembrane Sheet

F. GRI GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

G. GRI GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.04 WARRANTY

A. The Geosynthetic Installer shall furnish the Owner with a 1-year written warranty against defects in workmanship. Warranty conditions concerning limits of liability will be evaluated by, and must be acceptable to, the Owner.

1.05 SUBMITTALS

A. The Contractor shall submit to the Construction Manager, at least 7 days prior to commencement of work, the following information regarding the proposed geomembrane and geotextile:

1. Manufacturer and product name

2. Minimum property values of the proposed geotextile and the corresponding test procedures

3. Minimum property values of the proposed geomembrane and the corresponding test procedures

4. Projected delivery dates

5. List of roll numbers for rolls to be delivered to the Site

B. Upon completion of the installation, the Contractor shall be responsible for the submission to the Construction Manager of a warranty as specified in Subpart 1.04 of this Section.

C. Upon completion of the installation of the geomembrane repair, the Contractor shall be responsible for the submission to the Construction Manager of a Record Drawing showing the locations and numbers of repairs.

1.06 QUALITY ASSURANCE

A. The Contractor shall ensure that the geomembrane and geotextile materials, and installation methods used meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Construction Manager, will be rejected and shall be repaired or replaced by the Contractor.

B. The Contractor shall be aware of and accommodate all monitoring and conformance testing required by the CQA Plan. This monitoring and testing, including random conformance testing of construction materials and completed Work, will be performed by the CQA Consultant. If non-conformances or other deficiencies are found in the Contractor's materials or completed Work, the Contractor will be required to repair the deficiency or replace the deficient materials, at the expense of the Contractor.

PART 2 – PRODUCTS

2.01 GEOTEXTILE

A. Geotextile shall be GEOTEX® 200ST woven polypropylene manufactured by Propex GeoSolutions or equivalent as approved by the Engineer.

B. Geotextile suppliers shall furnish materials, which meet or exceed the criteria specified in Table 02770-1 in accordance with the minimum average roll value (MARV), as defined by ASTM D4439.

2.02 GEOMEMBRANE

A. The geomembrane shall be a 60-mil smooth or textured high density polyethylene (HDPE) geomembrane.

B. Geomembranes shall be produced in rolls free of holes, blisters, striations, undispersed raw materials, or any sign of contamination by foreign matter.

C. Resin used in the manufacturing of the geomembrane shall be new, first-quality, virgin polyethylene resin. The addition of reworked polymer (from the manufacturing process) to resin shall be permitted if it does not exceed 2% by weight, contains no encapsulated scrim, and is performed with appropriate cleanliness. The addition of post-consumer resin shall not be permitted.

D. Geomembrane resin shall be mixed with the specified amount of carbon black. The carbon black shall be pre-blended with the resin.

E. The geomembrane shall exhibit the minimum physical properties listed in Table 02770-2 (smooth geomembrane) or Table 02770-3 (textured geomembrane). Manufacturer quality control testing shall be performed in accordance with the frequencies presented in Table 02770-2 or 02770-3, accordingly.

F. The geomembrane shall be a white-surface geomembrane. The white surface shall be installed upwards.

G. Geomembrane trials seams shall meet the minimum requirements listed in GRI Test Method GM-19, shown in Table 02770-4. Frequency of trial seam testing shall be in accordance with Section 3.05H

H. Resin used for extrusion welding shall be produced from same resin type as the geomembrane and shall be the same color as the geomembrane surface to be exposed (i.e. white). Physical properties of the welding resin shall be the same as those of the resin used in the geomembrane.

2.03 MANUFACTURING QUALITY CONTROL (MQC)

A. The geotextile and geomembrane shall be manufactured with MQC procedures that meet or exceed generally accepted industry standards.

2.04 PACKING AND LABELING

A. Geotextile shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

B. Geomembrane and geotextile rolls shall be marked or tagged with the following information:

1. Manufacturer's name
2. Product identification
3. Lot or batch number
4. Roll number

5. Roll dimensions

2.05 TRANSPORTATION, HANDLING, AND STORAGE

A. The Contractor shall be liable for any damage to the materials incurred prior to and during transportation to the Site.

B. Handling, unloading, storage, and care of the geomembrane and geotextile prior to and following installation at the Site, is the responsibility of the Contractor and shall be performed in accordance with ASTM D4873.

C. The geotextile shall be protected from sunlight, puncture, or other damaging or deleterious conditions.

D. The geomembrane shall be protected from excessive puncture, cutting, or other damaging or deleterious conditions. Any additional storage procedures required by the Geomembrane Manufacturer shall be the Contractor's responsibility.

2.06 EQUIPMENT

A. The Contractor shall furnish all necessary equipment required to accomplish the installation of the geosynthetics specified herein.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the Work described in this Section.

B. If the Contractor has any concerns regarding the installed work of other Sections or the site, the Construction Manager shall be notified, in writing, prior to commencing the work. Failure to notify the Construction Manager or commencing installation of the geomembrane or geotextile will be construed as the Contractor's acceptance of the related work of all other Sections.

3.02 GEOTEXTILE PLACEMENT

A. The Contractor shall handle all geotextile in such a manner as to ensure it is not damaged in any way.

B. All geotextiles shall be deployed in accordance with the Manufacturer's recommendations, standards, and guidelines.

C. The Contractor shall ballast or anchor all geotextile with sandbags, or equivalent, to prevent wind uplift.

D. The Contractor shall examine the entire geotextile surface after installation to ensure that no foreign objects are present that may damage the geotextile. The Contractor shall remove any such foreign objects and shall replace any damaged geotextile.

E. Adjacent geotextile panels shall be overlapped a minimum of 12 inches.

3.03 GEOTEXTILE REPAIR

A. Holes or tears in the geotextile shall be repaired as follows: A patch made from the same geotextile shall be overlapped a minimum of 12 inches in each direction.

3.04 GEOMEMBRANE PLACEMENT

A. Cuts to existing geomembrane will be minimized to only those needed to facilitate temporary movement. Horizontal cuts on the side slope will not be allowed. Panel seams shall be installed at an angle of at least 45 degrees from vertical.

B. The geomembrane shall be weighted with sandbags or the equivalent ballast materials, to prevent movement caused by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind uplift of panels.

C. Geomembrane shall not be placed when the ambient temperature is below 32°F or above 122°F unless otherwise authorized in writing by the Engineer. Geomembrane panels shall be allowed to equilibrate to temperature of adjacent panels prior to seaming.

D. Geomembrane shall not be placed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of wind speeds greater than 20 mph.

E. The Contractor shall ensure that:

1. No vehicular traffic is allowed on the geomembrane with the exception of ATV's with a contact pressures less than 6 psi.

2. Equipment used does not damage the geomembrane by handling, trafficking, or leakage of hydrocarbons (i.e., fuels).

3. Personnel working on the geomembrane do not smoke, wear damaging shoes, bring glass onto the geomembrane, or engage in other activities that could damage the geomembrane.

4. The method used to unroll the panels does not scratch or crimp the geomembrane and does not damage the supporting soil or geosynthetics.

5. The geomembrane shall be securely anchored and then rolled in such a manner as to continually keep the geomembrane in tension to preclude folding.

6. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels). The method used to place the panels results in intimate contact between the geomembrane and adjacent components.

7. The geomembrane is especially protected from damage in heavily trafficked areas.

8. Any field panel or portion thereof that becomes seriously damaged (torn, twisted, or crimped) shall be replaced with new material. Less serious damage to the geomembrane may be repaired, as approved by the Construction Manager and CQA Site Manager. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area and not reused.

F. If the Contractor intends to install geomembrane between one hour before sunset and one hour after sunrise, he shall notify the Construction Manager in writing prior to the start of the work. The Contractor shall indicate additional precautions that shall be taken during these installation hours. The Contractor shall provide proper illumination for work during this time period.

3.05 FIELD SEAMING

A. Seam Layout:

1. In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No seams shall be located in an area of potential stress concentration.

B. Weather Conditions for Seaming:

1. No seaming shall be attempted below 32°F or above 122°F without approval of the Owner or Owner's Representative.

2. Geomembrane seaming below 32°F, if approved by the Owner or Owner’s Representative, shall be performed in accordance with GRI Test Method GM9.

3. Preheating of the geomembrane is not required for temperatures above 32°F.

4. Geomembrane shall be dry and protected from wind.

5. In the event of seaming below 32°F or above 122°F, certify in writing that low-temperature or high-temperature seaming procedures does not cause any physical or chemical modification to geomembrane that will generate any short or long-term damage to geomembrane.

C. Seam Preparation:

1. Prior to seaming, seam shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

2. If seam overlap grinding is required, process shall be completed according to the Manufacturer's instructions and in a way not damaging to the geomembrane.

3. Align seams with least possible number of wrinkles and "fish mouths".

D. General Seaming Requirements:

1. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle to achieve a flat overlap, ending the cut with circular cut-out. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is insufficient shall be patched with an oval or round patch of geomembrane that extends a minimum of 6 inches beyond the cut in all directions.

2. Place electric generator on smooth base. Place smooth insulating plate or fabric beneath hot welding apparatus after use. When protective material is in place, sudden stops or starts, sharp turns, and stationary churning of vehicles shall be strictly prohibited. Only use apparatus specifically approved by geomembrane Manufacturer.

3. Use double-track fusion welding for installation seaming wherever possible.

4. Seams shall extend to the top of the anchor trench.

E. Seaming Process:

1. Approved processes for field seaming are fusion welding and extrusion welding. Proposed alternate processes shall be documented and submitted to the Design Engineer and/CQA Engineer for approval prior to use. Extrusion welding shall be restricted to repairs and welding applications not possible by the fusion process.

2. Extrusion Equipment and Procedures:

   a. The Contractor shall maintain at least one spare operable seaming apparatus on site.

   b. Extrusion welding apparatuses shall be equipped with gauges giving the temperatures in the apparatuses.

   c. Prior to beginning an extrusion seam, the extruder shall be purged until all heat-degraded extrudate has been removed from the barrel.

   d. Grind edges of cross seams to an incline prior to welding.

F. Trial Seams:

1. Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Trial seams shall be conducted on the same material to be installed and under similar field conditions as production seams. Such trial seams shall be made at the beginning of each seaming period, typically at the beginning of the day and after lunch, for each seaming apparatus used each day, but no less frequently than once every 5 hours. The trial seam sample shall be a minimum of 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise for fusion equipment and at least 3 feet long by 1 foot wide for extrusion equipment. Seam overlap shall be as indicated in Subpart 3.05.C of this Section.

2. Four coupon specimens, each 1-inch wide, shall be cut from the trial seam sample by the Geosynthetics Installer using a die cutter to ensure precise 1-inch wide coupons. The coupons shall be tested, by the Contractor, with the CQA Site Manager present, in peel (both the outside and inside track for fusion welded seams) and in shear using an electronic readout field tensiometer in accordance with ASTM D 6392, at a strain rate of 2 inches/minute. The samples shall not exhibit failure in the seam, i.e., they shall exhibit a Film Tear Bond (FTB), which is a failure (yield) in the parent material. The required peel and shear seam strength values are listed in Table 02770-4. At no time shall specimens be soaked in water.

3. An additional trial weld shall be performed if a wide change in temperature (± 30ºF), humidity, or wind speed occurs since the previous trial weld.

4. If any coupon specimen fails, the trial seam shall be considered failing and the entire operation shall be repeated. If any of the additional coupon specimens fail, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

G. Nondestructive Seam Continuity Testing:

1. The Contractor shall nondestructively test for continuity on all field seams over their full length. Continuity testing shall be carried out as the seaming work progresses, not

at the completion of all field seaming. The Contractor shall complete any required repairs in accordance with Subpart 3.05.I of this Section. The following procedures shall apply:

a. Vacuum testing in accordance with ASTM D 5641.

b. Air channel pressure testing for double-track fusion seams in accordance with ASTM D 5820 and the following:

   i. Insert needle, or other approved pressure feed device, from pressure gauge and inflation device into the air channel at one end of a double track seam.

   ii. Energize the air pump and inflate air channel to a pressure between 25 and 30 pounds per square inch (psi). Close valve and sustain the pressure for not less than 5 minutes.

   iii. If loss of pressure exceeds 3 psi over 5 minutes, or if the pressure does not stabilize, locate the faulty area(s) and repair seam in accordance with Subpart 3.05.I of this Section.

   iv. After 5 minutes, cut the end of air channel opposite from the end with the pressure gauge and observe release of pressure to ensure air channel is not blocked. If the channel does not depressurize, find and repair the portion of the seam containing the blockage per Subpart 3.05.I of this Section. Repeat the air pressure test on the resulting segments of the original seam created by the repair and the ends of the seam. Repeat the process until the entire length of seam has successfully passed pressure testing or contains a repair. Repairs shall also be non-destructively tested per Subpart 3.05.I.5 of this Section.

   v. Remove needle, or other approved pressure feed device, and seal repair in accordance with Subpart 3.05.I of this Section.

H. Defects and Repairs:

1. The geomembrane will be inspected before and after seaming for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be swept or washed by the Contractor if surface contamination inhibits inspection.

2. At observed suspected flawed location, both in seamed and non-seamed areas, shall be nondestructively tested using the methods described herein. Each location that fails nondestructive testing shall be marked by the CQA Site Manager and repaired by the Contractor.

3. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the CQA Site Manager shall identify all excessive geomembrane wrinkles. The Contractor shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested.

4. Repair Procedures:

a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Contractor. Several repair procedures are acceptable. The final decision as to the appropriate repair procedure shall be agreed upon between the Design Engineer and the Contractor. The procedures available include:

   i. Patching – extrusion welding a patch to repair holes larger than 1/16 inch, tears, undispersed raw materials, and contamination by foreign matter;

   ii. Abrading and re-seaming – applying an extrusion seam to repair very small sections of faulty extruded seams;

   iii. Spot seaming – applying an extrusion bead to repair minor, localized flaws such as scratches and scuffs;

   iv. Capping – extrusion welding a geomembrane cap over long lengths of failed seams; and

   v. Strip repairing – cutting out bad seams and replacing with a strip of new material seamed into place on both sides with fusion welding.

b. In addition, the following criteria shall be satisfied:

   i. Surfaces of the geomembrane that are to be repaired shall be abraded no more than 20 minutes prior to the repair;

   ii. The grind depth around the repair shall not exceed ten percent of the core geomembrane thickness;

   iii. All surfaces must be clean and dry at the time of repair;

   iv. All seaming equipment used in repair procedures must be approved by trial seaming;

   v. Any other potential repair procedures shall be approved in advance, for the specific repair, by the design engineer;

   vi. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches and holes shall be rounded with a radius of at least 3 inches;

   vii. All ends of wrinkle or relief cuts should be cut to a rounded hole and patched or capped; and

   viii. Extrudate shall extend a minimum of 3 inches beyond the edge of the patch.

   ix. Cap strips shall not be installed on top of existing cap strips. In the event that a cap strip is required in proximity to an existing repair, the existing cap strip should be removed and a single new cap strip should be installed over the entire repair area.

   x.

5. Repair Verification:

a. Repairs shall be nondestructively tested using the methods described in Subpart 3.05.H of this Section, as appropriate. Repairs that pass nondestructive testing shall be considered acceptable repairs. Repairs that failed nondestructive or destructive testing will require the repair to be reconstructed and retested until passing test results are observed. At the discretion of the CQA Consultant, destructive testing may be required on any caps.

3.06 PROTECTION OF WORK

A. The Contractor shall protect all Work of this Section.

B. In the event of damage, the Contractor shall make repairs and replacements to the satisfaction of the CQA Consultant at the expense of the Contractor.

TABLE 02770-1
WOVEN GEOTEXTILE PROPERTIES

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values
Grab Strength (min. avg.)	ASTM D4632	1 per 100,000 sf	200 lbs
Puncture Strength (min. avg.)	ASTM D6241	1 per 100,000 sf	700 lbs
UV Resistance	ASTM D4355	1 per resin formulation	70%[(1)]

Notes: (1) After 500 hours of exposure.

TABLE 02770-2
60-MIL SMOOTH HDPE GEOMEMBRANE PROPERTIES

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values[9]
Thickness (min. avg.) • Lowest individual of 10 values	ASTM D5199	1 per Roll	54 mil
Density (min ave.)	ASTM D792 or ASTM D1505	1 per 200,000 lb	0.940 g/cc
Tensile Properties[1] (min. avg.) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 20,000 lb	126 lb/in 228 lb/in 12% 700%
Tear Resistance (min. avg.)	ASTM D1004 Die C	1 per 45,000 lb	42 lbs
Puncture Resistance (min. avg.)	ASTM D4833	1 per 45,000 lb	108 lbs
Stress Crack Resistance[2]	ASTM D5397 (App.)	Per GRI-GM10	500 hr
Carbon Black Content	ASTM D4218	1 per 20,000 lb	2.0-3.0%
Carbon Black Dispersion	ASTM D5596	1 per 45,000 lb	Note 3
Oxidative Induction Time (OIT)[4] (a) Standard OIT (min avg.) or (b) High Pressure OIT (min avg.)	 ASTM D3895 ASTM D5885	1 per 200,000 lb	 100 400
Oven Aging at 85°C [4][5] (a) Standard OIT (min avg.) or (b) High Pressure OIT (min avg.)	ASTM D5721 ASTM D3895 ASTM D5885	1 per Formulation	55% retained after 90d 80% retained after 90d
UV Resistance[6] (a) Standard OIT (min avg.) or (b) High Pressure OIT (min avg.)[8]	ASTM D7238 ASTM D3895 ASTM D5885	1 per Formulation	N.R. (7) 50% retained after 1600 hrs

Notes:

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Yield elongation is calculated using a gage length of 1.3 inches
- Break elongation is calculated using a gage length of 2.0 inches

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQA testing.

(3) Carbon black dispersion (only near spherical agglomerates) for 10 different views. 9 in Categories 1 or 2 and 1 in Category 3.

(4) The manufacturer has the option to select either one of the OIT methods listed to evaluation the antioxidant content in the geomembrane.

(5) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(6) The condition of the test should be 20hr. UV cycle at 75 °C followed by 4 hr. condensation at 60°C.

(7) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed sample.

(8) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(9) Based on GRI GM13, Rev. 14, 1/6/16

TABLE 02770-3
60-MIL TEXTURED HDPE GEOMEMBRANE PROPERTIES

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values(9)
Thickness (min. avg.) • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values	ASTM D5199	1 per Roll	57 mil 54 mil 51 mil
Asperity Height (min. avg.)	ASTM D7466	Every 2nd Roll	16 mil
Density (min ave.)	ASTM D792 or ASTM D1505	1 per 200,000 lb	0.940 g/cc
Tensile Properties(1) (min. avg.) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 20,000 lb	126 lb/in 90 lb/in 12% 100%
Tear Resistance (min. avg.)	ASTM D1004 Die C	1 per 45,000 lb	42 lbs
Puncture Resistance (min. avg.)	ASTM D4833	1 per 45,000 lb	90 lbs
Stress Crack Resistance(2)	ASTM D5397 (App.)	Per GRI-GM10	500 hr
Carbon Black Content	ASTM D4218	1 per 20,000 lb	2.0-3.0%
Carbon Black Dispersion	ASTM D5596	1 per 45,000 lb	Note 3
Oxidative Induction Time (OIT)(4) (c) Standard OIT (min avg.) or (d) High Pressure OIT (min avg.)	 ASTM D3895 ASTM D5885	1 per 200,000 lb	 100 400
Oven Aging at 85°C (4)(5) (c) Standard OIT (min avg.) or (d) High Pressure OIT (min avg.)	ASTM D5721 ASTM D3895 ASTM D5885	1 per Formulation	55% retained after 90d 80% retained after 90d
UV Resistance(6) (c) Standard OIT (min avg.), or (d) High Pressure OIT (min avg.)(8)	ASTM D7238 ASTM D3895 ASTM D5885	1 per Formulation	N.R. (7) 50% retained after 1600 hrs

Notes:

(10) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Yield elongation is calculated using a gage length of 1.3 inches
- Break elongation is calculated using a gage length of 2.0 inches

(11) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQA testing.

(12) Carbon black dispersion (only near spherical agglomerates) for 10 different views. 9 in Categories 1 or 2 and 1 in Category 3.

(13) The manufacturer has the option to select either one of the OIT methods listed to evaluation the antioxidant content in the geomembrane.

(14) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(15) The condition of the test should be 20hr. UV cycle at 75 °C followed by 4 hr. condensation at 60°C.

(16) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed sample.

(17) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(18) Based on GRI GM13, Rev. 14, 1/6/16

TABLE 02770-4
MINIMUM 60-MIL HDPE SEAM PROPERTIES

Property	Qualifier	Unit	Specified Value(1)	Test Method
Shear Strength (at yield point)	Minimum	lb./in. width	120	ASTM D6392
Peel Adhesion Fusion	Minimum	lb./in. width	91	ASTM D6392
Peel Adhesion Extrusion	Minimum	lb./in. width	78	ASTM D6392

(1) Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values

[END OF SECTION]

ATTACHMENT 2
NARRATIVE DESCRIPTION OF THE FACILITY

Attachment 2-1 CCR Laboratory Data Package eurofins

Environment Testing America

ANALYTICAL REPORT

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Tel: (708)534-5200

Laboratory Job ID: 500-202047-1
Client Project/Site: Waukegan - Bottom Ash

For:
Midwest Generation EME LLC
401 E Greenwood Avenue
Waukegan, Illinois 60087-5197

Attn: Mr. Mark Wehling

Authorized for release by:
7/19/2021 3:37:24 PM

Diana Mockler, Project Manager I
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Diana.Mockler@Eurofinset.com

LINKS

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This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Job ID: 500-202047-1

Laboratory: Eurofins TestAmerica, Chicago

Narrative

Job Narrative
500-202047-1

Comments
No additional comments.

Receipt
The sample was received on 7/8/2021 1:15 PM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 19.4º C.

Receipt Exceptions
The following sample(s) was received at the laboratory outside the required temperature criteria. There was no cooling media present in the cooler.

Metals
Method 6010B: The following sample was diluted due to the nature of the sample matrix: Waukegan Bottom Ash (500-202047-1). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Method Summary

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL CHI
7471A	Mercury (CVAA)	SW846	TAL CHI
9045C	pH	SW846	TAL CHI
9056A	Anions, Ion Chromatography	SW846	TAL CHI
Moisture	Percent Moisture	EPA	TAL CHI
SM 4500 F C	Fluoride	SM	TAL CHI
300_Prep	Anions, Ion Chromatography, 10% Wt/Vol	MCAWW	TAL CHI
3050B	Preparation, Metals	SW846	TAL CHI
7471A	Preparation, Mercury	SW846	TAL CHI

Protocol References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Sample Summary

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
500-202047-1	Waukegan Bottom Ash	Solid	07/01/21 14:55	07/08/21 13:15	

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Client Sample ID: Waukegan Bottom Ash
Date Collected: 07/01/21 14:55
Date Received: 07/08/21 13:15

Lab Sample ID: 500-202047-1
Matrix: Solid

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	<9.5		9.5	1.8	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Arsenic	**4.2**	**J**	4.7	1.6	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Barium	**2600**		4.7	0.54	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Beryllium	**1.9**		1.9	0.44	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Boron	**170**		24	2.2	mg/Kg		07/13/21 17:34	07/15/21 12:00	5
Cadmium	**0.24**	**J B**	0.95	0.17	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Chromium	**20**		4.7	2.3	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Cobalt	**9.4**	**J**	12	3.1	mg/Kg		07/13/21 17:34	07/15/21 12:04	25
Lead	**8.1**		2.4	1.1	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Lithium	**19**		4.7	1.4	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Molybdenum	<4.7		4.7	2.0	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Selenium	<4.7		4.7	2.8	mg/Kg		07/13/21 17:34	07/14/21 13:12	5
Thallium	**2.6**	**J**	4.7	2.4	mg/Kg		07/13/21 17:34	07/14/21 13:12	5

Method: 7471A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.077**		0.015	0.0049	mg/Kg		07/13/21 14:05	07/14/21 08:38	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
pH	**10**	**H**	0.2	0.2	SU			07/13/21 19:06	1
Chloride	**28**		1.8	1.6	mg/Kg		07/12/21 11:07	07/12/21 15:18	1
Sulfate	**1500**		46	22	mg/Kg		07/12/21 11:07	07/13/21 14:25	25
Fluoride	**2.7**		1.0	0.56	mg/Kg		07/19/21 11:11	07/19/21 14:16	1

Client: Midwest Generation EME LLC | Job ID: 500-202047-1
Project/Site: Waukegan - Bottom Ash

Qualifiers

Metals

Qualifier	Qualifier Description
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
H	Sample was prepped or analyzed beyond the specified holding time

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Metals

Prep Batch: 609137

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	7471A	
MB 500-609137/12-A	Method Blank	Total/NA	Solid	7471A	
LCS 500-609137/13-A	Lab Control Sample	Total/NA	Solid	7471A	

Prep Batch: 609197

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	3050B	
MB 500-609197/1-A	Method Blank	Total/NA	Solid	3050B	
LCS 500-609197/2-A	Lab Control Sample	Total/NA	Solid	3050B	

Analysis Batch: 609346

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	7471A	609137
MB 500-609137/12-A	Method Blank	Total/NA	Solid	7471A	609137
LCS 500-609137/13-A	Lab Control Sample	Total/NA	Solid	7471A	609137

Analysis Batch: 609487

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	6010B	609197
MB 500-609197/1-A	Method Blank	Total/NA	Solid	6010B	609197
LCS 500-609197/2-A	Lab Control Sample	Total/NA	Solid	6010B	609197

Analysis Batch: 609576

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	6010B	609197
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	6010B	609197
MB 500-609197/1-A	Method Blank	Total/NA	Solid	6010B	609197
LCS 500-609197/2-A	Lab Control Sample	Total/NA	Solid	6010B	609197

General Chemistry

Analysis Batch: 608877

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	Moisture	
500-202047-1 DU	Waukegan Bottom Ash	Total/NA	Solid	Moisture	

Prep Batch: 608902

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	300_Prep	
MB 500-608902/1-A	Method Blank	Total/NA	Solid	300_Prep	
LCS 500-608902/2-A	Lab Control Sample	Total/NA	Solid	300_Prep	

Analysis Batch: 608919

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	9056A	608902
MB 500-608902/1-A	Method Blank	Total/NA	Solid	9056A	608902
LCS 500-608902/2-A	Lab Control Sample	Total/NA	Solid	9056A	608902

Analysis Batch: 609151

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	9056A	608902

General Chemistry (Continued)

Analysis Batch: 609151 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 500-608902/1-A	Method Blank	Total/NA	Solid	9056A	608902
LCS 500-608902/2-A	Lab Control Sample	Total/NA	Solid	9056A	608902

Analysis Batch: 609236

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	9045C	
LCS 500-609236/2	Lab Control Sample	Total/NA	Solid	9045C	
LCSD 500-609236/3	Lab Control Sample Dup	Total/NA	Solid	9045C	

Prep Batch: 609998

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	300_Prep	
MB 500-609998/1-A	Method Blank	Total/NA	Solid	300_Prep	
LCS 500-609998/2-A	Lab Control Sample	Total/NA	Solid	300_Prep	
500-202047-1 MS	Waukegan Bottom Ash	Total/NA	Solid	300_Prep	
500-202047-1 MSD	Waukegan Bottom Ash	Total/NA	Solid	300_Prep	

Analysis Batch: 610037

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
500-202047-1	Waukegan Bottom Ash	Total/NA	Solid	SM 4500 F C	609998
MB 500-609998/1-A	Method Blank	Total/NA	Solid	SM 4500 F C	609998
LCS 500-609998/2-A	Lab Control Sample	Total/NA	Solid	SM 4500 F C	609998
500-202047-1 MS	Waukegan Bottom Ash	Total/NA	Solid	SM 4500 F C	609998
500-202047-1 MSD	Waukegan Bottom Ash	Total/NA	Solid	SM 4500 F C	609998

QC Sample Results

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 500-609197/1-A
Matrix: Solid
Analysis Batch: 609487

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 609197

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	<2.0		2.0	0.39	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Arsenic	<1.0		1.0	0.34	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Barium	<1.0		1.0	0.11	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Beryllium	<0.40		0.40	0.093	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Cadmium	0.0486	J	0.20	0.036	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Chromium	<1.0		1.0	0.50	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Cobalt	<0.50		0.50	0.13	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Lead	<0.50		0.50	0.23	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Lithium	<1.0		1.0	0.30	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Molybdenum	<1.0		1.0	0.42	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Selenium	<1.0		1.0	0.59	mg/Kg		07/13/21 17:34	07/14/21 12:02	1
Thallium	<1.0		1.0	0.50	mg/Kg		07/13/21 17:34	07/14/21 12:02	1

Lab Sample ID: MB 500-609197/1-A
Matrix: Solid
Analysis Batch: 609576

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 609197

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	<5.0		5.0	0.47	mg/Kg		07/13/21 17:34	07/15/21 11:53	1

Lab Sample ID: LCS 500-609197/2-A
Matrix: Solid
Analysis Batch: 609487

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 609197

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	50.0	52.3		mg/Kg		105	80 - 120
Arsenic	10.0	9.92		mg/Kg		99	80 - 120
Barium	200	204		mg/Kg		102	80 - 120
Beryllium	5.00	4.80		mg/Kg		96	80 - 120
Cadmium	5.00	4.86		mg/Kg		97	80 - 120
Chromium	20.0	19.3		mg/Kg		97	80 - 120
Cobalt	50.0	49.0		mg/Kg		98	80 - 120
Lead	10.0	9.72		mg/Kg		97	80 - 120
Lithium	50.0	54.2		mg/Kg		108	80 - 120
Molybdenum	100	102		mg/Kg		102	80 - 120
Selenium	10.0	8.96		mg/Kg		90	80 - 120
Thallium	10.0	9.68		mg/Kg		97	80 - 120

Lab Sample ID: LCS 500-609197/2-A
Matrix: Solid
Analysis Batch: 609576

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 609197

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Boron	100	86.7		mg/Kg		87	80 - 120

Client: Midwest Generation EME LLC
Project/Site: Waukegan - Bottom Ash

Job ID: 500-202047-1

Method: 7471A - Mercury (CVAA)

Lab Sample ID: MB 500-609137/12-A
Matrix: Solid
Analysis Batch: 609346

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 609137

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	<0.017		0.017	0.0056	mg/Kg		07/13/21 14:05	07/14/21 07:47	1

Lab Sample ID: LCS 500-609137/13-A
Matrix: Solid
Analysis Batch: 609346

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 609137

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.167	0.183		mg/Kg		109	80 - 120

Method: 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 500-608902/1-A
Matrix: Solid
Analysis Batch: 608919

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 608902

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<2.0		2.0	1.7	mg/Kg		07/12/21 11:07	07/12/21 12:20	1

Lab Sample ID: MB 500-608902/1-A
Matrix: Solid
Analysis Batch: 609151

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 608902

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	<2.0		2.0	1.7	mg/Kg		07/12/21 11:07	07/13/21 12:36	1
Sulfate	<2.0		2.0	0.95	mg/Kg		07/12/21 11:07	07/13/21 12:36	1

Lab Sample ID: LCS 500-608902/2-A
Matrix: Solid
Analysis Batch: 608919

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 608902

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	30.0	30.2		mg/Kg		101	80 - 120

Lab Sample ID: LCS 500-608902/2-A
Matrix: Solid
Analysis Batch: 609151

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 608902

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chloride	30.0	30.5		mg/Kg		102	80 - 120
Sulfate	50.0	54.4		mg/Kg		109	80 - 120

Method: SM 4500 F C - Fluoride

Lab Sample ID: MB 500-609998/1-A
Matrix: Solid
Analysis Batch: 610037

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 609998

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	<1.0		1.0	0.56	mg/Kg		07/19/21 11:11	07/19/21 14:07	1

Method: SM 4500 F C - Fluoride (Continued)

Lab Sample ID: LCS 500-609998/2-A
Matrix: Solid
Analysis Batch: 610037

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 609998

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Fluoride			100	110		mg/Kg		110	80 - 120		

Lab Sample ID: 500-202047-1 MS
Matrix: Solid
Analysis Batch: 610037

Client Sample ID: Waukegan Bottom Ash
Prep Type: Total/NA
Prep Batch: 609998

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits		
Fluoride	2.7		49.9	46.1		mg/Kg		87	75 - 125		

Lab Sample ID: 500-202047-1 MSD
Matrix: Solid
Analysis Batch: 610037

Client Sample ID: Waukegan Bottom Ash
Prep Type: Total/NA
Prep Batch: 609998

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Fluoride	2.7		49.8	47.6		mg/Kg		90	75 - 125	3	20

Eurofins TestAmerica, Chicago
2417 Bond Street
University Park, IL 60484
Phone (708) 534-5200 Phone (708) 534-5211

Chain of Custody Record

eurofins Environment Testing America

Client Information	Sampler: Mark Wehling	Lab PM: Mockler Diana J	Carrier Tracking No(s):	COC No
Client Contact: Mark Wehling	Phone: 847-599-2201	E-Mail: Diana Mockler@Eurofinset.com	State of Origin: Illinois	Page: Page 1 of 1
Company: Midwest Generation EME LLC	PWSID	Analysis Requested		Job #: 500-202047
Address: 401 E Greenwood Avenue	Due Date Requested			Preservation Codes
City: Waukegan	TAT Requested (days): 7			
State Zip: IL, 60087	Compliance Project: Δ Yes Δ No			
Phone: 847-662-6201	PO #: 4502042830			
Email: mark wehling@nrg com	WO #:			
Project Name: Waukegan Bottom Ash	Project #: 50001112			
Site	SSOW#:			Other:

500-202047 COC

Preservation Codes:
A - HCL, B NaOH, C Zn Acetate, D - Nitric Acid, E - NaHSO4, F MeOH, G Amchlor, H Ascorbic Acid, I Ice, J - DI Water, K - EDTA, L EDA
M Hexane, N - None, O AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S H2SO4, T - TSP Dodecahydrate, U Acetone, V - MCAA, W pH 4-5, Z - other (specify)

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	903.0 - Rad 226, 904.0 - Rad 228, Combined Rad 226/228	6010 - Metals (13 elements) + 7470 - Mercury	9056 - Sulfate	SM4500CLE - Chloride	4500FC - Fluoride	9045C - pH	Total Number of containers	Special Instructions/Note
			Preservation Code:				N	N	N					
Waukegan Bottom Ash	7/1/21	2 55 PM	C	Solid			X	X	X	X	X	X		

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested I II III, IV Other (specify)

Special Instructions/QC Requirements

Empty Kit Relinquished by:	Date	Time	Method of Shipment:		
Relinquished by: Mark Wehling	Date/Time: 7-8-21	Company: MWG	Received by: [signature]	Date/Time: 7/8/21 1110	Company: TA
Relinquished by: [signature]	Date/Time: 7/8/21 1315	Company: TA	Received by: Stephanie Hernandez	Date/Time: 7/8/21 1315	Company: ETA-CHI
Relinquished by:	Date/Time	Company	Received by:	Date/Time	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No	Cooler Temperature(s) °C and Other Remarks: 19.4

Ver 01/16/2019

Login Sample Receipt Checklist

Client: Midwest Generation EME LLC

Job Number: 500-202047-1

Login Number: 202047
List Number: 1
Creator: Hernandez, Stephanie

List Source: Eurofins TestAmerica, Chicago

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	False	
Cooler Temperature is acceptable.	False	
Cooler Temperature is recorded.	True	19.4
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Client Sample ID: Waukegan Bottom Ash　　Lab Sample ID: 500-202047-1

Date Collected: 07/01/21 14:55　　**Matrix: Solid**
Date Received: 07/08/21 13:15

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			609197	07/13/21 17:34	LMN	TAL CHI
Total/NA	Analysis	6010B		5	609487	07/14/21 13:12	JJB	TAL CHI
Total/NA	Prep	3050B			609197	07/13/21 17:34	LMN	TAL CHI
Total/NA	Analysis	6010B		5	609576	07/15/21 12:00	JJB	TAL CHI
Total/NA	Prep	3050B			609197	07/13/21 17:34	LMN	TAL CHI
Total/NA	Analysis	6010B		25	609576	07/15/21 12:04	JJB	TAL CHI
Total/NA	Prep	7471A			609137	07/13/21 14:05	MJG	TAL CHI
Total/NA	Analysis	7471A		1	609346	07/14/21 08:38	MJG	TAL CHI
Total/NA	Analysis	9045C		1	609236	07/13/21 19:06	LWN	TAL CHI
Total/NA	Prep	300_Prep			608902	07/12/21 11:07	PSP	TAL CHI
Total/NA	Analysis	9056A		1	608919	07/12/21 15:18	EAT	TAL CHI
Total/NA	Prep	300_Prep			608902	07/12/21 11:07	PSP	TAL CHI
Total/NA	Analysis	9056A		25	609151	07/13/21 14:25	EAT	TAL CHI
Total/NA	Analysis	Moisture		1	608877	07/12/21 10:22	LWN	TAL CHI
Total/NA	Prep	300_Prep			609998	07/19/21 11:11	MS	TAL CHI
Total/NA	Analysis	SM 4500 F C		1	610037	07/19/21 14:16	MS	TAL CHI

Laboratory References:

TAL CHI = Eurofins TestAmerica, Chicago, 2417 Bond Street, University Park, IL 60484, TEL (708)534-5200

Accreditation/Certification Summary

Client: Midwest Generation EME LLC
Job ID: 500-202047-1
Project/Site: Waukegan - Bottom Ash

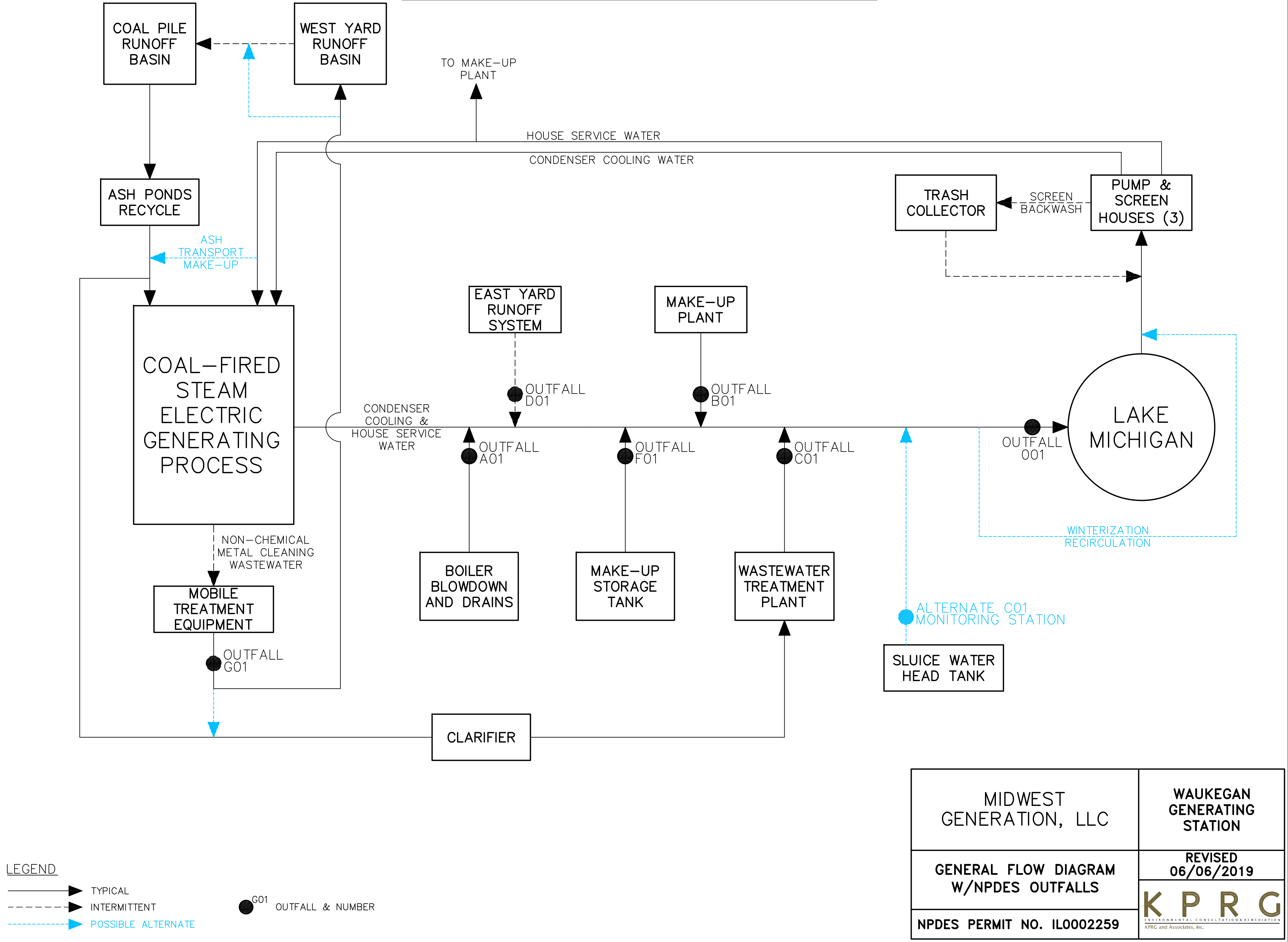
Laboratory: Eurofins TestAmerica, Chicago

The accreditations/certifications listed below are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Illinois	NELAP	IL00035	04-29-22

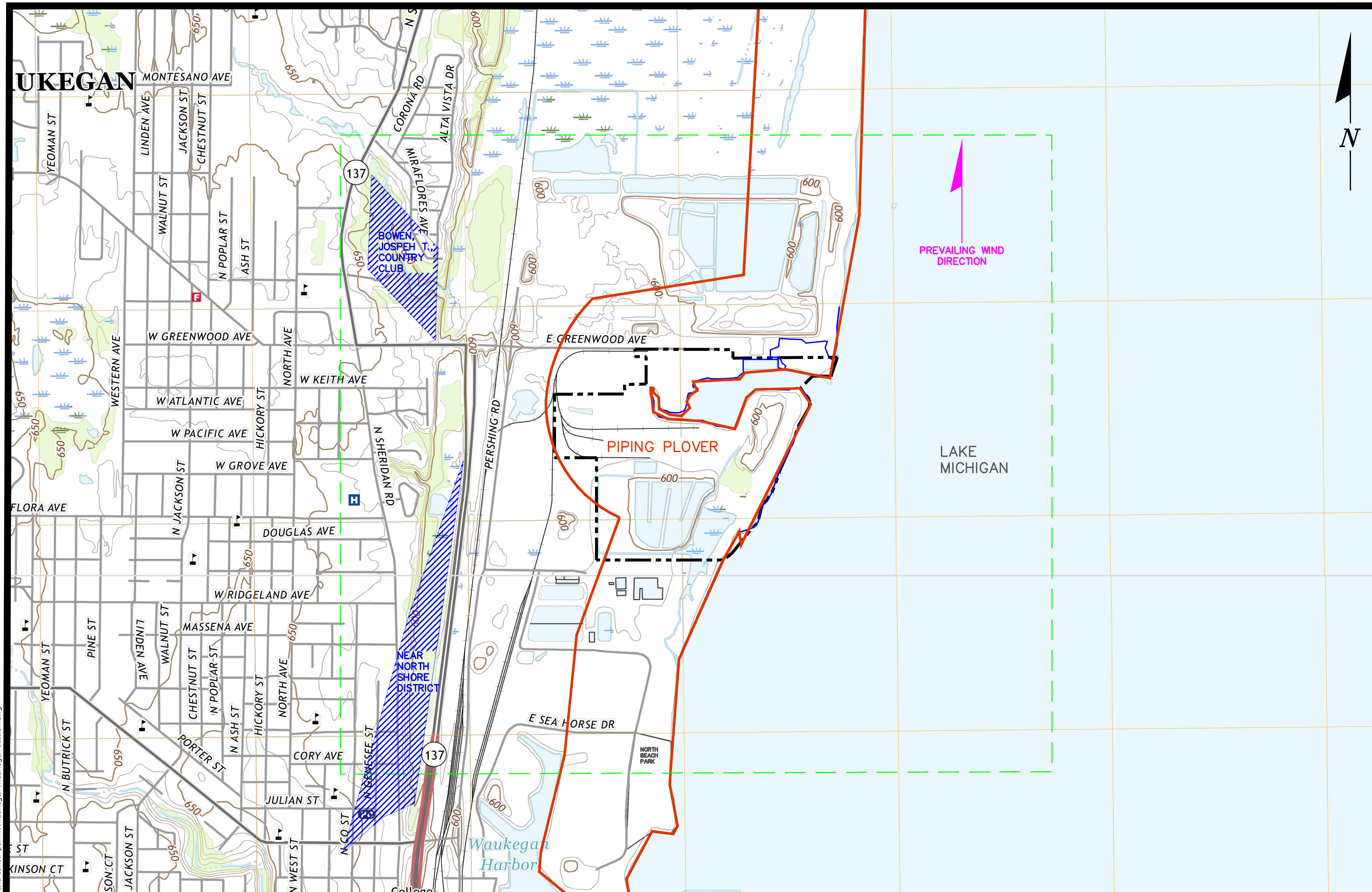
Attachment 2-2 Waukegan Station Flow Diagram

NPDES OUTFALLS (GENERAL FLOW DIAGRAM)



MIDWEST GENERATION, LLC	**WAUKEGAN GENERATING STATION**
GENERAL FLOW DIAGRAM W/NPDES OUTFALLS	**REVISED 06/06/2019**
NPDES PERMIT NO. IL0002259	KPRG

ATTACHMENT 3
SITE LOCATION MAP



LEGEND

3,280 FEET BOUNDARY

EXTENT OF AREA ON NATIONAL REGISTER OF HISTORIC PLACES

EXTENT OF HABITAT FOR PIPING PLOVER

0 2,000'

APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

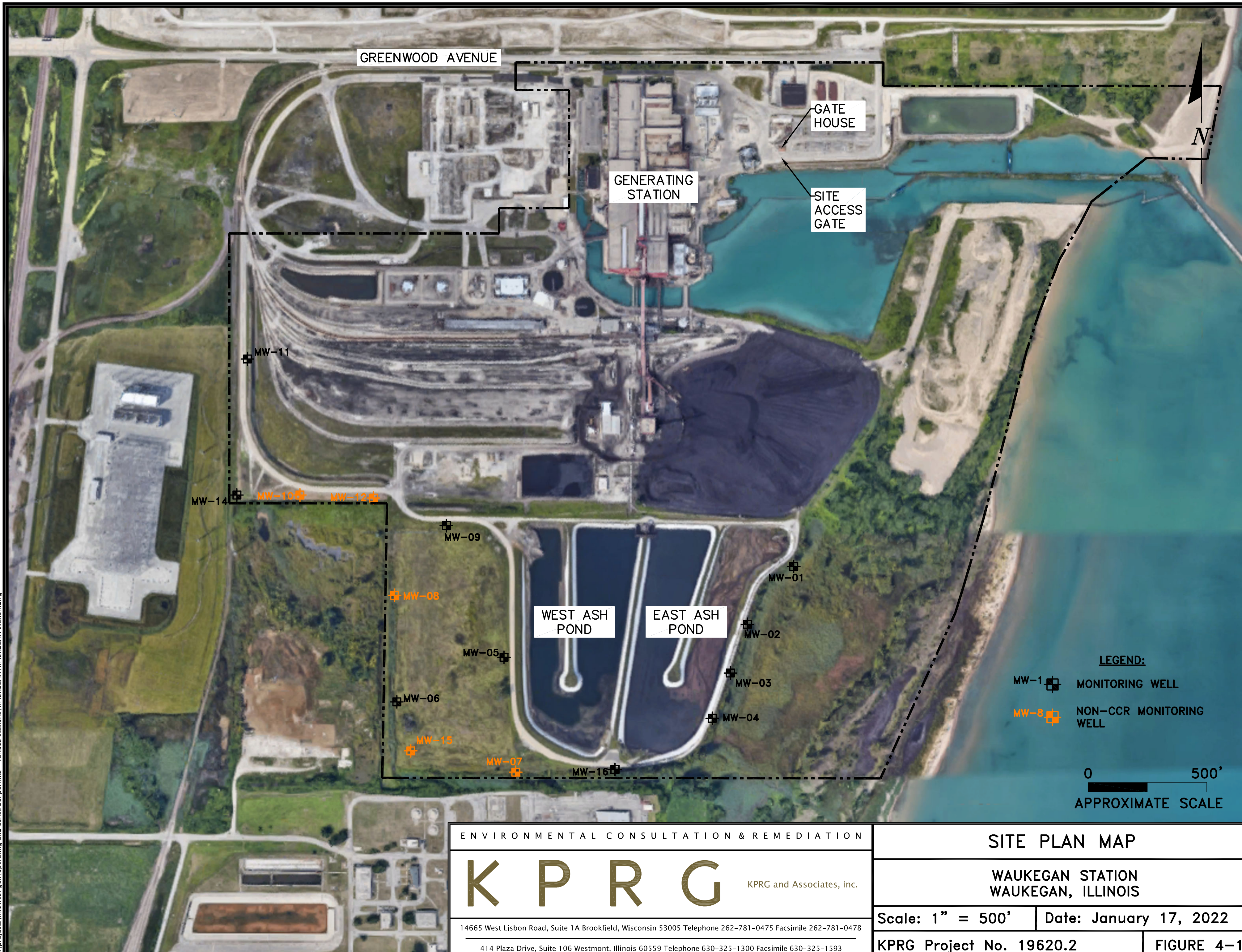
SITE LOCATION MAP

WAUKEGAN GENERATING STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 2,000'	Date: January 28, 2022
KPRG Project No. 19620.2	FIGURE 3

W:\projects\midwest generation\operating and constr permit\waukegan\waukegan station.dwg

ATTACHMENT 4
SITE PLAN MAPS



ENVIRONMENTAL CONSULTATION & REMEDIATION

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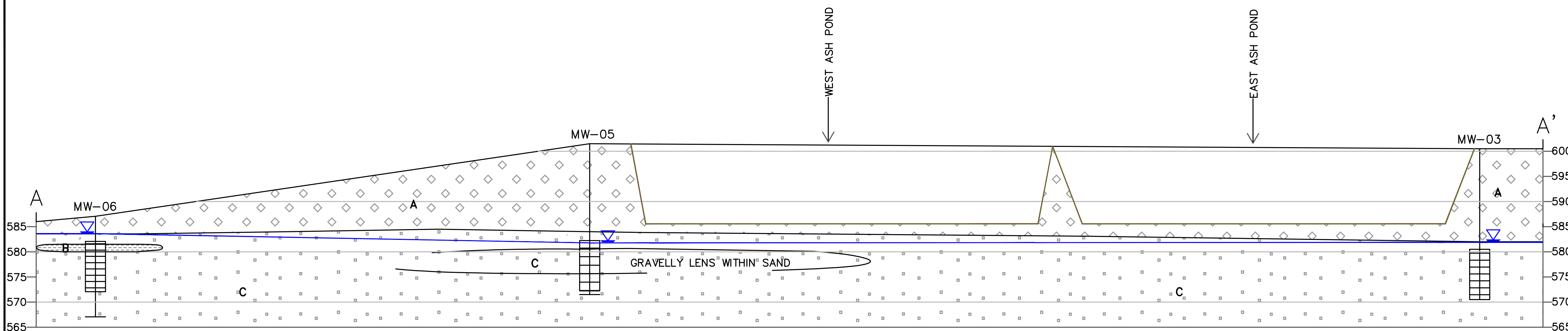
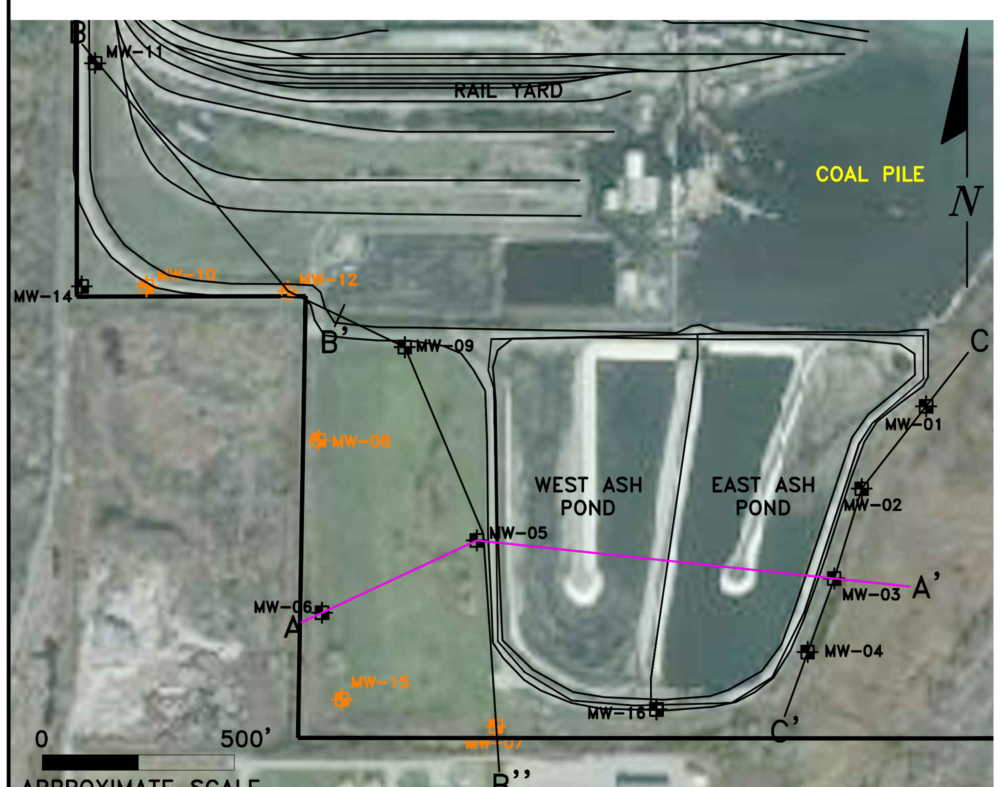
SITE PLAN MAP

WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 500'	Date: January 17, 2022
KPRG Project No. 19620.2	FIGURE 4-1

W:\projects\midwest gen\operating and construct permits - various stations\WAUKEGAN\WAUKEGAN station.dwg





A — FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS.

B — ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND.

C — SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS.

WATER LEVEL (5/21)

POND OUTLINE

20'
0
100'
APPROXIMATE SCALE

ENVIRONMENTAL CONSULTATION & REMEDIATION

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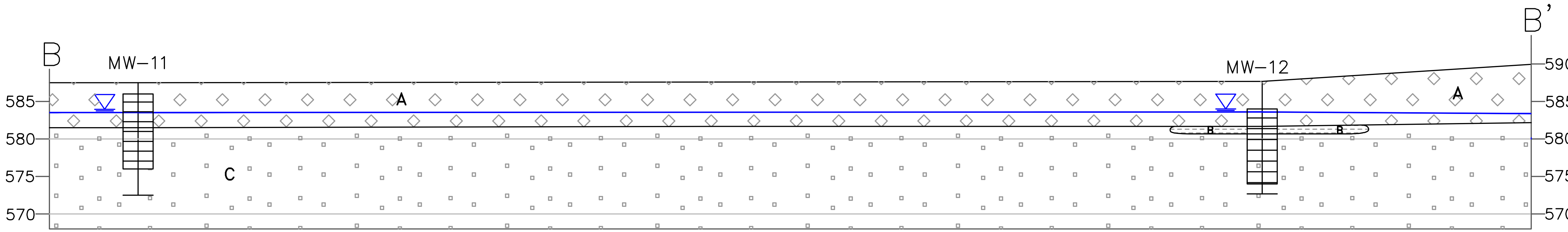
CROSS SECTION A–A'	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 4-2

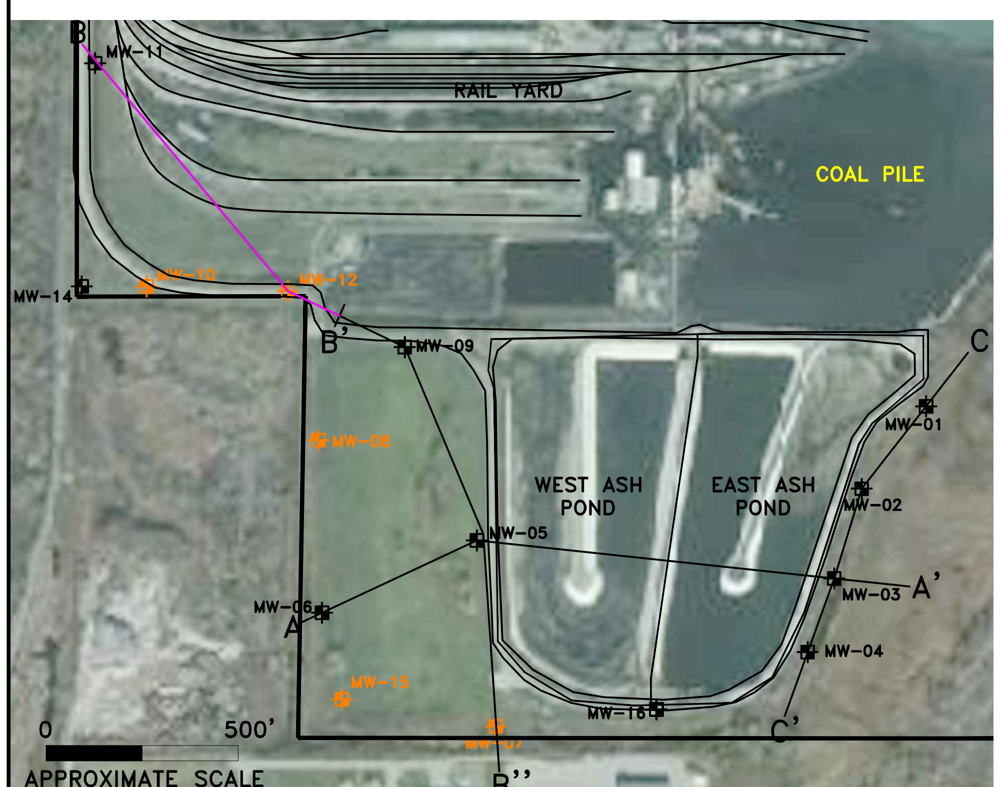


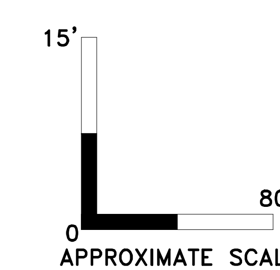
FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS. (A)

ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND. (B)

SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS. (C)

WATER LEVEL (5/21)





ENVIRONMENTAL CONSULTATION & REMEDIATION

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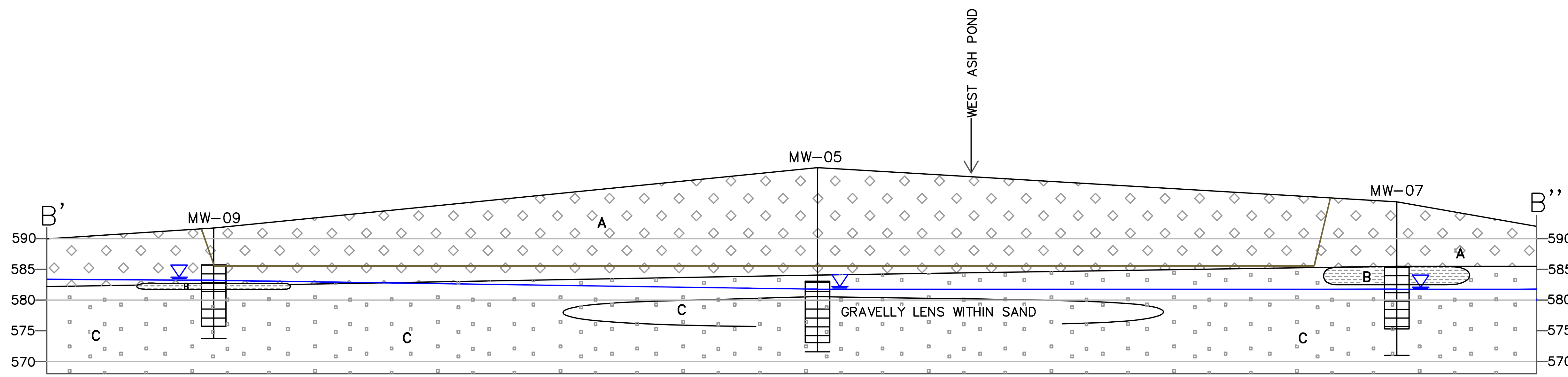
CROSS SECTION B–B'	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 4–3



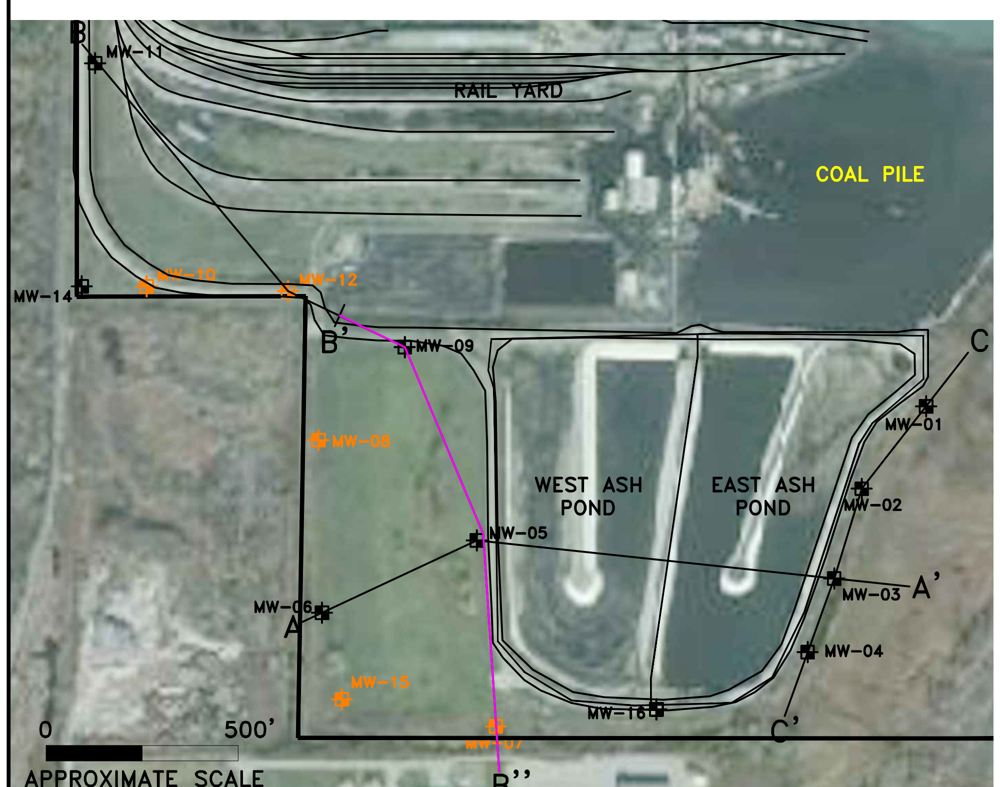
FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS. (A)

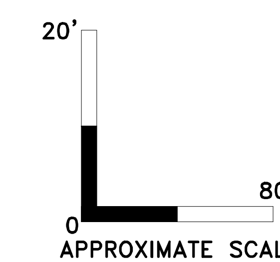
ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND. (B)

SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS. (C)

WATER LEVEL (5/21)

PROJECTED POND OUTLINE





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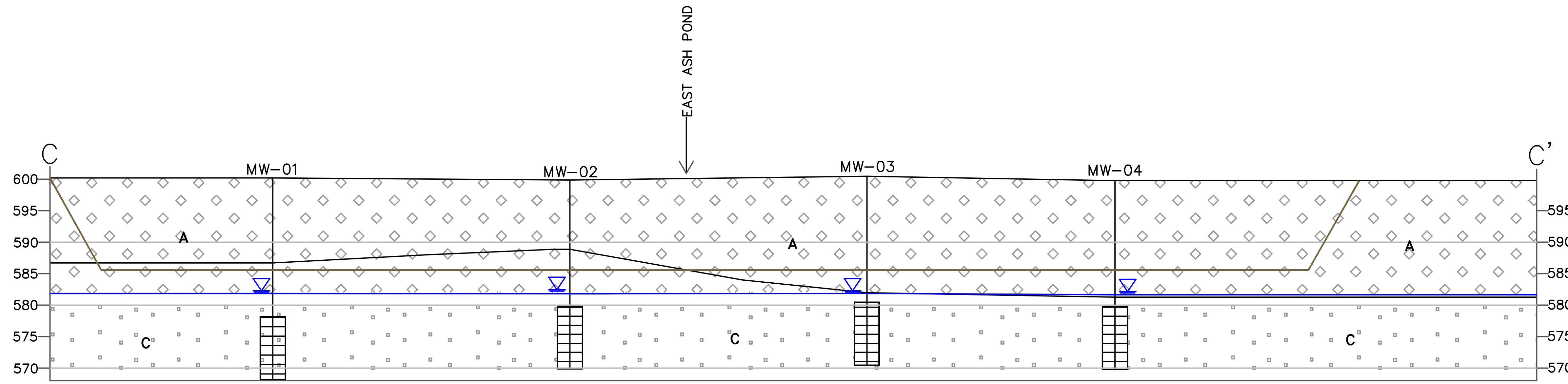
414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

CROSS SECTION B'–B''	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 4-4



FILL: CONSISTING OF BROWN AND BLACK FINE TO MEDIUM SAND WITH SOME GRAVEL AND SILT SEAMS. THE FILL MAY INCLUDE ASH, BLACK CINDERS, SLAG, AND OCCASIONAL COAL AND WOOD FRAGMENTS.

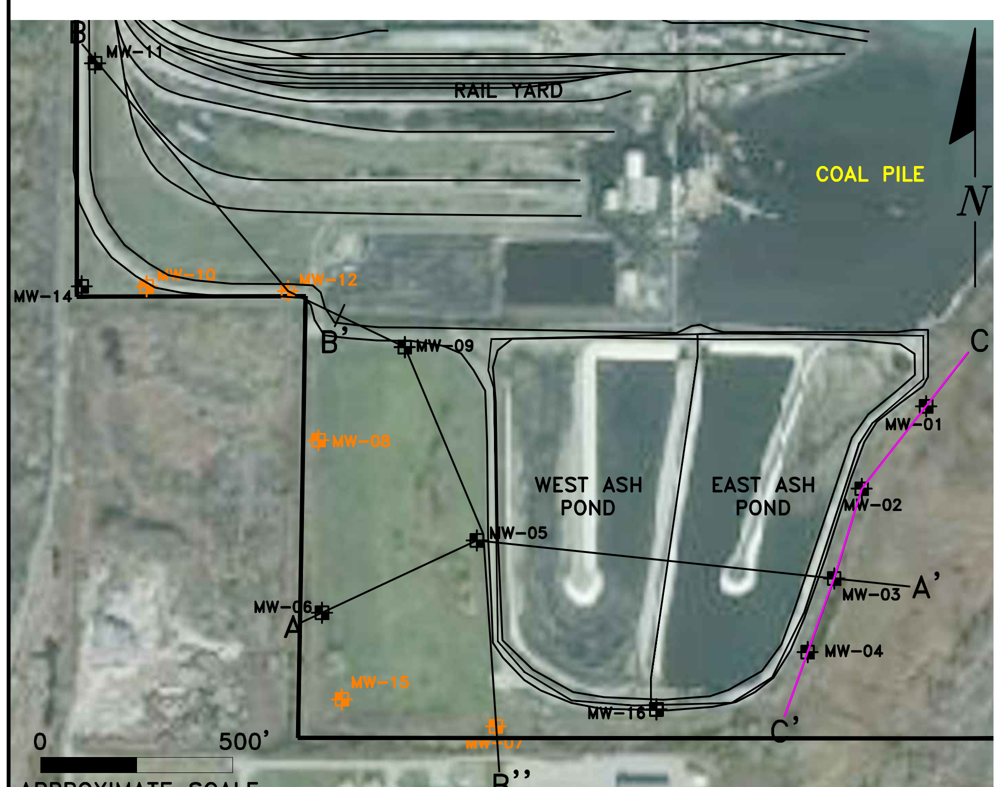
ORGANIC CLAYEY SILTS, SILTY SAND AND/OR PEAT: LOCALIZED, DISCONTINUOUS LENSES OF ORGANIC BLACK TO GRAY CLAYEY SILTS AND SILTY SANDS OR PEAT SEPARATING THE FILL FROM UNDERLYING SAND.

SAND: CONSISTING OF GENERALLY LIGHT BROWN TO BROWN OR GRAY, WELL GRADED, FINE TO MEDIUM SANDS WITH SOME LOCALIZED MORE GRAVELLY SEAMS/LAYERS.

WATER LEVEL (5/21)

PROJECTED POND OUTLINE

20'
100'
0
APPROXIMATE SCALE



ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG

KPRG and Associates, inc.

14665 West Lisbon Road, Suite 1A Brookfield, Wisconsin 53005 Telephone 262-781-0475 Facsimile 262-781-0478

414 Plaza Drive, Suite 106 Westmont, Illinois 60559 Telephone 630-325-1300 Facsimile 630-325-1593

CROSS SECTION C–C'	
WAUKEGAN STATION WAUKEGAN, ILLINOIS	
SEE SCALE	Date: September 21, 2021
KPRG Project No. 19520.2	FIGURE 4-5

ATTACHMENT 5
WEST POND & EAST POND CLOSURE DRAWINGS AND SPECIFICATIONS

MWG

Midwest Generation, LLC

WAUKEGAN GENERATING STATION

SPECIFICATION W-7900

EAST & WEST ASH POND CLOSURES

S&L PROJECT NO.: 12661-098

REVISION 0C

ISSUE PURPOSE: PERMIT

ISSUE DATE: 01-27-2022

Sargent & Lundy

SECTION 000106

ISSUE SUMMARY AND APPROVAL PAGE

Rev.	Purpose of Issue	Date	Sections Affected
0A	Client Comment	11-10-2021	All
0B	Public Comment	11-15-2021	All
0C	Permit	01-27-2022	All

This is to confirm that this Specification has been prepared, reviewed, and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0407, Specifications, which is part of our Quality Management System.

Contributor Summary & Current Revision Signatures

Rev.	Prepared By	Reviewed By	Approved By
0A	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0B	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0C	Youssef Banoub, P.E.	Thomas Dehlin, P.E.	Thomas Dehlin, P.E.
	Thomas Dehlin, P.E.	David Nielson, P.E.	

SECTION 000107

CERTIFICATION PAGE

Sargent & Lundy, L.L.C. (S&L) is registered in the State of Illinois to practice engineering. S&L's Illinois Department of Financial and Professional Regulation registration number is 184-000106.

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

Certified By: Thomas J. Dehlin Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

SECTION 000110

TABLE OF CONTENTS

END OF SECTION 000110

SECTION 011100

SUMMARY OF WORK

PART 1 - GENERAL

101. PROJECT INFORMATION

101.1 Owner: Midwest Generation, LLC (MWG)

101.2 Design Engineer: Sargent & Lundy (S&L)

101.3 Project Name: East & West Ash Pond Closures

101.4 Project Location: Waukegan Generating Station
401 E. Greenwood Ave.
Waukegan, IL 60087

102. DESCRIPTION OF THE PROJECT AND GENERAL BACKGROUND

102.1 The purpose of this project is to close the East Ash Pond and the West Ash Pond at Midwest Generation, LLC's Waukegan Generating Station in accordance with the Illinois Pollution Control Board's Coal Combustion Residuals (CCR) Rule, 35 Ill. Adm. Code Part 845, and with the U.S. Environmental Protection Agency's (EPA) CCR Rule, 40 CFR Part 257 Subpart D.

102.2 The West Ash Pond will be closed by removing all CCR and CCR-mixed materials stored in the pond and decontaminating the pond's geomembrane liner and appurtenant concrete structures. The pond's existing geomembrane liner and appurtenant concrete structures will remain in place. Following removal of CCR and CCR-mixed material from the pond and decontamination of the pond's facilities remaining in-place, the West Ash Pond area will be repurposed as a new low-volume waste pond for the Waukegan Generating Station.

102.3 The East Ash Pond will be closed by leaving the CCR and CCR-mixed materials stored in the pond in-place and installing a final cover system over the pond.

103. SCOPE OF WORK

103.1 In general, this Specification covers the technical requirements for a General Work (GW) Contractor to close the East and West Ash Ponds. The Work includes the following activities:

a. Surveying the project area to verify the accuracy of the existing topographic data shown on the Design Drawings.

b. Establishing benchmark monuments for survey control throughout the project.

c. Furnishing and installing temporary sediment and erosion control best management practices (BMPs) prior to and during all phases of earth disturbance work, including at the onsite sand stockpile adjacent to Lake Michigan and the haul road to and from the borrow site.

d. Closing the West Ash Pond so that it may be repurposed as a new low volume waste pond by:

d1. Removing all CCR and CCR-mixed materials stored in the pond with offsite disposal of dry waste material in a permitted landfill approved by the Owner and disposal of liquid waste in the East Ash Pond.

d2. Decontaminating the pond's existing geomembrane liner and appurtenant concrete structures.

d3. Ensuring all appropriate measures are taken to protect the West Ash Pond's existing HDPE geomembrane liner system from damage.

e. Closing the East Ash Pond by:

e1. Clearing, grubbing, and/or stripping topsoil from the East Ash Pond's perimeter dike and the dividing dike between the East and West Ash Ponds, with offsite disposal of material in a permitted landfill approved by the Owner.

e2. Dewatering, stabilizing, and preparing the CCR and CCR-mixed materials stored in the pond to receive Structural Fill.

e3. Placing, compacting, and grading Structural Fill to establish the lines and grades for the pond's final cover system as specified on the Design Drawings. Structural Fill will be obtained from onsite sand stockpile.

e4. Installing an engineered final cover system, ClosureTurf® (or Owner-approved equal), over the Structural Fill. ClosureTurf® is a multi-component final cover system design by Watershed Geo that consists of a structured geomembrane, a synthetic turf, and a ballast infill.

f. Restoring and cleaning the project and borrow areas.

g. GW Contractor shall allow access to all work areas by Owner, Design Engineer, CQA Contractor staff, and other parties as approved by Owner. GW Contractor shall not install, modify, repair or work on any elements of the project that are subject to the CQA testing and inspection services without notifying the CQA firm at least 2 work days in advance. Work on weekends or holidays shall be scheduled as soon as possible with the CQA Contractor. Failure to provide CQA Contractor adequate advanced notice to staff the site shall result in a hold on work until the CQA contractor staff arrive on site.

h. Developing fueling and maintenance facilities and practices to protect the project site from hydrocarbon spills or other environmental impacts that may impact the project site, adjacent property, or Lake Michigan.

103.2 In addition, the Work shall include but not be limited to the following:

a. Engineering and construction services required to perform or install the Work.

b. Surveying to ensure the Work is located as indicated on the Design Drawings in accordance with the benchmark monuments established by the GW Contractor.

c. Furnishing all installation equipment and tools including any calibrated instruments required for monitoring and testing.

d. Maintaining the project site in a dry condition that includes dewatering of all areas that collect storm water or groundwater in the area controlled by the GW Contractor, redirecting any surface water as a result of rainfall or water generated by the installation

Work. Any groundwater and/or surface water which requires removal from the area of work shall be disposed of in compliance with the Waukegan Generating Station's National Pollutant Discharge Elimination System (NPDES) discharge permit in effect at the time of the Work. The methods and proposed place of discharge shall be approved by the Owner prior to disposing of the water.

e. Excavated material and other construction related debris shall be disposed of offsite in a permitted landfill approved by the Owner.

f. Maintaining a record of the installation (i.e., as-built drawings) in accordance with the technical requirements of this Specification.

g. Furnishing the services of qualified personnel at the project site to perform the Work.

h. Progress reporting as specified in the Commercial Terms and Conditions.

i. Daily site cleanup and disposal of waste and debris.

j. Participation in the Owner's on-site safety program.

103.3 The Work shall conform to the requirements of this Specification and shall be performed and supervised by personnel who are experienced and knowledgeable in the crafts and trades required by the Scope of Work. The Work shall be performed exclusively by the GW Contractor's trained and competent personnel or, where permitted, that of its subcontractor(s); and shall comply with all applicable safety laws, regulations, programs, and practices to ensure the safety of all people located on the work site, including the Contractor's personnel (or that of its subcontractor(s)) performing the Work.

103.4 Performance of the Work shall include all the labor, supervision, administration, management, material procurement, tools, installation and testing equipment, miscellaneous material, and consumables to perform the Work specified herein.

103.5 Provide all installation equipment and all incidental items not shown or specified but reasonably implied for successful completion of the Work and in strict accordance with Design Drawings and this Specification, including inspection, testing and quality standards.

103.6 Provide installation quality assurance and quality control submittals where required.

103.7 Prepare red-lined as-built drawings for review upon completion of the Work to document any variances between the construction issue of the Design Drawings and the actual installation. Finalize as-built drawings after the Owner and the Design Engineer review.

103.8 All other work, as indicated on the Design Drawings, as specified herein or as required to properly complete the Work.

104. MATERIAL AND SERVICES FURNISHED BY OTHERS

104.1 The following work has been, or will be, performed and/or provided by Others:

a. Initial dewatering and removal of CCR from the West Ash Pond. The GW Contractor shall be responsible for dewatering (if necessary) and removing all CCR and CCR-mixed materials remaining in the West Ash Pond after the GW Contractor mobilizes to the site. Estimated quantity of CCR to be removed from the pond will be provided by Owner during the bid period for the Work.

b. Construction Quality Assurance services as detailed in Specification W-7901 will be procured by the Owner.

105. DEFINITIONS

105.1 The term "Design Drawing" means the Design Engineer's drawings indicating the Work to be performed.

105.2 The term "Work" means the material and services furnished to close the East and West Ash Ponds as identified on the Design Drawings and as specified herein.

105.3 The term "Owner-approved equal" means an acceptable equivalent to a specified material that has been accepted by the Owner.

106. INTENT OF DOCUMENTS

106.1 The Contract Documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the documents is to include all labor, material, equipment, and transportation necessary for the proper execution of the Work.

106.2 Discrepancies between the Design Drawings and this Specification, or errors or omissions or mis-description in either the Design Drawings or in this Specification, shall be referred to the Design Engineer for interpretation and adjustment prior to beginning the Work. Do not proceed without the Design Engineer’s written acceptance.

107. PERFORMANCE OF THE WORK

107.1 The GW Contractor shall provide materials and employ construction practices that are sustainable to the greatest extent possible, including disposal of waste.

107.2 The GW Contractor shall provide a representative that will input and provide daily force reports and daily production reports.

107.3 The performance of the Work, as specified herein and as indicated on the Design Drawings, shall comply with the current safety and health standards authorized by the U.S. Department of Labor's Occupational Safety and Health Administration, as well as state and local jurisdictional requirements.

107.4 The GW Contractor shall take all appropriate precautions to ensure the safety of all people working on site.

107.5 The GW Contractor shall maintain the necessary skilled and qualified labor force for the Work to ensure the on time completion of the Work.

107.6 The GW Contractor's personnel shall be competent, capable, qualified, and able to perform the duties required to the satisfaction of the Owner. A supervisor vested with authority to make decisions binding on the GW Contractor shall be assigned to the task to resolve installation problems as they arise so as not to delay completion of the Work.

107.7 The GW Contractor shall be solely responsible for advising the Design Engineer in writing of any conflicts between this Specification and the Design Drawings and the GW Contractor's drawings, including performance and levels of quality. The Contractor agrees that its obligations, liabilities, and warranties shall not be diminished or extinguished due to its meeting the requirements of this Specification and the Design Drawings.

108. REGULATORY REQUIREMENTS

108.1 The GW Contractor shall at all times be solely responsible for complying with all applicable laws, ordinances, regulations, and codes, including those relating to safety of all persons, in connection with the Work. No obligation of the Owner or Design Engineer shall impose upon them any duty to review the GW Contractor's compliance with safety measures.

109. PROTECTION OF PROPERTY AND PERSONNEL SAFETY

109.1 The GW Contractor shall take adequate precautions to protect existing structures, fences, pavements, aboveground utilities and underground utilities and to avoid damage thereto. The GW Contractor shall, at its own expense, repair any damage caused by its operations.

109.2 The GW Contractor shall conduct safety training of all its personnel (including any subcontractors) in accordance with the Owner's safety requirements.

109.3 The GW Contractor shall take adequate precautions to protect Lake Michigan and adjacent properties from environmental damage.

110. CLEAN-UP AND DISPOSAL OF DEBRIS

110.1 The Contractor shall be responsible for clean-up and disposal of all debris resulting from the installation work. All excavated material and other construction related debris shall be properly disposed of (i.e., in an environmentally responsible way) offsite in a permitted landfill approved by the Owner.

110.2 Clean up, disposal, and site restoration, if required, shall be in compliance with the applicable requirements of all access permits. If any additional permits are required for disposal of debris, these shall be the responsibility of the GW Contractor.

110.3 Work areas shall be kept clean and orderly at all times with as little disturbance as possible to existing conditions. Upon completion of work at each site, all tools, equipment, material, and debris shall be completely removed and the area left in a clean condition.

111. EXISTING SITE CONDITIONS

111.1 Existing Underground Obstructions:

a. The GW Contractor shall be responsible for location of underground utilities and obstructions prior to performance of the Work and shall promptly notify Owner of any potential interferences that may impact performance of the Work. Modifications to the design to resolve these interferences shall not be implemented until approved by the Owner.

b. If uncharted utilities or obstructions are encountered during the performance of the Work, the GW Contractor shall notify the Owner of any such uncharted utilities or obstructions that would prohibit proper completion of the Work for resolution.

111.2 Prior to performing any Work in any part of the project site, the GW Contractor shall make a thorough field check for the purposes of verifying existing conditions that may affect the Work. The GW Contractor shall include a thorough investigation of the potential interferences and difficulties that it may encounter in the proper and complete execution of the Work, including the field location and identification of underground and overhead utilities within and adjacent to the limits of the Work. The GW Contractor shall advise the Owner immediately of the discovery of any conditions, including the existence of underground and overhead utilities that may affect the timely and safe execution of the Work.

111.3 The GW Contractor further acknowledges that it has satisfied itself as to the character, quality and quantity of surface and subsurface material and obstacles, including underground or embedded utilities, to be encountered insofar as this information is reasonably ascertainable from an inspection of the site (including field location and identification of underground utilities) and reference drawings made available by the Owner, as well as from information presented by the drawings and specifications that are a part of the Contract, the character and extent of existing work within or adjacent thereto and any other work being performed thereon at the time of the submission of bids.

111.4 Should the GW Contractor fail to perform any of the obligations set forth above, the GW Contractor's later plea of ignorance of existing or foreseeable conditions which create difficulties or hindrances in the execution of the Work will not be considered as an excuse for any failure on the part of the GW Contractor to fulfill in every detail the requirements of the Contract nor will such a plea be acceptable as the basis of a claim for additional compensation or time to complete the work.

112. VERIFICATION OF DIMENSIONS ON DRAWINGS AND MEASUREMENTS AT SITE

112.1 The GW Contractor shall make a thorough field check for the purpose of verifying existing conditions that may affect the Work, such as existing topographic data shown on the Design Drawings, difficulties that might be encountered in the execution of the Work for any reason, and dimensions and other questions relating to interconnection of the Work with the existing ash pond construction.

112.2 The GW Contractor shall satisfy itself as to the accuracy of the dimensions of the existing ash pond construction as such dimensions relate to the dimensions given on any drawing issued by the Design Engineer. It shall be understood that neither the Design Engineer nor the Owner guarantee the exactness of such dimensions.

112.3 Should the GW Contractor discover any variation in the dimensions of existing conditions and the dimensions given on any drawings issued by the Design Engineer, the GW Contractor shall give immediate notice thereof to the Owner and the GW Contractor shall not proceed with the Work until such variation is resolved.

113. SOIL DATA

113.1 A structural stability and factor of safety assessment for the East and West Ash Ponds was prepared in October 2016. Site specific soil data and geotechnical recommendations are provided and referenced therein. The geotechnical information in and referenced by this assessment indicates the general character of the subsurface conditions at the site. This information is made available for the GW Contractor's information and for interpretation of soil and water conditions that may be encountered at the site. The logs and test data that are provided are not to be taken as a complete description of the site soil and water information, but only display what was found in borings at the indicated locations. The Owner and the Design Engineer take no responsibility for the accuracy of this information.

113.2 The GW Contractor may obtain additional subsurface information, as it deems necessary, for installation purposes.

114. LINES AND GRADES

114.1 The GW Contractor shall furnish and install a minimum of four (4) benchmark monuments as approved by the Owner to lay out lines and grades on the site during the lifetime of the project. All GW Contractor-installed benchmark monuments shall be shown on the red-lined as-built drawings. The GW Contractor is fully responsible for the correctness of such lines and grades and for proper execution of work to such lines and grades.

114.2 The Owner reserves the right to verify correctness of lines and grades during progress of the Work. Such verification by the Owner will not relieve the GW Contractor of responsibility as herein specified.

115. CONTROL AND CHARGE OF CONTRACTOR'S WORK

115.1 The Design Engineer shall have no authority to stop the Work by the GW Contractor for any reason.

115.2 The GW Contractor shall be responsible for the safety of its employees and subcontractors and for maintaining the safety of the job site.

115.3 The GW Contractor shall be solely responsible for construction means, methods, techniques, sequences, and procedures used in the construction of the Work. The Owner, however, reserves the right to request, and the Contractor shall supply, detailed information regarding the Work such as procedures or work methods.

115.4 Only the Owner (or its authorized representative) has the authority to stop the Work (in accordance with the Commercial Terms and Conditions) if such Work is determined to be not in accordance with this Specification, the Design Drawings, or the Contract documents.

116. DESIGN DRAWINGS

116.1 The Design Drawings prepared by the Design Engineer indicate the physical dimensions of the Work to be installed as defined by the Scope of Work and form a part hereof. Refer to Attachment 1 of this Specification for the applicable Design Drawings for this project.

117. REFERENCE DOCUMENTS

117.1 The reference documents assembled by the Design Engineer are for information only. Refer to Attachments 3 through 4 of this Specification for applicable reference documents for this project.

END OF SECTION 011100

SECTION 311522

ENGINEERED SYNTHETIC TURF FOR FINAL COVER SYSTEM

PART 1 - GENERAL

101. EXTENT

101.1 This section defines the minimum requirements for the material and installation of an engineered synthetic turf to be used in the ClosureTurf® final cover system (or Owner-approved equal) for the East Ash Pond, all in accordance with the Design Drawings and as specified herein.

101.2 The Work shall include, but not be limited to, the following items:

a. Manufacture, shipping, handling, and storage of synthetic turf materials.

b. Placement, splicing, and anchorage of synthetic turf.

c. Field testing of synthetic turf seams.

d. Repair of defects, holes, or tears in synthetic turf.

e. Visual inspection of the completed synthetic turf cover.

f. Placement of ballast infill between tufts of synthetic turf.

101.3 Definitions of Terms: The following definitions of terms shall apply throughout this section.

a. GW Contractor is contracted by and responsible to the Owner to perform all of the work specified herein. They may self-perform or subcontract the work. The final division of responsibilities between the Earthwork Contractor and Geosynthetics Contractor will be the responsibility of the GW Contractor.

b. Earthwork Contractor: The contractor who is generally responsible for earthwork for the facility and for excavation and backfill of anchor trenches. The Earthwork Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

c. Geosynthetics Contractor: The contractor who is generally responsible for the supply and installation of all geomembrane and synthetic turf materials as well as the unloading and storage of the materials. The Geosynthetics Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

d. Construction Quality Assurance (CQA) Contractor: The contractor who is independent of the GW Contractor and is responsible for all CQA work.

e. CQA Geosynthetics Inspector: An inspector who works for the CQA Contractor and is responsible for inspection of the Geosynthetic Contractor's work.

f. Synthetic Turf Manufacturer: The manufacturer who is responsible for manufacture of synthetic turf materials and for transporting synthetic turf materials to the site.

g. Watershed Geo: A geosynthetic technology company and the designer of the ClosureTurf® final cover system.

101.4 Qualifications:

a. Synthetic Turf Manufacturer:

a1. The Synthetic Turf Manufacturer shall be approved by the Owner.

b. Geosynthetics Contractor:

b1. The Geosynthetics Contractor shall meet the qualifications for the Geosynthetics Contractor specified in Section 319022.

b2. The Geosynthetics Contractor shall be approved by the Synthetic Turf Manufacturer for installation of the Synthetic Turf Manufacturer’s products.

b3. Synthetic Turf Seamers:

b3.1 Master Synthetic Turf Seamer shall have installed at least 5,000,000 square feet of geotextile materials.

b3.2 All other synthetic turf seamers shall have installed at least 1,000,000 square feet of geotextile materials. Personnel who do not meet this criterion may be allowed to seam synthetic turf panels but only under the direct supervision of the Master Synthetic Turf Seamer.

b3.3 Personnel performing fusion welding of synthetic turf panels shall be factory trained by Demtech Services, Inc.

102. <u>RELATED WORK SPECIFIED IN OTHER SECTIONS</u>

102.1 The work specified in this section shall be coordinated with work specified in the following related sections:

a. GW Specification (W-7900):

a1. Section 319022 – High Density Polyethylene Geomembrane Liner for Final Cover System.

b. CQA Specification (W-7901):

b1. Section 014362 – Construction Quality Assurance for Closing a CCR Surface Impoundment.

103. <u>REFERENCE DOCUMENTS</u>

103.1 Standards, Specifications, manuals, codes and other publications of nationally recognized organizations and association are referenced herein. Methods, equipment, and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state, or local codes having jurisdiction.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 Abbreviations listed indicate the form used to identify the reference documents in the Specification text.

103.4 ASTM – ASTM International:

a. C128 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

b. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

c. C1252 Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading).

d. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

e. D2256 Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method.

f. D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

g. D4884 Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.

h. D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

i. D5321 Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear.

j. D6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50mm Probe.

k. D6459 Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion

l. G147 Standard Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests.

m. G154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials.

104. SUBMITTALS

104.1 GW Contractor shall submit drawings and data as indicated below at least 30 days prior to use. GW Contractor's drawings and data shall be submitted via electronic medium in a format compatible for importing into Owner's information systems specified by Owner.

104.2 Submittals with Bid Proposal:

a. Resumes of key Geosynthetics Contractor personnel demonstrating Geosynthetics Contractor meets qualifications specified in Paragraph 101.4 of this section.

b. Synthetic Turf Material:

b1. Synthetic Turf Manufacturer's literature providing specifications on the synthetic turf material that will be supplied.

b2. Synthetic Turf Manufacturer's certification that synthetic turf materials to be supplied comply with the requirements of this Specification.

b3. Manufacturer's Quality Control (MQC) and Construction Quality Control Plans. The MQC plan shall include inspection records of the tufting procedures and indicate the following material properties for every 300,000 square feet of synthetic turf manufactured:

b3.1 Tufting gauge.

b3.2 Pile height.

b3.3 Roll length and roll numbers.

b3.4 Total product weight.

b3.5 CBR puncture per ASTM D6241.

b3.6 Tensile strength product (lb. / ft, minimum average roll value) per ASTM D4595.

b3.7 Tensile strength of yarn (lbs., minimum average roll value) per ASTM D2256.

c. Ballast Infill Material:

c1. Proposed construction equipment and method(s) to be used to install Ballast Infill material.

104.3 Submittals After Award of the Contract:

a. Synthetic Turf Material:

a1. Synthetic turf material samples for conformance testing as specified in Specification W-7901, Section 014632.

b. Ballast Infill Material:

b1. GW Contractor shall submit a 10-pound sample of Ballast Infill material to the Synthetic Turf Manufacturer.

b2. Ballast Infill material samples for conformance testing as specified in Specification W-7901, Section 014632.

105. QUALITY ASSURANCE

105.1 Materials and construction procedures shall be subject to inspection and testing by the CQA Contractor employed by the Owner. Such inspections and tests will not relieve the GW Contractor of responsibility for providing materials and installation in compliance with specified requirements.

105.2 The Owner reserves the right, at any time before final acceptance, to reject materials or workmanship not complying with specified requirements. The GW Contractor shall correct the deficiencies which the inspections and tests have indicated are not in compliance with specified requirements.

105.3 CQA activities for installing the engineered synthetic turf shall be performed as described herein and in Specification W-7901.

PART 2 - PRODUCTS

201. SYNTHETIC TURF MATERIALS

201.1 Acceptable Manufacturers:

a. The products of the following manufacturers meeting the requirements for synthetic turf herein are acceptable:

a1. Watershed Geo and their supplier Shaw Industries, Inc., 616 E. Walnut Avenue, Dalton, GA 30720, Tel.: 800-720-7429.

a2. Owner-approved equal.

201.2 Material Requirements:

a. Synthetic turf materials shall meet the requirements of Table 311522-1.

TABLE 311522-1

MINIMUM REQUIREMENTS FOR SYNTHETIC TURF MATERIALS

Property	Test Method	Specified Value
Yarn Type	N/A	Polyethylene
Yarn Color	N/A	TBD
Yarn Weight	ASTM D5261	20 oz. / sq. yd (min.)
Total Synthetic Turf Weight	ASTM D5261	32 oz. / sq. yd (min.)
Tensile Strength of Yarn	ASTM D2256	15 lbs. (min.)
CBR Puncture	ASTM D6241	1,500 lbs. (MARV)
Tensile Product:	ASTM D4595	
• Machine Direction		2,100 lb. / ft (MARV)
• Cross Direction		1,600 lb. / ft (MARV)
Interface Friction:	ASTM D5321	
• Between Synthetic Turf and 60 mil HDPE Textured Geomembrane		21° Peak (min.)
• Between Synthetic Turf and 60 mil HDPE Structured Geomembrane		35° Peak (min.)
Turf Fiber UV Stability	ASTM G147	60% (min.) retained tensile strength at 100 yrs (projected)
Geotextile Backing UV Stability (Exposed)	ASTM G154 Modified Cycle 1, UVA340	110 lb./ft retained tensile strength at 6,500 hrs (projected)
Aerodynamic Evaluation	GTRI Wind Tunnel	120 mph with max. uplift of 0.12 lb. / sq. ft
Rainfall Induced Erosion	ASTM D6459	Infill Loss 0.1% at 6 in./hr Rainfall

201.3 Packaging and Shipping Requirements:

a. Packaging and transportation shall be the responsibility of the Synthetic Turf Manufacturer, who shall retain responsibility until the synthetic turf is accepted at the site by the Geosynthetics Contractor.

b. Packaging:

b1. Deliver synthetic turf materials to the project site in rolls, each wrapped securely with a protective covering installed at the manufacturing facility. The covering shall prevent the entrance of water, vermin, and dirt, and shall be adequate for protection against ultraviolet exposure.

b2. The packaging shall not interfere with handling of the rolls either by slings or by using the central core upon which the synthetic turf is wound.

b3. A label shall be attached or adhered to each roll of synthetic turf identifying the following:

b3.1 Synthetic Turf Manufacturer’s name.

b3.2 Product identification.

b3.3 Date of manufacture of the synthetic turf.

b3.4 Lot number.

b3.5 Roll identification number.

202. <u>BALLAST INFILL MATERIALS</u>

202.1 Acceptable Ballast Infill Material:

a. Material used as Ballast Infill between the tufts of the synthetic turf shall meet the final aggregate angularity, specific gravity, and grain size distribution specified in Table 311521-2.

TABLE 311522-2

REQUIREMENTS FOR BALLAST INFILL MATERIALS

<table>
<tr><th>Property</th><th>Test Method</th><th colspan="2">Specified Value</th></tr>
<tr><td>Uncompacted Void Content</td><td>ASTM C1252
Method A</td><td colspan="2">40% min.</td></tr>
<tr><td>Bulk Oven-Dry Specific Gravity</td><td>ASTM C128</td><td colspan="2">2.40 min.</td></tr>
<tr><td rowspan="9">Grain Size Distribution</td><td rowspan="9">ASTM C136</td><td>Sieve Size</td><td>Percent Passing</td></tr>
<tr><td>3/8”</td><td>100</td></tr>
<tr><td>#4</td><td>90 – 100</td></tr>
<tr><td>#8</td><td>50 – 85</td></tr>
<tr><td>#16</td><td>25 – 65</td></tr>
<tr><td>#30</td><td>10 – 45</td></tr>
<tr><td>#50</td><td>0 – 30</td></tr>
<tr><td>#100</td><td>0 – 10</td></tr>
<tr><td>#200</td><td>0</td></tr>
</table>

PART 3 - EXECUTION

301. ONSITE HANDLING AND STORAGE

301.1 Receipt/Unloading:

a. Upon delivery of the materials to the project site, the unloading and other handling of synthetic turf materials shall be performed by the Geosynthetics Contractor and in a manner to ensure the material is handled with care and is not damaged.

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

301.2 Storage:

a. The on-site storage space near the work area where the synthetic turf will be placed shall be managed by the GW Contractor such that on-site transportation and handling are minimized.

b. Rolls of synthetic turf shall be placed on a smooth surface free of rocks and standing water.

c. Rolls of synthetic turf shall be stored in such a manner that cores are not crushed, the geotextile not 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. If stacked, the rolls shall be stacked per the Synthetic Turf Manufacturer's recommendations, but no more than three rolls high.

301.3 Inspection:

a. Upon delivery of the materials to the project site, the Synthetic Turf Contractor shall conduct a visual inspection of all rolls of synthetic turf 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 Synthetic Turf Manufacturer and Owner. Any roll, or portion thereof, which, in the judgment of Owner or Owner's Representative, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to Owner.

302. PRE-DEPLOYMENT OF SYNTHETIC TURF COVER

302.1 The geomembrane component of the ClosureTurf® final cover system shall be placed, seamed, tested, and approved in accordance with Section 319022 prior to deploying the synthetic turf component.

302.2 The geomembrane surface shall be substantially free of debris, large scraps, *etc*.

303. FIELD PLACEMENT OF SYNTHETIC TURF COVER

303.1 General Requirements:

a. The Synthetic Turf Contractor shall not remove the protective covering from the synthetic turf rolls to be deployed until immediately prior to deployment to ensure that synthetic turf panels are not excessively exposed to ultraviolet degradation.

b. During handling, the synthetic turf panels shall be handled in such a manner that the material is not damaged in any way. Damaged material shall not be used.

303.2 Panel Deployment:

a. Synthetic turf panels shall not be deployed until the CQA Contractor has inspected the surface of the geomembrane in accordance with Specification W-7901. Any synthetic turf panels deployed over areas not accepted by the CQA Contractor shall be removed to allow inspection at no cost to Owner or CQA Contractor.

b. All necessary precautions shall be taken to prevent damage to the underlying geomembrane upon which the synthetic turf is to be placed.

c. All personnel working on the geomembrane surface shall wear soft-soled shoes and shall not engage in any activity which may damage the geomembrane.

d. Except for seam welding machinery or All-Terrain Vehicles (ATV) approved for use by the Design Engineer in writing, machinery shall not be operated on the geomembrane.

e. The use of ATVs for the deployment of the synthetic turf and Ballast Infill material will be allowed. For ATVs to be used, the Contractor must demonstrate that the ATV exerts a maximum allowable pressure on the geomembrane or synthetic turf surface of 5 psi. The maximum allowable pressure on the geomembrane surface or synthetic turf is influenced by the tread pattern of the tires on the ATV. The maximum allowable pressure is not the reading from a tire pressure gauge. The ATVs shall only be used to deploy rolls of synthetic turf and Ballast Infill material and shall not be used to transport personnel, equipment, sandbags, or the like.

f. Deployment of synthetic turf panels on slopes shall proceed as follows:

f1. The synthetic turf shall be securely anchored at the top and then rolled down the slope in such a manner as to continually keep the panel in tension and keep the panel free of wrinkles and folds.

f2. The first synthetic turf panel deployed shall have the turf filaments facing upward.

f3. If the synthetic turf panels will be spliced by sewing, subsequent panels shall be deployed turf side down and on top of the previous panel. After sewing each panel, the panel shall be flipped onto the geomembrane surface with care to avoid pulling tufts in the drainage studs.

f4. The turf filaments in all synthetic turf panels shall be pointing upslope after deployment is complete.

g. Synthetic turf panels shall only be cut using an upward cutting hook blade. If synthetic turf panels are cut in place, special care shall be taken to protect the underlying geomembrane from damage which could be caused by cutting the synthetic turf panels.

h. Any damage or suspected damage to the geomembrane during deployment, cutting or seaming of synthetic turf shall immediately be identified to the CQA Contractor and the Owner. No work shall proceed in the area until the potential damage is evaluated, documented and repaired as necessary.

i. During placement of synthetic turf panels, care shall be taken not to entrap, in or beneath the synthetic turf, stones, excessive dust, or moisture that could damage the synthetic turf or underlying geomembrane, or hamper subsequent splicing.

j. All deployed synthetic turf panels shall be weighted with sandbags, old tires, or the equivalent to provide resistance to wind uplift. Such weights shall be installed during deployment and shall remain until the sand infill is placed. Uplifted material can be reused only if approved by Owner.

303.3 Field Splicing:

a. Method of Splicing:

a1. Successive panels of synthetic turf shall be continuously sewn (i.e., spot seaming is not allowed) or continuously heat bonded in accordance with Synthetic Turf Manufacturer's recommendations on slopes flatter than 10H:1V (10 percent).

a2. On slopes steeper than 10H:1V (10 percent), all successive panels of synthetic turf shall be continuously sewn (i.e., spot sewing and heat bonding are not allowed). All seams shall be vertical (parallel with the flow line of the slope). No horizontal seams (across the slope) shall be permitted.

b. Sewing:

b1. Sewing procedures shall conform to the latest procedures recommended by the Synthetic Turf Manufacturer.

b2. Sewing shall be done using 207 polyester sewing thread.

b3. Seams shall be "prayer" seams constructed using a Newlong sewing machine or Owner-approved equal. Seams shall be formed by mating the edges of the synthetic turf panels and sewing the panels together with continuous stitches located between the first and second rows of tufts on both sides of the synthetic turf panels.

c. Heat Bonding:

c1. Fusion seaming (heat bonding) shall be performed using a Demtech VM-20/4/A fusion welder only.

c2. Fusion seams shall be made with at least 5 inches of overlap between the synthetic turf panels being welded.

c3. Frayed or loosed geotextile strands shall be cut off or otherwise removed.

c4. Prior to starting production seaming, trial seams shall be performed per Paragraph 303.4d of this section.

c5. Mechanical or hot knife trimming and cutting devices shall be utilized for salvage trimming.

c6. Any damage that occurs due to production seaming shall be repaired in accordance with the Synthetic Turf Manufacturer's recommendations.

d. Trial Welds Prior to Beginning Heat Bonding:

d1. Trial welds are required for pre-qualification of personnel, equipment, and procedures for making seams on identical geotextile material under the same climatic conditions as the actual field production seams will be made.

d2. Trial welds shall be made as follows:

d2.1 Prior to each seaming period.

d2.2 Every 4 hours (*i.e.*, at the beginning of the work shift and after the lunch break).

d2.3 Whenever personnel or equipment are changed.

d2.4 When the welding apparatus has been turned off for longer than 30 minutes.

d2.5 When climatic conditions result in wide changes in geotextile temperature.

d2.6 When requested by the CQA Geosynthetic Inspector for any seaming crew or piece of welding equipment if problems are suspected.

d3. Once qualified by passing a trial weld, welding technicians shall not change parameters without performing another trial weld.

d4. A test strip shall be prepared by joining two pieces of synthetic turf. The test strip shall be at least 12 inches wide and 3 feet long, and the seam shall be centered lengthwise. The CQA Geosynthetic Inspector shall witness the fabrication of each test strip.

d5. Testing of a trial weld shall not commence until the seam cools to the ambient temperature.

d6. Trial Weld Testing Procedure and Pass/Fail Criteria:

d6.1 Trial welds shall comply with visual passing criteria, which is verified when manual peel/pull test is performed, and the top synthetic turf panel tufts transfer to the bottom synthetic turf panel.

d6.2 Passing Test: 75% or more of the tufts in the top synthetic turf panel transfer to the bottom synthetic turf panel.

d6.3 Failing Test: Less than approximately 75% of the tufts in the top synthetic turf panel transfer to the bottom synthetic turf panel.

d6.4 Two consecutive trial welds shall meet the visual passing criteria above prior to commencing production seaming.

304. <u>REPAIR OF SYNTHETIC TURF</u>

304.1 Repair of Holes or Tears:

a. All holes or tears in a synthetic turf panel shall be repaired by using a heat-bonded seam. A handheld heat gun with a pressure wheel shall be used in smaller, concentrated areas.

b. The patch material shall be the same synthetic turf material as the damaged synthetic turf panel.

c. Care shall be taken to remove any soil, object, and/or other material which penetrated or tore the synthetic turf.

d. Alternative patching techniques may be utilized by the Geosynthetics Contractor following a field demonstration and subsequent approval by Owner.

305. <u>ANCHOR TRENCH BACKFILLING</u>

305.1 Synthetic turf cover shall be anchored in an anchor trench at the bottom of the slope. See Section 319022 for anchor trench excavation and maintenance requirements.

305.2 Backfilling:

a. Anchor trench backfill shall be placed in accordance with Section 312205 of this Specification.

b. Backfilling of the anchor trench shall occur during the morning or during extended periods of overcast skies when the liners are at their most contracted state.

c. If compacted using hand-operated equipment, backfill shall be placed in layers not exceeding 4 inches loose thickness and shall be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D1557.

d. If compacted by self-propelled equipment, backfill shall be placed in layers not exceeding 8 inches loose thickness and shall be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D1557.

306. INSPECTION OF SYNTHETIC TURF COVER AFTER INSTALLATION:

306.1 After installation is complete, a visual examination of the synthetic turf shall be carried out over the entire surface of the synthetic turf to verify that no potentially harmful foreign objects, such as broken needles, are present.

306.2 When sewing seams, the Geosynthetics Contractor shall perform continuous inspection during the seaming process using an in-line metal detector with an adequate sweep rate to determine the presence of broken needles. If the presence of broken needles is indicated, a needle removal system using magnets shall be implemented.

307. PLACEMENT OF BALLAST INFILL:

307.1 Placement of Ballast Infill between the tufts of the synthetic turf shall be done within the time limit specified by the Synthetic Turf Manufacturer.

307.2 Placement Procedures:

a. Ballast Infill shall be spread and placing using conveyor systems and/or express blowers using the method(s) presented to the Owner by the Ballast Infill Installer during the pre-construction meeting.

b. Ballast Infill shall not be deployed when snow and/or ice are present on the synthetic turf.

c. Ballast Infill shall be deployed in such a manner that excessive tensile stress is not placed on the synthetic turf.

d. Placement of the Ballast Infill shall be done in such a manner that the ClosureTurf® components are not shifted from their intended positions and are not exposed or damaged. On slopes, this requires deployment of Ballast Infill material to proceed from the bottom of the slope upward.

307.3 Final Thickness:

a. Ballast Infill placed between the tufts of the synthetic turf shall be at least 0.5-inch thick but no more than 0.75-inch thick.

END OF SECTION 311522

SECTION 312205

EARTHWORK FOR CCR SURFACE IMPOUNDMENT CLOSURE

PART 1 - GENERAL

101. EXTENT

101.1 This section defines the material and installation requirements for earthwork as part of closing the East and West Ash Ponds at the Waukegan Generating Station. This work shall be performed in accordance with the Design Drawings and as specified herein. This design is compliant with the Illinois and U.S. EPA Coal Combustion Residual (CCR) Rules.

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

a. Surveying for alignment and grade.

b. Furnishing and installing sediment and erosion control best management practices (BMPs) prior to construction and maintaining these BMPs during construction. This shall include providing BMPs at the Project Site, the onsite sand stockpile adjacent to Lake Michigan, and the haul road to and from the borrow site.

c. Demolition and disposal of waste.

d. Clearing, grubbing and topsoil stripping as required for select areas of existing dikes and borrow site, along with offsite disposal of organic debris and waste.

e. Preparation of the subgrade (CCR) to receive fills,

f. Grading of CCR material along with placement and compaction of Structural Fill to support the final cover system.

g. All appropriate measures shall be taken to protect the existing HDPE geomembrane liner system.

h. Disposal of excess or unsuitable excavated material if required.

i. Installation of additional sediment and erosion control facilities during construction, if required.

j. Dust control.

102. RELATED WORK SPECIFIED IN OTHER SECTIONS

102.1 The work specified in this section shall be coordinated with work specified in the following related sections and specifications:

a. Specification W-7900:

a1. Section 311010 – Temporary Sediment Control During Construction.

a2. Section 319022 – High Density Polyethylene Geomembrane for Final Cover System.

b. Specification W-7901 (Construction Quality Assurance for East & West Ash Pond Closures):

b1. Section 014362 – Construction Quality Assurance for Closing a CCR Impoundment.

103. REFERENCE DOCUMENTS

103.1 Standards, Specifications, manuals, codes, and other publications of nationally recognized organizations are referenced herein.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 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 agencies having jurisdiction.

103.4 Abbreviations listed below refer to the applicable organizations or documents.

103.5 ASTM - ASTM International:

a. D422 Standard Test Method for Particle-Size Analysis of Soils (Withdrawn 2016).

b. D1140 Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing.

c. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

d. D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

e. D4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

f. D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

g. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

103.6 IDOT – Illinois Department of Transportation

a. Standard Specifications for Road and Bridge Construction

104. SUBMITTALS

104.1 The General Work (GW) Contractor shall submit drawings and data as specified. GW Contractor’s drawings and data shall be submitted via electronic medium in a format compatible for importing into the Owner’s information systems specified by the Owner.

104.2 The GW Contractor shall submit with its bid, as a minimum, information requested including:

a. Complete Proposal Pricing (PP) and Proposal Data (PD) pages.

b. Company and key personnel experience on at least 20 similar projects in the last 10 years.

c. Project Work Plan to execute the work that includes at a minimum:

c1. Preliminary schedule,

c2. Construction equipment and manufacturer's specifications, and

c3. Names of key personnel.

104.3 After construction is complete the GW Contractor shall submit:

a. Final as-built drawings, documents and data prior to the Contract close out.

b. Final as-built drawings shall be in PDF file format and include native AutoCAD files. Drawing files shall be submitted with the project name, Project Identification Number (PIN), station name, drawing and revision numbers, and CAD file names identified in a separate electronic drawing list.

105. QUALITY ASSURANCE

105.1 The GW Contractor shall examine the areas and conditions under which earthwork is to be done and notify Owner in writing of conditions detrimental to the proper and timely completion of the Work.

105.2 Material, placing procedures and installations are subject to inspection and tests conducted by the CQA Contractor (see Specification W-7901, "Construction Quality Assurance for East & West Ash Pond Closures"). Tests shall be in accordance with Specification W-7901, Section 014362. Such inspections and tests shall not relieve the GW Contractor of responsibility for providing material and placement in compliance with this specification. Owner reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

105.3 GW Contractor shall correct all deficiencies in earthwork which inspections and laboratory and field tests have indicated are not in compliance with this specification. The GW Contractor shall perform additional tests, at GW Contractor's expense, as may be necessary to reconfirm any noncompliance of the original Work, and as may be necessary to show compliance of corrected Work.

105.4 The GW Contractor shall promptly correct errors or flaws in the Work or material identified during construction which may prevent proper installation. GW Contractor shall make immediate substitution of the noncomplying material or shall make field changes to make the noncomplying material acceptable. The correction or substitution shall be performed at no cost to Owner.

106. GEOTECHNICAL AND TOPOGRAPHICAL DATA

106.1 Geotechnical Data:

a. A structural stability and factor of safety assessment for the East and West Ash Ponds was prepared by Geosyntec Consultants in October 2016. Site specific soil data and geotechnical recommendations are provided and referenced therein.

b. The GW Contractor is allowed to make its own soil investigations. Any additional investigations shall be performed at no additional cost to Owner.

106.2 Topography:

106.3 A topographic survey of the project site was prepared in 2014. The design drawings indicate contour lines, elevations, and dimensions of existing ground. This information is furnished for GW Contractor's convenience and use. Owner assumes no responsibility for the accuracy of information provided.

a. It is noted that the volume of material stored in and topographic surface of the East and West Ash Ponds has been modified since the 2014 survey. Known changes are noted on the Design Drawings, but these notes are not considered to be an exhaustive representation of all differences between the 2014 survey and existing conditions.

b. The GW Contractor is allowed to make its own topographic assessment or check the existing survey data. Any additional surveying of the project site shall be at no additional cost to Owner.

107. <u>CONSTRUCTION SURVEYING</u>

107.1 The GW Contractor shall furnish and install a minimum of four (4) benchmark monuments as approved by the Owner to lay out lines and grades on the site during the lifetime of the project. The GW Contractor is fully responsible for the correctness of such lines and grades and for proper execution of work to such lines and grades.

107.2 Owner reserves the right to verify correctness of lines and grades during progress of the Work. Such verification by Owner shall not relieve the GW Contractor of responsibility as herein specified.

107.3 The GW Contractor shall notify Owner of any difference in location of existing construction and conditions from those indicated wherever such difference might affect its work.

PART 2 - PRODUCTS

201. <u>MATERIALS FOR STRUCTURAL FILL</u>

201.1 Acceptable Material for Structural Fill:

a. Poorly graded sand (SP per the Unified Soil Classification System, ASTM D2487) is stockpiled on site within ½ mile of the East Ash Pond and is available for the GW Contractor's use in establishing the specified lines and grades for the pond's final cover system. This fill will be provided by Owner to the GW Contractor at no cost to the GW Contractor.

201.2 Unsatisfactory Material for Structural Fill:

a. Material unsatisfactory for use as Structural Fill beneath final cover system is as follows:

a1. Soils classified as silt or organic soils in the Unified Soil Classification System, ASTM D2487. Classifications are ML, MH, PT, OL and OH.

a2. Soils classified as high liquid limit clay soils in the Unified Soil Classification System, ASTM D2487. Classification is CH.

a3. Rock material without a soil matrix in which nesting of rocks could occur.

201.3 CCR Fill:

a. The existing CCR stored in the East Ash Pond may be used as Structural Fill to support the pond's final cover system but is not permitted to be used as fill beyond the limits of the pond's existing HDPE geomembrane liner or used as fill offsite. No chemical characterization is required.

201.4 Road Surfacing:

a. Surfacing for the permanent road above the final cover system shall be Class A or B CA 6 in accordance with Article 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction.

202. <u>RESTRICTIONS ON THE USE OF MATERIAL FOR ANY PURPOSE</u>

202.1 Any material, which is frozen, contains an excessive amount of organic material or trash, or contains rocks larger than 2", shall be considered unsatisfactory for use as fill.

202.2 Fill and backfill soils placed by previous construction shall be considered unsatisfactory for use as fill unless they meet the requirements for satisfactory material.

202.3 For the East Ash Pond, since CCR is existing onsite material, it shall not be taken offsite and shall be graded solely for the purpose of establishing the proper slopes for drainage of the protective cover system and/or to support Structural Fill used to establish the lines and grades for the final cover system. There are no restrictions on use of the ash within the limits of the East Ash Pond's existing HDPE geomembrane liner.

PART 3 - EXECUTION

301. <u>GENERAL</u>

301.1 Work required is shown on the Design Drawings. No work shall be performed outside of the designated area without prior written approval of the Owner.

301.2 All Work that is incidental to excavation or fill may not be specifically indicated on the design drawings, but shall be performed as part of the Work.

302. <u>CLEARING, GRUBBING, AND TOPSOIL STRIPPING</u>

302.1 Areas designated for excavation or fill shall be cleared and grubbed prior to beginning earth-moving operations.

302.2 Clearing and grubbing shall be done to remove all vegetation and root systems that are in excess of 5 percent of the soil by mass or larger than 1 inch in diameter.

302.3 Extent of Stripping:

a. Areas designated for excavation or fill shall be stripped of all topsoil and all other organic material.

b. Weeds, small roots, heavy grass, and other vegetation remaining after clearing and grubbing operations shall be removed with the topsoil.

c. Special care shall be taken to avoid damage to the existing HDPE liner system where organic material or topsoil are adjacent to or immediately above the liner.

302.4 Disposal of stripped topsoil:

a. Stripped topsoil shall be hauled offsite at a permanent disposal facility approved by the Owner that is permitted to receive coal combustion residual (CCR) waste.

303. <u>DEMOLITION</u>

303.1 Demolition of any structure, if required, will be shown on the Design Drawings.

303.2 Demolition and removal of minor items which are incidental to the earthwork may be required. The GW Contractor shall identify any such items during its prebid walkdown. The GW Contractor shall demolish such items as required as part of the performance of the Work.

304. EXCAVATION

304.1 CCR Excavation:

a. The minor excavation within the limits of grading shall be performed to the lines and grades indicated on the Design Drawings.

b. Excavated material shall be used for fill unless it is classified as unsatisfactory.

c. CCR and CCR-mixed materials stored in the East Ash Pond shall be excavated and used as fill using proper placement and compaction methods specified herein. Under no circumstances shall CCR and CCR-mixed materials be used as fill in areas outside of the limits of the East Ash Pond's existing geomembrane liner.

d. GW Contractor shall take all appropriate measures to protect the existing HDPE geomembrane liner systems during excavation activities. Any damage to the HDPE geomembrane liner systems caused by the GW Contractor shall be repaired by GW Contractor at no cost to Owner.

e. Excavations shall not be carried below grades indicated on the Design Drawings without approval of Owner. Overexcavations shall be refilled with compacted Structural Fill to the proper grade at no additional cost to Owner.

304.2 Borrow Site:

a. Excavation of the sand stockpile shall be performed in such a manner that stockpiled sand is prevented from entering Lake Michigan or the Waukegan Generating Station Intake Pond.

b. The excavation base where stockpiled soils are removed shall not extend below the elevation of the ground surrounding the stockpile.

c. Grading plans for the final stockpile are not included in the design. Instead, following the removal of the required sand to complete the work in the East Ash Pond, the GW Contractor shall grade the site to prevent erosion, pile instability, or ponding of water.

304.3 Excavation of Drainage Facilities:

a. Drainage ditches, swales, and channels shall be cut accurately to the cross section and grades indicated on the Design Drawings.

b. Roots, stumps, rocks and foreign material in the sides and bottom of drainage facilities shall be removed and the facility trimmed and dressed.

c. Care shall be taken not to excavate ditches and channels below the grades indicated. Excessive excavation shall be backfilled with compacted Structural Fill material.

d. Drainage facilities shall be maintained until final acceptance of the Work by the Owner.

e. Material excavated from the drainage facilities shall be used as fill or transported to the designated offsite disposal area.

305. DISPOSAL OF EXCESS MATERIAL

305.1 Disposal of Unsatisfactory Material:

a. Excavated material, which is unsatisfactory for use as Structural Fill, shall be disposed of in an offsite landfill permitted to receive CCR and approved by the Owner. Unsatisfactory fill material shall not be mixed with satisfactory fill material.

b. When transporting CCR and/or CCR-mixed materials offsite, the GW Contractor shall responsibly handle and transport the material in accordance with 35 Ill. Adm. Code 845.740(c)(1).

306. PREPARATION OF EXISTING SUBGRADE (CCR) TO RECEIVE FINAL COVER SYSTEM

306.1 Removal of Topsoil and Debris:

a. Areas to receive Structural Fill or any component of the East Ash Pond's final cover system shall be cleared and grubbed, stripped of topsoil, and cleared of any debris left by demolition Work and shall be inspected and approved by CQA Contractor prior to placement of Structural Fill or any component of the final cover system.

306.2 Subgrade Compaction and Proofroll:

a. Where the existing HDPE geomembrane liner is at least 2 feet below subgrade, the subgrade beneath areas to receive fill shall be compacted and proofrolled prior to placing the fill. The subgrade shall be compacted to the minimum degree of compaction specified in Table 312205-1. Proofrolling shall consist of furnishing and operating compaction equipment for testing the stability of subgrade prior to receiving the fill. The intent is to locate any unstable areas. Proofrolling shall be performed in the presence of the CQA Contractor to allow for observation of unstable areas.

b. Where the existing HDPE geomembrane liner is less than 2 feet below subgrade, subgrade preparation and testing are not required nor shall they be performed.

c. Compact the surface of the subgrade to achieve the required density prior to performing proofroll.

d. Equipment such as a fully loaded water wagon having a gross weight of not less than 25 tons or loaded dump truck weighing at least 25 tons shall be used for proofrolling

e. Proofroll the surface by making a minimum of two coverages with the approved equipment at a speed no greater than 3 mph. Each succeeding trip of the proofroller shall be offset by not greater than one tire width. Make additional passes over areas of suspected instability.

f. Failure: The subgrade shall be considered failed if, under the action of proofrolling, the subgrade yields, pumps, or is otherwise unstable. Yielding is defined as rutting of more than 1 inch measured from the top of the construction grade to the bottom of the rut.

g. Remedial Action: Either moisture condition, scarify and recompact failed area or remove all failed areas a minimum depth of one foot or as directed by the Owner and replace with satisfactory fill compacted as specified for Structural Fill.

307. PLACEMENT OF STRUCTURAL FILL

307.1 Structural Fill materials include sand material from the onsite stockpile and existing CCR or CCR-mixed materials within the East Ash Pond as described in Paragraphs 201.1 and 201.3, respectively.

307.2 Lift Thickness:

a. Fill shall be placed in horizontal layers.

b. Unless otherwise approved by Owner, the loose thickness shall not exceed the following:

b1. Eight inches maximum loose lift thickness for compaction by self-propelled equipment.

b2. Four inches maximum loose lift thickness for compaction by hand-operated equipment.

b3. These lift thicknesses may be increased if the results of a test section prove that a thicker loose lift can be compacted to the required specified densities. The maximum loose lift thickness shall be 12 inches.

307.3 Placement:

a. Where fill is placed with less than 2 feet of separation from the existing HDPE geomembrane liner, care shall be taken to avoid any damage to the existing liner system. This includes placing fill against the existing dikes from the bottom up while maintaining adequate fill thickness to prevent damage to the existing liner system.

b. Each layer of fill shall be evenly spread and moistened or aerated as required to achieve the required moisture content.

c. The top surface of each layer shall be approximately level but shall have sufficient crown or cross fall to provide adequate drainage of water at all times during the construction period. The crown or crossfall shall be at least 1 in 50 (two percent) but no greater than 1 in 20 (five percent).

d. Fill slopes steeper than 20 percent (i.e., five horizontal to one vertical) shall be overfilled a minimum of 6 inches beyond the face of the slope, measured horizontally, and then cut back and trimmed to the required line and grade to expose a smooth surface uniformly compacted to the required density. Installing the fill slope to lines and grades shown on the design drawings and then running over the surface with compaction equipment is not acceptable.

308. COMPACTING STRUCTURAL FILL

308.1 Equipment:

a. Each layer of fill shall be compacted by a smooth drum vibratory roller or other mechanical means acceptable to Owner that will produce the specified compaction.

b. At locations where it would be impractical because of inaccessibility to use self-propelled compacting equipment, fill layers shall be compacted using hand propelled compaction equipment.

308.2 Inspection and Testing:

a. All Work is subject to inspection and testing by the CQA Contractor. The CQA Contractor shall have access to the Work at all times. Testing shall be in accordance with the Contract. Refer to Specification W-7901 for inspection and testing requirements.

b. Each layer of compacted fill shall be tested and accepted before proceeding with the next layer.

c. It is the GW Contractor's responsibility to request inspection prior to proceeding with further Work that would make parts of the Work inaccessible for inspection.

d. If the fill material fails to meet the required density, the material shall be removed and replaced or reworked, altering the construction method as necessary to obtain the required density and compaction. Sufficient time shall be allotted between lifts for the necessary testing of the soils.

309. COMPACTION DENSITIES

309.1 The degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained at optimum moisture content in accordance with the standards listed in Table 312205-1.

309.2 The minimum degree of compaction for fills for different areas is presented in Table 312205-1. The GW Contractor shall use data from this table which are applicable to the project.

309.3 Provided GW Contractor can achieve the specified degree of compaction, moisture content of granular soils (e.g. poorly graded sand (SP), CCR and IDOT CA 6) shall not be a sole basis for rejection of the compacted fill.

310. GRADING TOLERANCES

310.1 Lines and Grades: The acceptable deviation from lines and grades indicated on the Design Drawings shall be as shown in Table 312205-2. The GW Contractor shall use data from that table which is applicable to the project.

310.2 Slopes: Slopes shall be finished in conformance with the lines and grades shown on the Design Drawings. When completed, the average plane of a slope shall conform to the slope indicated on the Design Drawings and no point on the completed slope shall vary from the designated plane by more than 6 inches measured at right angles to the slope.

311. DUST CONTROL

311.1 The GW Contractor shall be responsible for controlling dust caused by the grading operation in compliance with the Fugitive Dust Plan in place for the facility and in accordance with 35 Ill. Adm. Code 845.740(c)(2). The facility's active Fugitive Dust Plan may be downloaded from https://midwestgenerationllc.com.

311.2 Water shall be applied uniformly and lightly to prevent muddy, slippery, or other hazardous conditions. The application shall be frequent enough to adequately control the dust nuisance. However, excessive application that would affect compacting operations shall be avoided.

312. TEMPORARY SEDIMENT CONTROL DURING CONSTRUCTION

312.1 The GW Contractor shall be responsible for providing temporary facilities for the control of sediment in site area runoff during construction.

312.2 Silt fences, straw bale dikes and other temporary facilities shall be provided as required and as specified on the Design Drawings.

313. EROSION CONTROL

313.1 The GW Contractor shall be responsible for temporary protection of graded areas against erosion and for correction of erosion, which occurs.

313.2 Slopes, ditches, or other disturbed areas shall not be exposed for more than 21 days without a permanent cover.

TABLE 312205-1

MINIMUM COMPACTION REQUIREMENTS

Area	ASTM D1557 (percent)
Subgrade (CCR)	
Subgrade beneath fills	90
Structural Fills (Including Ash Fill)	
All Structural Fill	95

TABLE 312205-2

ACCEPTABLE DEVIATIONS FROM LINES AND GRADES ON DESIGN DRAWINGS

Type of Installation (Excavation or Fill)	Maximum Acceptable Deviation from Line (feet)	Maximum Acceptable Deviation from Grade(1) (feet)
General Earthwork		
General Site Area	±0.3	±0.2
Fill Areas Above Final Cover System (i.e. Permeant Road)	±0.3	+0.3 to -0.0
Drainage Facilities		
Permanent Drainage Channel	±0.3	+0.0 to -0.1
Slope Drainage Benches and Drainage Diversion Dikes	±0.5	±0.1

Notes:

(1) After initial settlement has taken place. Initial settlement is that settlement that will occur up to the time of determination and acceptance of final grade elevations by the Owner.

END OF SECTION 312205

SECTION 319022

HIGH DENSITY POLYETHYLENE GEOMEMBRANE FOR FINAL COVER SYSTEM

PART 1 - GENERAL

101. EXTENT

101.1 This section defines the minimum requirements for material and installation of non-textured, textured, and structured high density polyethylene (HDPE) geomembrane to be used in the ClosureTurf® final cover system (or Owner-approved equal) for the East Ash Pond, all in accordance with the Design Drawings and as specified herein.

101.2 The Work shall include, but not be limited to, the following items:

a. Manufacture, shipping, handling, and storage of geomembrane materials.

b. Inspection and approval of surfaces to be covered.

c. Placement and field seaming of geomembrane.

d. Anchorage of geomembrane in anchor trenches.

e. Attachment of geomembrane to structures and penetrations.

f. Non-destructive field testing of geomembrane seams.

g. Removal of samples of geomembrane seams and submittal to the CQA Contractor for destructive testing.

h. Repair of defective geomembrane seams.

i. Repair of defects in the geomembrane and locations where samples were taken.

j. Visual inspection of the completed geomembrane cover.

101.3 Definitions of Terms: The following definitions of terms shall apply throughout this section.

a. GW Contractor is contracted by and responsible to the Owner to perform all of the work specified herein. They may self-perform or subcontract the work. The final division of responsibilities between the Earthwork Contractor and Geosynthetics Contractor will be the responsibility of the GW Contractor.

b. Earthwork Contractor: The contractor who is generally responsible for earthwork for the facility and for excavation and backfill of anchor trenches. The Earthwork Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

c. Geosynthetics Contractor: The contractor who is generally responsible for the supply and installation of all geomembrane and synthetic turf materials as well as the unloading and storage of the materials. The Geosynthetics Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

d. Construction Quality Assurance (CQA) Contractor: The contractor who is independent of the GW Contractor and is responsible for all CQA work.

e. CQA Geosynthetics Inspector: An inspector who works for the CQA Contractor and is responsible for inspection of the Geosynthetics Contractor’s work.

f. Geomembrane Manufacturer: The manufacturer who is responsible for manufacture of geomembrane materials and for transporting geomembrane materials to the site.

g. Watershed Geo: A geosynthetic technology company and the designer of the ClosureTurf® final cover system.

101.4 Qualifications:

a. Geomembrane Manufacturer:

a1. The Geomembrane Manufacturer shall be approved by the Owner.

a2. The Geomembrane Manufacturer shall be approved by Watershed Geo for supplying the geomembrane component of the ClosureTurf® final cover system (or Owner-approved equal).

b. Geosynthetics Contractor:

b1. The Geosynthetics Contractor shall be approved by the Geomembrane Manufacturer for installation of the Geomembrane Manufacturer's products.

b2. The Geosynthetics Contractor shall be approved by the Owner.

b3. Geosynthetics Contractor personnel shall attend ClosureTurf® orientation provided by Watershed Geo prior to the start of the Work if this project is the Geosynthetics Contractor's first ClosureTurf® installation project.

b4. Geomembrane Seamers:

b4.1 Master Geomembrane Seamer shall have installed at least 5,000,000 square feet of geomembrane materials.

b4.2 All other geomembrane seamers shall have installed at least 1,000,000 square feet of geomembrane materials. Personnel who do not meet this criterion may be allowed to seam geomembrane materials but only under the direct supervision of the Master Geomembrane Seamer.

102. <u>RELATED WORK SPECIFIED IN OTHER SECTIONS</u>

102.1 The work specified in this section shall be coordinated with work specified in the following related sections and specifications:

a. GW Specification (Specification W-7900 – East & West Ash Pond Closures):

a1. Section 311522 – Engineered Synthetic Turf for Final Cover System.

a2. Section 312205 – Earthwork for CCR Surface Impoundment Closure.

b. CQA Specification (Specification W-7901 – Construction Quality Assurance for East & West Ash Pond Closures):

b1. Section 014362 – Quality Assurance for Closing a CCR Surface Impoundment.

103. <u>REFERENCE DOCUMENTS</u>

103.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment, and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state, or local agencies having jurisdiction.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 Abbreviations listed indicate the form used to identify the reference documents in the Specification Section text.

103.4 ASTM – ASTM International:

a. A276 Specification for Stainless Steel Bars and Shapes.

b. B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

c. D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

d. D1004 Test Method for Tear Resistance of Plastic Film and Sheeting.

e. D1505 Test Method for Density of Plastics by the Density-Gradient Technique.

f. D1603 Test Method for Carbon Black Content in Olefin Plastics.

g. D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

h. D4833 Test Method for Index Puncture Resistance of Geomembranes and Related Products.

i. D5199 Test Method for Measuring Nominal Thickness of Geosynthetics.

j. D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

k. D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

l. D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

m. D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

n. D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

o. D5885 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

p. D5994 Test Method for Measuring Core Thickness of Textured Geomembrane.

q. D6392 Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

r. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

s. D7466 Test Method for Measuring Asperity Height of Textured Geomembranes.

t. D8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry.

103.5 GRI – Geosynthetic Research Institute:

a. GM6 Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes.

b. GM10 The Stress Crack Resistance of HDPE Geomembrane Sheet.

c. GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

d. GM14 Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.

e. GM19a Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barrier.

104. SUBMITTALS

104.1 GW Contractor shall submit the drawings and data as specified below within 30 days prior to use. Contractor's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Owner's information systems specified by the Owner.

104.2 Submittals with the Bid Proposal:

a. HDPE Geomembrane Material:

a1. Certification of Compliance from the Geomembrane Manufacturer signed by its authorized representative indicating that the HDPE geomembrane sheeting material meets the criteria specified herein.

a2. One representative sample of each type of HDPE geomembrane material.

a3. Geomembrane Manufacturer's Quality Control and Quality Assurance Policies and Procedures.

b. Warranty:

b1. Written warranties from the Geomembrane Manufacturer and the Geosynthetics Contractor covering the quality of the material and workmanship as specified.

b2. The minimum period of warranty for materials shall be 20 years with first year non-prorated. The minimum period of warranty for installation shall be 5 years with the first year non-prorated.

b3. Any warranty conditions proposed, including limits of liability, will be evaluated by the Owner in approving the Geomembrane Manufacturer and the Geosynthetics Contractor. Warranty conditions are considered to be valid justification for exclusion or one or more bids.

c. Geosynthetics Contractor:

c1. Geosynthetics Contractor's name, address, and telephone number.

c2. Geosynthetics Contractor's qualifications.

c3. Installer's qualifications if the Geosynthetics Contractor is proposing to subcontract installation work.

104.3 Submittals After Award of the Contract:

a. Progress Reports:

a1. GW Contractor shall submit status reports at regular intervals as specified by the Owner. The reports shall indicate the status of the schedule.

b. Geomembrane Resin:

b1. Geomembrane Manufacturer's signed certificate that the resin meets the criteria specified herein.

b2. Geomembrane Manufacturer's signed certification of the origin of the resin and that all resin is from the same manufacturer (including Geomembrane Manufacturer's name, identification brand name, and number).

b3. Copies of Geomembrane Manufacturer and resin suppliers' QA/QC certificates. Certificates shall include a summary report of test results conducted to verify the quality of the resin used in each batch used to manufacture geomembrane for this project. As a minimum, the report shall include tests on specific gravity, melt flow index and percent carbon black.

c. Geomembrane Sheeting:

c1. Prior to material shipment to the site, the Geomembrane Manufacturer shall submit to the CQA Contractor representative samples of the geomembrane to be shipped to the site, along with chain of custody and certification that the samples submitted are from the geomembrane material to be delivered to the site. The number of samples shall be determined in accordance with the number of CQA conformance tests specified in Specification W-7901, Section 014362.

c2. Signed certification that the properties of the manufactured sheeting meet the criteria specified herein and are guaranteed by the Geomembrane Manufacturer.

c3. Statement certifying that no post consumer resin (PCR) has been added to the formulation.

c4. Copies of all of the Geomembrane Manufacturer's QA/QC certificates. The certificates shall include documents of test results.

d. Extrudate Resins or Rod for Seaming Geomembranes:

d1. Certification that all extrudate is the same resin type as the geomembrane and was obtained from the same resin supplier as the resin used to manufacture the geomembranes.

e. Installation Data:

e1. Geomembrane Manufacturer's proposed geomembrane panel layout for each installation.

e2. Geomembrane Manufacturer's recommended procedures for making and testing seams if different from those specified herein.

e3. Geomembrane Manufacturer's recommended procedures for repairing damaged geomembrane sections and seams if different from those specified herein.

e4. Geomembrane Manufacturer's details of geomembrane liner anchorage and attachment to structures and penetrations if different from those specified herein and the details shown on the Design Drawings.

104.4 Submittals After Construction is Complete:

a. Geosynthetics Contractor:

a1. As-built panel layout.

a2. Drawing showing location of repairs and type of repairs made.

a3. Location of destructive tests.

a4. Results of destructive tests.

a5. Results of non-destructive tests.

105. QUALITY ASSURANCE

105.1 Materials and construction procedures shall be subject to inspection and testing by the CQA Contractor. Such inspections and tests will not relieve the GW Contractor of responsibility for providing materials and installation in compliance with specified requirements.

105.2 The Owner reserves the right, at any time before final acceptance, to reject materials or workmanship not complying with specified requirements. The GW Contractor shall correct the deficiencies which the inspections and tests have indicated are not in compliance with specified requirements.

105.3 CQA activities for installing geomembrane materials shall be performed as described herein and in Specification W-7901.

PART 2 - PRODUCTS

201. HIGH DENSITY POLYETHYLENE GEOMEMBRANE

201.1 Manufacturers of HDPE Geomembrane Products:

a. The products of the following manufacturers meeting the requirements herein are acceptable:

a1. Watershed Geo and their supplier AGRU America Manufacturing, Inc., 500 Garrison Road, Georgetown, SC 29440, Tel.: 800-373-2478.

a2. Owner-approved equal.

201.2 General Requirements:

a. All non-textured HDPE geomembrane shall be white. There is no color requirement for textured and structured HDPE geomembranes.

b. The HDPE geomembrane shall be manufactured from first quality, virgin resin. Blending of resins shall not be allowed. No recycled or reworked geomembrane may be used except edge trim generated during the manufacturing process (no more than 10%). No post-consumer resin (PCR) of any type shall be added to the formulation.

c. The resin used to produce the geomembrane shall be formulated to be resistant to chemical and ultraviolet degradation.

d. The geomembrane shall be free of plasticizers.

e. The geomembrane shall be free of leachable additives.

f. During manufacture, each roll of geomembrane shall be continuously monitored across the width to assure uniformity of thickness. Thickness measurements shall meet the requirements of Table 319022-1 for non-textured geomembrane, Table 319022-2 for textured geomembrane, and Table 319022-3 for structured geomembrane.

g. The geomembrane shall be free of factory seams.

h. The geomembrane shall be free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, blisters, pits, tears, holes, pores, pinholes, voids, undispersed raw material, any sign of contamination or other defects that may affect serviceability, and shall be uniform in color, thickness, and surface texture.

i. The geomembrane shall be capable of being seamed in the field to yield seams that are as resistant to waste liquids as the sheeting.

j. The geomembrane shall be manufactured in the United States or Canada.

201.3 Non-Textured HDPE Geomembrane:

a. Non-textured HDPE geomembrane shall meet the requirements of Table 319022-1.

b. The location of non-textured HDPE geomembrane to be used for each installation shall be as shown on the Design Drawings.

201.4 Textured and Structured HDPE Geomembranes:

a. Textured HDPE geomembrane shall meet the requirements of Table 319022-2.

b. Structured HDPE geomembrane shall meet the requirements of Table 319022-3.

c. The location of textured and structured HDPE geomembranes to be used for each installation shall be as shown on the Design Drawings.

d. Textured and structured geomembranes shall be manufactured using a co-extrusion process.

e. The textured/structured deformations shall be manufactured on <u>both</u> sides of the base sheet.

f. Textured and structured geomembranes shall have uniform texturing appearance. The geomembrane shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

g. Each roll shall have 6-inch wide smooth edges (minimum) to provide suitable seaming surfaces. Textured and/or structured geomembrane without smooth edges may be provided if approved by the Owner.

TABLE 319022-1

HIGH DENSITY POLYETHYLENE NON-TEXTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value		Testing Frequency
Nominal thickness, mil	--	--	60	100	---
Resin Properties					
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D8117	100	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D8117	55	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 Hrs	D5885	50	--	--	one per formulation
Analytical Properties					
Formulated density, g/cc minimum	D1505/D792	0.940	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	45,000 lbs. .of Resin
Mechanical Properties					
Thickness, mils	D5199	--	--	--	One per roll
Average		--	60	100	
Lowest individual of 10 values		--	54	90	
Tensile properties, in each direction (minimum):	D6693 (Type IV Specimen at 2 ipm)				
Tensile stress at yield, ppi minimum		--	126	210	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	228	380	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	700	700	20,000 lbs. of Resin
Tear resistance, lb (minimum avg)	D1004	--	42	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	108	180	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	
Shear strength, ppi		--	120	200	
Peel adhesion (fusion), ppi		--	91	151	
Peel adhesion (extrusion), ppi		--	78	130	
Environmental and Aging Effect on Properties					
Stress Crack Resistance, hours (min)	D5397	--	500	500	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, Revision 16 (March 17, 2021), except for bonded seam strength.
2. Seam requirements shown in this table meet the minimum requirements of GRI Standard GM19a, Revision 10 (March 18, 2021).

TABLE 319022-2

HIGH DENSITY POLYETHYLENE TEXTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value		Testing Frequency
Nominal thickness, mil	--	--	60	100	---
Resin Properties					
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D8117	100	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D8117	55	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 hrs.	D5885	50	--	--	one per formulation
Analytical Properties					
Formulated density, g/cc minimum	D1505/D792	0.940	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	45,000 lbs. of Resin
Mechanical Properties					
Thickness, mils	D5994	--	--	--	One per roll
Minimum Average		--	57	95	
Lowest individual for 8 out of 10 values		--	54	90	
Lowest individual for 10 out of 10 values		--	51	85	
Asperity Height, mils (min avg)	D7466	--	16	16	Every second roll
Tensile properties, in each direction (minimum average)	D6693 (Type IV Specimen at 2 ipm)				
Tensile stress at yield, ppi minimum		--	126	210	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	90	150	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	100	100	20,000 lbs. of Resin
Tear resistance, lb. (minimum avg)	D1004	--	42	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	90	150	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	
Shear strength, ppi		--	120	200	
Peel adhesion (fusion), ppi		--	91	151	
Peel adhesion (extrusion), ppi		--	78	130	
Environmental and Aging Effect on Properties					
Stress Crack Resistance, hours (min)	D5397	--	200	200	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, Revision 16 (March 17, 2021), except for bonded seam strength.
2. Seam requirements shown in this table meet the minimum requirements of GRI Standard GM19a, Revision 10 (March 18, 2021).

TABLE 319022-3

HIGH DENSITY POLYETHYLENE STRUCTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value		Testing Frequency
Nominal thickness, mil	--	--	60	100	---
Resin Properties					
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D8117	100	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D8117	55	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 hrs.	D5885	50	--	--	one per formulation
Analytical Properties					
Formulated density, g/cc minimum	D1505/D792	0.940	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	45,000 lbs. of Resin

Mechanical Properties					
Thickness, mils	D5994	--	--	--	One per roll
Minimum Average		--	57	95	
Lowest individual for 8 out of 10 values		--	54	90	
Lowest individual for 10 out of 10 values		--	51	85	
Drainage Stud Height, mils (min avg)	D7466	--	130	130	
Friction Spike Height, mils (min avg)	D7466	--	175	175	Every second roll
Tensile properties, in each direction (minimum average)	D6693 (Type IV Specimen at 2 ipm)				
Tensile stress at yield, ppi minimum		--	132	220	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	132	220	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	200	200	20,000 lbs. of Resin
Tear resistance, lb. (minimum avg)	D1004	--	42	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	90	150	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	
Shear strength, ppi		--	120	200	
Peel adhesion (fusion), ppi		--	91	151	
Peel adhesion (extrusion), ppi		--	78	130	
Environmental and Aging Effect on Properties					
Stress Crack Resistance, hours (min)	D5397	--	500	500	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, Revision 16 (March 17, 2021), except for bonded seam strength.
2. Seam requirements shown in this table meet the minimum requirements of GRI Standard GM19a, Revision 10 (March 18, 2021).

201.5 Panel Layout:

a. Prior to manufacture of the geomembrane, a panel layout of the surface to be covered shall be made. Each panel to be used for the installation shall be given a numeric or alphanumeric identification number.

b. The panel identification number shall be related in writing to the manufacturing roll number that identifies the resin type, batch number, and date of manufacture.

c. The panel layout shall be made considering the following requirements:

c1. Panel lengths shall include slope gain and anchorage.

c2. Perpendicular tie-ins shall be made a minimum of 5 feet beyond the toe of the slope.

c3. A minimum of 6 inch overlap shall be allowed at double fusion welded seams.

c4. All field seams on slopes shall be oriented parallel to the slope (oriented along, not across the slope).

c5. The number of seams in corners or odd shaped geometric locations shall be minimized.

201.6 Packaging and Shipping:

a. The geomembrane shall be shipped to the project site in rolls. No material shall be folded.

b. A label shall be attached or adhered to each roll of the geomembrane identifying the following:

b1. Manufacturer.

b2. Product Identification, which can be traced back to the origin of the base material (resin supplier’s name, resin production plant, resin brand name type, resin brand number, and production date of the resin).

b3. Date of manufacture of the geomembrane.

b4. Roll identification number.

b5. Geomembrane thickness and type.

b6. Roll dimensions (length and width).

b7. Batch number.

b8. Order number.

b9. Panel number.

201.7 Packaging and Transportation:

a. Packaging and transportation shall be the responsibility of the Geomembrane Manufacturer, who shall retain responsibility until the geomembrane is accepted at the site by the Geosynthetics Contractor.

202. MATERIALS FOR ATTACHMENT OF GEOMEMBRANE TO CONCRETE

202.1 Batten Strip:

a. Batten strip material shall be hot rolled, annealed, and pickled Type 306 L stainless steel in accordance with ASTM A276.

b. Strips shall be ¼ inch thick by 2 inches wide. Random lengths are acceptable.

202.2 Expansion Anchors:

a. Expansion anchors shall be stud type with a single piece three section wedge and zinc plated in accordance with ASTM B633. Wedges shall be manufactured from ANSI Type 304 stainless steel. Hilti Kwik Bolt 3 Expansion Anchors, or equal, are acceptable.

b. Minimum yield strength of 60,000 psi for wedge-type anchors and a minimum tensile strength of 65,000 psi for stud type anchors.

c. Anchors shall be 3/8 inch diameter by 3 1/2 inch long.

d. Washers for anchors shall be Type 18-8 stainless steel flat washers for 3/8 inch bolt size.

202.3 Neoprene Gasket:

a. Neoprene gaskets shall be 1/4 inch thick by 2 inches wide closed cell neoprene sponge sealing strips. Operating temperature range of neoprene shall be –40°F to +220°F.

b. Neoprene gaskets placed against concrete shall have a pressure sensitive adhesive on the side of the gasket placed against the concrete.

PART 3 - EXECUTION

301. ONSITE HANDLING AND STORAGE

301.1 Receipt/Unloading:

a. Unloading and storage of materials shall be the responsibility of the Geomembrane Manufacturer.

b. The unloading and other handling of materials shall be performed by the Geomembrane Manufacturer to ensure that the material is handled with care and not damaged.

301.2 Storage:

a. The GW Contractor shall provide temporary on-site storage space in a location near the area to be covered such that on-site transportation and handling are minimized. The GW Contractor shall be responsible for protecting stored material from theft and vandalism.

b. The rolls of geomembrane shall be placed on a smooth surface free of rocks and standing water.

301.3 Inspection:

a. Upon delivery of the material to the project site, the Geosynthetics Contractor shall conduct a visual inspection of all rolls of geomembrane for damage or defects. This inspection shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

b. Any damage or defects shall be noted and immediately reported to the Owner, the Geomembrane Manufacturer, and to the carrier that transported the material. Any roll or portion thereof, which, in the judgement of the Owner, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Owner.

302. PREPARATION OF SURFACES TO BE COVERED

302.1 General:

a. The Earthwork Contractor shall be responsible for preparing and maintaining the surfaces to be covered as specified in Section 312205 prior to placement of the geomembrane.

b. The Geosynthetics Contractor shall confirm the conditions of the finished surfaces to be covered prior to placement of the liner.

302.2 Grading Requirements:

a. The subgrade surface on which a lining is to be placed shall be graded to elevations shown on the Design Drawings. Tolerances shall be as specified in Section 312205.

302.3 Preparation of Concrete Surfaces:

a. All portions of concrete walls, curbs and foundations that will come in contact with a geomembrane shall be free of sharp edges or rough spots that can puncture or abrade the geomembrane. Where necessary, the concrete shall be ground smooth by the Earthwork Contractor. Where specified on the Design Drawings, one or more layers of geomembrane scuff strips shall be placed between the concrete and the geomembrane to act as a protective layer for the geomembrane cap.

302.4 Subgrade Acceptance:

a. See Section 312205 regarding inspection and acceptance of surfaces to be covered.

303. FIELD PLACEMENT OF THE GEOMEMBRANE COVER

303.1 General Requirements:

a. Placement Procedure: The placement procedure used for the geomembrane cover shall include the conditions listed below.

b. Weather:

b1. Geomembrane shall not be placed when the air temperature is above 104°F or below 41°F unless it can be demonstrated to the approval of the Owner by trial welds that acceptable welds can be made at the prevailing temperature. Trial welds shall be as described in Paragraph 303.2.c.

b2. Geomembrane shall not be placed when there is any rainfall or snowfall, in the presence of excessive moisture due to fog or dew, in ponded water, on a frozen subgrade, or during high winds.

c. Panel Layout:

c1. The panels shall be placed in accordance with the Geomembrane Manufacturer's panel layout drawing to ensure that they are placed in the proper direction for seaming.

c2. If panels are installed in a location other than indicated on the Geomembrane Manufacturer's panel layout drawing, the revised location shall be indicated on an "as-built" layout drawing. The "as-built" record drawing shall be submitted to the Owner at the completion of the project.

d. Panel Deployment:

d1. Only the panels that can be anchored and seamed together in one shift shall be unrolled.

d2. Unroll and layout panels in as close to the final position as possible. Pulling geomembrane panels should be minimized to reduce the chance of permanent tension.

d3. The methods and equipment used to deploy the panels shall not damage the geomembrane or the supporting surface.

d4. Wrinkles shall be minimized. However, enough slack shall be provided in both directions so that there will be no tension in the geomembrane at the lowest expected operating temperature.

e. Precautions to Prevent Wind Damage:

e1. If possible, work shall be oriented in the direction of the prevailing wind.

e2. Provide adequate temporary loading and/or anchoring of the geomembrane by the use of sandbags, tires or other means which will not damage the geomembrane, to prevent uplift of the geomembrane by wind.

f. Other Precautions to Prevent Damage:

f1. Protection of the geomembrane from damage due to foot traffic on the slopes shall be provided.

f2. Provisions of facilities for safe entrance and egress of employees from sloped depressions is required.

g. Replacement of Damaged Geomembrane:

g1. Any area of a panel, which, in the judgement of the Owner, becomes seriously damaged (torn, twisted, or crimped permanently) shall be replaced at no additional cost to the Owner.

303.2 Field Seaming:

a. Method of Seaming:

a1. The primary welding procedure for seams shall be double wedge fusion welding.

a2. Extrusion welding shall be used only for repairs, detail work, and for seaming where double wedge fusion welding is not possible.

a3. The rods used for extrusion welding shall be the same type of resin as the geomembrane, unless otherwise approved by the Owner.

a4. The use of solvents or adhesives is not permitted.

b. General Requirements for Seaming:

b1. On slopes steeper than 10 horizontal to 1 vertical, seams shall be oriented parallel to the line of maximum slope (oriented up and down, not across the slope) when possible. No seams oriented across the slope shall be used unless approved by the Owner.

b2. Seams parallel to the toe of the slope shall be located a minimum of 5 feet from the toe.

b3. Seams parallel to the crest of the slope shall be located a minimum of 2 feet from the crest.

b4. Seams at the bottom of a slope shall be overlapped so that the upslope sheet is positioned above the downslope sheet.

b5. Seaming shall extend to the outside edge of panels to be placed in the anchor trench. Seams at sheet corners of three or four sheets shall be completed with a patch having a minimum dimension of 24 inches, and extrusion welded to the parent sheets.

b6. All cross seams between the two rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of geomembrane.

c. Trial Welds Prior to Beginning Seaming:

c1. Trial welds are required for pre-qualification of personnel, equipment, and procedures for making seams on identical geomembrane material under the same climatic conditions as the actual field production seams will be made.

c2. Trial welds shall be made as follows:

c2.1 Prior to each seaming period.

c2.2 Every 4 to 5 hours (i.e., at the beginning of the work shift and after the lunch break).

c2.3 Whenever personnel or equipment are changed.

c2.4 When climatic conditions result in wide changes in geomembrane temperature.

c2.5 When requested by the CQA Geomembrane Inspector for any seaming crew or piece of welding equipment if problems are suspected.

c3. Once qualified by passing a trial weld, welding technicians shall not change parameters without performing another trial weld.

c4. Trial welds shall be made on both double wedge fusion welds and on extrusion welds.

c5. A test strip shall be prepared by joining two pieces of geomembrane, each piece shall be at least 6 inches wide. The length of double wedge fusion welded seams shall be a minimum of 10 feet long. The length of an extrusion welded seam shall be a minimum of 4 feet long. The CQA Geomembrane Inspector shall witness the fabrication of each test strip.

c6. All test welds shall be tested by destructive testing. Testing can be done as soon as the seam cools.

c7. A minimum of three (3) one (1) inch wide sample strips shall be cut from each test strip, one from each end and one from the middle. The location of each sample shall be selected by the CQA Geomembrane Inspector. The test strips shall be tested in peel at

2 inches per minute using a field tensiometer. The CQA Geomembrane Inspector shall witness all tests.

c8. If any of the test specimens fail, a new test strip shall be fabricated and the tests repeated for the new strip. If additional specimens fail, the seaming apparatus and the seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and successful trial welds have been achieved.

c9. The trial weld is considered acceptable if, when tested for peel adhesion using the field tensiometer, all three specimens meet the criteria specified for both the peel and shear under Bonded Seam Strength in Table 319022-1 (non-textured geomembrane specimens), Table 319022-2 (textured geomembrane specimens), or Table 319022-3 (structured geomembrane specimens), or the three specimens exhibit Film Tear Bond (FTB) (yielding of the parent material before seam failure). In the case of double wedge fusion welded seams, both welds must pass in order to be considered acceptable.

c10. If the specimens pass the tests, production seaming operations can begin.

c11. The GW Contractor shall document all data on each trial weld, including:

c11.1 Date.

c11.2 Time.

c11.3 Operator.

c11.4 Machine number.

c11.5 Ambient temperature.

c11.6 Operating temperature.

c11.7 Speed setting.

c11.8 Pass/Fail designation.

d. Preparation for Seaming:

d1. Prior to seaming, the surface of the geomembrane shall be wiped with a clean cloth to ensure that it is clean and free from moisture, grease, dust, dirt, and debris of any kind before seam welding is started.

d2. The panels shall be adjusted so that the seams are aligned to eliminate wrinkles and fish mouths. Where necessary, fish mouths and wrinkles shall be cut to achieve flat overlap.

e. Seaming:

e1. Seaming shall be performed in accordance with the Geomembrane Manufacturer's accepted procedure.

e2. Double Wedge Fusion Welds:

e2.1 The panels shall be overlapped a minimum of 4 inches prior to welding.

e2.2 Vehicle mounted automated hot wedge welding apparatus shall be used to make the seam.

e3. Extrusion Fillet Welding:

e3.1 Geomembrane overlap shall be a minimum of 3 inches for extrusion welding.

e3.2 Geomembrane panels shall be temporarily bonded using a hot air device prior to extrusion welding.

e3.3 The edge of the geomembrane to be fillet welded shall be pre-beveled before heat-tacking the seam in place.

e3.4 The seam overlap shall be ground (abraded) no more than one hour prior to welding.

e3.5 Grinding shall be performed in accordance with the Geomembrane Manufacturer's instructions in a manner that does not damage the geomembrane.

e3.6 Grinding shall not extend more than 1/4 inch past the area to be covered with extrudate during welding.

e3.7 All grind marks shall be covered with extrudate.

e3.8 Geomembrane overlap shall be a minimum of 3 inches for extrusion welding.

303.3 Non-Destructive Field Testing:

a. General:

a1. All non-destructive field testing shall be performed and documented by the Geosynthetics Contractor.

a2. The CQA Geomembrane Inspector shall observe all non-destructive test procedures.

a3. One hundred (100) percent of the seam length shall be tested using non-destructive procedures to check the continuity of the field seams. Non-destructive testing is not meant to qualify seam strength.

a4. Air pressure testing shall be performed in accordance with ASTM D5820 and GRI GM6.

a5. Vacuum box testing shall be performed in accordance with ASTM D5641 and as specified herein.

a6. Continuity testing shall be performed as seaming progresses or as soon as a suitable length of seam is available, not at the completion of all field seaming.

b. Double Wedge Fusion Welded Seams:

b1. Double fusion welded seams shall be tested using air pressure testing.

b2. The procedure for testing shall be as specified in GRI GM6 for the type and thickness of geomembrane in use.

b3. The following test pressures are applicable to non-textured, textured, and structured HDPE geomembrane. After an initial 2 minute pressure stabilization period, the pressure shall be maintained between 27 and 30 psi for 60 mil HDPE and 30 and 35 psi for 100 mil HDPE. The pressure shall be sustained for a minimum of 5 minutes. The loss of pressure shall not exceed a maximum of 3 psi in 5 minutes. If the pressure does not stabilize in the first two minutes or the pressure loss exceeds the loss specified, the seam test shall be considered a failure.

b4. The leak or suspected leak shall be located and repaired.

b5. The repaired seam shall be re-tested as required until all leaks are identified, and repaired, and the seam passes a subsequent air pressure test.

b6. When the geometry of a double wedge fusion weld makes air testing impossible or impractical, vacuum testing may be used to test the seam.

c. Extrusion Welded Seams:

c1. Extrusion welded seams shall be tested using vacuum chamber testing in accordance with ASTM D5641.

c2. The completed seam shall exhibit no leakage when tested between 4 and 8 psi minimum vacuum for approximately 10 seconds.

c3. If leaks are discovered during testing, they shall be located, marked, and repaired.

c4. The repaired area shall be re-tested and exhibit no leakage.

d. Inaccessible Seams:

d1. Where extrusion welded seam, locations make use of vacuum box testing impractical, then the electric wire method of testing shall be used or the seam shall be cap stripped as approved by the Owner.

d2. If cap stripping is approved by the Owner, the seams shall be cap stripped as described in Paragraph 304.4, with strips of the same type and thickness of geomembrane being installed. The cap stripping shall be performed in the presence of the Owner.

d3. The electric wire test method shall consist of placing a 24 gauge copper wire 1/8 inch beneath the top sheet overlap of the two sheets prior to welding with the extruder. The wire shall be imbedded in the seam. After welding, a holiday spark detector, operating at 20,000 volts, shall be connected to one end of the wire, and slowly moved over the length of the seam. A seam defect between the probe and the embedded wire shall result in an audible alarm indicating where the defect is located.

e. Test Reports:

e1. Test reports for all air pressure tests shall contain all data specified in ASTM D5820 and GRI GM6.

e2. Test reports for vacuum box testing shall contain all the data specified in ASTM D5641.

e3. Test reports for other types of non-destructive tests shall contain as a minimum for each test:

e3.1 Location.

e3.2 Type of test.

e3.3 Test parameters.

e3.4 Test data.

e3.5 Test number.

e3.6 Name of tester.

e3.7 Outcome of the test.

303.4 Destructive Testing:

a. Testing:

a1. Destructive testing shall be performed by an independent third party laboratory employed by the CQA Contractor on samples cut from production welds in the field by the Geosynthetics Contractor.

a2. Samples shall be taken by the Geosynthetics Contractor to the third party laboratory and tested for shear strength and peel adhesion. For double wedge seam samples, both welds shall be tested for peel adhesion.

b. Location and Frequency:

b1. Test locations shall be determined after seaming. The location where the test samples shall be marked by the CQA Geomembrane Inspector. Locations may be prompted by the appearance of excessive heating, contaminations, offset welds, or a suspected defect. Destructive test samples shall be taken at a minimum average frequency of one per every 500 linear feet of seam length.

b2. The Method of Attributes described in GRI GM14 may be exercised to minimize the number of test samples taken if more than 100 destructive seam samples will be required based on the sampling strategy given in Paragraph 303.4.b1.

b3. Each sample location shall be numbered and marked with permanent identification and the location of the sample and the locations shall be indicated on a plan drawing prepared and maintained by the Geosynthetics Contractor. The following shall be recorded for each sample:

b3.1 Date and time.

b3.2 Ambient temperature.

b3.3 Seam number and location.

b3.4 Welding apparatus used.

b3.5 Name of Master Geomembrane Seamer.

b3.6 Reason for taking the sample.

b3.7 Size of sample.

b3.8 Test results.

b3.9 Name of tester.

b4. Samples shall be cut by the Geosynthetics Contractor. The CQA Geomembrane Inspector shall witness test sample cutting.

b5. Test samples shall be cut every shift and taken by the Geosynthetics Contractor to the third party laboratory the same day that the sample is prepared.

c. Sample Size:

c1. The minimum sample size shall be 12 inches wide with a seam 16 inches long centered length wise in the sample. As agreed, to with Owner, a sample may be increased in size to accommodate the requirements of the testing laboratory.

d. Field Testing:

d1. A one-inch wide specimen shall be cut from each end of each sample for field testing.

d2. Each one-inch wide specimen shall be tested with a field tensiometer for peel adhesion.

d3. The CQA Geomembrane Inspector shall witness each field test.

d4. A test is considered acceptable if a specimen meets the criteria for both peel and shear under Bonded Seam Strength specified in Table 319022-1 (non-textured geomembrane specimen), Table 319022-2 (textured geomembrane specimen), or Table 319022-3 (structured geomembrane specimen), or exhibits Film Tear Bond (FTB). For double wedge fusion welds, both welds must pass the test. If either sample fails the field test, it shall be assumed that the seam will not pass the specified laboratory testing and the sample shall be given a fail designation.

e. Laboratory Testing:

e1. Full size (12 inch minimum length) samples shall be taken to an independent third-party laboratory for testing.

e2. Samples shall be tested for shear strength and peel adhesion in accordance with ASTM D6392. Five specimens shall be tested for each test method. All samples shall meet minimum requirements for shear strength and peel adhesion given under Bonded Seam Strength in Table 319022-1 (non-textured geomembrane specimens), Table 319022-2 (textured geomembrane specimens), or Table 319022-3 (structured geomembrane specimens).

f. Test Results:

f1. Verbal test results shall be given to the Geosynthetics Contractor within 24 hours of receipt of the samples. Written results shall follow within one week.

f2. All test locations shall be marked with a pass/fail designation on the liner and on the drawings maintained by the Geosynthetics Contractor for submittal to the Owner after construction is complete.

g. Re-Testing if Failure Occurs:

g1. If a seam fails testing, one additional sample shall be taken 10 feet on each side of the location of the failed test. Additional samples shall continue to be taken at 10 foot intervals until tests show that seam strength is adequate and the zone in which the seam requires reconstruction is identified.

g2. All passing seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

g3. The entire seam length failing strength tests shall be reconstructed at no additional cost to the Owner.

g4. If the length of reconstructed seam exceeds 150 feet, a sample shall be taken of the reconstructed seam every 150 feet and shall pass destructive testing.

303.5 Inspection:

a. After seaming is complete, the Geosynthetics Contractor and the CQA Geomembrane Inspector shall conduct a detailed walk-down to visually check all seams and non-seam areas of the geomembrane.

b. All defects, holes, blisters, tears, signs of damage during installation, areas of undispersed carbon and holes from destructive or non-destructive testing shall be marked and repaired.

304. <u>REPAIR OF DEFECTS AND SEAMS</u>

304.1 Patching:

a. Patching shall be used to repair large holes, tears, and destructive sample locations.

b. All patches shall be round, oval, or shall have rounded corners.

c. All patches shall be made of the base geomembrane material and shall extend a minimum of 3 inches beyond the edges of the defect.

d. Patches shall be extrusion welded to the base sheet.

304.2 Grinding and Welding:

a. Grinding and welding shall be used to repair sections of extruded fillet seams with small defects.

304.3 Spot Welding:

a. Spot welding shall be used to repair small tears, pinholes, or other minor localized flaws.

304.4 Capping:

a. Capping shall be used to repair lengths of extrusion welded seams with large defects and to repair double wedge fusion welded seams.

b. Cap strips shall be made with strips of the same type and thickness of geomembrane being installed. Strips shall extend a minimum of 6 inches beyond the weld and shall have rounded corners.

c. Cap strips shall be extrusion welded to the base sheet.

304.5 Cut Out and Replacement:

a. When approved by the Owner, a length of defective seam may be cut out and replaced with a strip of new material seamed into place.

304.6 Verification of Repairs:

a. All repairs shall be non-destructive tested using one of the procedures described in Paragraph 303.3.

b. Repairs, which pass the non-destructive test, shall be deemed acceptable.

c. Repairs of a seam in excess of 150 feet in length shall have one destructive seam test per 150 feet in length.

305. <u>ANCHOR TRENCH EXCAVATION AND BACKFILLING</u>

305.1 Excavation and Shaping:

a. Unless specified otherwise on the Design Drawings, the geomembrane cover shall be anchored in an anchor trench at the bottom of the slope. The anchor trench shall be excavated by the Earthwork Contractor to the lines and widths shown on the Design Drawings prior to placement of the geomembrane cover.

b. A slightly rounded corner shall be provided in the trench where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench.

c. The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open.

305.2 Backfilling:

a. See Section 311522 for anchor trench backfill requirements.

306. ATTACHMENT TO CONCRETE

306.1 Geomembrane shall be attached to concrete using batten strips in accordance with details on the Design Drawings.

END OF SECTION 319022

ATTACHMENT 1

DESIGN DRAWINGS

DRAWING NO.	REV.	TITLE
WKG-AP-CSK-001	C	ASH POND CLOSURE COVER SHEET
WKG-AP-CSK-002	C	ASH POND CLOSURE GENERAL NOTES
WKG-AP-CSK-003	C	WEST ASH POND EXISTING CONDITIONS
WKG-AP-CSK-004	C	WEST ASH POND EXCAVATION PLAN
WKG-AP-CSK-005	C	WEST ASH POND EXCAVATION SECTIONS & DETAILS
WKG-AP-CSK-006	C	EAST ASH POND EXISTING CONDITIONS
WKG-AP-CSK-007	C	EAST ASH POND DEMOLITION & REMOVAL PLAN
WKG-AP-CSK-008	C	EAST ASH POND FINAL COVER SYSTEM GRADING PLAN
WKG-AP-CSK-009	C	EAST ASH POND FINAL COVER SYSTEM SECTIONS & DETAILS

ATTACHMENT 2

SPECIFICATION W-7901 – CONSTRUCTION QUALITY ASSURANCE FOR EAST & WEST ASH POND CLOSURES

MWG

Midwest Generation, LLC

WAUKEGAN GENERATING STATION

SPECIFICATION W-7901

CONSTRUCTION QUALITY ASSURANCE FOR EAST & WEST ASH POND CLOSURES

S&L PROJECT NO.: 12661-098

REVISION 0C

ISSUE PURPOSE: PERMIT

ISSUE DATE: 01-27-2022

Sargent & Lundy

SECTION 000106

ISSUE SUMMARY AND APPROVAL PAGE

Rev.	Purpose of Issue	Date	Sections Affected
0A	Client Comment	11-10-2021	All
0B	Public Comment	11-15-2021	All
0C	Permit	01-27-2022	All

This is to confirm that this Specification has been prepared, reviewed, and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0407, Specifications, which is part of our Quality Management System.

Contributor Summary & Current Revision Signatures

Rev.	Prepared By	Reviewed By	Approved By
0A	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0B	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0C	Youssef Banoub, P.E.	Thomas Dehlin, P.E.	Thomas Dehlin, P.E.
	Thomas Dehlin, P.E.	David Nielson, P.E.	

SECTION 000107

CERTIFICATION PAGE

Sargent & Lundy, L.L.C. (S&L) is registered in the State of Illinois to practice engineering. S&L's Illinois Department of Financial and Professional Regulation registration number is 184-000106.

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

Certified By: Thomas J. Dehlin Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

SECTION 000110

TABLE OF CONTENTS

END OF SECTION 000110

SECTION 011100

SUMMARY OF WORK

PART 1 - GENERAL

101. PROJECT INFORMATION

101.1	Owner:	Midwest Generation, LLC (MWG)
101.2	Design Engineer:	Sargent & Lundy (S&L)
101.3	Project Name:	Construction Quality Assurance for East & West Ash Pond Closures
101.4	Project Location:	Waukegan Generating Station 401 E. Greenwood Ave. Waukegan, IL 60087

102. DESCRIPTION OF THE PROJECT AND GENERAL BACKGROUND

102.1 The purpose of this project is to close the East Ash Pond and the West Ash Pond at Midwest Generation, LLC's Waukegan Generating Station in accordance with the Illinois Pollution Control Board's Coal Combustion Residuals (CCR) Rule, 35 Ill. Adm. Code Part 845, and with the U.S. Environmental Protection Agency's (EPA) CCR Rule, 40 CFR Part 257 Subpart D.

102.2 The West Ash Pond will be closed by removing all CCR and CCR-mixed materials stored in the pond and decontaminating the pond's geomembrane liner and appurtenant concrete structures. The pond's existing geomembrane liner and appurtenant concrete structures will remain in-place. Following removal of CCR and CCR-mixed materials from the pond and decontamination of the pond facilities remaining in-place, the West Ash Pond area will be repurposed as a new low-volume waste pond for the Waukegan Generating Station.

102.3 The East Ash Pond will be closed by leaving the CCR and CCR-mixed materials stored in the pond in-place and installing a final cover system over the pond.

103. SCOPE OF WORK

103.1 In general, this Specification covers the field and laboratory activities for a Construction Quality Assurance (CQA) Contractor to provide assurance and documentation that the East and West Ash Ponds are closed in accordance with the General Work (GW) Specification (W-7900), the Design Drawings, and permit requirements.

103.2 The CQA Work shall include but not be limited to the following:

a. Prepare a CQA Plan that provides a detailed description of the activities that will be performed by the CQA Contractor in accordance with the Design Drawings and this Specification.

b. Verify all appropriate measures are taken by the GW Contractor to protect the West Ash Pond's existing geomembrane liner from damage during material removal and liner decontamination activities at the pond.

c. Verify decontamination of the West Ash Pond's existing geomembrane liner as specified in Section 014362 following material removal and liner decontamination activities performed by the GW Contractor.

d. Perform earthwork inspection and testing work specified in Section 014362 to:

d1. Verify compliance of materials with the GW Specification and Design Drawings.

d2. Perform field material and installation tests.

d3. Obtain samples and perform laboratory tests and/or contract to have laboratory tests performed and audit laboratory test results.

d4. Perform inspections during construction.

e. Perform geosynthetics inspection and testing work specified in Section 014362 to:

e1. Verify compliance of materials with the GW Specification and Design Drawings.

e2. Perform field material and installation tests.

e3. Obtain samples and perform laboratory tests and/or contract to have laboratory tests performed and audit laboratory test results.

e4. Witness field testing and audit field test results.

e5. Perform inspections during construction.

f. Identify non-conforming work.

g. Meetings, Documentation, and Reports:

g1. Participate in project meetings.

g2. Prepare CQA records and documents.

g3. Prepare CQA reports, including:

g3.1 Maintaining an Acceptance Report throughout the project.

g3.2 Preparing and certifying weekly Summary Reports until the end of the project.

g3.3 Preparing and certifying a Final Report at the end of the project.

103.3 The CQA Work shall conform to the requirements of this Specification and shall be performed and supervised by personnel who are experienced and knowledgeable in the crafts and trades required by the Scope of Work. The CQA Work shall be performed exclusively by the CQA Contractor's trained and competent personnel or, where permitted, that of its subcontractor(s); and shall comply with all applicable safety laws, regulations, programs, and practices to ensure the safety of those located on the work site and associated laboratories, including the CQA Contractor's personnel (or that of its subcontractor(s)) performing the CQA Work.

103.4 Performance of the CQA Work shall include all the labor, supervision, administration, management, tools, testing equipment, and consumables to execute the CQA Work identified herein.

103.5 Inspection and tests specified in this Specification shall be performed by personnel qualified to perform such inspections and tests.

104. RESPONSIBILITY AND AUTHORITY

104.1 The responsibilities and authority are described below for the organizations that will be involved in the design, permitting, and construction activities associated with the project.

a. Permitting Authority – Illinois EPA:

a1. The Illinois EPA is the Permitting Authority and is responsible for reviewing the permit applications for closing the East and West Ash Ponds to assure compliance with state regulations and for granting permits for the project.

a2. The Permitting Authority may review any design revisions during construction and any requests for variance submitted by the Owner. The Permitting Authority has the authority to review and approve all CQA documentation and reports and to confirm the East and West Ash Ponds were closed as specified in Project Specifications and the Design Drawings.

b. Owner – MWG:

b1. MWG is the Owner of the facility and has the authority to accept or reject materials and workmanship of the GW Contractor or reports and recommendations of the CQA Contractor.

b2. The Owner will ultimately be responsible for the closure construction for the East and West Ash Ponds and for assuring the Permitting Authority that the construction meets or exceeds the requirements specified in state regulations, permits, Project Specifications, and the Design Drawings. The Owner will accomplish this by retaining a CQA Contractor for the project.

c. Design Engineer: S&L:

c1. S&L is the Design Engineer and is responsible for designing the closures for the East and West Ash Ponds.

c2. The Design Engineer will assure that the design meets the construction requirements of the Owner and meets or exceeds the requirements of the Permitting Authority.

c3. The Design Engineer shall resolve unexpected conditions or unanticipated problems during construction, which may require changes to the permitted design. Changes to the permitted design shall require approval of the Owner and Design Engineer to ensure that the original design objectives are still maintained. All changes shall meet state regulatory requirements and the rules promulgated thereunder and may include Permitting Authority-approved variances to the rules.

d. GW Contractor:

d1. The GW Contractor shall be responsible for constructing the facility in accordance with the GW Specification (W-7900) and the Design Drawings and shall implement additional quality control and quality assurance procedures and techniques as necessary during construction.

d2. The GW Contractor will consist of an Earthwork Contractor performing the earthwork and a Geosynthetics Contractor installing the geosynthetic materials for the East Ash Pond's final cover system. The GW Contractor may self-perform or subcontract the duties of the Earthwork Contractor and/or Geosynthetics Contractor.

e. CQA Contractor:

e1. The CQA Contractor shall be the company employed by the Owner who is responsible for performing the CQA Work. The CQA Contractor shall be objective, competent, and independent from the GW Contractor whose work is being inspected. The CQA Contractor shall remain independent throughout the duration of the project.

e2. The CQA Contractor's team shall include the CQA Officer and two or more CQA Inspectors.

f. CQA Officer:

f1. The CQA Officer shall be a professional engineer licensed in the State of Illinois who shall be responsible for implementation of the CQA Work. The CQA Officer shall be responsible to the Owner.

f2. The CQA Officer shall be responsible for the performance of activities specified herein such as auditing, inspecting, sampling, testing, documenting, and preparing and certifying the Final Report. In addition, the CQA Officer and/or its inspectors shall have the responsibility of daily coordination with CQA Inspectors, the GW Contractor and its subcontractors, and the Owner to discuss daily progress, review completed work, perform visual inspections, review test results, and discuss and assist in resolving any current or potential construction problems.

f3. Except as provided by Paragraph 104.1f4, the CQA Officer shall be present to provide supervision and assume responsibility for performing all inspections of the following activities, when applicable:

f3.1 Compaction of subgrade materials.

f3.2 Installation of the final cover system, including installation of the geomembrane cover.

f4. If the CQA Officer is unable to be present as required by Paragraph 104.1f3, the CQA Officer shall provide the following in writing:

f4.1 The reasons for the CQA Officer's absence.

f4.2 A designation of a person who must exercise professional judgment in carrying out the duties of the CQA Officer-in-Absentia.

f4.3 A signed statement that the CQA Officer assumes full responsibility for all inspections performed and reports prepared by the designated CQA Officer-in-Absentia during the absence of the CQA Officer.

g. CQA Inspectors:

g1. The CQA Inspectors shall be responsible for performing visual examinations and for performing or obtaining field and laboratory tests. The CQA Inspectors shall be under the direct supervision of the CQA Officer.

g2. The CQA Inspectors shall be responsible for reporting to the CQA Officer the results of any inspections or tests indicating materials or installed work are of unacceptable quality or do not meet specified design requirements.

g3. The work will be divided so that two or more CQA Inspectors, each with specialized knowledge and training, will be involved in inspection work.

105. QUALIFICATIONS

105.1 CQA Officer:

a. The CQA Officer shall be a registered professional engineer in the State of Illinois with at least 10 years of experience in design/construction/permitting/licensing, at least 5 years of which is CQA experience as a certifying engineer on landfills or ponds with geomembrane liner systems.

b. The CQA Officer shall be qualified by education, technical knowledge, and experience to complete the technical certifications required by this Specification.

105.2 CQA Inspectors:

a. The CQA Inspectors shall have adequate formal academic training and sufficient practical and technical experience needed to execute and record auditing and inspection activities conducted at the site and perform all required laboratory and field testing. This includes a demonstrated knowledge of the various aspects of the type of work being conducted.

b. As required, different CQA Inspectors, each with specialized knowledge and experience, shall be employed for different portions of the work.

c. CQA Earthwork Inspectors:

c1. The lead CQA field inspector for earthwork (Lead CQA Earthwork Inspector) shall have at least 5 years of experience as an earthwork inspector.

c2. All CQA Earthwork Inspectors shall be knowledgeable in:

c2.1 Field practices relating to construction techniques used for the type of earthwork being performed.

c2.2 Construction and compaction equipment.

c2.3 All codes and regulations concerning material installation.

c2.4 Observation procedures for earthwork construction.

c2.5 Sampling and earthwork testing procedures.

c2.6 Testing equipment.

c2.7 Documentation procedures.

c2.8 Site safety.

d. CQA Geosynthetics Inspectors:

d1. The lead CQA field inspector for geosynthetics (Lead CQA Geosynthetics Inspector) shall have at least 5 years of CQA experience as a field inspector on projects with a geomembrane lining system including two years as a CQA inspector.

d2. All CQA Geosynthetics Inspectors shall be knowledgeable in:

d2.1 Field practice relating to techniques used for the installation of high density polyethylene (HDPE) geomembranes and geotextiles.

d2.2 HDPE geomembrane welding equipment and the correct operating procedures for seaming HDPE.

d2.3 Geotextile seaming equipment and the correct procedures for splicing geotextiles.

d2.4 All codes and regulations concerning material installation.

d2.5 Non-destructive seam testing procedures and failure criteria.

d2.6 Sampling for destructive testing of samples of seams and laboratory testing procedures.

d2.7 Testing equipment.

d2.8 Documentation procedures for field and laboratory tests.

d2.9 Site safety.

106. DEFINITIONS

106.1 The term "Design Drawing" means the Design Engineer's drawings indicating the Work to be performed.

106.2 The term "Work" means the services furnished to complete the CQA activities specified herein.

106.3 The term "Owner-approved equal" means an acceptable equivalent to a specified material or equipment that has been accepted by the Owner.

107. PROJECT MEETINGS

107.1 Project meetings will be held on a periodic basis during the lifetime of the project. The meetings will include:

a. A preconstruction meeting.

b. Progress meetings.

c. Additional meetings as required to discuss problems or work deficiencies.

107.2 Preconstruction Meeting:

a. The preconstruction meeting will be organized by the Owner. In addition to the Owner, the Design Engineer, the GW Contractor (including representatives of the Earthwork Contractor and Geosynthetics Contractor), the CQA Officer (or CQA Officer-in-Absentia), the Lead CQA Inspectors, and any other interested party designated by the Owner shall attend the preconstruction meeting.

b. The preconstruction meeting shall be used to discuss:

b1. Site specific safety requirements.

b2. Requirements of the Design Drawings, GW Specification, and CQA Specification.

b3. The CQA Contractor’s CQA Plan and the responsibilities of each party.

b4. The lines of authority and communication.

b5. Procedure for submittal of manufacturer QA/QC documents for audit.

b6. Procedures for examination of materials delivered to the site.

b7. Location of material storage area(s).

b8. Field and laboratory test requirements and sample sizes.

b9. Procedures for observance of field tests.

b10. Coordination between each contractor and the CQA Inspector to obtain timely field samples and tests.

b11. Procedure for handling construction deficiencies, repairs, and retesting.

b12. Work area security and safety protocol.

b13. Work days and work hours.

b14. Coordination with other contractors or trades.

b15. Site visits.

107.3 Weekly Progress Meetings:

a. Weekly progress meetings will be scheduled by the Owner. In addition to the Owner, the meetings shall be attended by the Design Engineer, the GW Contractor (including representatives of the Earthwork Contractor and the Geosynthetics Contractor), the CQA Officer (or CQA Officer-in-Absentia), and the Lead CQA Inspectors.

b. If needed, daily meetings shall be held each day to review the work schedule, work completed, results of tests, and to discuss potential construction problems.

c. The Owner or its designee will document each meeting and distribute copies of meeting minutes to all responsible parties.

107.4 Additional Meetings:

a. Additional meetings between one or more contractors, the Lead CQA Inspector(s), and the CQA Officer (or the CQA Officer-in-Absentia) shall be held immediately after a work deficiency is identified or a problem arises. These meetings shall be used to define and resolve the problem.

b. Any supervisor/superintendent can request such a meeting through their line of authority.

c. Possible solutions to the problem shall be discussed, and an acceptable solution shall be selected. This solution shall be implemented provided it does not conflict with or require a change to the Design Drawings, in which case the solution shall be submitted to the Design Engineer for review.

d. The Design Engineer shall resolve unexpected conditions or unanticipated problems during construction, which may require changes to the permitted design. Changes from the permitted design shall require approval by the Owner and Design Engineer to ensure that the original design objectives are maintained. All changes shall meet the requirements of the Permitting Authority and may include regulations approved by the Permitting Authority.

e. The CQA Contractor shall document each special meeting and distribute copies of minutes to all responsible parties.

108. PERFORMANCE AUDITS AND DOCUMENTATION

108.1 As a minimum, the CQA Officer shall conduct the following reviews and performance audits:

a. Full review and audit of results of preconstruction testing or GW Contractor's material certificates used to qualify earthwork materials for construction use.

b. Full review and audit of manufacturer certificates that qualify geosynthetic materials and ballast infill materials for use in the final cover system (including geomembrane and synthetic turf).

c. Weekly audit of reports and test data sheets during and after construction of the earthwork until completion of work.

d. Weekly audit of reports and test data sheets during and after installation of geosynthetic materials and ballast infill materials (including geomembrane and synthetic turf) until completion of the work.

108.2 CQA documentation shall be well-documented and include at least the following:

a. Daily records, which shall include:

a1. Inspection data sheets.

a2. Data sheets listing the number and types of construction equipment used by the GW Contractor and construction equipment data.

a3. Problem identification reports and corrective action reports. Problem identification reports and corrective action reports shall include detailed descriptions of materials and/or workmanship that do not meet a specified design and shall be cross-referenced to specific inspection data sheets where the problem was identified and corrected.

b. Testing records, which shall include:

b1. Material shipping and manufacturer QA/QC data sheets.

b2. Data sheets describing field samples taken.

b3. Laboratory data sheets.

b4. Field test data sheets.

b5. Notes, charts, drawings, or sketches identifying the location and elevation of field tests, location of failures and repairs or retests, and where samples were obtained.

b6. Non-destructive test reports including location of failures, records of repairs, and results of retests.

c. Photographic records, which shall include:

c1. Digital photographs, each with a unique identifying number.

c2. Figure indicating the location from which each photograph was taken.

c3. Summary list giving the date and time of each photograph.

108.3 All records shall, at a minimum, bear the following:

a. Unique identifying sheet number.

b. The date.

c. Project name, project number, and location.

d. Descriptive remarks.

e. Data sheets for tests.

f. Written text descriptions for visual observations

g. Signature of the preparer of designated authority.

END OF SECTION 011100

SECTION 014362

CONSTRUCTION QUALITY ASSURANCE FOR CLOSING A CCR SURFACE IMPOUNDMENT

PART 1 – GENERAL

101. EXTENT

101.1 The intent of this section is to define the requirements for Construction Quality Assurance (CQA) activities to ensure that the quality of materials and installation procedures used to close the East and West Ash Ponds are in accordance with the General Work (GW) Specification W-7900, Design Drawings, permit requirements, and as specified herein.

101.2 The Work within this Specification is the responsibility of the CQA Contractor and shall include, but not be limited to, the following items:

a. Attend project meetings and site visits as scheduled by the GW Contractor for coordination between the Owner, GW Contractor, subcontractors, and CQA Contractor.

b. Perform pre-construction material certification activities to ensure materials meet or exceed GW Specification requirements that include but are not limited to:

b1. Testing for suitability of material prior to use.

b2. Performing pre-construction audits of material certifications prior to material use.

c. Perform CQA activities during construction to ensure materials meet or exceed GW Specification requirements:

c1. Perform audits of material certifications.

c2. Perform observations, inspections, and tests.

c3. Review laboratory test data.

c4. Material sampling.

d. Documentation of all observations, samples, certifications, test results, and conformance of work to the GW Specification that will be submitted by the Owner to the Permitting Authority.

e. Prepare a weekly summary report at the end of each week of construction, until construction is complete.

f. After the GW Contractor complete closure construction activities at each ash pond, prepare a Final Report that demonstrates that the given ash pond (*i.e.*, West Ash Pond or East Ash Pond) was closed in conformance with the GW Specification and the Design Drawings. This report shall include all test data, observations, audits, material certificates, and any other relevant documentation.

g. Submit a draft version of each Final Report to the Owner and Design Engineer for their review and comment. Upon resolution of all comments, submit a final version of the Final Report to the Owner and Design Engineer.

102. RELATED WORK SPECIFIED IN OTHER SECTIONS

102.1 CQA Specification (Specification W-7901):

a. Section 011100 – Summary of Work

102.2 GW Specification (Specification W-7900):

a. Section 311522 – Engineered Synthetic Turf for Final Cover System

b. Section 312205 – Earthwork for CCR Surface Impoundment Closure

c. Section 319022 – High Density Polyethylene Geomembrane Liner for Final Cover System

103. REFERENCE DOCUMENTS

103.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

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

103.4 ASTM – ASTM International:

a. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

b. D422 Standard Test Method for Particle-Size Analysis of Soils (Withdrawn 2016).

c. D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

d. D1004 Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

e. D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.

f. D1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

g. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

h. D1603 Standard Test Method for Carbon Black Content in Olefin Plastics.

i. D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

j. D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

k. D2256 Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method.

l. D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

m. D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).

n. D2974 Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils.

o. D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

p. D4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

q. D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

r. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

s. D4643 Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating.

t. D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

u. D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

v. D4959 Standard Test Method for Determination of Water Content of Soil By Direct Heating.

w. D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

x. D5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes.

y. D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.

z. D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

aa. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

bb. D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

104. SUBMITTALS

104.1 Submittals with Bid Proposal:

a. Documentation to substantiate that the CQA Contractor’s and its laboratory’s Accreditation Certifications are current.

b. Detailed resumes on all CQA laboratory and field personnel proposed for the Work, including a complete description of their qualifications and previous experience in the same type of work and documentation of certification to perform required testing.

104.2 Submittals During the Course of the Work:

a. Certifications and submittals as specified herein.

b. Quality Reports shall be submitted on a weekly basis while performing the work.

c. An Index Report, an Acceptance Report, Weekly Summary Reports, and a Final Report as described below shall be prepared for the West Ash Pond, and a second set of reports shall be prepared for the East Ash Pond (*i.e.*, one set of reports per ash pond).

c1. Index Report:

c1.1 An Index Report shall be prepared listing all records and reports.

c1.2 The Index Report shall be assembled in chronological framework for recording and identifying all reports.

c2. Acceptance Report:

c2.1 All reports and data sheets shall be assembled and summarized into an Acceptance Report in order to verify that the materials and construction procedures comply with the specified design. As a minimum, this report shall contain all inspection reports, inspection data sheets, problem identification reports and corrective action reports.

c2.2 The Acceptance Report shall be prepared by the CQA Inspectors and updated on a daily basis.

c3. Weekly Summary Report:

c3.1 At the end of each week of construction, until construction is complete, a Summary Report must be prepared by either the CQA Officer or under the supervision of the CQA Officer and submitted to the Owner. The CQA Officer must review and approve the Summary Report.

c3.2 The Summary Report shall contain descriptions of the weather, locations where construction occurred during the previous week, materials used, results of testing, inspection reports, and procedures used to perform the inspections.

c4. Final Report:

c4.1 A Final Report for the earthwork and the installation of the geosynthetic materials shall be prepared by the CQA Officer. The Final Report shall contain all data sheets, testing records, manufacturer data sheets, reports and photographs concerning items which were installed and tested. This report shall contain documentation that construction proceeded in accordance with the Design Drawings, Project Specifications, and permit requirements.

c4.2 The Final Report shall also include a certification (sealed by the CQA Officer) that the GW Contractor's work is in compliance with the Design Drawings, Project Specifications, and permit requirements. When applicable, the report shall also include the following certifications (sealed by the CQA Officer) pursuant to 35 Ill. Adm. Code 845.290(b)(3):

c4.2.1 All bedding material contains no undesirable objects.

c4.2.2 The final closure plan approved by the construction permit issued by the Illinois Environmental Protection Agency has been followed.

c4.2.3 All anchor trenches and backfill were constructed to prevent damage to the geomembrane.

c4.2.4 All tears, rips, punctures, and other damage have been repaired.

c4.2.5 All geomembrane seams have been properly constructed and tested in accordance with the manufacturer's specifications.

c4.2.6 The CCR material in the East Ash Pond was appropriately stabilized prior to placement of Structural Fill and/or final cover system materials.

c4.3 The Final Report shall be submitted within 2 weeks after completion of CQA Work.

105. <u>CONSTRUCTION QUALITY ASSURANCE REQUIREMENTS</u>

105.1 General:

a. This section describes the CQA activities that shall be performed to assure the quality of materials and construction procedures used to close the East and West Ash Ponds. These activities are intended to ensure that the materials and construction procedures used to close the East and West Ash Ponds meet the GW Specification requirements and to provide assurance that the ash ponds have been closed in manners that meet or exceed the requirements stated on the Design Drawings and in the GW Specification.

105.2 Organizations Involved:

a. The organizations involved in the design, permitting, and construction activities associated with the Work are defined in Section 011100.

b. The responsibilities and authority of the organizations and personnel associated with the Work are defined in Section 011100.

105.3 Qualifications:

a. The qualifications of the CQA Contractor personnel are described in Section 011100.

105.4 Project Meetings and Audits:

a. The requirements for project meetings and audits are described in Section 011100.

105.5 Performance Audits and CQA Documentation:

a. The requirements for performance audits and CQA documentation are described in Section 011100.

<u>PART 2 – PRODUCTS</u>

201. <u>PRODUCTS</u>

201.1 The requirements for the various products used for the construction of the impoundment are specified in their respective technical specification sections in the GW Specification.

201.2 All permanent materials to be used in the Work are supplied by the GW Contractor. The GW Contractor and CQA Contractor shall coordinate obtaining materials for testing by the CQA Contractor.

PART 3 – EXECUTION

301. GENERAL CQA TESTING AND INSPECTION REQUIREMENTS

301.1 Record daily atmospheric conditions.

301.2 Field tests shall document the elevation and coordinate location for each test. The locations may be determined by survey, taping, pacing off distances, or hand-held GPS receiver provided the receiver indicates an error of 20 ft or less at the time the coordinates are recorded. All locations should be reported in appropriate significant figures. Locations of seams, damage to geosynthetics, and repairs to geosynthetics shall be obtained through quality survey methodologies.

301.3 Material Source Testing: Material source testing activities include visual observations and laboratory and field testing at the material source to control material quality and material preparation prior to transport of the material to the facility.

302. CQA TESTING AND INSPECTION REQUIREMENTS FOR EXISTING LINER DECONTAMINATION ACTIVITIES (WEST ASH POND)

302.1 Testing During Construction:

a. CQA activities during removal of material from and decontamination of the West Ash Pond's existing geomembrane liner shall include visual observations and field testing to verify the liner has been decontaminated in accordance with the Design Drawings.

b. Visual Observations:

b1. Observe and record method(s) of material removal and decontamination.

b2. Verify the GW Contractor is taking necessary precautions to avoid damaging the geomembrane liner.

b3. Verify the GW Contractor has developed and is implementing fugitive dust controls in accordance with 35 Ill. Adm. Code 845.740(c)(2).

b4. Verify the GW Contractor has developed and is implementing measures to prevent contamination of surface water, groundwater, soil, and sediments in accordance with 35 Ill. Adm. Code 845.740(c)(4).

b5. Verify all material removal and decontamination work is performed in a systematic manner to remove all ash and ash residuals from the liner surface.

b6. Verify the GW Contractor is providing adequate temporary loading on exposed liner areas to prevent uplift of the geomembrane by wind by the use of sandbags and/or other means which will not damage the geomembrane.

b7. For areas of geomembrane that are damaged, record location and nature of damage, and verify the GW Contractor addresses the damaged areas as specified on the Design Drawings.

b8. Record location and size of all samples obtained from existing liner, and verify the GW Contractor repairs all locations of the geomembrane from which samples are obtained for verification of decontamination.

c. Laboratory and Field Tests:

c1. Perform an electrical leak location survey over decontaminated liner areas as specified on the Design Drawings.

c2. Collect samples of the existing geomembrane liner for verification of decontamination by laboratory testing as specified on the Design Drawings.

c3. Perform laboratory testing of existing geomembrane liner samples as specified on the Design Drawings.

d. Test Acceptance Criteria:

d1. Laboratory and field test acceptance criteria shall be as specified on the Design Drawings.

d2. If the results from any of the laboratory and field tests do meet the respective pass/fail thresholds, then the CQA Officer shall reject all existing geomembrane liner areas corresponding to the failed test(s) as decontaminated.

303. CQA TESTING AND INSPECTION REQUIREMENTS FOR SUBGRADE (CCR) TO RECEIVE STRUCTURAL FILL OR GEOMEMBRANE (EAST ASH POND)

303.1 Testing During Construction:

a. CQA activities during subgrade preparation work shall include visual observations and field testing to ensure that subgrade (CCR) preparation for Structural Fill is in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-1 and the following paragraphs.

b. Visual Observations:

b1. Record type and size of compaction equipment in use:

b1.1 For rubber-tired rollers, record the tire inflation pressure, spacing of tires, and empty and ballasted wheel loads.

b1.2 For vibratory rollers, record the static weight, imparted dynamic force, operating frequency of vibration, and drum diameter and length.

b1.3 For hand tampers, record make, model number, size and compactive effort.

b2. Observe and record compactive effort, uniformity of compaction and scarification and connection between compacted lifts. Record number of passes of a roller by type, size, and weight of roller.

b3. For proofrolling, record the type, size, and weight of compaction equipment or other vehicles used for proofrolling.

b4. Observe removal of all organic and undesirable material.

b5. Observe that there are no moisture seeps, puddling, or ponding.

b6. Observe proofrolling to identify soft spots, and observe removal of material in soft spots.

b7. Observe compaction of the subgrade prior to placement of the proceeding layer of material. For areas of the subgrade on which the geomembrane component of the final cover system will be directly placed, inspect for any large, protruding, or sharp material that could puncture a geomembrane.

b8. Verify measurements and determine that the depth and slope of all excavations meet design requirements and that there are no slope failures from moisture seeps or other causes.

c. Laboratory and Field Tests:

c1. Laboratory testing and field testing for subgrade shall be performed in accordance with the requirements specified in Table 014362-1.

d. Test Acceptance Criteria:

d1. Acceptance criteria for subgrade approval shall be as specified in GW Specification Section 312205.

304. <u>CQA TESTING AND INSPECTION REQUIREMENTS FOR STRUCTURAL FILL MATERIAL (EAST ASH POND)</u>

304.1 Initial Material Certification:

a. Inspect the onsite sand stockpile and identify areas that are not appropriate to be used as Structural Fill per the GW Specification. Perform sampling of the stockpile material to obtain appropriate test samples to prequalify the onsite sand stockpile for use as Structural Fill in accordance with the Design Drawings and the GW Specification.

304.2 Testing During Construction:

a. CQA activities during placement of Structural Fill shall include visual observations and field testing to ensure that Structural Fill is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-2 and the following paragraphs.

b. Visual Observation of the Material Source for Structural Fill Material During Construction:

b1. Inspect materials to ensure that they are uniform.

b2. Visually inspect the material in accordance with ASTM D2488.

b3. Inspect to ensure that only suitable material is transported to the site or obtained from onsite cuts or borrow areas, observe segregation operations when unsuitable materials are present, and observe removal of organic soils, roots, stumps, and stones.

b4. Observe changes in color or texture that can be indicative of a change in material type or moisture content.

b5. Observe moisture conditioning activities to ensure that any required substantial changes in moisture content are made at the source.

c. Visual Observation of Fill Placement:

c1. Record type and size of compaction equipment in use:

c1.1 For rubber-tired rollers, record the tire inflation pressure, spacing of tires, and empty and ballasted wheel loads.

c1.2 For vibratory rollers, record the static weight, imparted dynamic force, operating frequency of vibration, and drum diameter and length.

c1.3 For hand tampers, record make, model number, size and compactive effort.

c1.4 Observe and record compactive effort, uniformity of compaction and scarification and connection between compacted lifts. Record number of passes of a roller by type, size, and weight of roller.

c1.5 For proofrolling, record the type, size, and weight of compaction equipment or other vehicles used for proofrolling.

c2. Observe removal of roots, rocks, rubbish, or out-of-specification soil from the borrow material.

c3. Observe and record changes in soil characteristics necessitating a change in construction procedures.

c4. Observe fill placement and procedures for proper fill thickness.

c5. Observe procedures to be followed to adjust the soil moisture content to obtain uniform moisture content.

c6. Observe and record final finishing procedures.

c7. Observe and record that final grade is consistent with the design grade specified on the Design Drawings in the GW Specification.

c8. Observe that there is proper placement and compaction of any backfill around recessed areas, pipes, or sumps.

d. Laboratory and Field Tests:

d1. Laboratory and field testing shall be performed in accordance with the requirements specified in Table 014362-2.

e. Test Acceptance Criteria:

e1. Acceptance criteria shall be as specified in GW Specification Section 312205.

305. <u>CQA TESTING AND INSPECTION REQUIREMENTS FOR GEOMEMBRANE COMPONENT OF FINAL COVER SYSTEM (EAST ASH POND)</u>

305.1 Initial Material Certification:

a. Prior to shipment of any geomembrane materials, the CQA Contractor shall assemble and document the receipt of and audit the Geomembrane Manufacturer submittals listed below for conformance with the GW Specification.

a1. Geomembrane Resin:

a1.1 Certificate that the resin meets GW Specification requirements.

a1.2 Certificate of the origin of the resin and that all resin is from the same manufacturer (name, identification brand name and number).

a1.3 Copies of the Geomembrane Manufacturer’s QA/QC certificates for the geomembrane resin. Certificates shall include a summary report of test results conducted to verify the quality of the resin used in each batch to manufacture geomembrane for this project. As a minimum, the report shall include tests on specific gravity, melt flow index and percent carbon black.

a2. Geomembrane Sheeting:

a2.1 Certification that the properties of the manufactured sheeting meet GW Specification requirements and are guaranteed by the Geomembrane Manufacturer.

a2.2 Statement certifying that no post consumer resin (PCR) has been added to the formulation.

a2.3 Copies of all of the Geomembrane Manufacturer's QA/QC certificates for the geomembrane sheeting. The certificates shall include test results.

a3. Extrudate Resins or Rod for Seaming Geomembrane:

a3.1 Certification from the Geomembrane Manufacturer that all extrudate is the same resin type as the geomembrane and was obtained from the same resin supplier as the resin used to manufacture the geomembrane.

b. Geomembrane Field Installation Quality Control (QC) Plan:

b1. Document receipt of the GW Contractor’s QC plan for installing geomembrane.

b2. Review the plan for compliance with the GW Specification and document where the plan is not in compliance.

c. Geomembrane Panel Layout:

c1. Document receipt of the GW Contractor’s panel layout for geomembrane.

305.2 Transportation, Handling, and Storage:

a. Documentation of Delivery:

a1. Document arrival of rolls of geomembrane.

a2. Document that each roll is marked with the following information:

a2.1 Name of Geomembrane Manufacturer.

a2.2 Product identification, which can be traced back to the origin of the base material (resin supplier’s name, resin production plant, resin brand name type, resin brand number, and production date of the resin).

a2.3 Date of manufacture of the geomembrane.

a2.4 Roll identification number.

a2.5 Geomembrane thickness and type.

a2.6 Roll dimensions (length and width).

a2.7 Batch number.

a2.8 Order number.

a2.9 Panel number.

a3. Check the Quality Control certificates on each roll to verify that the rolls received onsite meet the GW Specification. Take photograph or copy the identifying labels from each roll or pallet and save them for future reference.

a4. Recommend rejection of rolls which do not have the required documentation and ensure that the rolls are removed from the site.

b. Inspection of Manufactured Rolls:

b1. Inspect all manufactured rolls upon delivery to the site.

b2. Ensure that packaging is secure and that no damage has occurred.

b3. If damage to packaging has occurred, inspect exposed roll surfaces, and note and identify any damage or repairable flaws. Note: This visual observation shall be conducted without unrolling rolls unless the extent of surface damage indicates that internal damage may be present.

b4. If damage to just the packaging has occurred, document repair of the packaging.

b5. If damage to the product has occurred, document that the damage or flaws are repaired or that the damaged material is wasted and removed from the site.

b6. Report all damage to the Owner.

c. Handling:

c1. Inspect the onsite handling equipment being used to move materials to ensure that it is adequate to minimize the risk of damage to materials.

c2. Inspect the handling of materials by installing personnel to ensure that care is used.

d. Storage:

d1. Inspect the storage facility.

d2. Inspect the ground surface to ensure that it is dry, relatively level, smooth and free of rocks, holes, and debris.

d3. Document unsafe or improper storage conditions.

305.3 Preconstruction Testing:

a. Prior to material shipment to the site, the Geomembrane Manufacturer shall submit to the CQA Contractor representative samples of the geomembrane to be shipped to the site, along with chain of custody and certification that the samples submitted are from the geomembrane material to be delivered to the site. The CQA Geosynthetics Inspector shall perform conformance testing of the received geomembrane samples in accordance with Table 014362-5. The laboratory tests shall be performed at least at the corresponding minimum frequencies specified in Table 014362-5.

b. Test acceptance criteria shall be as specified in GW Specification Section 319022. If the results from any of the tests in Table 014362-5 do not meet the respective pass/fail thresholds, then the CQA Officer shall reject all geomembrane material from the resin batch corresponding to the failed test(s) for use in the project.

305.4 Testing During Construction:

a. CQA activities during placement of the geomembrane component of the ClosureTurf® final cover system shall include visual observations and field testing to ensure that the geomembrane cover is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-5 and the following paragraphs.

b. Weather Conditions for Placement:

b1. Observe and document the weather conditions (i.e., temperature, humidity, precipitation, and wind) to ensure that they are acceptable for geosynthetic material placement and seaming. The GW Specification describes acceptable weather conditions.

b2. If the weather becomes unacceptable for installation of the geosynthetic materials, recommend stopping the installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.

c. Geomembrane Placement:

c1. Prior to placement of the geomembrane cover, visually inspect the surface to be covered to ensure that it meets the requirements of the GW Specification. Confirm that it is compacted, free from clods of soil, rocks larger than specified, roots, sudden or sharp changes in grade and standing water. Field observations shall be performed in accordance with the requirements specified in Table 014362-3.

c2. Provide documentation of daily inspection of the surface to be covered for the area of geomembrane to be placed that day.

c3. Observe and document that the GW Contractor’s geomembrane placement plan is being followed. Note where the plan is not being followed and document the GW Contractor’s reasons for not following the plan. As each panel is placed, visually inspect the geomembrane for tears, punctures, and thin spots. The CQA Geosynthetics Inspector shall traverse the panels in such a way that the entire surface is inspected. Any defects shall be documented on a drawing and marked on the geomembrane for repair.

c4. Document that the locations of geomembrane seams meet the general requirements for seaming contained in GW Specification Section 319022.

c5. At the time of placement, make measurements to confirm that required overlap of adjacent geomembrane sheets has been achieved, that proper temporary anchorage is being used (e.g., sand bags or tires), and that the geomembrane is being placed in a relaxed (nonstressed) state.

c6. Document any liner damage from adverse weather conditions, equipment, inadequate temporary anchoring, or rough handling. Mark the location of damage on the geomembrane for repair and on a drawing.

c7. Document improper liner placement (if the placement plan is not followed) and, as a result, inadequate coverage with the available materials or an excess number of field seams.

c8. Document inadequate sheet overlap resulting in poor quality seams.

c9. Document nonwelded or cut panels.

c10. Document repair of damage. Documentation shall include location, type, and method of repair.

d. Geomembrane Seaming and Seam Repair:

d1. Trial Welds Prior to Beginning Seaming:

d1.1 Observe that trial welds are being made at the frequency specified in GW Specification Section 319022.

d1.2 Observe fabrication of test strips and note that test strips are fabricated correctly.

d1.3 Specify where samples are to be cut from the test strips and witness all destructive tests.

d1.4 Observe documentation of results of the destructive tests by the GW Contractor.

d1.5 Audit documentation of each trial weld received from the GW Contractor.

d2. Seaming and Seam Repair: Activities that shall be documented during field seaming operations include:

d2.1 Observe that the geomembrane is free from dirt, dust, and moisture.

d2.2 Observe that the seaming materials and seam welding equipment are as specified.

d2.3 Observe that a firm foundation is available for seaming.

d2.4 Observe that geomembrane overlap and panel adjustment are correct prior to seaming.

d2.5 For extrusion welding, observe that the geomembrane is pre-beveled and the geomembrane is properly abraded and that the panels are temporarily bonded.

d2.6 Observe that grind marks are covered with extrudite.

d2.7 Observe weather conditions (e.g., temperature, humidity, wind) to ensure that they are acceptable for seaming.

d2.8 Measurements of temperatures, pressures, and speed of seaming to ensure that they are as specified. Gages and dials on seaming equipment shall be checked and readings recorded.

d2.9 Observe that the geomembrane is not damaged by equipment or personnel during the seaming process.

d2.10 Observe that no solvents or adhesives are used.

e. Anchor Trench:

e1. Field measurements, observations, and testing shall be performed in accordance with the requirements specified in Table 014362-4.

e2. Measurements:

e2.1 Perform measurements of the anchor trench to ensure that the trench width, depth, and location is as specified on the Design Drawings.

e3. Observations:

e3.1 Observe that the trench corners are rounded as specified.

e3.2 Observe that good housekeeping practices are followed in the trenching operation by not allowing soil to fall back into the trench or down the slope and not allowing water to pond in the trench.

e3.3 Observe that the trench is backfilled as soon as possible and compacted such that the geomembrane (both geomembranes and the synthetic turf (if applicable)) are not damaged.

f. Anchorage to Objects:

f1. Where the Design Drawings specify attaching / anchoring the geomembrane to objects (*e.g.*, concrete structures), CQA Geosynthetics Inspectors shall make the following inspections, at a minimum:

f1.1 Observations to ensure that all objects that are placed adjacent to the geomembrane (i.e., batten bars, soil in an anchor trench) are smooth and free of objects or conditions that may damage the geomembrane.

f1.2 Observations to ensure that all anchors are complete:

f1.3 No gaps or areas of uncompacted backfill.

f1.4 Batten bars of the specified material, width, and thickness and prepunched at the specified spacing.

f1.5 Anchor bolts of the specified size and material.

f1.6 Anchor bolts spaced as specified.

f2. Observations to confirm that all cover connections are installed as specified. Cover connections shall be verified for appropriate clamp and caulking use, for appropriate material, for good seaming, and for good housekeeping practices. No sharp bends on foundations (concrete pads) shall be allowed. Soil compaction adjacent to concrete pads shall be performed as specified to prevent differential settlement.

g. Geomembrane Production Seam Testing:

g1. Non-Destructive: Activities to be observed and documented include the following:

g1.1 Observe that 100 percent of the seam lengths are tested using non-destructive procedures.

g1.2 Observe that testing is performed as seaming progresses.

g1.3 Observe that the correct procedures are used for testing each type of seam.

g1.4 Observe all non-destructive test procedures.

g1.5 For air pressure testing, observe that the equipment, procedures, and air pressure meet specified requirements. Observe that all testing is properly documented.

g1.6 For vacuum box testing, observe that testing is being performed correctly.

g1.7 For inaccessible seams, observe that a procedure acceptable to the Owner is used to test the seams.

g1.8 Observe that all leaks are marked, recorded as to location, and repaired.

g1.9 Observe that repairs are made in accordance with approved techniques.

g1.10 Observe that all repairs are re-tested and that no leakage is present.

g1.11 Review leakage data for possible patterns. Make suggestions to the GW Contractor if data shows a consistent pattern of failure of a particular machine or crew.

g1.12 Audit documentation of testing prepared by the GW Contractor to make sure that the location of leaks is identified on the drawings.

g2. Destructive:

g2.1 Destructive seam testing shall be performed at specific frequencies.

g2.2 The CQA Geosynthetics Inspector shall specify the location where each sample shall be taken and record data for each sample.

g2.3 The CQA Geosynthetics Inspector shall designate any additional test locations that may be necessary. These locations may be based on the suspicion of contamination by dirt or moisture, change in seaming materials, increase in failed nondestructive tests, and other causes that could result in unacceptable seams.

g2.4 Laboratory testing shall be performed in accordance with the GW Specification Section 319022. Predetermined pass/fail values are specified in that section.

g2.5 Audit and document the results of laboratory testing on seam samples. Note any sample that does not pass and identify the location on the geomembrane for repair in the field and on the drawings.

g3. Repair of Failed Seams:

g3.1 For field seams that fail, the seam can either be reconstructed between the failed and any previous passed seam location or the installer can go on either side of the failed seam location (10-foot minimum), take another sample, test it and if it passes, reconstruct the seam between the two locations. If it fails, the process shall be continued. In all cases, acceptable seams must be bounded by two passed test locations. The CQA Geosynthetics Inspector shall document the procedure used and results of tests.

g3.2 Document that repairs are made. Documentation shall include location, type, and method of repair.

306. <u>CQA TESTING AND INSPECTION REQUIREMENTS FOR ENGINEERED SYNTHETIC TURF COMPONENT OF FINAL COVER SYSTEM (EAST ASH POND)</u>

306.1 Initial Material Certification:

a. Prior to shipment of any synthetic turf materials, the CQA Contractor shall assemble and document the receipt of and audit the Synthetic Turf Manufacturer submittals listed below for conformance with the GW Specification:

a1.1 Certification that the properties of the synthetic turf panels meet GW Specification requirements and are guaranteed by the Synthetic Turf Manufacturer.

a1.2 Copies of the Synthetic Turf Manufacturer’s Quality Control and Construction Quality Control Plans. The plans shall include the inspection records and test results required by the GW Specification.

306.2 Transportation, Handling, and Storage:

a. Documentation of Delivery:

a1. Document arrival of rolls of synthetic turf.

a2. Document that each roll is marked with the following information:

a2.1 Name of Synthetic Turf Manufacturer.

a2.2 Product identification.

a2.3 Date of manufacture of synthetic turf.

a2.4 Lot number.

a2.5 Roll identification number.

a3. Check the Quality Control certificates on each roll to verify that the rolls received onsite meet the GW Specification. Take photographs or copies of the identifying labels from each roll or pallet and save them for future reference.

a4. Recommend rejection of rolls which do not have the required documentation and ensure that the rolls are removed from the site.

b. Inspection of Manufactured Rolls:

b1. Inspect all manufactured rolls upon delivery to the site.

b2. Ensure that packaging is secure and that no damage has occurred.

b3. If damage to packaging has occurred, inspect exposed roll surfaces, and note and identify any damage or repairable flaws. Note: This visual observation shall be conducted without unrolling rolls unless the extent of surface damage indicates that internal damage may be present.

b4. If damage to just the packaging has occurred, document repair of the packaging.

b5. If damage to the product has occurred, document that the damage or flaws are repaired or that the damaged material is wasted and removed from the project site.

b6. Report all damage to the Owner.

c. Handling:

c1. Inspect the onsite handling equipment being used to move materials to ensure that it is adequate to minimize the risk of damage to materials.

c2. Inspect the handling of materials by installing personnel to ensure that care is used.

d. Storage:

d1. Inspect the storage facility.

d2. Inspect the ground surface to ensure that it is dry, relatively level, smooth and free of rocks, holes, and debris.

d3. Document unsafe or improper storage conditions.

306.3 Preconstruction Testing:

a. Prior to material shipment to the site, the Synthetic Turf Manufacturer shall submit to the CQA Contractor representative samples of the synthetic turf material to be shipped to the site, along with chain of custody and certification that the samples submitted are from the synthetic turf material to be delivered to the site. The CQA Geosynthetics Inspector shall perform conformance testing of the received synthetic turf samples in accordance with Table 014362-6. The laboratory tests shall be performed at least at the corresponding minimum frequencies specified in Table 014362-6.

b. Test acceptance criteria shall be as specified in GW Specification Section 311522. If the results from any of the tests in Table 014362-6 do not meet the respective pass/fail thresholds, then the CQA Officer shall reject all synthetic turf material from the lot corresponding to the failed test(s) for use in the project.

306.4 Testing During Construction:

a. CQA activities during installation of the synthetic turf component of the ClosureTurf® final cover system shall include visual observations and field testing to ensure that the synthetic turf is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-6 and the following paragraphs.

b. Weather Conditions for Placement:

b1. Observe and document the weather conditions (i.e., temperature, humidity, precipitation, and wind) to ensure that they are acceptable for geosynthetic material placement and seaming. The GW Specification describes acceptable weather conditions.

b2. If the weather becomes unacceptable for installation of the geosynthetic materials, recommend stopping the installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.

c. Synthetic Turf Placement:

c1. Prior to placement of the synthetic turf cover, visually inspect the geomembrane surface to be covered to ensure that it meets the requirements of the GW Specification (i.e., has been seamed, tested, and approved for further ClosureTurf® component deployment). Confirm that it is substantially free of debris and/or large scraps. Field observations shall be performed in accordance with the requirements specified in Table 014362-6.

c2. Provide documentation of daily inspection of the surface to be covered for the area of synthetic turf to be placed that day.

c3. As each synthetic turf panel is placed, visually inspect the panel for tears, punctures, and thin spots. The CQA Geosynthetics Inspector shall traverse the panels in such a way that the entire surface is inspected. Any defects shall be documented on a drawing and marked on the synthetic turf for repair.

c4. Document that the locations of synthetic turf splices meet the general requirements for seaming contained in GW Specification Section 311522.

c5. During placement:

c5.1 Make measurements to confirm that required overlap of adjacent synthetic turf sheets has been achieved, that proper temporary anchorage is being used (e.g., sand bags or tires), and that the synthetic turf is being placed in a relaxed (nonstressed) state.

c5.2 Observe and verify that tufts in the synthetic turf are not excessively pulled out by the installation process.

c5.3 Observe and verify that the first synthetic turf panel deployed on a slope has the turf filaments facing upward.

c5.4 Observe and verify that the turf filaments in all synthetic turf panels are pointed upslope after deployment is complete.

c5.5 Observe and verify that equipment being used to place the synthetic turf panels does not damage the synthetic turf or underlying geomembrane.

c6. Document any panel damage from adverse weather conditions, equipment, inadequate temporary anchoring, or rough handling. Mark the location of damage on the synthetic turf for repair and on a drawing.

c7. Document improper synthetic turf panel placement and, as a result, inadequate coverage with the available materials or an excess number of field seams.

c8. Document inadequate sheet overlap resulting in poor quality seams.

c9. Document nonwelded or cut panels.

c10. Document repair of damage. Documentation shall include location, type, and method of repair.

d. Synthetic Turf Splicing and Seam Repair:

d1. Trial Welds Prior to Beginning Seaming:

d1.1 If successive synthetic turf panels are to be spliced by welding, observe that trial welds are being made at the frequency specified in GW Specification Section 311522.

d1.2 Observe fabrication of test strips and note that test strips are fabricated correctly.

d1.3 Specify where samples are to be cut from the test strips and witness all peel/pull tests.

d1.4 Observe documentation of results of the peel/pull tests by the GW Contractor.

d1.5 Audit documentation of each trial weld received from the GW Contractor.

d1.6 Document the following information for each trial weld:

d1.6.1 Names of the seaming personnel.

d1.6.2 Name of the fusion seaming technician.

d1.6.3 The welding apparatus number and temperature.

d1.6.4 Date, time, and ambient air temperature.

d2. Splicing and Seam Repair. Activities that shall be documented during field splicing operations include:

d2.1 Observe that the synthetic turf is free from dirt, dust, and moisture.

d2.2 Observe that synthetic turf panel overlap and adjustment are correct prior to splicing.

d2.3 Observe that the synthetic turf is not damaged by equipment or personnel during the splicing process. Observe that any damages or defects are repaired in accordance with the GW Specification and/or the Synthetic Turf Manufacturer's recommendations.

d2.4 For synthetic turf panels spliced by sewing:

d2.4.1 Observe that the sewing materials and equipment are as specified in GW Specification Section 311522.

d2.4.2 Observe that seams are sewn as specified in GW Specification Section 311522.

d2.5 For synthetic turf panels spliced by fusion welding (heat bonding):

d2.5.1 Observe that the seaming materials and seam welding equipment are as specified.

d2.5.2 Observe weather conditions (e.g., temperature, humidity, wind) to ensure that they are acceptable for seaming.

d2.5.3 Measurements of temperatures, pressures, and speed of seaming to ensure that they are as specified. Gages and dials on seaming equipment shall be checked and readings recorded.

d2.5.4 Observe that no solvents or adhesives are used.

307. CQA TESTING AND INSPECTION REQUIREMENTS FOR BALLAST INFILL MATERIAL

307.1 Initial Material Certification:

a. Prior to shipment of any materials, the CQA Contractor shall assemble, document the receipt of, and audit the material supplier's test results and certification(s) that the properties of the material(s) meet GW Specification requirements.

307.2 Testing During Construction:

a. CQA activities during placement of Ballast Infill shall include visual observations and field testing to ensure that Ballast Infill is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-7 and the following paragraphs.

b. Visual Observation of Infill Placement:

b1. Record type of equipment in use.

b2. Observe installation method(s) are consistent with the method(s) presented to the Owner by the Ballast Infill Installer during the pre-construction meeting.

b3. Observe the Ballast Infill material is worked into the synthetic turf between the synthetic yarn blades.

b4. Observe that the underlying geomembrane and synthetic turf components are not displaced or damaged.

b5. Observe that Ballast Infill material is not placed when snow and/or ice are present on the synthetic turf.

c. Laboratory and Field Tests:

c1. Laboratory and field testing shall be performed in accordance with the requirements specified in Table 014362-7.

d. Test Acceptance Criteria:

d1. Acceptance criteria shall be as specified in GW Specification Section 311522.

308. SAMPLING PATTERN

308.1 The CQA Officer shall establish a completely random sampling pattern for determining the choice of sampling points for field tests. Each block of work shall be subdivided into a sampling grid with at least 10 times as many grids as samples or tests to be taken or as directed by the Owner. The grid shall have a numeric identification system devised to distinguish each set of tests for a specific area from all other sets of tests. Each lift shall have a separate grid.

308.2 Sampling points shall be chosen by a random number generator or other acceptable method to obtain uniform coverage. Tests shall be numbered beginning with test number one (1) and no numbers shall be skipped. In areas where a test of any type fails to meet specification criteria and a retest is performed, the retest shall have the same test number as the original test except that an “R” shall follow the test designation.

309. VERIFICATION AND CALIBRATION

309.1 Verification of Selected Field Tests:

a. The following tests shall be verified at the following frequency:

Test Requiring Verification	Frequency of Verification Test
Nuclear In-Place Density and Nuclear In-Place Moisture Content, ASTM D 6938	Note 1
“Quick” Moisture Content Test Using Microwave, (ASTM D4643) or Gas Stove, Frying Pan, or Infrared Oven, (ASTM D4959), etc.	One standard oven-dry moisture content (ASTM D2216) test per 20 quick tests.
Lift Thickness Measured Using a Shaft or Shovel	One lift thickness verified by surveying every two acre-lifts.

Notes:

1 – A standard block test as required by ASTM D6938 shall be performed at the start of each day on each Nuclear apparatus that will be used that day. At the start of earthwork construction, a series of five Nuclear tests and five sand cone or rubber balloon tests shall be performed in the borrow area, or area to be excavated, on a compacted test strip to calibrate the Nuclear apparatus. During construction, one of the last Nuclear readings performed at the end of each day shall be verified using a sand cone (ASTM D1556) or rubber balloon (ASTM D2167) density and moisture content test for each apparatus used that day. The average wet density and moisture content for each apparatus shall be computed for every ten tests. If variations greater than those permitted by the ASTM’s occur, corrections shall be applied to all future tests for the apparatus until the next set of 10 tests is performed.

309.2 Calibration:

a. Procedures for calibration of field and laboratory testing equipment shall be submitted by the CQA Contractor prior to the start of testing. These procedures shall meet ASTM requirements.

310. CORRECTIVE ACTION PROCEDURES

310.1 Failure of Material Quality Tests:

a. The GW Contractor and the Owner shall be notified immediately if gradation or Atterberg limits tests do not meet acceptance criteria. Failure to meet acceptance criteria of one or more of these groups of tests may indicate problems with the quality of soil materials. The GW Contractor shall cease all construction activities until the source of the problem or “out-of-specification” materials is identified.

310.2 Failure of Field Density or Moisture Content Tests:

a. If the results of field density or moisture content tests fail to meet acceptance criteria, those tests shall be re-run after recompaction. Judgment shall be used to select re-test locations suspected of having lower than specified density or moisture content. If the results of the re-test meet specification requirements, the compaction can be considered acceptable. If the results of the re-tests show out-of-specification densities or moisture contents, the CQA Officer shall immediately inform the Owner of the extent of the defective area. The defective area shall be removed and reconstructed or recompacted by the GW Contractor.

TABLE 014362-1

CQA FOR SUBGRADE (CCR)

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Proofrolling of subgrade	Observation		Continuous
2	Field Density / Soil Compaction	Nuclear Density Gauge, Sand Cone or Rubber Balloon Method	ASTM D6938, ASTM D2167, or ASTM D1556	Four per acre of compacted subgrade. Four additional tests per lift per acre of any regrading or fill. One per 500 cubic yards.
3	Field Moisture content	Nuclear Density Gauge or Direct Heat Method	ASTM D6938 or ASTM D4959	At each field density test location
4	Lift thickness, uncompacted	Direct Measurement		Four times per acre per lift
5	Moisture-density curve	Proctor or Index Density	ASTM D2216 and: • ASTM D1557, or • ASTM D4253 and ASTM D4254	One per 2 acres of compacted subgrade. One per 4 acres per lift fill and when changes in material are observed.

TABLE 014362-2

CQA FOR STRUCTURAL FILL MATERIAL

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Moisture Density Curve	Proctor	ASTM D2216 and: • ASTM D1557, or • ASTM D4253 and ASTM D4254	One per 30,000 cubic yards, and for all changes in material.
2	Soil Index Properties	Atterberg Limits (Note: If the fill is non-plastic, verify and document test is not required.)	ASTM D4318	One for each moisture density curve sample.
3	Soil Index Properties	Grain Size	ASTM D422	One for each moisture density curve sample.
4	Field Density / Soil Compaction	Nuclear Density Gauge, Sand Cone or Rubber Balloon Method	ASTM D6938, ASTM D2167, or ASTM D1556	Four per acre per lift.
5	Field Moisture content	Nuclear Density Gauge or Direct Heat Method	ASTM D6938, ASTM D4959, or ASTM D2978	At each field density test location.
6	Uncompacted and Compacted Thickness of Each Lift	Direct measurement		Four per acre per lift.
7	Fill Lines and Grades	Surveying		One per 100-foot grid spacing and at grade breaks.

TABLE 014362-3

CQA FOR AREAS TO RECEIVE GEOMEMBRANE

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Certification of Surface Elevation Prior to Geomembrane	Surveying		One per 100 ft grid and at grade breaks (toe and top of slopes).
2	Subgrade Firm and Unyielding	Observe and Document Proofroll		Continuous on Impoundment Floor
3	Slope Condition	Observe and document absence of erosion, slope failures, loose material or other non-conforming conditions on slopes		Continuous on slopes
4	Subgrade Free of Deleterious Conditions	Observe and document exposed subgrade is free from: • Irregularities • Protrusions • Loose soil or soft spots • Abrupt changes in grade • Debris • Clods • Stones • Roots • Organic material • Moisture seeps, puddling, or ponding • Frozen material		Continuous

TABLE 014362-4

CQA FOR ANCHOR TRENCHES

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Trench Geometry	Measurement		1 location per 100 ft of trench
2	Trench Condition	Observe and Document: • Trench free of sloughed material • Trench free from ponded water • Absence of loose material below geosynthetics		Continuous
3	Trench Backfill	Observe and document prompt backfill of trenches		Continuous
4	Field Density / Soil Compaction	Nuclear Density Gauge, Sand Cone or Rubber Balloon Method	ASTM D6938, ASTM D2167, or ASTM D1556	One per 200 ft of trench per lift by self-propelled equipment One per 200 ft of trench per every other lift by hand-operated equipment

TABLE 014362-5

CQA FOR HDPE GEOMEMBRANE

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Receipt of Delivery	Observe and document: • Name of Geomembrane Manufacturer • Product identification • Date of manufacture of the geomembrane • Roll identification number • Geomembrane thickness and type • Roll dimensions (length and width) • Batch number • Order number • Panel number (where applicable)	Visual	Each Roll
2	Inspection of Rolls	Lack of uniformity	Visual	Each Roll
		Damage, Tears, Punctures	Visual	Each Roll
		Imperfections, Blisters, Excessive Folding	Visual	Each Roll
3	Geomembrane Properties	Thickness	ASTM D5994 or ASTM D5199	5 per roll of geomembrane delivered at locations evenly distributed throughout roll

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
		Density	ASTM D1505/D792	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Tensile properties (strength and elongation at yield and at break)	ASTM D6693	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Tear resistance	ASTM D1004	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Puncture resistance	ASTM D4833	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Carbon black content	ASTM D4218 ASTM D1603 is acceptable if an appropriate correlation to D4218 has been established	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Carbon black dispersion	ASTM D5596	Per resin batch, but not less than once per 50,000 SF of geomembrane
4	Weather and site conditions at time of HDPE deployment and seaming	Observe and document: • Visual and weather measurements		Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
5	Panel Deployment	Observe and document: • Relaxed deployment • Damage prevention • Wrinkles minimized • Temporary anchorage • Protected from damage • Proper overlap • Seam location	Visual	Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
6	Trial Welds	Observe and document Construction Contractor staff performing and testing trial welds		• Prior to each seaming period. • Every 4 hours of continuous seaming. • Whenever personnel or equipment are changed. • When climatic conditions result in wide changes in geomembrane temperature. • When requested by the CQA Geosynthetics Inspector(s) for any seaming crew or piece of welding equipment if problems are suspected.
7	Preparation for Seaming	Observe and document: • HDPE is clean • Minimum wrinkles and fish mouths • Fish mouths cut as necessary to lay flat • Firm surface for seaming	Visual	Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
8	Seaming	Observe and document: • Materials • Equipment • Staff • Acceptable procedures • Weather • Pressure • Speed • Damage • Absence of solvents	Visual	Continuous
9	Non-Destructive seam tests	Observe and document: • Equipment • Methods • Pressures • Leaks marked • Repairs made • Repairs retested	Various as applicable to seam type	100 percent of seam lengths shall be tested.

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
10	Destructive Samples and Testing	Observe and document: • Removal of all destructive test samples • Repair of sampled areas • Testing of repairs Label all samples	Shear strength and peel adhesion	• One test per every 500 linear feet of seam length if the seam is welded with a fusion weld. • One test per every 400 linear feet of seam length if the seam is welded with an extrusion weld. • One test for each seaming machine

TABLE 014362-6

CQA FOR SYNTHETIC TURF

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Receipt of Delivery	Observe and document: • Name of Synthetic Turf Manufacturer • Product identification • Date of manufacture of the synthetic turf • Lot number • Roll identification number	Visual	Each Roll
2	Inspection of Rolls	Lack of uniformity	Visual	Each Roll
		Damage, Tears, Punctures	Visual	Each Roll
		Imperfections, Blisters, Excessive Folding	Visual	Each Roll
3	Synthetic Turf Properties	Total Product Weight	ASTM D5261	Per 150,000 SF of synthetic turf
		CBR Puncture	ASTM D6241	Per 150,000 SF of synthetic turf
		Tensile Strength Product	ASTM D4595	Per 150,000 SF of synthetic turf
		Tensile Strength of Yarn	ASTM D2256	Per 150,000 SF of synthetic turf

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
4	Weather and Site Conditions at Time of Synthetic Turf Deployment and Seaming	Observe and document: • Visual and weather measurements		Continuous
5	Panel Deployment	Observe and document: • Geomembrane surface has been seamed, tested, and approved and is substantially free of debris and/or large scraps • Relaxed deployment • Damage prevention • Wrinkles minimized • Temporary anchorage • Protected from damage • Proper overlap • Seam location • First synthetic turf panel on a slope has the turf filaments facing upward • Turf filaments point upslope • Equipment does not damage synthetic turf or underlying geomembrane	Visual	Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
6	Trial Welds	Observe and document Geosynthetics Contractor personnel performing and testing trial welds.	Visual	• Prior to each seaming period. • Every 4 hours of continuous seaming. • Whenever personnel or equipment are changed. • When climatic conditions result in wide changes in geomembrane temperature. • When requested by the CQA Geosynthetics Inspector for any seaming crew or piece of welding equipment if problems are suspected.

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
7	Seaming	Observe and document: • Seaming method • Seaming materials and equipment • For sewn seams: stitching type and length • For welded seams: weather, pressure, speed, and absence of solvents • Damage and repairs	Visual	Continuous
8	Repairs	Identify areas to be patched. Document patching method and location.	Visual	Continuous

TABLE 014362-7

CQA FOR BALLAST INFILL MATERIAL

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Soil Index Properties	Grain Size	ASTM C136	One per 175 cubic yards.
2	Thickness	Direct measurement using digital caliper or Owner-approved alternate		Twenty (20) per acre.

END OF SECTION 014362

MWG

Midwest Generation, LLC

WAUKEGAN GENERATING STATION

SPECIFICATION W-7901

CONSTRUCTION QUALITY ASSURANCE
FOR
EAST & WEST ASH POND CLOSURES

S&L PROJECT NO.: 12661-098

REVISION 0C

ISSUE PURPOSE: PERMIT

ISSUE DATE: 01-27-2022

Sargent & Lundy

SECTION 000106

ISSUE SUMMARY AND APPROVAL PAGE

Rev.	Purpose of Issue	Date	Sections Affected
0A	Client Comment	11-10-2021	All
0B	Public Comment	11-15-2021	All
0C	Permit	01-27-2022	All

This is to confirm that this Specification has been prepared, reviewed, and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0407, Specifications, which is part of our Quality Management System.

Contributor Summary & Current Revision Signatures

Rev.	Prepared By	Reviewed By	Approved By
0A	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0B	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0C	Youssef Banoub, P.E.	Thomas Dehlin, P.E.	Thomas Dehlin, P.E.
	Thomas Dehlin, P.E.	David Nielson, P.E.	

SECTION 000107

CERTIFICATION PAGE

Sargent & Lundy, L.L.C. (S&L) is registered in the State of Illinois to practice engineering. S&L's Illinois Department of Financial and Professional Regulation registration number is 184-000106.

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

Certified By: Thomas J. Dehlin Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

SECTION 000110

TABLE OF CONTENTS

DIVISION 00 – PROCUREMENT AND CONTRACTING

DIVISION 01 - GENERAL REQUIREMENTS

ATTACHMENTS

END OF SECTION 000110

SECTION 011100

SUMMARY OF WORK

PART 1 - GENERAL

101. PROJECT INFORMATION

101.1 Owner: Midwest Generation, LLC (MWG)

101.2 Design Engineer: Sargent & Lundy (S&L)

101.3 Project Name: Construction Quality Assurance for East & West Ash Pond Closures

101.4 Project Location: Waukegan Generating Station
401 E. Greenwood Ave.
Waukegan, IL 60087

102. DESCRIPTION OF THE PROJECT AND GENERAL BACKGROUND

102.1 The purpose of this project is to close the East Ash Pond and the West Ash Pond at Midwest Generation, LLC's Waukegan Generating Station in accordance with the Illinois Pollution Control Board's Coal Combustion Residuals (CCR) Rule, 35 Ill. Adm. Code Part 845, and with the U.S. Environmental Protection Agency's (EPA) CCR Rule, 40 CFR Part 257 Subpart D.

102.2 The West Ash Pond will be closed by removing all CCR and CCR-mixed materials stored in the pond and decontaminating the pond's geomembrane liner and appurtenant concrete structures. The pond's existing geomembrane liner and appurtenant concrete structures will remain in-place. Following removal of CCR and CCR-mixed materials from the pond and decontamination of the pond facilities remaining in-place, the West Ash Pond area will be repurposed as a new low-volume waste pond for the Waukegan Generating Station.

102.3 The East Ash Pond will be closed by leaving the CCR and CCR-mixed materials stored in the pond in-place and installing a final cover system over the pond.

103. SCOPE OF WORK

103.1 In general, this Specification covers the field and laboratory activities for a Construction Quality Assurance (CQA) Contractor to provide assurance and documentation that the East and West Ash Ponds are closed in accordance with the General Work (GW) Specification (W-7900), the Design Drawings, and permit requirements.

103.2 The CQA Work shall include but not be limited to the following:

a. Prepare a CQA Plan that provides a detailed description of the activities that will be performed by the CQA Contractor in accordance with the Design Drawings and this Specification.

b. Verify all appropriate measures are taken by the GW Contractor to protect the West Ash Pond's existing geomembrane liner from damage during material removal and liner decontamination activities at the pond.

c. Verify decontamination of the West Ash Pond's existing geomembrane liner as specified in Section 014362 following material removal and liner decontamination activities performed by the GW Contractor.

d. Perform earthwork inspection and testing work specified in Section 014362 to:

d1. Verify compliance of materials with the GW Specification and Design Drawings.

d2. Perform field material and installation tests.

d3. Obtain samples and perform laboratory tests and/or contract to have laboratory tests performed and audit laboratory test results.

d4. Perform inspections during construction.

e. Perform geosynthetics inspection and testing work specified in Section 014362 to:

e1. Verify compliance of materials with the GW Specification and Design Drawings.

e2. Perform field material and installation tests.

e3. Obtain samples and perform laboratory tests and/or contract to have laboratory tests performed and audit laboratory test results.

e4. Witness field testing and audit field test results.

e5. Perform inspections during construction.

f. Identify non-conforming work.

g. Meetings, Documentation, and Reports:

g1. Participate in project meetings.

g2. Prepare CQA records and documents.

g3. Prepare CQA reports, including:

g3.1 Maintaining an Acceptance Report throughout the project.

g3.2 Preparing and certifying weekly Summary Reports until the end of the project.

g3.3 Preparing and certifying a Final Report at the end of the project.

103.3 The CQA Work shall conform to the requirements of this Specification and shall be performed and supervised by personnel who are experienced and knowledgeable in the crafts and trades required by the Scope of Work. The CQA Work shall be performed exclusively by the CQA Contractor's trained and competent personnel or, where permitted, that of its subcontractor(s); and shall comply with all applicable safety laws, regulations, programs, and practices to ensure the safety of those located on the work site and associated laboratories, including the CQA Contractor's personnel (or that of its subcontractor(s)) performing the CQA Work.

103.4 Performance of the CQA Work shall include all the labor, supervision, administration, management, tools, testing equipment, and consumables to execute the CQA Work identified herein.

103.5 Inspection and tests specified in this Specification shall be performed by personnel qualified to perform such inspections and tests.

104. RESPONSIBILITY AND AUTHORITY

104.1 The responsibilities and authority are described below for the organizations that will be involved in the design, permitting, and construction activities associated with the project.

a. Permitting Authority – Illinois EPA:

a1. The Illinois EPA is the Permitting Authority and is responsible for reviewing the permit applications for closing the East and West Ash Ponds to assure compliance with state regulations and for granting permits for the project.

a2. The Permitting Authority may review any design revisions during construction and any requests for variance submitted by the Owner. The Permitting Authority has the authority to review and approve all CQA documentation and reports and to confirm the East and West Ash Ponds were closed as specified in Project Specifications and the Design Drawings.

b. Owner – MWG:

b1. MWG is the Owner of the facility and has the authority to accept or reject materials and workmanship of the GW Contractor or reports and recommendations of the CQA Contractor.

b2. The Owner will ultimately be responsible for the closure construction for the East and West Ash Ponds and for assuring the Permitting Authority that the construction meets or exceeds the requirements specified in state regulations, permits, Project Specifications, and the Design Drawings. The Owner will accomplish this by retaining a CQA Contractor for the project.

c. Design Engineer: S&L:

c1. S&L is the Design Engineer and is responsible for designing the closures for the East and West Ash Ponds.

c2. The Design Engineer will assure that the design meets the construction requirements of the Owner and meets or exceeds the requirements of the Permitting Authority.

c3. The Design Engineer shall resolve unexpected conditions or unanticipated problems during construction, which may require changes to the permitted design. Changes to the permitted design shall require approval of the Owner and Design Engineer to ensure that the original design objectives are still maintained. All changes shall meet state regulatory requirements and the rules promulgated thereunder and may include Permitting Authority-approved variances to the rules.

d. GW Contractor:

d1. The GW Contractor shall be responsible for constructing the facility in accordance with the GW Specification (W-7900) and the Design Drawings and shall implement additional quality control and quality assurance procedures and techniques as necessary during construction.

d2. The GW Contractor will consist of an Earthwork Contractor performing the earthwork and a Geosynthetics Contractor installing the geosynthetic materials for the East Ash Pond's final cover system. The GW Contractor may self-perform or subcontract the duties of the Earthwork Contractor and/or Geosynthetics Contractor.

e. CQA Contractor:

e1. The CQA Contractor shall be the company employed by the Owner who is responsible for performing the CQA Work. The CQA Contractor shall be objective, competent, and independent from the GW Contractor whose work is being inspected. The CQA Contractor shall remain independent throughout the duration of the project.

e2. The CQA Contractor's team shall include the CQA Officer and two or more CQA Inspectors.

f. CQA Officer:

f1. The CQA Officer shall be a professional engineer licensed in the State of Illinois who shall be responsible for implementation of the CQA Work. The CQA Officer shall be responsible to the Owner.

f2. The CQA Officer shall be responsible for the performance of activities specified herein such as auditing, inspecting, sampling, testing, documenting, and preparing and certifying the Final Report. In addition, the CQA Officer and/or its inspectors shall have the responsibility of daily coordination with CQA Inspectors, the GW Contractor and its subcontractors, and the Owner to discuss daily progress, review completed work, perform visual inspections, review test results, and discuss and assist in resolving any current or potential construction problems.

f3. Except as provided by Paragraph 104.1f4, the CQA Officer shall be present to provide supervision and assume responsibility for performing all inspections of the following activities, when applicable:

f3.1 Compaction of subgrade materials.

f3.2 Installation of the final cover system, including installation of the geomembrane cover.

f4. If the CQA Officer is unable to be present as required by Paragraph 104.1f3, the CQA Officer shall provide the following in writing:

f4.1 The reasons for the CQA Officer's absence.

f4.2 A designation of a person who must exercise professional judgment in carrying out the duties of the CQA Officer-in-Absentia.

f4.3 A signed statement that the CQA Officer assumes full responsibility for all inspections performed and reports prepared by the designated CQA Officer-in-Absentia during the absence of the CQA Officer.

g. CQA Inspectors:

g1. The CQA Inspectors shall be responsible for performing visual examinations and for performing or obtaining field and laboratory tests. The CQA Inspectors shall be under the direct supervision of the CQA Officer.

g2. The CQA Inspectors shall be responsible for reporting to the CQA Officer the results of any inspections or tests indicating materials or installed work are of unacceptable quality or do not meet specified design requirements.

g3. The work will be divided so that two or more CQA Inspectors, each with specialized knowledge and training, will be involved in inspection work.

105. QUALIFICATIONS

105.1 CQA Officer:

a. The CQA Officer shall be a registered professional engineer in the State of Illinois with at least 10 years of experience in design/construction/permitting/licensing, at least 5 years of which is CQA experience as a certifying engineer on landfills or ponds with geomembrane liner systems.

b. The CQA Officer shall be qualified by education, technical knowledge, and experience to complete the technical certifications required by this Specification.

105.2 CQA Inspectors:

a. The CQA Inspectors shall have adequate formal academic training and sufficient practical and technical experience needed to execute and record auditing and inspection activities conducted at the site and perform all required laboratory and field testing. This includes a demonstrated knowledge of the various aspects of the type of work being conducted.

b. As required, different CQA Inspectors, each with specialized knowledge and experience, shall be employed for different portions of the work.

c. CQA Earthwork Inspectors:

c1. The lead CQA field inspector for earthwork (Lead CQA Earthwork Inspector) shall have at least 5 years of experience as an earthwork inspector.

c2. All CQA Earthwork Inspectors shall be knowledgeable in:

c2.1 Field practices relating to construction techniques used for the type of earthwork being performed.

c2.2 Construction and compaction equipment.

c2.3 All codes and regulations concerning material installation.

c2.4 Observation procedures for earthwork construction.

c2.5 Sampling and earthwork testing procedures.

c2.6 Testing equipment.

c2.7 Documentation procedures.

c2.8 Site safety.

d. CQA Geosynthetics Inspectors:

d1. The lead CQA field inspector for geosynthetics (Lead CQA Geosynthetics Inspector) shall have at least 5 years of CQA experience as a field inspector on projects with a geomembrane lining system including two years as a CQA inspector.

d2. All CQA Geosynthetics Inspectors shall be knowledgeable in:

d2.1 Field practice relating to techniques used for the installation of high density polyethylene (HDPE) geomembranes and geotextiles.

d2.2 HDPE geomembrane welding equipment and the correct operating procedures for seaming HDPE.

d2.3 Geotextile seaming equipment and the correct procedures for splicing geotextiles.

d2.4 All codes and regulations concerning material installation.

d2.5 Non-destructive seam testing procedures and failure criteria.

d2.6 Sampling for destructive testing of samples of seams and laboratory testing procedures.

d2.7 Testing equipment.

d2.8 Documentation procedures for field and laboratory tests.

d2.9 Site safety.

106. DEFINITIONS

106.1 The term "Design Drawing" means the Design Engineer's drawings indicating the Work to be performed.

106.2 The term "Work" means the services furnished to complete the CQA activities specified herein.

106.3 The term "Owner-approved equal" means an acceptable equivalent to a specified material or equipment that has been accepted by the Owner.

107. PROJECT MEETINGS

107.1 Project meetings will be held on a periodic basis during the lifetime of the project. The meetings will include:

a. A preconstruction meeting.

b. Progress meetings.

c. Additional meetings as required to discuss problems or work deficiencies.

107.2 Preconstruction Meeting:

a. The preconstruction meeting will be organized by the Owner. In addition to the Owner, the Design Engineer, the GW Contractor (including representatives of the Earthwork Contractor and Geosynthetics Contractor), the CQA Officer (or CQA Officer-in-Absentia), the Lead CQA Inspectors, and any other interested party designated by the Owner shall attend the preconstruction meeting.

b. The preconstruction meeting shall be used to discuss:

b1. Site specific safety requirements.

b2. Requirements of the Design Drawings, GW Specification, and CQA Specification.

b3. The CQA Contractor’s CQA Plan and the responsibilities of each party.

b4. The lines of authority and communication.

b5. Procedure for submittal of manufacturer QA/QC documents for audit.

b6. Procedures for examination of materials delivered to the site.

b7. Location of material storage area(s).

b8. Field and laboratory test requirements and sample sizes.

b9. Procedures for observance of field tests.

b10. Coordination between each contractor and the CQA Inspector to obtain timely field samples and tests.

b11. Procedure for handling construction deficiencies, repairs, and retesting.

b12. Work area security and safety protocol.

b13. Work days and work hours.

b14. Coordination with other contractors or trades.

b15. Site visits.

107.3 Weekly Progress Meetings:

a. Weekly progress meetings will be scheduled by the Owner. In addition to the Owner, the meetings shall be attended by the Design Engineer, the GW Contractor (including representatives of the Earthwork Contractor and the Geosynthetics Contractor), the CQA Officer (or CQA Officer-in-Absentia), and the Lead CQA Inspectors.

b. If needed, daily meetings shall be held each day to review the work schedule, work completed, results of tests, and to discuss potential construction problems.

c. The Owner or its designee will document each meeting and distribute copies of meeting minutes to all responsible parties.

107.4 Additional Meetings:

a. Additional meetings between one or more contractors, the Lead CQA Inspector(s), and the CQA Officer (or the CQA Officer-in-Absentia) shall be held immediately after a work deficiency is identified or a problem arises. These meetings shall be used to define and resolve the problem.

b. Any supervisor/superintendent can request such a meeting through their line of authority.

c. Possible solutions to the problem shall be discussed, and an acceptable solution shall be selected. This solution shall be implemented provided it does not conflict with or require a change to the Design Drawings, in which case the solution shall be submitted to the Design Engineer for review.

d. The Design Engineer shall resolve unexpected conditions or unanticipated problems during construction, which may require changes to the permitted design. Changes from the permitted design shall require approval by the Owner and Design Engineer to ensure that the original design objectives are maintained. All changes shall meet the requirements of the Permitting Authority and may include regulations approved by the Permitting Authority.

e. The CQA Contractor shall document each special meeting and distribute copies of minutes to all responsible parties.

108. PERFORMANCE AUDITS AND DOCUMENTATION

108.1 As a minimum, the CQA Officer shall conduct the following reviews and performance audits:

a. Full review and audit of results of preconstruction testing or GW Contractor's material certificates used to qualify earthwork materials for construction use.

b. Full review and audit of manufacturer certificates that qualify geosynthetic materials and ballast infill materials for use in the final cover system (including geomembrane and synthetic turf).

c. Weekly audit of reports and test data sheets during and after construction of the earthwork until completion of work.

d. Weekly audit of reports and test data sheets during and after installation of geosynthetic materials and ballast infill materials (including geomembrane and synthetic turf) until completion of the work.

108.2 CQA documentation shall be well-documented and include at least the following:

a. Daily records, which shall include:

a1. Inspection data sheets.

a2. Data sheets listing the number and types of construction equipment used by the GW Contractor and construction equipment data.

a3. Problem identification reports and corrective action reports. Problem identification reports and corrective action reports shall include detailed descriptions of materials and/or workmanship that do not meet a specified design and shall be cross-referenced to specific inspection data sheets where the problem was identified and corrected.

b. Testing records, which shall include:

b1. Material shipping and manufacturer QA/QC data sheets.

b2. Data sheets describing field samples taken.

b3. Laboratory data sheets.

b4. Field test data sheets.

b5. Notes, charts, drawings, or sketches identifying the location and elevation of field tests, location of failures and repairs or retests, and where samples were obtained.

b6. Non-destructive test reports including location of failures, records of repairs, and results of retests.

c. Photographic records, which shall include:

c1. Digital photographs, each with a unique identifying number.

c2. Figure indicating the location from which each photograph was taken.

c3. Summary list giving the date and time of each photograph.

108.3 All records shall, at a minimum, bear the following:

a. Unique identifying sheet number.

b. The date.

c. Project name, project number, and location.

d. Descriptive remarks.

e. Data sheets for tests.

f. Written text descriptions for visual observations

g. Signature of the preparer of designated authority.

END OF SECTION 011100

SECTION 014362

CONSTRUCTION QUALITY ASSURANCE FOR CLOSING A CCR SURFACE IMPOUNDMENT

PART 1 – GENERAL

101. EXTENT

101.1 The intent of this section is to define the requirements for Construction Quality Assurance (CQA) activities to ensure that the quality of materials and installation procedures used to close the East and West Ash Ponds are in accordance with the General Work (GW) Specification W-7900, Design Drawings, permit requirements, and as specified herein.

101.2 The Work within this Specification is the responsibility of the CQA Contractor and shall include, but not be limited to, the following items:

a. Attend project meetings and site visits as scheduled by the GW Contractor for coordination between the Owner, GW Contractor, subcontractors, and CQA Contractor.

b. Perform pre-construction material certification activities to ensure materials meet or exceed GW Specification requirements that include but are not limited to:

b1. Testing for suitability of material prior to use.

b2. Performing pre-construction audits of material certifications prior to material use.

c. Perform CQA activities during construction to ensure materials meet or exceed GW Specification requirements:

c1. Perform audits of material certifications.

c2. Perform observations, inspections, and tests.

c3. Review laboratory test data.

c4. Material sampling.

d. Documentation of all observations, samples, certifications, test results, and conformance of work to the GW Specification that will be submitted by the Owner to the Permitting Authority.

e. Prepare a weekly summary report at the end of each week of construction, until construction is complete.

f. After the GW Contractor complete closure construction activities at each ash pond, prepare a Final Report that demonstrates that the given ash pond (*i.e.*, West Ash Pond or East Ash Pond) was closed in conformance with the GW Specification and the Design Drawings. This report shall include all test data, observations, audits, material certificates, and any other relevant documentation.

g. Submit a draft version of each Final Report to the Owner and Design Engineer for their review and comment. Upon resolution of all comments, submit a final version of the Final Report to the Owner and Design Engineer.

102. RELATED WORK SPECIFIED IN OTHER SECTIONS

102.1 CQA Specification (Specification W-7901):

a. Section 011100 – Summary of Work

102.2 GW Specification (Specification W-7900):

a. Section 311522 – Engineered Synthetic Turf for Final Cover System

b. Section 312205 – Earthwork for CCR Surface Impoundment Closure

c. Section 319022 – High Density Polyethylene Geomembrane Liner for Final Cover System

103. REFERENCE DOCUMENTS

103.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

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

103.4 ASTM – ASTM International:

a. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

b. D422 Standard Test Method for Particle-Size Analysis of Soils (Withdrawn 2016).

c. D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

d. D1004 Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

e. D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.

f. D1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

g. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

h. D1603 Standard Test Method for Carbon Black Content in Olefin Plastics.

i. D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

j. D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

k. D2256 Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method.

l. D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

m. D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).

n. D2974 Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils.

o. D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

p. D4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

q. D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

r. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

s. D4643 Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating.

t. D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

u. D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

v. D4959 Standard Test Method for Determination of Water Content of Soil By Direct Heating.

w. D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

x. D5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes.

y. D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.

z. D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

aa. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

bb. D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

104. SUBMITTALS

104.1 Submittals with Bid Proposal:

a. Documentation to substantiate that the CQA Contractor's and its laboratory's Accreditation Certifications are current.

b. Detailed resumes on all CQA laboratory and field personnel proposed for the Work, including a complete description of their qualifications and previous experience in the same type of work and documentation of certification to perform required testing.

104.2 Submittals During the Course of the Work:

a. Certifications and submittals as specified herein.

b. Quality Reports shall be submitted on a weekly basis while performing the work.

c. An Index Report, an Acceptance Report, Weekly Summary Reports, and a Final Report as described below shall be prepared for the West Ash Pond, and a second set of reports shall be prepared for the East Ash Pond (*i.e.*, one set of reports per ash pond).

c1. Index Report:

c1.1 An Index Report shall be prepared listing all records and reports.

c1.2 The Index Report shall be assembled in chronological framework for recording and identifying all reports.

c2. Acceptance Report:

c2.1 All reports and data sheets shall be assembled and summarized into an Acceptance Report in order to verify that the materials and construction procedures comply with the specified design. As a minimum, this report shall contain all inspection reports, inspection data sheets, problem identification reports and corrective action reports.

c2.2 The Acceptance Report shall be prepared by the CQA Inspectors and updated on a daily basis.

c3. Weekly Summary Report:

c3.1 At the end of each week of construction, until construction is complete, a Summary Report must be prepared by either the CQA Officer or under the supervision of the CQA Officer and submitted to the Owner. The CQA Officer must review and approve the Summary Report.

c3.2 The Summary Report shall contain descriptions of the weather, locations where construction occurred during the previous week, materials used, results of testing, inspection reports, and procedures used to perform the inspections.

c4. Final Report:

c4.1 A Final Report for the earthwork and the installation of the geosynthetic materials shall be prepared by the CQA Officer. The Final Report shall contain all data sheets, testing records, manufacturer data sheets, reports and photographs concerning items which were installed and tested. This report shall contain documentation that construction proceeded in accordance with the Design Drawings, Project Specifications, and permit requirements.

c4.2 The Final Report shall also include a certification (sealed by the CQA Officer) that the GW Contractor's work is in compliance with the Design Drawings, Project Specifications, and permit requirements. When applicable, the report shall also include the following certifications (sealed by the CQA Officer) pursuant to 35 Ill. Adm. Code 845.290(b)(3):

c4.2.1 All bedding material contains no undesirable objects.

c4.2.2 The final closure plan approved by the construction permit issued by the Illinois Environmental Protection Agency has been followed.

c4.2.3 All anchor trenches and backfill were constructed to prevent damage to the geomembrane.

c4.2.4 All tears, rips, punctures, and other damage have been repaired.

c4.2.5 All geomembrane seams have been properly constructed and tested in accordance with the manufacturer's specifications.

c4.2.6 The CCR material in the East Ash Pond was appropriately stabilized prior to placement of Structural Fill and/or final cover system materials.

c4.3 The Final Report shall be submitted within 2 weeks after completion of CQA Work.

105. <u>CONSTRUCTION QUALITY ASSURANCE REQUIREMENTS</u>

105.1 General:

a. This section describes the CQA activities that shall be performed to assure the quality of materials and construction procedures used to close the East and West Ash Ponds. These activities are intended to ensure that the materials and construction procedures used to close the East and West Ash Ponds meet the GW Specification requirements and to provide assurance that the ash ponds have been closed in manners that meet or exceed the requirements stated on the Design Drawings and in the GW Specification.

105.2 Organizations Involved:

a. The organizations involved in the design, permitting, and construction activities associated with the Work are defined in Section 011100.

b. The responsibilities and authority of the organizations and personnel associated with the Work are defined in Section 011100.

105.3 Qualifications:

a. The qualifications of the CQA Contractor personnel are described in Section 011100.

105.4 Project Meetings and Audits:

a. The requirements for project meetings and audits are described in Section 011100.

105.5 Performance Audits and CQA Documentation:

a. The requirements for performance audits and CQA documentation are described in Section 011100.

<u>PART 2 – PRODUCTS</u>

201. <u>PRODUCTS</u>

201.1 The requirements for the various products used for the construction of the impoundment are specified in their respective technical specification sections in the GW Specification.

201.2 All permanent materials to be used in the Work are supplied by the GW Contractor. The GW Contractor and CQA Contractor shall coordinate obtaining materials for testing by the CQA Contractor.

PART 3 – EXECUTION

301. GENERAL CQA TESTING AND INSPECTION REQUIREMENTS

301.1 Record daily atmospheric conditions.

301.2 Field tests shall document the elevation and coordinate location for each test. The locations may be determined by survey, taping, pacing off distances, or hand-held GPS receiver provided the receiver indicates an error of 20 ft or less at the time the coordinates are recorded. All locations should be reported in appropriate significant figures. Locations of seams, damage to geosynthetics, and repairs to geosynthetics shall be obtained through quality survey methodologies.

301.3 Material Source Testing: Material source testing activities include visual observations and laboratory and field testing at the material source to control material quality and material preparation prior to transport of the material to the facility.

302. CQA TESTING AND INSPECTION REQUIREMENTS FOR EXISTING LINER DECONTAMINATION ACTIVITIES (WEST ASH POND)

302.1 Testing During Construction:

a. CQA activities during removal of material from and decontamination of the West Ash Pond's existing geomembrane liner shall include visual observations and field testing to verify the liner has been decontaminated in accordance with the Design Drawings.

b. Visual Observations:

b1. Observe and record method(s) of material removal and decontamination.

b2. Verify the GW Contractor is taking necessary precautions to avoid damaging the geomembrane liner.

b3. Verify the GW Contractor has developed and is implementing fugitive dust controls in accordance with 35 Ill. Adm. Code 845.740(c)(2).

b4. Verify the GW Contractor has developed and is implementing measures to prevent contamination of surface water, groundwater, soil, and sediments in accordance with 35 Ill. Adm. Code 845.740(c)(4).

b5. Verify all material removal and decontamination work is performed in a systematic manner to remove all ash and ash residuals from the liner surface.

b6. Verify the GW Contractor is providing adequate temporary loading on exposed liner areas to prevent uplift of the geomembrane by wind by the use of sandbags and/or other means which will not damage the geomembrane.

b7. For areas of geomembrane that are damaged, record location and nature of damage, and verify the GW Contractor addresses the damaged areas as specified on the Design Drawings.

b8. Record location and size of all samples obtained from existing liner, and verify the GW Contractor repairs all locations of the geomembrane from which samples are obtained for verification of decontamination.

c. Laboratory and Field Tests:

c1. Perform an electrical leak location survey over decontaminated liner areas as specified on the Design Drawings.

c2. Collect samples of the existing geomembrane liner for verification of decontamination by laboratory testing as specified on the Design Drawings.

c3. Perform laboratory testing of existing geomembrane liner samples as specified on the Design Drawings.

d. Test Acceptance Criteria:

d1. Laboratory and field test acceptance criteria shall be as specified on the Design Drawings.

d2. If the results from any of the laboratory and field tests do meet the respective pass/fail thresholds, then the CQA Officer shall reject all existing geomembrane liner areas corresponding to the failed test(s) as decontaminated.

303. <u>CQA TESTING AND INSPECTION REQUIREMENTS FOR SUBGRADE (CCR) TO RECEIVE STRUCTURAL FILL OR GEOMEMBRANE (EAST ASH POND)</u>

303.1 Testing During Construction:

a. CQA activities during subgrade preparation work shall include visual observations and field testing to ensure that subgrade (CCR) preparation for Structural Fill is in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-1 and the following paragraphs.

b. Visual Observations:

b1. Record type and size of compaction equipment in use:

b1.1 For rubber-tired rollers, record the tire inflation pressure, spacing of tires, and empty and ballasted wheel loads.

b1.2 For vibratory rollers, record the static weight, imparted dynamic force, operating frequency of vibration, and drum diameter and length.

b1.3 For hand tampers, record make, model number, size and compactive effort.

b2. Observe and record compactive effort, uniformity of compaction and scarification and connection between compacted lifts. Record number of passes of a roller by type, size, and weight of roller.

b3. For proofrolling, record the type, size, and weight of compaction equipment or other vehicles used for proofrolling.

b4. Observe removal of all organic and undesirable material.

b5. Observe that there are no moisture seeps, puddling, or ponding.

b6. Observe proofrolling to identify soft spots, and observe removal of material in soft spots.

b7. Observe compaction of the subgrade prior to placement of the proceeding layer of material. For areas of the subgrade on which the geomembrane component of the final cover system will be directly placed, inspect for any large, protruding, or sharp material that could puncture a geomembrane.

b8. Verify measurements and determine that the depth and slope of all excavations meet design requirements and that there are no slope failures from moisture seeps or other causes.

c. Laboratory and Field Tests:

c1. Laboratory testing and field testing for subgrade shall be performed in accordance with the requirements specified in Table 014362-1.

d. Test Acceptance Criteria:

d1. Acceptance criteria for subgrade approval shall be as specified in GW Specification Section 312205.

304. CQA TESTING AND INSPECTION REQUIREMENTS FOR STRUCTURAL FILL MATERIAL (EAST ASH POND)

304.1 Initial Material Certification:

a. Inspect the onsite sand stockpile and identify areas that are not appropriate to be used as Structural Fill per the GW Specification. Perform sampling of the stockpile material to obtain appropriate test samples to prequalify the onsite sand stockpile for use as Structural Fill in accordance with the Design Drawings and the GW Specification.

304.2 Testing During Construction:

a. CQA activities during placement of Structural Fill shall include visual observations and field testing to ensure that Structural Fill is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-2 and the following paragraphs.

b. Visual Observation of the Material Source for Structural Fill Material During Construction:

b1. Inspect materials to ensure that they are uniform.

b2. Visually inspect the material in accordance with ASTM D2488.

b3. Inspect to ensure that only suitable material is transported to the site or obtained from onsite cuts or borrow areas, observe segregation operations when unsuitable materials are present, and observe removal of organic soils, roots, stumps, and stones.

b4. Observe changes in color or texture that can be indicative of a change in material type or moisture content.

b5. Observe moisture conditioning activities to ensure that any required substantial changes in moisture content are made at the source.

c. Visual Observation of Fill Placement:

c1. Record type and size of compaction equipment in use:

c1.1 For rubber-tired rollers, record the tire inflation pressure, spacing of tires, and empty and ballasted wheel loads.

c1.2 For vibratory rollers, record the static weight, imparted dynamic force, operating frequency of vibration, and drum diameter and length.

c1.3 For hand tampers, record make, model number, size and compactive effort.

c1.4 Observe and record compactive effort, uniformity of compaction and scarification and connection between compacted lifts. Record number of passes of a roller by type, size, and weight of roller.

c1.5 For proofrolling, record the type, size, and weight of compaction equipment or other vehicles used for proofrolling.

c2. Observe removal of roots, rocks, rubbish, or out-of-specification soil from the borrow material.

c3. Observe and record changes in soil characteristics necessitating a change in construction procedures.

c4. Observe fill placement and procedures for proper fill thickness.

c5. Observe procedures to be followed to adjust the soil moisture content to obtain uniform moisture content.

c6. Observe and record final finishing procedures.

c7. Observe and record that final grade is consistent with the design grade specified on the Design Drawings in the GW Specification.

c8. Observe that there is proper placement and compaction of any backfill around recessed areas, pipes, or sumps.

d. Laboratory and Field Tests:

d1. Laboratory and field testing shall be performed in accordance with the requirements specified in Table 014362-2.

e. Test Acceptance Criteria:

e1. Acceptance criteria shall be as specified in GW Specification Section 312205.

305. CQA TESTING AND INSPECTION REQUIREMENTS FOR GEOMEMBRANE COMPONENT OF FINAL COVER SYSTEM (EAST ASH POND)

305.1 Initial Material Certification:

a. Prior to shipment of any geomembrane materials, the CQA Contractor shall assemble and document the receipt of and audit the Geomembrane Manufacturer submittals listed below for conformance with the GW Specification.

a1. Geomembrane Resin:

a1.1 Certificate that the resin meets GW Specification requirements.

a1.2 Certificate of the origin of the resin and that all resin is from the same manufacturer (name, identification brand name and number).

a1.3 Copies of the Geomembrane Manufacturer's QA/QC certificates for the geomembrane resin. Certificates shall include a summary report of test results conducted to verify the quality of the resin used in each batch to manufacture geomembrane for this project. As a minimum, the report shall include tests on specific gravity, melt flow index and percent carbon black.

a2. Geomembrane Sheeting:

a2.1 Certification that the properties of the manufactured sheeting meet GW Specification requirements and are guaranteed by the Geomembrane Manufacturer.

a2.2 Statement certifying that no post consumer resin (PCR) has been added to the formulation.

a2.3 Copies of all of the Geomembrane Manufacturer's QA/QC certificates for the geomembrane sheeting. The certificates shall include test results.

a3. Extrudate Resins or Rod for Seaming Geomembrane:

a3.1 Certification from the Geomembrane Manufacturer that all extrudate is the same resin type as the geomembrane and was obtained from the same resin supplier as the resin used to manufacture the geomembrane.

b. Geomembrane Field Installation Quality Control (QC) Plan:

b1. Document receipt of the GW Contractor’s QC plan for installing geomembrane.

b2. Review the plan for compliance with the GW Specification and document where the plan is not in compliance.

c. Geomembrane Panel Layout:

c1. Document receipt of the GW Contractor’s panel layout for geomembrane.

305.2 Transportation, Handling, and Storage:

a. Documentation of Delivery:

a1. Document arrival of rolls of geomembrane.

a2. Document that each roll is marked with the following information:

a2.1 Name of Geomembrane Manufacturer.

a2.2 Product identification, which can be traced back to the origin of the base material (resin supplier’s name, resin production plant, resin brand name type, resin brand number, and production date of the resin).

a2.3 Date of manufacture of the geomembrane.

a2.4 Roll identification number.

a2.5 Geomembrane thickness and type.

a2.6 Roll dimensions (length and width).

a2.7 Batch number.

a2.8 Order number.

a2.9 Panel number.

a3. Check the Quality Control certificates on each roll to verify that the rolls received onsite meet the GW Specification. Take photograph or copy the identifying labels from each roll or pallet and save them for future reference.

a4. Recommend rejection of rolls which do not have the required documentation and ensure that the rolls are removed from the site.

b. Inspection of Manufactured Rolls:

b1. Inspect all manufactured rolls upon delivery to the site.

b2. Ensure that packaging is secure and that no damage has occurred.

b3. If damage to packaging has occurred, inspect exposed roll surfaces, and note and identify any damage or repairable flaws. Note: This visual observation shall be conducted without unrolling rolls unless the extent of surface damage indicates that internal damage may be present.

b4. If damage to just the packaging has occurred, document repair of the packaging.

b5. If damage to the product has occurred, document that the damage or flaws are repaired or that the damaged material is wasted and removed from the site.

b6. Report all damage to the Owner.

c. Handling:

c1. Inspect the onsite handling equipment being used to move materials to ensure that it is adequate to minimize the risk of damage to materials.

c2. Inspect the handling of materials by installing personnel to ensure that care is used.

d. Storage:

d1. Inspect the storage facility.

d2. Inspect the ground surface to ensure that it is dry, relatively level, smooth and free of rocks, holes, and debris.

d3. Document unsafe or improper storage conditions.

305.3 Preconstruction Testing:

a. Prior to material shipment to the site, the Geomembrane Manufacturer shall submit to the CQA Contractor representative samples of the geomembrane to be shipped to the site, along with chain of custody and certification that the samples submitted are from the geomembrane material to be delivered to the site. The CQA Geosynthetics Inspector shall perform conformance testing of the received geomembrane samples in accordance with Table 014362-5. The laboratory tests shall be performed at least at the corresponding minimum frequencies specified in Table 014362-5.

b. Test acceptance criteria shall be as specified in GW Specification Section 319022. If the results from any of the tests in Table 014362-5 do not meet the respective pass/fail thresholds, then the CQA Officer shall reject all geomembrane material from the resin batch corresponding to the failed test(s) for use in the project.

305.4 Testing During Construction:

a. CQA activities during placement of the geomembrane component of the ClosureTurf® final cover system shall include visual observations and field testing to ensure that the geomembrane cover is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-5 and the following paragraphs.

b. Weather Conditions for Placement:

b1. Observe and document the weather conditions (i.e., temperature, humidity, precipitation, and wind) to ensure that they are acceptable for geosynthetic material placement and seaming. The GW Specification describes acceptable weather conditions.

b2. If the weather becomes unacceptable for installation of the geosynthetic materials, recommend stopping the installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.

c. Geomembrane Placement:

c1. Prior to placement of the geomembrane cover, visually inspect the surface to be covered to ensure that it meets the requirements of the GW Specification. Confirm that it is compacted, free from clods of soil, rocks larger than specified, roots, sudden or sharp changes in grade and standing water. Field observations shall be performed in accordance with the requirements specified in Table 014362-3.

c2. Provide documentation of daily inspection of the surface to be covered for the area of geomembrane to be placed that day.

c3. Observe and document that the GW Contractor’s geomembrane placement plan is being followed. Note where the plan is not being followed and document the GW Contractor’s reasons for not following the plan. As each panel is placed, visually inspect the geomembrane for tears, punctures, and thin spots. The CQA Geosynthetics Inspector shall traverse the panels in such a way that the entire surface is inspected. Any defects shall be documented on a drawing and marked on the geomembrane for repair.

c4. Document that the locations of geomembrane seams meet the general requirements for seaming contained in GW Specification Section 319022.

c5. At the time of placement, make measurements to confirm that required overlap of adjacent geomembrane sheets has been achieved, that proper temporary anchorage is being used (e.g., sand bags or tires), and that the geomembrane is being placed in a relaxed (nonstressed) state.

c6. Document any liner damage from adverse weather conditions, equipment, inadequate temporary anchoring, or rough handling. Mark the location of damage on the geomembrane for repair and on a drawing.

c7. Document improper liner placement (if the placement plan is not followed) and, as a result, inadequate coverage with the available materials or an excess number of field seams.

c8. Document inadequate sheet overlap resulting in poor quality seams.

c9. Document nonwelded or cut panels.

c10. Document repair of damage. Documentation shall include location, type, and method of repair.

d. Geomembrane Seaming and Seam Repair:

d1. Trial Welds Prior to Beginning Seaming:

d1.1 Observe that trial welds are being made at the frequency specified in GW Specification Section 319022.

d1.2 Observe fabrication of test strips and note that test strips are fabricated correctly.

d1.3 Specify where samples are to be cut from the test strips and witness all destructive tests.

d1.4 Observe documentation of results of the destructive tests by the GW Contractor.

d1.5 Audit documentation of each trial weld received from the GW Contractor.

d2. Seaming and Seam Repair: Activities that shall be documented during field seaming operations include:

d2.1 Observe that the geomembrane is free from dirt, dust, and moisture.

d2.2 Observe that the seaming materials and seam welding equipment are as specified.

d2.3 Observe that a firm foundation is available for seaming.

d2.4 Observe that geomembrane overlap and panel adjustment are correct prior to seaming.

d2.5 For extrusion welding, observe that the geomembrane is pre-beveled and the geomembrane is properly abraded and that the panels are temporarily bonded.

d2.6 Observe that grind marks are covered with extrudite.

d2.7 Observe weather conditions (e.g., temperature, humidity, wind) to ensure that they are acceptable for seaming.

d2.8 Measurements of temperatures, pressures, and speed of seaming to ensure that they are as specified. Gages and dials on seaming equipment shall be checked and readings recorded.

d2.9 Observe that the geomembrane is not damaged by equipment or personnel during the seaming process.

d2.10 Observe that no solvents or adhesives are used.

e. Anchor Trench:

e1. Field measurements, observations, and testing shall be performed in accordance with the requirements specified in Table 014362-4.

e2. Measurements:

e2.1 Perform measurements of the anchor trench to ensure that the trench width, depth, and location is as specified on the Design Drawings.

e3. Observations:

e3.1 Observe that the trench corners are rounded as specified.

e3.2 Observe that good housekeeping practices are followed in the trenching operation by not allowing soil to fall back into the trench or down the slope and not allowing water to pond in the trench.

e3.3 Observe that the trench is backfilled as soon as possible and compacted such that the geomembrane (both geomembranes and the synthetic turf (if applicable)) are not damaged.

f. Anchorage to Objects:

f1. Where the Design Drawings specify attaching / anchoring the geomembrane to objects (*e.g.*, concrete structures), CQA Geosynthetics Inspectors shall make the following inspections, at a minimum:

f1.1 Observations to ensure that all objects that are placed adjacent to the geomembrane (i.e., batten bars, soil in an anchor trench) are smooth and free of objects or conditions that may damage the geomembrane.

f1.2 Observations to ensure that all anchors are complete:

f1.3 No gaps or areas of uncompacted backfill.

f1.4 Batten bars of the specified material, width, and thickness and prepunched at the specified spacing.

f1.5 Anchor bolts of the specified size and material.

f1.6 Anchor bolts spaced as specified.

f2. Observations to confirm that all cover connections are installed as specified. Cover connections shall be verified for appropriate clamp and caulking use, for appropriate material, for good seaming, and for good housekeeping practices. No sharp bends on foundations (concrete pads) shall be allowed. Soil compaction adjacent to concrete pads shall be performed as specified to prevent differential settlement.

g. Geomembrane Production Seam Testing:

g1. Non-Destructive: Activities to be observed and documented include the following:

g1.1 Observe that 100 percent of the seam lengths are tested using non-destructive procedures.

g1.2 Observe that testing is performed as seaming progresses.

g1.3 Observe that the correct procedures are used for testing each type of seam.

g1.4 Observe all non-destructive test procedures.

g1.5 For air pressure testing, observe that the equipment, procedures, and air pressure meet specified requirements. Observe that all testing is properly documented.

g1.6 For vacuum box testing, observe that testing is being performed correctly.

g1.7 For inaccessible seams, observe that a procedure acceptable to the Owner is used to test the seams.

g1.8 Observe that all leaks are marked, recorded as to location, and repaired.

g1.9 Observe that repairs are made in accordance with approved techniques.

g1.10 Observe that all repairs are re-tested and that no leakage is present.

g1.11 Review leakage data for possible patterns. Make suggestions to the GW Contractor if data shows a consistent pattern of failure of a particular machine or crew.

g1.12 Audit documentation of testing prepared by the GW Contractor to make sure that the location of leaks is identified on the drawings.

g2. Destructive:

g2.1 Destructive seam testing shall be performed at specific frequencies.

g2.2 The CQA Geosynthetics Inspector shall specify the location where each sample shall be taken and record data for each sample.

g2.3 The CQA Geosynthetics Inspector shall designate any additional test locations that may be necessary. These locations may be based on the suspicion of contamination by dirt or moisture, change in seaming materials, increase in failed nondestructive tests, and other causes that could result in unacceptable seams.

g2.4 Laboratory testing shall be performed in accordance with the GW Specification Section 319022. Predetermined pass/fail values are specified in that section.

g2.5 Audit and document the results of laboratory testing on seam samples. Note any sample that does not pass and identify the location on the geomembrane for repair in the field and on the drawings.

g3. Repair of Failed Seams:

g3.1 For field seams that fail, the seam can either be reconstructed between the failed and any previous passed seam location or the installer can go on either side of the failed seam location (10-foot minimum), take another sample, test it and if it passes, reconstruct the seam between the two locations. If it fails, the process shall be continued. In all cases, acceptable seams must be bounded by two passed test locations. The CQA Geosynthetics Inspector shall document the procedure used and results of tests.

g3.2 Document that repairs are made. Documentation shall include location, type, and method of repair.

306. <u>CQA TESTING AND INSPECTION REQUIREMENTS FOR ENGINEERED SYNTHETIC TURF COMPONENT OF FINAL COVER SYSTEM (EAST ASH POND)</u>

306.1 Initial Material Certification:

a. Prior to shipment of any synthetic turf materials, the CQA Contractor shall assemble and document the receipt of and audit the Synthetic Turf Manufacturer submittals listed below for conformance with the GW Specification:

a1.1 Certification that the properties of the synthetic turf panels meet GW Specification requirements and are guaranteed by the Synthetic Turf Manufacturer.

a1.2 Copies of the Synthetic Turf Manufacturer's Quality Control and Construction Quality Control Plans. The plans shall include the inspection records and test results required by the GW Specification.

306.2 Transportation, Handling, and Storage:

a. Documentation of Delivery:

a1. Document arrival of rolls of synthetic turf.

a2. Document that each roll is marked with the following information:

a2.1 Name of Synthetic Turf Manufacturer.

a2.2 Product identification.

a2.3 Date of manufacture of synthetic turf.

a2.4 Lot number.

a2.5 Roll identification number.

a3. Check the Quality Control certificates on each roll to verify that the rolls received onsite meet the GW Specification. Take photographs or copies of the identifying labels from each roll or pallet and save them for future reference.

a4. Recommend rejection of rolls which do not have the required documentation and ensure that the rolls are removed from the site.

b. Inspection of Manufactured Rolls:

b1. Inspect all manufactured rolls upon delivery to the site.

b2. Ensure that packaging is secure and that no damage has occurred.

b3. If damage to packaging has occurred, inspect exposed roll surfaces, and note and identify any damage or repairable flaws. Note: This visual observation shall be conducted without unrolling rolls unless the extent of surface damage indicates that internal damage may be present.

b4. If damage to just the packaging has occurred, document repair of the packaging.

b5. If damage to the product has occurred, document that the damage or flaws are repaired or that the damaged material is wasted and removed from the project site.

b6. Report all damage to the Owner.

c. Handling:

c1. Inspect the onsite handling equipment being used to move materials to ensure that it is adequate to minimize the risk of damage to materials.

c2. Inspect the handling of materials by installing personnel to ensure that care is used.

d. Storage:

d1. Inspect the storage facility.

d2. Inspect the ground surface to ensure that it is dry, relatively level, smooth and free of rocks, holes, and debris.

d3. Document unsafe or improper storage conditions.

306.3 Preconstruction Testing:

a. Prior to material shipment to the site, the Synthetic Turf Manufacturer shall submit to the CQA Contractor representative samples of the synthetic turf material to be shipped to the site, along with chain of custody and certification that the samples submitted are from the synthetic turf material to be delivered to the site. The CQA Geosynthetics Inspector shall perform conformance testing of the received synthetic turf samples in accordance with Table 014362-6. The laboratory tests shall be performed at least at the corresponding minimum frequencies specified in Table 014362-6.

b. Test acceptance criteria shall be as specified in GW Specification Section 311522. If the results from any of the tests in Table 014362-6 do not meet the respective pass/fail thresholds, then the CQA Officer shall reject all synthetic turf material from the lot corresponding to the failed test(s) for use in the project.

306.4 Testing During Construction:

a. CQA activities during installation of the synthetic turf component of the ClosureTurf® final cover system shall include visual observations and field testing to ensure that the synthetic turf is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-6 and the following paragraphs.

b. Weather Conditions for Placement:

b1. Observe and document the weather conditions (i.e., temperature, humidity, precipitation, and wind) to ensure that they are acceptable for geosynthetic material placement and seaming. The GW Specification describes acceptable weather conditions.

b2. If the weather becomes unacceptable for installation of the geosynthetic materials, recommend stopping the installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.

c. Synthetic Turf Placement:

c1. Prior to placement of the synthetic turf cover, visually inspect the geomembrane surface to be covered to ensure that it meets the requirements of the GW Specification (i.e., has been seamed, tested, and approved for further ClosureTurf® component deployment). Confirm that it is substantially free of debris and/or large scraps. Field observations shall be performed in accordance with the requirements specified in Table 014362-6.

c2. Provide documentation of daily inspection of the surface to be covered for the area of synthetic turf to be placed that day.

c3. As each synthetic turf panel is placed, visually inspect the panel for tears, punctures, and thin spots. The CQA Geosynthetics Inspector shall traverse the panels in such a way that the entire surface is inspected. Any defects shall be documented on a drawing and marked on the synthetic turf for repair.

c4. Document that the locations of synthetic turf splices meet the general requirements for seaming contained in GW Specification Section 311522.

c5. During placement:

c5.1 Make measurements to confirm that required overlap of adjacent synthetic turf sheets has been achieved, that proper temporary anchorage is being used (e.g., sand bags or tires), and that the synthetic turf is being placed in a relaxed (nonstressed) state.

c5.2 Observe and verify that tufts in the synthetic turf are not excessively pulled out by the installation process.

c5.3 Observe and verify that the first synthetic turf panel deployed on a slope has the turf filaments facing upward.

c5.4 Observe and verify that the turf filaments in all synthetic turf panels are pointed upslope after deployment is complete.

c5.5 Observe and verify that equipment being used to place the synthetic turf panels does not damage the synthetic turf or underlying geomembrane.

c6. Document any panel damage from adverse weather conditions, equipment, inadequate temporary anchoring, or rough handling. Mark the location of damage on the synthetic turf for repair and on a drawing.

c7. Document improper synthetic turf panel placement and, as a result, inadequate coverage with the available materials or an excess number of field seams.

c8. Document inadequate sheet overlap resulting in poor quality seams.

c9. Document nonwelded or cut panels.

c10. Document repair of damage. Documentation shall include location, type, and method of repair.

d. Synthetic Turf Splicing and Seam Repair:

d1. Trial Welds Prior to Beginning Seaming:

d1.1 If successive synthetic turf panels are to be spliced by welding, observe that trial welds are being made at the frequency specified in GW Specification Section 311522.

d1.2 Observe fabrication of test strips and note that test strips are fabricated correctly.

d1.3 Specify where samples are to be cut from the test strips and witness all peel/pull tests.

d1.4 Observe documentation of results of the peel/pull tests by the GW Contractor.

d1.5 Audit documentation of each trial weld received from the GW Contractor.

d1.6 Document the following information for each trial weld:

d1.6.1 Names of the seaming personnel.

d1.6.2 Name of the fusion seaming technician.

d1.6.3 The welding apparatus number and temperature.

d1.6.4 Date, time, and ambient air temperature.

d2. Splicing and Seam Repair. Activities that shall be documented during field splicing operations include:

d2.1 Observe that the synthetic turf is free from dirt, dust, and moisture.

d2.2 Observe that synthetic turf panel overlap and adjustment are correct prior to splicing.

d2.3 Observe that the synthetic turf is not damaged by equipment or personnel during the splicing process. Observe that any damages or defects are repaired in accordance with the GW Specification and/or the Synthetic Turf Manufacturer's recommendations.

d2.4 For synthetic turf panels spliced by sewing:

d2.4.1 Observe that the sewing materials and equipment are as specified in GW Specification Section 311522.

d2.4.2 Observe that seams are sewn as specified in GW Specification Section 311522.

d2.5 For synthetic turf panels spliced by fusion welding (heat bonding):

d2.5.1 Observe that the seaming materials and seam welding equipment are as specified.

d2.5.2 Observe weather conditions (e.g., temperature, humidity, wind) to ensure that they are acceptable for seaming.

d2.5.3 Measurements of temperatures, pressures, and speed of seaming to ensure that they are as specified. Gages and dials on seaming equipment shall be checked and readings recorded.

d2.5.4 Observe that no solvents or adhesives are used.

307. CQA TESTING AND INSPECTION REQUIREMENTS FOR BALLAST INFILL MATERIAL

307.1 Initial Material Certification:

a. Prior to shipment of any materials, the CQA Contractor shall assemble, document the receipt of, and audit the material supplier's test results and certification(s) that the properties of the material(s) meet GW Specification requirements.

307.2 Testing During Construction:

a. CQA activities during placement of Ballast Infill shall include visual observations and field testing to ensure that Ballast Infill is installed in accordance with GW Specification requirements. Field observations and tests shall be performed in accordance with the requirements specified in Table 014362-7 and the following paragraphs.

b. Visual Observation of Infill Placement:

b1. Record type of equipment in use.

b2. Observe installation method(s) are consistent with the method(s) presented to the Owner by the Ballast Infill Installer during the pre-construction meeting.

b3. Observe the Ballast Infill material is worked into the synthetic turf between the synthetic yarn blades.

b4. Observe that the underlying geomembrane and synthetic turf components are not displaced or damaged.

b5. Observe that Ballast Infill material is not placed when snow and/or ice are present on the synthetic turf.

c. Laboratory and Field Tests:

c1. Laboratory and field testing shall be performed in accordance with the requirements specified in Table 014362-7.

d. Test Acceptance Criteria:

d1. Acceptance criteria shall be as specified in GW Specification Section 311522.

308. SAMPLING PATTERN

308.1 The CQA Officer shall establish a completely random sampling pattern for determining the choice of sampling points for field tests. Each block of work shall be subdivided into a sampling grid with at least 10 times as many grids as samples or tests to be taken or as directed by the Owner. The grid shall have a numeric identification system devised to distinguish each set of tests for a specific area from all other sets of tests. Each lift shall have a separate grid.

308.2 Sampling points shall be chosen by a random number generator or other acceptable method to obtain uniform coverage. Tests shall be numbered beginning with test number one (1) and no numbers shall be skipped. In areas where a test of any type fails to meet specification criteria and a retest is performed, the retest shall have the same test number as the original test except that an “R” shall follow the test designation.

309. VERIFICATION AND CALIBRATION

309.1 Verification of Selected Field Tests:

a. The following tests shall be verified at the following frequency:

Test Requiring Verification	Frequency of Verification Test
Nuclear In-Place Density and Nuclear In-Place Moisture Content, ASTM D 6938	Note 1
“Quick” Moisture Content Test Using Microwave, (ASTM D4643) or Gas Stove, Frying Pan, or Infrared Oven, (ASTM D4959), etc.	One standard oven-dry moisture content (ASTM D2216) test per 20 quick tests.
Lift Thickness Measured Using a Shaft or Shovel	One lift thickness verified by surveying every two acre-lifts.

Notes:

1 – A standard block test as required by ASTM D6938 shall be performed at the start of each day on each Nuclear apparatus that will be used that day. At the start of earthwork construction, a series of five Nuclear tests and five sand cone or rubber balloon tests shall be performed in the borrow area, or area to be excavated, on a compacted test strip to calibrate the Nuclear apparatus. During construction, one of the last Nuclear readings performed at the end of each day shall be verified using a sand cone (ASTM D1556) or rubber balloon (ASTM D2167) density and moisture content test for each apparatus used that day. The average wet density and moisture content for each apparatus shall be computed for every ten tests. If variations greater than those permitted by the ASTM’s occur, corrections shall be applied to all future tests for the apparatus until the next set of 10 tests is performed.

309.2 Calibration:

a. Procedures for calibration of field and laboratory testing equipment shall be submitted by the CQA Contractor prior to the start of testing. These procedures shall meet ASTM requirements.

310. CORRECTIVE ACTION PROCEDURES

310.1 Failure of Material Quality Tests:

a. The GW Contractor and the Owner shall be notified immediately if gradation or Atterberg limits tests do not meet acceptance criteria. Failure to meet acceptance criteria of one or more of these groups of tests may indicate problems with the quality of soil materials. The GW Contractor shall cease all construction activities until the source of the problem or “out-of-specification” materials is identified.

310.2 Failure of Field Density or Moisture Content Tests:

a. If the results of field density or moisture content tests fail to meet acceptance criteria, those tests shall be re-run after recompaction. Judgment shall be used to select re-test locations suspected of having lower than specified density or moisture content. If the results of the re-test meet specification requirements, the compaction can be considered acceptable. If the results of the re-tests show out-of-specification densities or moisture contents, the CQA Officer shall immediately inform the Owner of the extent of the defective area. The defective area shall be removed and reconstructed or recompacted by the GW Contractor.

TABLE 014362-1

CQA FOR SUBGRADE (CCR)

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Proofrolling of subgrade	Observation		Continuous
2	Field Density / Soil Compaction	Nuclear Density Gauge, Sand Cone or Rubber Balloon Method	ASTM D6938, ASTM D2167, or ASTM D1556	Four per acre of compacted subgrade. Four additional tests per lift per acre of any regrading or fill. One per 500 cubic yards.
3	Field Moisture content	Nuclear Density Gauge or Direct Heat Method	ASTM D6938 or ASTM D4959	At each field density test location
4	Lift thickness, uncompacted	Direct Measurement		Four times per acre per lift
5	Moisture-density curve	Proctor or Index Density	ASTM D2216 and: • ASTM D1557, or • ASTM D4253 and ASTM D4254	One per 2 acres of compacted subgrade. One per 4 acres per lift fill and when changes in material are observed.

TABLE 014362-2

CQA FOR STRUCTURAL FILL MATERIAL

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Moisture Density Curve	Proctor	ASTM D2216 and: • ASTM D1557, or • ASTM D4253 and ASTM D4254	One per 30,000 cubic yards, and for all changes in material.
2	Soil Index Properties	Atterberg Limits (Note: If the fill is non-plastic, verify and document test is not required.)	ASTM D4318	One for each moisture density curve sample.
3	Soil Index Properties	Grain Size	ASTM D422	One for each moisture density curve sample.
4	Field Density / Soil Compaction	Nuclear Density Gauge, Sand Cone or Rubber Balloon Method	ASTM D6938, ASTM D2167, or ASTM D1556	Four per acre per lift.
5	Field Moisture content	Nuclear Density Gauge or Direct Heat Method	ASTM D6938, ASTM D4959, or ASTM D2978	At each field density test location.
6	Uncompacted and Compacted Thickness of Each Lift	Direct measurement		Four per acre per lift.
7	Fill Lines and Grades	Surveying		One per 100-foot grid spacing and at grade breaks.

TABLE 014362-3

CQA FOR AREAS TO RECEIVE GEOMEMBRANE

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Certification of Surface Elevation Prior to Geomembrane	Surveying		One per 100 ft grid and at grade breaks (toe and top of slopes).
2	Subgrade Firm and Unyielding	Observe and Document Proofroll		Continuous on Impoundment Floor
3	Slope Condition	Observe and document absence of erosion, slope failures, loose material or other non-conforming conditions on slopes		Continuous on slopes
4	Subgrade Free of Deleterious Conditions	Observe and document exposed subgrade is free from: • Irregularities • Protrusions • Loose soil or soft spots • Abrupt changes in grade • Debris • Clods • Stones • Roots • Organic material • Moisture seeps, puddling, or ponding • Frozen material		Continuous

TABLE 014362-4

CQA FOR ANCHOR TRENCHES

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Trench Geometry	Measurement		1 location per 100 ft of trench
2	Trench Condition	Observe and Document: • Trench free of sloughed material • Trench free from ponded water • Absence of loose material below geosynthetics		Continuous
3	Trench Backfill	Observe and document prompt backfill of trenches		Continuous
4	Field Density / Soil Compaction	Nuclear Density Gauge, Sand Cone or Rubber Balloon Method	ASTM D6938, ASTM D2167, or ASTM D1556	One per 200 ft of trench per lift by self-propelled equipment One per 200 ft of trench per every other lift by hand-operated equipment

TABLE 014362-5

CQA FOR HDPE GEOMEMBRANE

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Receipt of Delivery	Observe and document: • Name of Geomembrane Manufacturer • Product identification • Date of manufacture of the geomembrane • Roll identification number • Geomembrane thickness and type • Roll dimensions (length and width) • Batch number • Order number • Panel number (where applicable)	Visual	Each Roll
2	Inspection of Rolls	Lack of uniformity	Visual	Each Roll
		Damage, Tears, Punctures	Visual	Each Roll
		Imperfections, Blisters, Excessive Folding	Visual	Each Roll
3	Geomembrane Properties	Thickness	ASTM D5994 or ASTM D5199	5 per roll of geomembrane delivered at locations evenly distributed throughout roll

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
		Density	ASTM D1505/D792	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Tensile properties (strength and elongation at yield and at break)	ASTM D6693	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Tear resistance	ASTM D1004	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Puncture resistance	ASTM D4833	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Carbon black content	ASTM D4218 ASTM D1603 is acceptable if an appropriate correlation to D4218 has been established	Per resin batch, but not less than once per 50,000 SF of geomembrane
		Carbon black dispersion	ASTM D5596	Per resin batch, but not less than once per 50,000 SF of geomembrane
4	Weather and site conditions at time of HDPE deployment and seaming	Observe and document: • Visual and weather measurements		Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
5	Panel Deployment	Observe and document: • Relaxed deployment • Damage prevention • Wrinkles minimized • Temporary anchorage • Protected from damage • Proper overlap • Seam location	Visual	Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
6	Trial Welds	Observe and document Construction Contractor staff performing and testing trial welds		• Prior to each seaming period. • Every 4 hours of continuous seaming. • Whenever personnel or equipment are changed. • When climatic conditions result in wide changes in geomembrane temperature. • When requested by the CQA Geosynthetics Inspector(s) for any seaming crew or piece of welding equipment if problems are suspected.
7	Preparation for Seaming	Observe and document: • HDPE is clean • Minimum wrinkles and fish mouths • Fish mouths cut as necessary to lay flat • Firm surface for seaming	Visual	Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
8	Seaming	Observe and document: • Materials • Equipment • Staff • Acceptable procedures • Weather • Pressure • Speed • Damage • Absence of solvents	Visual	Continuous
9	Non-Destructive seam tests	Observe and document: • Equipment • Methods • Pressures • Leaks marked • Repairs made • Repairs retested	Various as applicable to seam type	100 percent of seam lengths shall be tested.

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
10	Destructive Samples and Testing	Observe and document: • Removal of all destructive test samples • Repair of sampled areas • Testing of repairs Label all samples	Shear strength and peel adhesion	• One test per every 500 linear feet of seam length if the seam is welded with a fusion weld. • One test per every 400 linear feet of seam length if the seam is welded with an extrusion weld. • One test for each seaming machine

TABLE 014362-6

CQA FOR SYNTHETIC TURF

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Receipt of Delivery	Observe and document: • Name of Synthetic Turf Manufacturer • Product identification • Date of manufacture of the synthetic turf • Lot number • Roll identification number	Visual	Each Roll
2	Inspection of Rolls	Lack of uniformity	Visual	Each Roll
		Damage, Tears, Punctures	Visual	Each Roll
		Imperfections, Blisters, Excessive Folding	Visual	Each Roll
3	Synthetic Turf Properties	Total Product Weight	ASTM D5261	Per 150,000 SF of synthetic turf
		CBR Puncture	ASTM D6241	Per 150,000 SF of synthetic turf
		Tensile Strength Product	ASTM D4595	Per 150,000 SF of synthetic turf
		Tensile Strength of Yarn	ASTM D2256	Per 150,000 SF of synthetic turf

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
4	Weather and Site Conditions at Time of Synthetic Turf Deployment and Seaming	Observe and document: • Visual and weather measurements		Continuous
5	Panel Deployment	Observe and document: • Geomembrane surface has been seamed, tested, and approved and is substantially free of debris and/or large scraps • Relaxed deployment • Damage prevention • Wrinkles minimized • Temporary anchorage • Protected from damage • Proper overlap • Seam location • First synthetic turf panel on a slope has the turf filaments facing upward • Turf filaments point upslope • Equipment does not damage synthetic turf or underlying geomembrane	Visual	Continuous

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
6	Trial Welds	Observe and document Geosynthetics Contractor personnel performing and testing trial welds.	Visual	• Prior to each seaming period. • Every 4 hours of continuous seaming. • Whenever personnel or equipment are changed. • When climatic conditions result in wide changes in geomembrane temperature. • When requested by the CQA Geosynthetics Inspector for any seaming crew or piece of welding equipment if problems are suspected.

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
7	Seaming	Observe and document: • Seaming method • Seaming materials and equipment • For sewn seams: stitching type and length • For welded seams: weather, pressure, speed, and absence of solvents • Damage and repairs	Visual	Continuous
8	Repairs	Identify areas to be patched. Document patching method and location.	Visual	Continuous

TABLE 014362-7

CQA FOR BALLAST INFILL MATERIAL

No.	Characteristic to be Monitored	Test		
		Monitoring/Testing Method	Test Method Reference	Minimum Test Frequency
1	Soil Index Properties	Grain Size	ASTM C136	One per 175 cubic yards.
2	Thickness	Direct measurement using digital caliper or Owner-approved alternate		Twenty (20) per acre.

END OF SECTION 014362

ATTACHMENT 1

SPECIFICATION W-7900 – EAST & WEST ASH POND CLOSURES

MWG

Midwest Generation, LLC

WAUKEGAN GENERATING STATION

SPECIFICATION W-7900

EAST & WEST ASH POND CLOSURES

S&L PROJECT NO.: 12661-098

REVISION 0C

ISSUE PURPOSE: PERMIT

ISSUE DATE: 01-27-2022

Sargent & Lundy

SECTION 000106

ISSUE SUMMARY AND APPROVAL PAGE

Rev.	Purpose of Issue	Date	Sections Affected
0A	Client Comment	11-10-2021	All
0B	Public Comment	11-15-2021	All
0C	Permit	01-27-2022	All

This is to confirm that this Specification has been prepared, reviewed, and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0407, Specifications, which is part of our Quality Management System.

Contributor Summary & Current Revision Signatures

Rev.	Prepared By	Reviewed By	Approved By
0A	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0B	Y. Banoub & T. Dehlin	T. Dehlin & D. Nielson	--
0C	Youssef Banoub, P.E.	Thomas Dehlin, P.E.	Thomas Dehlin, P.E.
	Thomas Dehlin, P.E.	David Nielson, P.E.	

SECTION 000107

CERTIFICATION PAGE

Sargent & Lundy, L.L.C. (S&L) is registered in the State of Illinois to practice engineering. S&L's Illinois Department of Financial and Professional Regulation registration number is 184-000106.

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

Certified By: Thomas J. Dehlin   Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

SECTION 000110

TABLE OF CONTENTS

DIVISION 00 – PROCUREMENT AND CONTRACTING

DIVISION 01 - GENERAL REQUIREMENTS

DIVISION 31 - EARTHWORK

ATTACHMENTS

END OF SECTION 000110

SECTION 011100

SUMMARY OF WORK

PART 1 - GENERAL

101. PROJECT INFORMATION

101.1 Owner: Midwest Generation, LLC (MWG)

101.2 Design Engineer: Sargent & Lundy (S&L)

101.3 Project Name: East & West Ash Pond Closures

101.4 Project Location: Waukegan Generating Station
401 E. Greenwood Ave.
Waukegan, IL 60087

102. DESCRIPTION OF THE PROJECT AND GENERAL BACKGROUND

102.1 The purpose of this project is to close the East Ash Pond and the West Ash Pond at Midwest Generation, LLC's Waukegan Generating Station in accordance with the Illinois Pollution Control Board's Coal Combustion Residuals (CCR) Rule, 35 Ill. Adm. Code Part 845, and with the U.S. Environmental Protection Agency's (EPA) CCR Rule, 40 CFR Part 257 Subpart D.

102.2 The West Ash Pond will be closed by removing all CCR and CCR-mixed materials stored in the pond and decontaminating the pond's geomembrane liner and appurtenant concrete structures. The pond's existing geomembrane liner and appurtenant concrete structures will remain in place. Following removal of CCR and CCR-mixed material from the pond and decontamination of the pond's facilities remaining in-place, the West Ash Pond area will be repurposed as a new low-volume waste pond for the Waukegan Generating Station.

102.3 The East Ash Pond will be closed by leaving the CCR and CCR-mixed materials stored in the pond in-place and installing a final cover system over the pond.

103. SCOPE OF WORK

103.1 In general, this Specification covers the technical requirements for a General Work (GW) Contractor to close the East and West Ash Ponds. The Work includes the following activities:

a. Surveying the project area to verify the accuracy of the existing topographic data shown on the Design Drawings.

b. Establishing benchmark monuments for survey control throughout the project.

c. Furnishing and installing temporary sediment and erosion control best management practices (BMPs) prior to and during all phases of earth disturbance work, including at the onsite sand stockpile adjacent to Lake Michigan and the haul road to and from the borrow site.

d. Closing the West Ash Pond so that it may be repurposed as a new low volume waste pond by:

d1. Removing all CCR and CCR-mixed materials stored in the pond with offsite disposal of dry waste material in a permitted landfill approved by the Owner and disposal of liquid waste in the East Ash Pond.

d2. Decontaminating the pond's existing geomembrane liner and appurtenant concrete structures.

d3. Ensuring all appropriate measures are taken to protect the West Ash Pond's existing HDPE geomembrane liner system from damage.

e. Closing the East Ash Pond by:

e1. Clearing, grubbing, and/or stripping topsoil from the East Ash Pond's perimeter dike and the dividing dike between the East and West Ash Ponds, with offsite disposal of material in a permitted landfill approved by the Owner.

e2. Dewatering, stabilizing, and preparing the CCR and CCR-mixed materials stored in the pond to receive Structural Fill.

e3. Placing, compacting, and grading Structural Fill to establish the lines and grades for the pond's final cover system as specified on the Design Drawings. Structural Fill will be obtained from onsite sand stockpile.

e4. Installing an engineered final cover system, ClosureTurf® (or Owner-approved equal), over the Structural Fill. ClosureTurf® is a multi-component final cover system design by Watershed Geo that consists of a structured geomembrane, a synthetic turf, and a ballast infill.

f. Restoring and cleaning the project and borrow areas.

g. GW Contractor shall allow access to all work areas by Owner, Design Engineer, CQA Contractor staff, and other parties as approved by Owner. GW Contractor shall not install, modify, repair or work on any elements of the project that are subject to the CQA testing and inspection services without notifying the CQA firm at least 2 work days in advance. Work on weekends or holidays shall be scheduled as soon as possible with the CQA Contractor. Failure to provide CQA Contractor adequate advanced notice to staff the site shall result in a hold on work until the CQA contractor staff arrive on site.

h. Developing fueling and maintenance facilities and practices to protect the project site from hydrocarbon spills or other environmental impacts that may impact the project site, adjacent property, or Lake Michigan.

103.2 In addition, the Work shall include but not be limited to the following:

a. Engineering and construction services required to perform or install the Work.

b. Surveying to ensure the Work is located as indicated on the Design Drawings in accordance with the benchmark monuments established by the GW Contractor.

c. Furnishing all installation equipment and tools including any calibrated instruments required for monitoring and testing.

d. Maintaining the project site in a dry condition that includes dewatering of all areas that collect storm water or groundwater in the area controlled by the GW Contractor, redirecting any surface water as a result of rainfall or water generated by the installation

Work. Any groundwater and/or surface water which requires removal from the area of work shall be disposed of in compliance with the Waukegan Generating Station's National Pollutant Discharge Elimination System (NPDES) discharge permit in effect at the time of the Work. The methods and proposed place of discharge shall be approved by the Owner prior to disposing of the water.

e. Excavated material and other construction related debris shall be disposed of offsite in a permitted landfill approved by the Owner.

f. Maintaining a record of the installation (i.e., as-built drawings) in accordance with the technical requirements of this Specification.

g. Furnishing the services of qualified personnel at the project site to perform the Work.

h. Progress reporting as specified in the Commercial Terms and Conditions.

i. Daily site cleanup and disposal of waste and debris.

j. Participation in the Owner's on-site safety program.

103.3 The Work shall conform to the requirements of this Specification and shall be performed and supervised by personnel who are experienced and knowledgeable in the crafts and trades required by the Scope of Work. The Work shall be performed exclusively by the GW Contractor's trained and competent personnel or, where permitted, that of its subcontractor(s); and shall comply with all applicable safety laws, regulations, programs, and practices to ensure the safety of all people located on the work site, including the Contractor's personnel (or that of its subcontractor(s)) performing the Work.

103.4 Performance of the Work shall include all the labor, supervision, administration, management, material procurement, tools, installation and testing equipment, miscellaneous material, and consumables to perform the Work specified herein.

103.5 Provide all installation equipment and all incidental items not shown or specified but reasonably implied for successful completion of the Work and in strict accordance with Design Drawings and this Specification, including inspection, testing and quality standards.

103.6 Provide installation quality assurance and quality control submittals where required.

103.7 Prepare red-lined as-built drawings for review upon completion of the Work to document any variances between the construction issue of the Design Drawings and the actual installation. Finalize as-built drawings after the Owner and the Design Engineer review.

103.8 All other work, as indicated on the Design Drawings, as specified herein or as required to properly complete the Work.

104. MATERIAL AND SERVICES FURNISHED BY OTHERS

104.1 The following work has been, or will be, performed and/or provided by Others:

a. Initial dewatering and removal of CCR from the West Ash Pond. The GW Contractor shall be responsible for dewatering (if necessary) and removing all CCR and CCR-mixed materials remaining in the West Ash Pond after the GW Contractor mobilizes to the site. Estimated quantity of CCR to be removed from the pond will be provided by Owner during the bid period for the Work.

b. Construction Quality Assurance services as detailed in Specification W-7901 will be procured by the Owner.

105. DEFINITIONS

105.1 The term "Design Drawing" means the Design Engineer's drawings indicating the Work to be performed.

105.2 The term "Work" means the material and services furnished to close the East and West Ash Ponds as identified on the Design Drawings and as specified herein.

105.3 The term "Owner-approved equal" means an acceptable equivalent to a specified material that has been accepted by the Owner.

106. INTENT OF DOCUMENTS

106.1 The Contract Documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the documents is to include all labor, material, equipment, and transportation necessary for the proper execution of the Work.

106.2 Discrepancies between the Design Drawings and this Specification, or errors or omissions or mis-description in either the Design Drawings or in this Specification, shall be referred to the Design Engineer for interpretation and adjustment prior to beginning the Work. Do not proceed without the Design Engineer’s written acceptance.

107. PERFORMANCE OF THE WORK

107.1 The GW Contractor shall provide materials and employ construction practices that are sustainable to the greatest extent possible, including disposal of waste.

107.2 The GW Contractor shall provide a representative that will input and provide daily force reports and daily production reports.

107.3 The performance of the Work, as specified herein and as indicated on the Design Drawings, shall comply with the current safety and health standards authorized by the U.S. Department of Labor's Occupational Safety and Health Administration, as well as state and local jurisdictional requirements.

107.4 The GW Contractor shall take all appropriate precautions to ensure the safety of all people working on site.

107.5 The GW Contractor shall maintain the necessary skilled and qualified labor force for the Work to ensure the on time completion of the Work.

107.6 The GW Contractor's personnel shall be competent, capable, qualified, and able to perform the duties required to the satisfaction of the Owner. A supervisor vested with authority to make decisions binding on the GW Contractor shall be assigned to the task to resolve installation problems as they arise so as not to delay completion of the Work.

107.7 The GW Contractor shall be solely responsible for advising the Design Engineer in writing of any conflicts between this Specification and the Design Drawings and the GW Contractor's drawings, including performance and levels of quality. The Contractor agrees that its obligations, liabilities, and warranties shall not be diminished or extinguished due to its meeting the requirements of this Specification and the Design Drawings.

108. REGULATORY REQUIREMENTS

108.1 The GW Contractor shall at all times be solely responsible for complying with all applicable laws, ordinances, regulations, and codes, including those relating to safety of all persons, in connection with the Work. No obligation of the Owner or Design Engineer shall impose upon them any duty to review the GW Contractor's compliance with safety measures.

109. PROTECTION OF PROPERTY AND PERSONNEL SAFETY

109.1 The GW Contractor shall take adequate precautions to protect existing structures, fences, pavements, aboveground utilities and underground utilities and to avoid damage thereto. The GW Contractor shall, at its own expense, repair any damage caused by its operations.

109.2 The GW Contractor shall conduct safety training of all its personnel (including any subcontractors) in accordance with the Owner's safety requirements.

109.3 The GW Contractor shall take adequate precautions to protect Lake Michigan and adjacent properties from environmental damage.

110. CLEAN-UP AND DISPOSAL OF DEBRIS

110.1 The Contractor shall be responsible for clean-up and disposal of all debris resulting from the installation work. All excavated material and other construction related debris shall be properly disposed of (i.e., in an environmentally responsible way) offsite in a permitted landfill approved by the Owner.

110.2 Clean up, disposal, and site restoration, if required, shall be in compliance with the applicable requirements of all access permits. If any additional permits are required for disposal of debris, these shall be the responsibility of the GW Contractor.

110.3 Work areas shall be kept clean and orderly at all times with as little disturbance as possible to existing conditions. Upon completion of work at each site, all tools, equipment, material, and debris shall be completely removed and the area left in a clean condition.

111. EXISTING SITE CONDITIONS

111.1 Existing Underground Obstructions:

a. The GW Contractor shall be responsible for location of underground utilities and obstructions prior to performance of the Work and shall promptly notify Owner of any potential interferences that may impact performance of the Work. Modifications to the design to resolve these interferences shall not be implemented until approved by the Owner.

b. If uncharted utilities or obstructions are encountered during the performance of the Work, the GW Contractor shall notify the Owner of any such uncharted utilities or obstructions that would prohibit proper completion of the Work for resolution.

111.2 Prior to performing any Work in any part of the project site, the GW Contractor shall make a thorough field check for the purposes of verifying existing conditions that may affect the Work. The GW Contractor shall include a thorough investigation of the potential interferences and difficulties that it may encounter in the proper and complete execution of the Work, including the field location and identification of underground and overhead utilities within and adjacent to the limits of the Work. The GW Contractor shall advise the Owner immediately of the discovery of any conditions, including the existence of underground and overhead utilities that may affect the timely and safe execution of the Work.

111.3 The GW Contractor further acknowledges that it has satisfied itself as to the character, quality and quantity of surface and subsurface material and obstacles, including underground or embedded utilities, to be encountered insofar as this information is reasonably ascertainable from an inspection of the site (including field location and identification of underground utilities) and reference drawings made available by the Owner, as well as from information presented by the drawings and specifications that are a part of the Contract, the character and extent of existing work within or adjacent thereto and any other work being performed thereon at the time of the submission of bids.

111.4 Should the GW Contractor fail to perform any of the obligations set forth above, the GW Contractor's later plea of ignorance of existing or foreseeable conditions which create difficulties or hindrances in the execution of the Work will not be considered as an excuse for any failure on the part of the GW Contractor to fulfill in every detail the requirements of the Contract nor will such a plea be acceptable as the basis of a claim for additional compensation or time to complete the work.

112. VERIFICATION OF DIMENSIONS ON DRAWINGS AND MEASUREMENTS AT SITE

112.1 The GW Contractor shall make a thorough field check for the purpose of verifying existing conditions that may affect the Work, such as existing topographic data shown on the Design Drawings, difficulties that might be encountered in the execution of the Work for any reason, and dimensions and other questions relating to interconnection of the Work with the existing ash pond construction.

112.2 The GW Contractor shall satisfy itself as to the accuracy of the dimensions of the existing ash pond construction as such dimensions relate to the dimensions given on any drawing issued by the Design Engineer. It shall be understood that neither the Design Engineer nor the Owner guarantee the exactness of such dimensions.

112.3 Should the GW Contractor discover any variation in the dimensions of existing conditions and the dimensions given on any drawings issued by the Design Engineer, the GW Contractor shall give immediate notice thereof to the Owner and the GW Contractor shall not proceed with the Work until such variation is resolved.

113. SOIL DATA

113.1 A structural stability and factor of safety assessment for the East and West Ash Ponds was prepared in October 2016. Site specific soil data and geotechnical recommendations are provided and referenced therein. The geotechnical information in and referenced by this assessment indicates the general character of the subsurface conditions at the site. This information is made available for the GW Contractor's information and for interpretation of soil and water conditions that may be encountered at the site. The logs and test data that are provided are not to be taken as a complete description of the site soil and water information, but only display what was found in borings at the indicated locations. The Owner and the Design Engineer take no responsibility for the accuracy of this information.

113.2 The GW Contractor may obtain additional subsurface information, as it deems necessary, for installation purposes.

114. LINES AND GRADES

114.1 The GW Contractor shall furnish and install a minimum of four (4) benchmark monuments as approved by the Owner to lay out lines and grades on the site during the lifetime of the project. All GW Contractor-installed benchmark monuments shall be shown on the red-lined as-built drawings. The GW Contractor is fully responsible for the correctness of such lines and grades and for proper execution of work to such lines and grades.

114.2 The Owner reserves the right to verify correctness of lines and grades during progress of the Work. Such verification by the Owner will not relieve the GW Contractor of responsibility as herein specified.

115. CONTROL AND CHARGE OF CONTRACTOR'S WORK

115.1 The Design Engineer shall have no authority to stop the Work by the GW Contractor for any reason.

115.2 The GW Contractor shall be responsible for the safety of its employees and subcontractors and for maintaining the safety of the job site.

115.3 The GW Contractor shall be solely responsible for construction means, methods, techniques, sequences, and procedures used in the construction of the Work. The Owner, however, reserves the right to request, and the Contractor shall supply, detailed information regarding the Work such as procedures or work methods.

115.4 Only the Owner (or its authorized representative) has the authority to stop the Work (in accordance with the Commercial Terms and Conditions) if such Work is determined to be not in accordance with this Specification, the Design Drawings, or the Contract documents.

116. DESIGN DRAWINGS

116.1 The Design Drawings prepared by the Design Engineer indicate the physical dimensions of the Work to be installed as defined by the Scope of Work and form a part hereof. Refer to Attachment 1 of this Specification for the applicable Design Drawings for this project.

117. REFERENCE DOCUMENTS

117.1 The reference documents assembled by the Design Engineer are for information only. Refer to Attachments 3 through 4 of this Specification for applicable reference documents for this project.

END OF SECTION 011100

SECTION 311522

ENGINEERED SYNTHETIC TURF FOR FINAL COVER SYSTEM

PART 1 - GENERAL

101. EXTENT

101.1 This section defines the minimum requirements for the material and installation of an engineered synthetic turf to be used in the ClosureTurf® final cover system (or Owner-approved equal) for the East Ash Pond, all in accordance with the Design Drawings and as specified herein.

101.2 The Work shall include, but not be limited to, the following items:

a. Manufacture, shipping, handling, and storage of synthetic turf materials.

b. Placement, splicing, and anchorage of synthetic turf.

c. Field testing of synthetic turf seams.

d. Repair of defects, holes, or tears in synthetic turf.

e. Visual inspection of the completed synthetic turf cover.

f. Placement of ballast infill between tufts of synthetic turf.

101.3 Definitions of Terms: The following definitions of terms shall apply throughout this section.

a. GW Contractor is contracted by and responsible to the Owner to perform all of the work specified herein. They may self-perform or subcontract the work. The final division of responsibilities between the Earthwork Contractor and Geosynthetics Contractor will be the responsibility of the GW Contractor.

b. Earthwork Contractor: The contractor who is generally responsible for earthwork for the facility and for excavation and backfill of anchor trenches. The Earthwork Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

c. Geosynthetics Contractor: The contractor who is generally responsible for the supply and installation of all geomembrane and synthetic turf materials as well as the unloading and storage of the materials. The Geosynthetics Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

d. Construction Quality Assurance (CQA) Contractor: The contractor who is independent of the GW Contractor and is responsible for all CQA work.

e. CQA Geosynthetics Inspector: An inspector who works for the CQA Contractor and is responsible for inspection of the Geosynthetic Contractor’s work.

f. Synthetic Turf Manufacturer: The manufacturer who is responsible for manufacture of synthetic turf materials and for transporting synthetic turf materials to the site.

g. Watershed Geo: A geosynthetic technology company and the designer of the ClosureTurf® final cover system.

101.4 Qualifications:

a. Synthetic Turf Manufacturer:

a1. The Synthetic Turf Manufacturer shall be approved by the Owner.

b. Geosynthetics Contractor:

b1. The Geosynthetics Contractor shall meet the qualifications for the Geosynthetics Contractor specified in Section 319022.

b2. The Geosynthetics Contractor shall be approved by the Synthetic Turf Manufacturer for installation of the Synthetic Turf Manufacturer's products.

b3. Synthetic Turf Seamers:

b3.1 Master Synthetic Turf Seamer shall have installed at least 5,000,000 square feet of geotextile materials.

b3.2 All other synthetic turf seamers shall have installed at least 1,000,000 square feet of geotextile materials. Personnel who do not meet this criterion may be allowed to seam synthetic turf panels but only under the direct supervision of the Master Synthetic Turf Seamer.

b3.3 Personnel performing fusion welding of synthetic turf panels shall be factory trained by Demtech Services, Inc.

102. <u>RELATED WORK SPECIFIED IN OTHER SECTIONS</u>

102.1 The work specified in this section shall be coordinated with work specified in the following related sections:

a. GW Specification (W-7900):

a1. Section 319022 – High Density Polyethylene Geomembrane Liner for Final Cover System.

b. CQA Specification (W-7901):

b1. Section 014362 – Construction Quality Assurance for Closing a CCR Surface Impoundment.

103. <u>REFERENCE DOCUMENTS</u>

103.1 Standards, Specifications, manuals, codes and other publications of nationally recognized organizations and association are referenced herein. Methods, equipment, and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state, or local codes having jurisdiction.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 Abbreviations listed indicate the form used to identify the reference documents in the Specification text.

103.4 ASTM – ASTM International:

a. C128 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

b. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

c. C1252 Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading).

d. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

e. D2256 Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method.

f. D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

g. D4884 Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.

h. D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

i. D5321 Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear.

j. D6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50mm Probe.

k. D6459 Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion

l. G147 Standard Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests.

m. G154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials.

104. SUBMITTALS

104.1 GW Contractor shall submit drawings and data as indicated below at least 30 days prior to use. GW Contractor's drawings and data shall be submitted via electronic medium in a format compatible for importing into Owner's information systems specified by Owner.

104.2 Submittals with Bid Proposal:

a. Resumes of key Geosynthetics Contractor personnel demonstrating Geosynthetics Contractor meets qualifications specified in Paragraph 101.4 of this section.

b. Synthetic Turf Material:

b1. Synthetic Turf Manufacturer's literature providing specifications on the synthetic turf material that will be supplied.

b2. Synthetic Turf Manufacturer's certification that synthetic turf materials to be supplied comply with the requirements of this Specification.

b3. Manufacturer's Quality Control (MQC) and Construction Quality Control Plans. The MQC plan shall include inspection records of the tufting procedures and indicate the following material properties for every 300,000 square feet of synthetic turf manufactured:

b3.1 Tufting gauge.

b3.2 Pile height.

b3.3 Roll length and roll numbers.

b3.4 Total product weight.

b3.5 CBR puncture per ASTM D6241.

b3.6 Tensile strength product (lb. / ft, minimum average roll value) per ASTM D4595.

b3.7 Tensile strength of yarn (lbs., minimum average roll value) per ASTM D2256.

c. Ballast Infill Material:

c1. Proposed construction equipment and method(s) to be used to install Ballast Infill material.

104.3 Submittals After Award of the Contract:

a. Synthetic Turf Material:

a1. Synthetic turf material samples for conformance testing as specified in Specification W-7901, Section 014632.

b. Ballast Infill Material:

b1. GW Contractor shall submit a 10-pound sample of Ballast Infill material to the Synthetic Turf Manufacturer.

b2. Ballast Infill material samples for conformance testing as specified in Specification W-7901, Section 014632.

105. QUALITY ASSURANCE

105.1 Materials and construction procedures shall be subject to inspection and testing by the CQA Contractor employed by the Owner. Such inspections and tests will not relieve the GW Contractor of responsibility for providing materials and installation in compliance with specified requirements.

105.2 The Owner reserves the right, at any time before final acceptance, to reject materials or workmanship not complying with specified requirements. The GW Contractor shall correct the deficiencies which the inspections and tests have indicated are not in compliance with specified requirements.

105.3 CQA activities for installing the engineered synthetic turf shall be performed as described herein and in Specification W-7901.

PART 2 - PRODUCTS

201. SYNTHETIC TURF MATERIALS

201.1 Acceptable Manufacturers:

a. The products of the following manufacturers meeting the requirements for synthetic turf herein are acceptable:

a1. Watershed Geo and their supplier Shaw Industries, Inc., 616 E. Walnut Avenue, Dalton, GA 30720, Tel.: 800-720-7429.

a2. Owner-approved equal.

201.2 Material Requirements:

a. Synthetic turf materials shall meet the requirements of Table 311522-1.

TABLE 311522-1

MINIMUM REQUIREMENTS FOR SYNTHETIC TURF MATERIALS

Property	Test Method	Specified Value
Yarn Type	N/A	Polyethylene
Yarn Color	N/A	TBD
Yarn Weight	ASTM D5261	20 oz. / sq. yd (min.)
Total Synthetic Turf Weight	ASTM D5261	32 oz. / sq. yd (min.)
Tensile Strength of Yarn	ASTM D2256	15 lbs. (min.)
CBR Puncture	ASTM D6241	1,500 lbs. (MARV)
Tensile Product:	ASTM D4595	
• Machine Direction		2,100 lb. / ft (MARV)
• Cross Direction		1,600 lb. / ft (MARV)
Interface Friction:	ASTM D5321	
• Between Synthetic Turf and 60 mil HDPE Textured Geomembrane		21° Peak (min.)
• Between Synthetic Turf and 60 mil HDPE Structured Geomembrane		35° Peak (min.)
Turf Fiber UV Stability	ASTM G147	60% (min.) retained tensile strength at 100 yrs (projected)
Geotextile Backing UV Stability (Exposed)	ASTM G154 Modified Cycle 1, UVA340	110 lb./ft retained tensile strength at 6,500 hrs (projected)
Aerodynamic Evaluation	GTRI Wind Tunnel	120 mph with max. uplift of 0.12 lb. / sq. ft
Rainfall Induced Erosion	ASTM D6459	Infill Loss 0.1% at 6 in./hr Rainfall

201.3 Packaging and Shipping Requirements:

a. Packaging and transportation shall be the responsibility of the Synthetic Turf Manufacturer, who shall retain responsibility until the synthetic turf is accepted at the site by the Geosynthetics Contractor.

b. Packaging:

b1. Deliver synthetic turf materials to the project site in rolls, each wrapped securely with a protective covering installed at the manufacturing facility. The covering shall prevent the entrance of water, vermin, and dirt, and shall be adequate for protection against ultraviolet exposure.

b2. The packaging shall not interfere with handling of the rolls either by slings or by using the central core upon which the synthetic turf is wound.

b3. A label shall be attached or adhered to each roll of synthetic turf identifying the following:

b3.1 Synthetic Turf Manufacturer's name.

b3.2 Product identification.

b3.3 Date of manufacture of the synthetic turf.

b3.4 Lot number.

b3.5 Roll identification number.

202. <u>BALLAST INFILL MATERIALS</u>

202.1 Acceptable Ballast Infill Material:

a. Material used as Ballast Infill between the tufts of the synthetic turf shall meet the final aggregate angularity, specific gravity, and grain size distribution specified in Table 311521-2.

TABLE 311522-2

REQUIREMENTS FOR BALLAST INFILL MATERIALS

Property	Test Method	Specified Value	
Uncompacted Void Content	ASTM C1252 Method A	40% min.	
Bulk Oven-Dry Specific Gravity	ASTM C128	2.40 min.	
Grain Size Distribution	ASTM C136	Sieve Size	Percent Passing
		3/8"	100
		#4	90 – 100
		#8	50 – 85
		#16	25 – 65
		#30	10 – 45
		#50	0 – 30
		#100	0 – 10
		#200	0

PART 3 - EXECUTION

301. ONSITE HANDLING AND STORAGE

301.1 Receipt/Unloading:

a. Upon delivery of the materials to the project site, the unloading and other handling of synthetic turf materials shall be performed by the Geosynthetics Contractor and in a manner to ensure the material is handled with care and is not damaged.

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

301.2 Storage:

a. The on-site storage space near the work area where the synthetic turf will be placed shall be managed by the GW Contractor such that on-site transportation and handling are minimized.

b. Rolls of synthetic turf shall be placed on a smooth surface free of rocks and standing water.

c. Rolls of synthetic turf shall be stored in such a manner that cores are not crushed, the geotextile not 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. If stacked, the rolls shall be stacked per the Synthetic Turf Manufacturer's recommendations, but no more than three rolls high.

301.3 Inspection:

a. Upon delivery of the materials to the project site, the Synthetic Turf Contractor shall conduct a visual inspection of all rolls of synthetic turf 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 Synthetic Turf Manufacturer and Owner. Any roll, or portion thereof, which, in the judgment of Owner or Owner's Representative, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to Owner.

302. PRE-DEPLOYMENT OF SYNTHETIC TURF COVER

302.1 The geomembrane component of the ClosureTurf® final cover system shall be placed, seamed, tested, and approved in accordance with Section 319022 prior to deploying the synthetic turf component.

302.2 The geomembrane surface shall be substantially free of debris, large scraps, *etc*.

303. FIELD PLACEMENT OF SYNTHETIC TURF COVER

303.1 General Requirements:

a. The Synthetic Turf Contractor shall not remove the protective covering from the synthetic turf rolls to be deployed until immediately prior to deployment to ensure that synthetic turf panels are not excessively exposed to ultraviolet degradation.

b. During handling, the synthetic turf panels shall be handled in such a manner that the material is not damaged in any way. Damaged material shall not be used.

303.2 Panel Deployment:

a. Synthetic turf panels shall not be deployed until the CQA Contractor has inspected the surface of the geomembrane in accordance with Specification W-7901. Any synthetic turf panels deployed over areas not accepted by the CQA Contractor shall be removed to allow inspection at no cost to Owner or CQA Contractor.

b. All necessary precautions shall be taken to prevent damage to the underlying geomembrane upon which the synthetic turf is to be placed.

c. All personnel working on the geomembrane surface shall wear soft-soled shoes and shall not engage in any activity which may damage the geomembrane.

d. Except for seam welding machinery or All-Terrain Vehicles (ATV) approved for use by the Design Engineer in writing, machinery shall not be operated on the geomembrane.

e. The use of ATVs for the deployment of the synthetic turf and Ballast Infill material will be allowed. For ATVs to be used, the Contractor must demonstrate that the ATV exerts a maximum allowable pressure on the geomembrane or synthetic turf surface of 5 psi. The maximum allowable pressure on the geomembrane surface or synthetic turf is influenced by the tread pattern of the tires on the ATV. The maximum allowable pressure is not the reading from a tire pressure gauge. The ATVs shall only be used to deploy rolls of synthetic turf and Ballast Infill material and shall not be used to transport personnel, equipment, sandbags, or the like.

f. Deployment of synthetic turf panels on slopes shall proceed as follows:

f1. The synthetic turf shall be securely anchored at the top and then rolled down the slope in such a manner as to continually keep the panel in tension and keep the panel free of wrinkles and folds.

f2. The first synthetic turf panel deployed shall have the turf filaments facing upward.

f3. If the synthetic turf panels will be spliced by sewing, subsequent panels shall be deployed turf side down and on top of the previous panel. After sewing each panel, the panel shall be flipped onto the geomembrane surface with care to avoid pulling tufts in the drainage studs.

f4. The turf filaments in all synthetic turf panels shall be pointing upslope after deployment is complete.

g. Synthetic turf panels shall only be cut using an upward cutting hook blade. If synthetic turf panels are cut in place, special care shall be taken to protect the underlying geomembrane from damage which could be caused by cutting the synthetic turf panels.

h. Any damage or suspected damage to the geomembrane during deployment, cutting or seaming of synthetic turf shall immediately be identified to the CQA Contractor and the Owner. No work shall proceed in the area until the potential damage is evaluated, documented and repaired as necessary.

i. During placement of synthetic turf panels, care shall be taken not to entrap, in or beneath the synthetic turf, stones, excessive dust, or moisture that could damage the synthetic turf or underlying geomembrane, or hamper subsequent splicing.

j. All deployed synthetic turf panels shall be weighted with sandbags, old tires, or the equivalent to provide resistance to wind uplift. Such weights shall be installed during deployment and shall remain until the sand infill is placed. Uplifted material can be reused only if approved by Owner.

303.3 Field Splicing:

a. Method of Splicing:

a1. Successive panels of synthetic turf shall be continuously sewn (i.e., spot seaming is not allowed) or continuously heat bonded in accordance with Synthetic Turf Manufacturer's recommendations on slopes flatter than 10H:1V (10 percent).

a2. On slopes steeper than 10H:1V (10 percent), all successive panels of synthetic turf shall be continuously sewn (i.e., spot sewing and heat bonding are not allowed). All seams shall be vertical (parallel with the flow line of the slope). No horizontal seams (across the slope) shall be permitted.

b. Sewing:

b1. Sewing procedures shall conform to the latest procedures recommended by the Synthetic Turf Manufacturer.

b2. Sewing shall be done using 207 polyester sewing thread.

b3. Seams shall be "prayer" seams constructed using a Newlong sewing machine or Owner-approved equal. Seams shall be formed by mating the edges of the synthetic turf panels and sewing the panels together with continuous stitches located between the first and second rows of tufts on both sides of the synthetic turf panels.

c. Heat Bonding:

c1. Fusion seaming (heat bonding) shall be performed using a Demtech VM-20/4/A fusion welder only.

c2. Fusion seams shall be made with at least 5 inches of overlap between the synthetic turf panels being welded.

c3. Frayed or loosed geotextile strands shall be cut off or otherwise removed.

c4. Prior to starting production seaming, trial seams shall be performed per Paragraph 303.4d of this section.

c5. Mechanical or hot knife trimming and cutting devices shall be utilized for salvage trimming.

c6. Any damage that occurs due to production seaming shall be repaired in accordance with the Synthetic Turf Manufacturer's recommendations.

d. Trial Welds Prior to Beginning Heat Bonding:

d1. Trial welds are required for pre-qualification of personnel, equipment, and procedures for making seams on identical geotextile material under the same climatic conditions as the actual field production seams will be made.

d2. Trial welds shall be made as follows:

d2.1 Prior to each seaming period.

d2.2 Every 4 hours (*i.e.*, at the beginning of the work shift and after the lunch break).

d2.3 Whenever personnel or equipment are changed.

d2.4 When the welding apparatus has been turned off for longer than 30 minutes.

d2.5 When climatic conditions result in wide changes in geotextile temperature.

d2.6 When requested by the CQA Geosynthetic Inspector for any seaming crew or piece of welding equipment if problems are suspected.

d3. Once qualified by passing a trial weld, welding technicians shall not change parameters without performing another trial weld.

d4. A test strip shall be prepared by joining two pieces of synthetic turf. The test strip shall be at least 12 inches wide and 3 feet long, and the seam shall be centered lengthwise. The CQA Geosynthetic Inspector shall witness the fabrication of each test strip.

d5. Testing of a trial weld shall not commence until the seam cools to the ambient temperature.

d6. Trial Weld Testing Procedure and Pass/Fail Criteria:

d6.1 Trial welds shall comply with visual passing criteria, which is verified when manual peel/pull test is performed, and the top synthetic turf panel tufts transfer to the bottom synthetic turf panel.

d6.2 Passing Test: 75% or more of the tufts in the top synthetic turf panel transfer to the bottom synthetic turf panel.

d6.3 Failing Test: Less than approximately 75% of the tufts in the top synthetic turf panel transfer to the bottom synthetic turf panel.

d6.4 Two consecutive trial welds shall meet the visual passing criteria above prior to commencing production seaming.

304. <u>REPAIR OF SYNTHETIC TURF</u>

304.1 Repair of Holes or Tears:

a. All holes or tears in a synthetic turf panel shall be repaired by using a heat-bonded seam. A handheld heat gun with a pressure wheel shall be used in smaller, concentrated areas.

b. The patch material shall be the same synthetic turf material as the damaged synthetic turf panel.

c. Care shall be taken to remove any soil, object, and/or other material which penetrated or tore the synthetic turf.

d. Alternative patching techniques may be utilized by the Geosynthetics Contractor following a field demonstration and subsequent approval by Owner.

305. <u>ANCHOR TRENCH BACKFILLING</u>

305.1 Synthetic turf cover shall be anchored in an anchor trench at the bottom of the slope. See Section 319022 for anchor trench excavation and maintenance requirements.

305.2 Backfilling:

a. Anchor trench backfill shall be placed in accordance with Section 312205 of this Specification.

b. Backfilling of the anchor trench shall occur during the morning or during extended periods of overcast skies when the liners are at their most contracted state.

c. If compacted using hand-operated equipment, backfill shall be placed in layers not exceeding 4 inches loose thickness and shall be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D1557.

d. If compacted by self-propelled equipment, backfill shall be placed in layers not exceeding 8 inches loose thickness and shall be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D1557.

306. <u>INSPECTION OF SYNTHETIC TURF COVER AFTER INSTALLATION:</u>

306.1 After installation is complete, a visual examination of the synthetic turf shall be carried out over the entire surface of the synthetic turf to verify that no potentially harmful foreign objects, such as broken needles, are present.

306.2 When sewing seams, the Geosynthetics Contractor shall perform continuous inspection during the seaming process using an in-line metal detector with an adequate sweep rate to determine the presence of broken needles. If the presence of broken needles is indicated, a needle removal system using magnets shall be implemented.

307. <u>PLACEMENT OF BALLAST INFILL:</u>

307.1 Placement of Ballast Infill between the tufts of the synthetic turf shall be done within the time limit specified by the Synthetic Turf Manufacturer.

307.2 Placement Procedures:

a. Ballast Infill shall be spread and placing using conveyor systems and/or express blowers using the method(s) presented to the Owner by the Ballast Infill Installer during the pre-construction meeting.

b. Ballast Infill shall not be deployed when snow and/or ice are present on the synthetic turf.

c. Ballast Infill shall be deployed in such a manner that excessive tensile stress is not placed on the synthetic turf.

d. Placement of the Ballast Infill shall be done in such a manner that the ClosureTurf® components are not shifted from their intended positions and are not exposed or damaged. On slopes, this requires deployment of Ballast Infill material to proceed from the bottom of the slope upward.

307.3 Final Thickness:

a. Ballast Infill placed between the tufts of the synthetic turf shall be at least 0.5-inch thick but no more than 0.75-inch thick.

END OF SECTION 311522

SECTION 312205

EARTHWORK FOR CCR SURFACE IMPOUNDMENT CLOSURE

PART 1 - GENERAL

101. EXTENT

101.1 This section defines the material and installation requirements for earthwork as part of closing the East and West Ash Ponds at the Waukegan Generating Station. This work shall be performed in accordance with the Design Drawings and as specified herein. This design is compliant with the Illinois and U.S. EPA Coal Combustion Residual (CCR) Rules.

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

a. Surveying for alignment and grade.

b. Furnishing and installing sediment and erosion control best management practices (BMPs) prior to construction and maintaining these BMPs during construction. This shall include providing BMPs at the Project Site, the onsite sand stockpile adjacent to Lake Michigan, and the haul road to and from the borrow site.

c. Demolition and disposal of waste.

d. Clearing, grubbing and topsoil stripping as required for select areas of existing dikes and borrow site, along with offsite disposal of organic debris and waste.

e. Preparation of the subgrade (CCR) to receive fills,

f. Grading of CCR material along with placement and compaction of Structural Fill to support the final cover system.

g. All appropriate measures shall be taken to protect the existing HDPE geomembrane liner system.

h. Disposal of excess or unsuitable excavated material if required.

i. Installation of additional sediment and erosion control facilities during construction, if required.

j. Dust control.

102. RELATED WORK SPECIFIED IN OTHER SECTIONS

102.1 The work specified in this section shall be coordinated with work specified in the following related sections and specifications:

a. Specification W-7900:

a1. Section 311010 – Temporary Sediment Control During Construction.

a2. Section 319022 – High Density Polyethylene Geomembrane for Final Cover System.

b. Specification W-7901 (Construction Quality Assurance for East & West Ash Pond Closures):

b1. Section 014362 – Construction Quality Assurance for Closing a CCR Impoundment.

103. REFERENCE DOCUMENTS

103.1 Standards, Specifications, manuals, codes, and other publications of nationally recognized organizations are referenced herein.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 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 agencies having jurisdiction.

103.4 Abbreviations listed below refer to the applicable organizations or documents.

103.5 ASTM - ASTM International:

a. D422 Standard Test Method for Particle-Size Analysis of Soils (Withdrawn 2016).

b. D1140 Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing.

c. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

d. D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

e. D4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

f. D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

g. D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

103.6 IDOT – Illinois Department of Transportation

a. Standard Specifications for Road and Bridge Construction

104. SUBMITTALS

104.1 The General Work (GW) Contractor shall submit drawings and data as specified. GW Contractor's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Owner's information systems specified by the Owner.

104.2 The GW Contractor shall submit with its bid, as a minimum, information requested including:

a. Complete Proposal Pricing (PP) and Proposal Data (PD) pages.

b. Company and key personnel experience on at least 20 similar projects in the last 10 years.

c. Project Work Plan to execute the work that includes at a minimum:

c1. Preliminary schedule,

c2. Construction equipment and manufacturer's specifications, and

c3. Names of key personnel.

104.3 After construction is complete the GW Contractor shall submit:

a. Final as-built drawings, documents and data prior to the Contract close out.

b. Final as-built drawings shall be in PDF file format and include native AutoCAD files. Drawing files shall be submitted with the project name, Project Identification Number (PIN), station name, drawing and revision numbers, and CAD file names identified in a separate electronic drawing list.

105. QUALITY ASSURANCE

105.1 The GW Contractor shall examine the areas and conditions under which earthwork is to be done and notify Owner in writing of conditions detrimental to the proper and timely completion of the Work.

105.2 Material, placing procedures and installations are subject to inspection and tests conducted by the CQA Contractor (see Specification W-7901, "Construction Quality Assurance for East & West Ash Pond Closures"). Tests shall be in accordance with Specification W-7901, Section 014362. Such inspections and tests shall not relieve the GW Contractor of responsibility for providing material and placement in compliance with this specification. Owner reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

105.3 GW Contractor shall correct all deficiencies in earthwork which inspections and laboratory and field tests have indicated are not in compliance with this specification. The GW Contractor shall perform additional tests, at GW Contractor's expense, as may be necessary to reconfirm any noncompliance of the original Work, and as may be necessary to show compliance of corrected Work.

105.4 The GW Contractor shall promptly correct errors or flaws in the Work or material identified during construction which may prevent proper installation. GW Contractor shall make immediate substitution of the noncomplying material or shall make field changes to make the noncomplying material acceptable. The correction or substitution shall be performed at no cost to Owner.

106. GEOTECHNICAL AND TOPOGRAPHICAL DATA

106.1 Geotechnical Data:

a. A structural stability and factor of safety assessment for the East and West Ash Ponds was prepared by Geosyntec Consultants in October 2016. Site specific soil data and geotechnical recommendations are provided and referenced therein.

b. The GW Contractor is allowed to make its own soil investigations. Any additional investigations shall be performed at no additional cost to Owner.

106.2 Topography:

106.3 A topographic survey of the project site was prepared in 2014. The design drawings indicate contour lines, elevations, and dimensions of existing ground. This information is furnished for GW Contractor's convenience and use. Owner assumes no responsibility for the accuracy of information provided.

a. It is noted that the volume of material stored in and topographic surface of the East and West Ash Ponds has been modified since the 2014 survey. Known changes are noted on the Design Drawings, but these notes are not considered to be an exhaustive representation of all differences between the 2014 survey and existing conditions.

b. The GW Contractor is allowed to make its own topographic assessment or check the existing survey data. Any additional surveying of the project site shall be at no additional cost to Owner.

107. <u>CONSTRUCTION SURVEYING</u>

107.1 The GW Contractor shall furnish and install a minimum of four (4) benchmark monuments as approved by the Owner to lay out lines and grades on the site during the lifetime of the project. The GW Contractor is fully responsible for the correctness of such lines and grades and for proper execution of work to such lines and grades.

107.2 Owner reserves the right to verify correctness of lines and grades during progress of the Work. Such verification by Owner shall not relieve the GW Contractor of responsibility as herein specified.

107.3 The GW Contractor shall notify Owner of any difference in location of existing construction and conditions from those indicated wherever such difference might affect its work.

PART 2 - PRODUCTS

201. <u>MATERIALS FOR STRUCTURAL FILL</u>

201.1 Acceptable Material for Structural Fill:

a. Poorly graded sand (SP per the Unified Soil Classification System, ASTM D2487) is stockpiled on site within ½ mile of the East Ash Pond and is available for the GW Contractor’s use in establishing the specified lines and grades for the pond’s final cover system. This fill will be provided by Owner to the GW Contractor at no cost to the GW Contractor.

201.2 Unsatisfactory Material for Structural Fill:

a. Material unsatisfactory for use as Structural Fill beneath final cover system is as follows:

a1. Soils classified as silt or organic soils in the Unified Soil Classification System, ASTM D2487. Classifications are ML, MH, PT, OL and OH.

a2. Soils classified as high liquid limit clay soils in the Unified Soil Classification System, ASTM D2487. Classification is CH.

a3. Rock material without a soil matrix in which nesting of rocks could occur.

201.3 CCR Fill:

a. The existing CCR stored in the East Ash Pond may be used as Structural Fill to support the pond’s final cover system but is not permitted to be used as fill beyond the limits of the pond’s existing HDPE geomembrane liner or used as fill offsite. No chemical characterization is required.

201.4 Road Surfacing:

a. Surfacing for the permanent road above the final cover system shall be Class A or B CA 6 in accordance with Article 1004.04 of the IDOT Standard Specifications for Road and Bridge Construction.

202. RESTRICTIONS ON THE USE OF MATERIAL FOR ANY PURPOSE

202.1 Any material, which is frozen, contains an excessive amount of organic material or trash, or contains rocks larger than 2", shall be considered unsatisfactory for use as fill.

202.2 Fill and backfill soils placed by previous construction shall be considered unsatisfactory for use as fill unless they meet the requirements for satisfactory material.

202.3 For the East Ash Pond, since CCR is existing onsite material, it shall not be taken offsite and shall be graded solely for the purpose of establishing the proper slopes for drainage of the protective cover system and/or to support Structural Fill used to establish the lines and grades for the final cover system. There are no restrictions on use of the ash within the limits of the East Ash Pond's existing HDPE geomembrane liner.

PART 3 - EXECUTION

301. GENERAL

301.1 Work required is shown on the Design Drawings. No work shall be performed outside of the designated area without prior written approval of the Owner.

301.2 All Work that is incidental to excavation or fill may not be specifically indicated on the design drawings, but shall be performed as part of the Work.

302. CLEARING, GRUBBING, AND TOPSOIL STRIPPING

302.1 Areas designated for excavation or fill shall be cleared and grubbed prior to beginning earth-moving operations.

302.2 Clearing and grubbing shall be done to remove all vegetation and root systems that are in excess of 5 percent of the soil by mass or larger than 1 inch in diameter.

302.3 Extent of Stripping:

a. Areas designated for excavation or fill shall be stripped of all topsoil and all other organic material.

b. Weeds, small roots, heavy grass, and other vegetation remaining after clearing and grubbing operations shall be removed with the topsoil.

c. Special care shall be taken to avoid damage to the existing HDPE liner system where organic material or topsoil are adjacent to or immediately above the liner.

302.4 Disposal of stripped topsoil:

a. Stripped topsoil shall be hauled offsite at a permanent disposal facility approved by the Owner that is permitted to receive coal combustion residual (CCR) waste.

303. DEMOLITION

303.1 Demolition of any structure, if required, will be shown on the Design Drawings.

303.2 Demolition and removal of minor items which are incidental to the earthwork may be required. The GW Contractor shall identify any such items during its prebid walkdown. The GW Contractor shall demolish such items as required as part of the performance of the Work.

304. EXCAVATION

304.1 CCR Excavation:

a. The minor excavation within the limits of grading shall be performed to the lines and grades indicated on the Design Drawings.

b. Excavated material shall be used for fill unless it is classified as unsatisfactory.

c. CCR and CCR-mixed materials stored in the East Ash Pond shall be excavated and used as fill using proper placement and compaction methods specified herein. Under no circumstances shall CCR and CCR-mixed materials be used as fill in areas outside of the limits of the East Ash Pond's existing geomembrane liner.

d. GW Contractor shall take all appropriate measures to protect the existing HDPE geomembrane liner systems during excavation activities. Any damage to the HDPE geomembrane liner systems caused by the GW Contractor shall be repaired by GW Contractor at no cost to Owner.

e. Excavations shall not be carried below grades indicated on the Design Drawings without approval of Owner. Overexcavations shall be refilled with compacted Structural Fill to the proper grade at no additional cost to Owner.

304.2 Borrow Site:

a. Excavation of the sand stockpile shall be performed in such a manner that stockpiled sand is prevented from entering Lake Michigan or the Waukegan Generating Station Intake Pond.

b. The excavation base where stockpiled soils are removed shall not extend below the elevation of the ground surrounding the stockpile.

c. Grading plans for the final stockpile are not included in the design. Instead, following the removal of the required sand to complete the work in the East Ash Pond, the GW Contractor shall grade the site to prevent erosion, pile instability, or ponding of water.

304.3 Excavation of Drainage Facilities:

a. Drainage ditches, swales, and channels shall be cut accurately to the cross section and grades indicated on the Design Drawings.

b. Roots, stumps, rocks and foreign material in the sides and bottom of drainage facilities shall be removed and the facility trimmed and dressed.

c. Care shall be taken not to excavate ditches and channels below the grades indicated. Excessive excavation shall be backfilled with compacted Structural Fill material.

d. Drainage facilities shall be maintained until final acceptance of the Work by the Owner.

e. Material excavated from the drainage facilities shall be used as fill or transported to the designated offsite disposal area.

305. DISPOSAL OF EXCESS MATERIAL

305.1 Disposal of Unsatisfactory Material:

a. Excavated material, which is unsatisfactory for use as Structural Fill, shall be disposed of in an offsite landfill permitted to receive CCR and approved by the Owner. Unsatisfactory fill material shall not be mixed with satisfactory fill material.

b. When transporting CCR and/or CCR-mixed materials offsite, the GW Contractor shall responsibly handle and transport the material in accordance with 35 Ill. Adm. Code 845.740(c)(1).

306. PREPARATION OF EXISTING SUBGRADE (CCR) TO RECEIVE FINAL COVER SYSTEM

306.1 Removal of Topsoil and Debris:

a. Areas to receive Structural Fill or any component of the East Ash Pond's final cover system shall be cleared and grubbed, stripped of topsoil, and cleared of any debris left by demolition Work and shall be inspected and approved by CQA Contractor prior to placement of Structural Fill or any component of the final cover system.

306.2 Subgrade Compaction and Proofroll:

a. Where the existing HDPE geomembrane liner is at least 2 feet below subgrade, the subgrade beneath areas to receive fill shall be compacted and proofrolled prior to placing the fill. The subgrade shall be compacted to the minimum degree of compaction specified in Table 312205-1. Proofrolling shall consist of furnishing and operating compaction equipment for testing the stability of subgrade prior to receiving the fill. The intent is to locate any unstable areas. Proofrolling shall be performed in the presence of the CQA Contractor to allow for observation of unstable areas.

b. Where the existing HDPE geomembrane liner is less than 2 feet below subgrade, subgrade preparation and testing are not required nor shall they be performed.

c. Compact the surface of the subgrade to achieve the required density prior to performing proofroll.

d. Equipment such as a fully loaded water wagon having a gross weight of not less than 25 tons or loaded dump truck weighing at least 25 tons shall be used for proofrolling

e. Proofroll the surface by making a minimum of two coverages with the approved equipment at a speed no greater than 3 mph. Each succeeding trip of the proofroller shall be offset by not greater than one tire width. Make additional passes over areas of suspected instability.

f. Failure: The subgrade shall be considered failed if, under the action of proofrolling, the subgrade yields, pumps, or is otherwise unstable. Yielding is defined as rutting of more than 1 inch measured from the top of the construction grade to the bottom of the rut.

g. Remedial Action: Either moisture condition, scarify and recompact failed area or remove all failed areas a minimum depth of one foot or as directed by the Owner and replace with satisfactory fill compacted as specified for Structural Fill.

307. PLACEMENT OF STRUCTURAL FILL

307.1 Structural Fill materials include sand material from the onsite stockpile and existing CCR or CCR-mixed materials within the East Ash Pond as described in Paragraphs 201.1 and 201.3, respectively.

307.2 Lift Thickness:

a. Fill shall be placed in horizontal layers.

b. Unless otherwise approved by Owner, the loose thickness shall not exceed the following:

b1. Eight inches maximum loose lift thickness for compaction by self-propelled equipment.

b2. Four inches maximum loose lift thickness for compaction by hand-operated equipment.

b3. These lift thicknesses may be increased if the results of a test section prove that a thicker loose lift can be compacted to the required specified densities. The maximum loose lift thickness shall be 12 inches.

307.3 Placement:

a. Where fill is placed with less than 2 feet of separation from the existing HDPE geomembrane liner, care shall be taken to avoid any damage to the existing liner system. This includes placing fill against the existing dikes from the bottom up while maintaining adequate fill thickness to prevent damage to the existing liner system.

b. Each layer of fill shall be evenly spread and moistened or aerated as required to achieve the required moisture content.

c. The top surface of each layer shall be approximately level but shall have sufficient crown or cross fall to provide adequate drainage of water at all times during the construction period. The crown or crossfall shall be at least 1 in 50 (two percent) but no greater than 1 in 20 (five percent).

d. Fill slopes steeper than 20 percent (i.e., five horizontal to one vertical) shall be overfilled a minimum of 6 inches beyond the face of the slope, measured horizontally, and then cut back and trimmed to the required line and grade to expose a smooth surface uniformly compacted to the required density. Installing the fill slope to lines and grades shown on the design drawings and then running over the surface with compaction equipment is not acceptable.

308. COMPACTING STRUCTURAL FILL

308.1 Equipment:

a. Each layer of fill shall be compacted by a smooth drum vibratory roller or other mechanical means acceptable to Owner that will produce the specified compaction.

b. At locations where it would be impractical because of inaccessibility to use self-propelled compacting equipment, fill layers shall be compacted using hand propelled compaction equipment.

308.2 Inspection and Testing:

a. All Work is subject to inspection and testing by the CQA Contractor. The CQA Contractor shall have access to the Work at all times. Testing shall be in accordance with the Contract. Refer to Specification W-7901 for inspection and testing requirements.

b. Each layer of compacted fill shall be tested and accepted before proceeding with the next layer.

c. It is the GW Contractor's responsibility to request inspection prior to proceeding with further Work that would make parts of the Work inaccessible for inspection.

d. If the fill material fails to meet the required density, the material shall be removed and replaced or reworked, altering the construction method as necessary to obtain the required density and compaction. Sufficient time shall be allotted between lifts for the necessary testing of the soils.

309. COMPACTION DENSITIES

309.1 The degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained at optimum moisture content in accordance with the standards listed in Table 312205-1.

309.2 The minimum degree of compaction for fills for different areas is presented in Table 312205-1. The GW Contractor shall use data from this table which are applicable to the project.

309.3 Provided GW Contractor can achieve the specified degree of compaction, moisture content of granular soils (e.g. poorly graded sand (SP), CCR and IDOT CA 6) shall not be a sole basis for rejection of the compacted fill.

310. GRADING TOLERANCES

310.1 Lines and Grades: The acceptable deviation from lines and grades indicated on the Design Drawings shall be as shown in Table 312205-2. The GW Contractor shall use data from that table which is applicable to the project.

310.2 Slopes: Slopes shall be finished in conformance with the lines and grades shown on the Design Drawings. When completed, the average plane of a slope shall conform to the slope indicated on the Design Drawings and no point on the completed slope shall vary from the designated plane by more than 6 inches measured at right angles to the slope.

311. DUST CONTROL

311.1 The GW Contractor shall be responsible for controlling dust caused by the grading operation in compliance with the Fugitive Dust Plan in place for the facility and in accordance with 35 Ill. Adm. Code 845.740(c)(2). The facility's active Fugitive Dust Plan may be downloaded from https://midwestgenerationllc.com.

311.2 Water shall be applied uniformly and lightly to prevent muddy, slippery, or other hazardous conditions. The application shall be frequent enough to adequately control the dust nuisance. However, excessive application that would affect compacting operations shall be avoided.

312. TEMPORARY SEDIMENT CONTROL DURING CONSTRUCTION

312.1 The GW Contractor shall be responsible for providing temporary facilities for the control of sediment in site area runoff during construction.

312.2 Silt fences, straw bale dikes and other temporary facilities shall be provided as required and as specified on the Design Drawings.

313. EROSION CONTROL

313.1 The GW Contractor shall be responsible for temporary protection of graded areas against erosion and for correction of erosion, which occurs.

313.2 Slopes, ditches, or other disturbed areas shall not be exposed for more than 21 days without a permanent cover.

TABLE 312205-1

MINIMUM COMPACTION REQUIREMENTS

Area	ASTM D1557 (percent)
Subgrade (CCR)	
Subgrade beneath fills	90
Structural Fills (Including Ash Fill)	
All Structural Fill	95

TABLE 312205-2

ACCEPTABLE DEVIATIONS FROM LINES AND GRADES ON DESIGN DRAWINGS

Type of Installation (Excavation or Fill)	Maximum Acceptable Deviation from Line (feet)	Maximum Acceptable Deviation from Grade(1) (feet)
General Earthwork		
General Site Area	±0.3	±0.2
Fill Areas Above Final Cover System (i.e. Permeant Road)	±0.3	+0.3 to -0.0
Drainage Facilities		
Permanent Drainage Channel	±0.3	+0.0 to -0.1
Slope Drainage Benches and Drainage Diversion Dikes	±0.5	±0.1

Notes:

(1) After initial settlement has taken place. Initial settlement is that settlement that will occur up to the time of determination and acceptance of final grade elevations by the Owner.

END OF SECTION 312205

SECTION 319022

HIGH DENSITY POLYETHYLENE GEOMEMBRANE FOR FINAL COVER SYSTEM

PART 1 - GENERAL

101. EXTENT

101.1 This section defines the minimum requirements for material and installation of non-textured, textured, and structured high density polyethylene (HDPE) geomembrane to be used in the ClosureTurf® final cover system (or Owner-approved equal) for the East Ash Pond, all in accordance with the Design Drawings and as specified herein.

101.2 The Work shall include, but not be limited to, the following items:

a. Manufacture, shipping, handling, and storage of geomembrane materials.

b. Inspection and approval of surfaces to be covered.

c. Placement and field seaming of geomembrane.

d. Anchorage of geomembrane in anchor trenches.

e. Attachment of geomembrane to structures and penetrations.

f. Non-destructive field testing of geomembrane seams.

g. Removal of samples of geomembrane seams and submittal to the CQA Contractor for destructive testing.

h. Repair of defective geomembrane seams.

i. Repair of defects in the geomembrane and locations where samples were taken.

j. Visual inspection of the completed geomembrane cover.

101.3 Definitions of Terms: The following definitions of terms shall apply throughout this section.

a. GW Contractor is contracted by and responsible to the Owner to perform all of the work specified herein. They may self-perform or subcontract the work. The final division of responsibilities between the Earthwork Contractor and Geosynthetics Contractor will be the responsibility of the GW Contractor.

b. Earthwork Contractor: The contractor who is generally responsible for earthwork for the facility and for excavation and backfill of anchor trenches. The Earthwork Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

c. Geosynthetics Contractor: The contractor who is generally responsible for the supply and installation of all geomembrane and synthetic turf materials as well as the unloading and storage of the materials. The Geosynthetics Contractor may be the GW Contractor or a subcontractor to the GW Contractor.

d. Construction Quality Assurance (CQA) Contractor: The contractor who is independent of the GW Contractor and is responsible for all CQA work.

e. CQA Geosynthetics Inspector: An inspector who works for the CQA Contractor and is responsible for inspection of the Geosynthetics Contractor's work.

f. Geomembrane Manufacturer: The manufacturer who is responsible for manufacture of geomembrane materials and for transporting geomembrane materials to the site.

g. Watershed Geo: A geosynthetic technology company and the designer of the ClosureTurf® final cover system.

101.4 Qualifications:

a. Geomembrane Manufacturer:

a1. The Geomembrane Manufacturer shall be approved by the Owner.

a2. The Geomembrane Manufacturer shall be approved by Watershed Geo for supplying the geomembrane component of the ClosureTurf® final cover system (or Owner-approved equal).

b. Geosynthetics Contractor:

b1. The Geosynthetics Contractor shall be approved by the Geomembrane Manufacturer for installation of the Geomembrane Manufacturer’s products.

b2. The Geosynthetics Contractor shall be approved by the Owner.

b3. Geosynthetics Contractor personnel shall attend ClosureTurf® orientation provided by Watershed Geo prior to the start of the Work if this project is the Geosynthetics Contractor’s first ClosureTurf® installation project.

b4. Geomembrane Seamers:

b4.1 Master Geomembrane Seamer shall have installed at least 5,000,000 square feet of geomembrane materials.

b4.2 All other geomembrane seamers shall have installed at least 1,000,000 square feet of geomembrane materials. Personnel who do not meet this criterion may be allowed to seam geomembrane materials but only under the direct supervision of the Master Geomembrane Seamer.

102. <u>RELATED WORK SPECIFIED IN OTHER SECTIONS</u>

102.1 The work specified in this section shall be coordinated with work specified in the following related sections and specifications:

a. GW Specification (Specification W-7900 – East & West Ash Pond Closures):

a1. Section 311522 – Engineered Synthetic Turf for Final Cover System.

a2. Section 312205 – Earthwork for CCR Surface Impoundment Closure.

b. CQA Specification (Specification W-7901 – Construction Quality Assurance for East & West Ash Pond Closures):

b1. Section 014362 – Quality Assurance for Closing a CCR Surface Impoundment.

103. <u>REFERENCE DOCUMENTS</u>

103.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment, and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state, or local agencies having jurisdiction.

103.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

103.3 Abbreviations listed indicate the form used to identify the reference documents in the Specification Section text.

103.4 ASTM – ASTM International:

a. A276 Specification for Stainless Steel Bars and Shapes.

b. B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

c. D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

d. D1004 Test Method for Tear Resistance of Plastic Film and Sheeting.

e. D1505 Test Method for Density of Plastics by the Density-Gradient Technique.

f. D1603 Test Method for Carbon Black Content in Olefin Plastics.

g. D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

h. D4833 Test Method for Index Puncture Resistance of Geomembranes and Related Products.

i. D5199 Test Method for Measuring Nominal Thickness of Geosynthetics.

j. D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

k. D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

l. D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

m. D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

n. D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

o. D5885 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

p. D5994 Test Method for Measuring Core Thickness of Textured Geomembrane.

q. D6392 Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

r. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

s. D7466 Test Method for Measuring Asperity Height of Textured Geomembranes.

t. D8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry.

103.5 GRI – Geosynthetic Research Institute:

a. GM6 Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes.

b. GM10 The Stress Crack Resistance of HDPE Geomembrane Sheet.

c. GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

d. GM14 Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.

e. GM19a Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barrier.

104. SUBMITTALS

104.1 GW Contractor shall submit the drawings and data as specified below within 30 days prior to use. Contractor's drawings and data shall be submitted via electronic medium in a format compatible for importing into the Owner's information systems specified by the Owner.

104.2 Submittals with the Bid Proposal:

a. HDPE Geomembrane Material:

a1. Certification of Compliance from the Geomembrane Manufacturer signed by its authorized representative indicating that the HDPE geomembrane sheeting material meets the criteria specified herein.

a2. One representative sample of each type of HDPE geomembrane material.

a3. Geomembrane Manufacturer's Quality Control and Quality Assurance Policies and Procedures.

b. Warranty:

b1. Written warranties from the Geomembrane Manufacturer and the Geosynthetics Contractor covering the quality of the material and workmanship as specified.

b2. The minimum period of warranty for materials shall be 20 years with first year non-prorated. The minimum period of warranty for installation shall be 5 years with the first year non-prorated.

b3. Any warranty conditions proposed, including limits of liability, will be evaluated by the Owner in approving the Geomembrane Manufacturer and the Geosynthetics Contractor. Warranty conditions are considered to be valid justification for exclusion or one or more bids.

c. Geosynthetics Contractor:

c1. Geosynthetics Contractor's name, address, and telephone number.

c2. Geosynthetics Contractor's qualifications.

c3. Installer's qualifications if the Geosynthetics Contractor is proposing to subcontract installation work.

104.3 Submittals After Award of the Contract:

a. Progress Reports:

a1. GW Contractor shall submit status reports at regular intervals as specified by the Owner. The reports shall indicate the status of the schedule.

b. Geomembrane Resin:

b1. Geomembrane Manufacturer's signed certificate that the resin meets the criteria specified herein.

b2. Geomembrane Manufacturer's signed certification of the origin of the resin and that all resin is from the same manufacturer (including Geomembrane Manufacturer's name, identification brand name, and number).

b3. Copies of Geomembrane Manufacturer and resin suppliers' QA/QC certificates. Certificates shall include a summary report of test results conducted to verify the quality of the resin used in each batch used to manufacture geomembrane for this project. As a minimum, the report shall include tests on specific gravity, melt flow index and percent carbon black.

c. Geomembrane Sheeting:

c1. Prior to material shipment to the site, the Geomembrane Manufacturer shall submit to the CQA Contractor representative samples of the geomembrane to be shipped to the site, along with chain of custody and certification that the samples submitted are from the geomembrane material to be delivered to the site. The number of samples shall be determined in accordance with the number of CQA conformance tests specified in Specification W-7901, Section 014362.

c2. Signed certification that the properties of the manufactured sheeting meet the criteria specified herein and are guaranteed by the Geomembrane Manufacturer.

c3. Statement certifying that no post consumer resin (PCR) has been added to the formulation.

c4. Copies of all of the Geomembrane Manufacturer's QA/QC certificates. The certificates shall include documents of test results.

d. Extrudate Resins or Rod for Seaming Geomembranes:

d1. Certification that all extrudate is the same resin type as the geomembrane and was obtained from the same resin supplier as the resin used to manufacture the geomembranes.

e. Installation Data:

e1. Geomembrane Manufacturer's proposed geomembrane panel layout for each installation.

e2. Geomembrane Manufacturer's recommended procedures for making and testing seams if different from those specified herein.

e3. Geomembrane Manufacturer's recommended procedures for repairing damaged geomembrane sections and seams if different from those specified herein.

e4. Geomembrane Manufacturer's details of geomembrane liner anchorage and attachment to structures and penetrations if different from those specified herein and the details shown on the Design Drawings.

104.4 Submittals After Construction is Complete:

a. Geosynthetics Contractor:

a1. As-built panel layout.

a2. Drawing showing location of repairs and type of repairs made.

a3. Location of destructive tests.

a4. Results of destructive tests.

a5. Results of non-destructive tests.

105. QUALITY ASSURANCE

105.1 Materials and construction procedures shall be subject to inspection and testing by the CQA Contractor. Such inspections and tests will not relieve the GW Contractor of responsibility for providing materials and installation in compliance with specified requirements.

105.2 The Owner reserves the right, at any time before final acceptance, to reject materials or workmanship not complying with specified requirements. The GW Contractor shall correct the deficiencies which the inspections and tests have indicated are not in compliance with specified requirements.

105.3 CQA activities for installing geomembrane materials shall be performed as described herein and in Specification W-7901.

PART 2 - PRODUCTS

201. HIGH DENSITY POLYETHYLENE GEOMEMBRANE

201.1 Manufacturers of HDPE Geomembrane Products:

a. The products of the following manufacturers meeting the requirements herein are acceptable:

a1. Watershed Geo and their supplier AGRU America Manufacturing, Inc., 500 Garrison Road, Georgetown, SC 29440, Tel.: 800-373-2478.

a2. Owner-approved equal.

201.2 General Requirements:

a. All non-textured HDPE geomembrane shall be white. There is no color requirement for textured and structured HDPE geomembranes.

b. The HDPE geomembrane shall be manufactured from first quality, virgin resin. Blending of resins shall not be allowed. No recycled or reworked geomembrane may be used except edge trim generated during the manufacturing process (no more than 10%). No post-consumer resin (PCR) of any type shall be added to the formulation.

c. The resin used to produce the geomembrane shall be formulated to be resistant to chemical and ultraviolet degradation.

d. The geomembrane shall be free of plasticizers.

e. The geomembrane shall be free of leachable additives.

f. During manufacture, each roll of geomembrane shall be continuously monitored across the width to assure uniformity of thickness. Thickness measurements shall meet the requirements of Table 319022-1 for non-textured geomembrane, Table 319022-2 for textured geomembrane, and Table 319022-3 for structured geomembrane.

g. The geomembrane shall be free of factory seams.

h. The geomembrane shall be free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, blisters, pits, tears, holes, pores, pinholes, voids, undispersed raw material, any sign of contamination or other defects that may affect serviceability, and shall be uniform in color, thickness, and surface texture.

i. The geomembrane shall be capable of being seamed in the field to yield seams that are as resistant to waste liquids as the sheeting.

j. The geomembrane shall be manufactured in the United States or Canada.

201.3 Non-Textured HDPE Geomembrane:

a. Non-textured HDPE geomembrane shall meet the requirements of Table 319022-1.

b. The location of non-textured HDPE geomembrane to be used for each installation shall be as shown on the Design Drawings.

201.4 Textured and Structured HDPE Geomembranes:

a. Textured HDPE geomembrane shall meet the requirements of Table 319022-2.

b. Structured HDPE geomembrane shall meet the requirements of Table 319022-3.

c. The location of textured and structured HDPE geomembranes to be used for each installation shall be as shown on the Design Drawings.

d. Textured and structured geomembranes shall be manufactured using a co-extrusion process.

e. The textured/structured deformations shall be manufactured on both sides of the base sheet.

f. Textured and structured geomembranes shall have uniform texturing appearance. The geomembrane shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

g. Each roll shall have 6-inch wide smooth edges (minimum) to provide suitable seaming surfaces. Textured and/or structured geomembrane without smooth edges may be provided if approved by the Owner.

TABLE 319022-1

HIGH DENSITY POLYETHYLENE NON-TEXTURED

GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value		Testing Frequency
Nominal thickness, mil	--	--	60	100	---
Resin Properties					
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D8117	100	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D8117	55	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 Hrs	D5885	50	--	--	one per formulation
Analytical Properties					
Formulated density, g/cc minimum	D1505/D792	0.940	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	45,000 lbs. .of Resin

Mechanical Properties					
Thickness, mils	D5199	--	--	--	One per roll
Average		--	60	100	
Lowest individual of 10 values		--	54	90	
Tensile properties, in each direction (minimum):	D6693 (Type IV Specimen at 2 ipm)				
Tensile stress at yield, ppi minimum		--	126	210	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	228	380	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	700	700	20,000 lbs. of Resin
Tear resistance, lb (minimum avg)	D1004	--	42	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	108	180	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	
Shear strength, ppi		--	120	200	
Peel adhesion (fusion), ppi		--	91	151	
Peel adhesion (extrusion), ppi		--	78	130	
Environmental and Aging Effect on Properties					
Stress Crack Resistance, hours (min)	D5397	--	500	500	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, Revision 16 (March 17, 2021), except for bonded seam strength.
2. Seam requirements shown in this table meet the minimum requirements of GRI Standard GM19a, Revision 10 (March 18, 2021).

TABLE 319022-2

HIGH DENSITY POLYETHYLENE TEXTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value		Testing Frequency
Nominal thickness, mil	--	--	60	100	---
Resin Properties					
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D8117	100	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D8117	55	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 hrs.	D5885	50	--	--	one per formulation
Analytical Properties					
Formulated density, g/cc minimum	D1505/D792	0.940	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	45,000 lbs. of Resin
Mechanical Properties					
Thickness, mils	D5994	--	--	--	One per roll
Minimum Average		--	57	95	
Lowest individual for 8 out of 10 values		--	54	90	
Lowest individual for 10 out of 10 values		--	51	85	
Asperity Height, mils (min avg)	D7466	--	16	16	Every second roll
Tensile properties, in each direction (minimum average)	D6693 (Type IV Specimen at 2 ipm)				
Tensile stress at yield, ppi minimum		--	126	210	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	90	150	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	100	100	20,000 lbs. of Resin
Tear resistance, lb. (minimum avg)	D1004	--	42	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	90	150	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	
Shear strength, ppi		--	120	200	
Peel adhesion (fusion), ppi		--	91	151	
Peel adhesion (extrusion), ppi		--	78	130	
Environmental and Aging Effect on Properties					
Stress Crack Resistance, hours (min)	D5397	--	200	200	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, Revision 16 (March 17, 2021), except for bonded seam strength.
2. Seam requirements shown in this table meet the minimum requirements of GRI Standard GM19a, Revision 10 (March 18, 2021).

TABLE 319022-3

HIGH DENSITY POLYETHYLENE STRUCTURED GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value		Testing Frequency
Nominal thickness, mil	--	--	60	100	---
Resin Properties					
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D8117	100	--	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400	--	--	200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--	--	--	
Standard OIT (min avg), percent retained after 90 days or	D8117	55	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80	--	--	one per formulation
High Pressure OIT (min avg), percent retained after 1600 hrs.	D5885	50	--	--	one per formulation
Analytical Properties					
Formulated density, g/cc minimum	D1505/D792	0.940	--	--	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3	--	--	45,000 lbs. of Resin

Mechanical Properties					
Thickness, mils	D5994	--	--	--	One per roll
Minimum Average		--	57	95	
Lowest individual for 8 out of 10 values		--	54	90	
Lowest individual for 10 out of 10 values		--	51	85	
Drainage Stud Height, mils (min avg)	D7466	--	130	130	
Friction Spike Height, mils (min avg)	D7466	--	175	175	Every second roll
Tensile properties, in each direction (minimum average)	D6693 (Type IV Specimen at 2 ipm)				
Tensile stress at yield, ppi minimum		--	132	220	20,000 lbs. of Resin
Elongation at yield, % minimum		--	12	12	20,000 lbs. of Resin
Tensile stress at break, ppi minimum		--	132	220	20,000 lbs. of Resin
Elongation at break, % minimum 2" gage length		--	200	200	20,000 lbs. of Resin
Tear resistance, lb. (minimum avg)	D1004	--	42	70	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--	90	150	45,000 lbs. of Resin
Bonded seam strength[2]	D6392	--	--	--	
Shear strength, ppi		--	120	200	
Peel adhesion (fusion), ppi		--	91	151	
Peel adhesion (extrusion), ppi		--	78	130	
Environmental and Aging Effect on Properties					
Stress Crack Resistance, hours (min)	D5397	--	500	500	per GRI GM10

Notes:

1. Requirements shown in this table meet the minimum requirements of GRI Standard GM13, Revision 16 (March 17, 2021), except for bonded seam strength.
2. Seam requirements shown in this table meet the minimum requirements of GRI Standard GM19a, Revision 10 (March 18, 2021).

201.5 Panel Layout:

a. Prior to manufacture of the geomembrane, a panel layout of the surface to be covered shall be made. Each panel to be used for the installation shall be given a numeric or alphanumeric identification number.

b. The panel identification number shall be related in writing to the manufacturing roll number that identifies the resin type, batch number, and date of manufacture.

c. The panel layout shall be made considering the following requirements:

c1. Panel lengths shall include slope gain and anchorage.

c2. Perpendicular tie-ins shall be made a minimum of 5 feet beyond the toe of the slope.

c3. A minimum of 6 inch overlap shall be allowed at double fusion welded seams.

c4. All field seams on slopes shall be oriented parallel to the slope (oriented along, not across the slope).

c5. The number of seams in corners or odd shaped geometric locations shall be minimized.

201.6 Packaging and Shipping:

a. The geomembrane shall be shipped to the project site in rolls. No material shall be folded.

b. A label shall be attached or adhered to each roll of the geomembrane identifying the following:

b1. Manufacturer.

b2. Product Identification, which can be traced back to the origin of the base material (resin supplier's name, resin production plant, resin brand name type, resin brand number, and production date of the resin).

b3. Date of manufacture of the geomembrane.

b4. Roll identification number.

b5. Geomembrane thickness and type.

b6. Roll dimensions (length and width).

b7. Batch number.

b8. Order number.

b9. Panel number.

201.7 Packaging and Transportation:

a. Packaging and transportation shall be the responsibility of the Geomembrane Manufacturer, who shall retain responsibility until the geomembrane is accepted at the site by the Geosynthetics Contractor.

202. MATERIALS FOR ATTACHMENT OF GEOMEMBRANE TO CONCRETE

202.1 Batten Strip:

a. Batten strip material shall be hot rolled, annealed, and pickled Type 306 L stainless steel in accordance with ASTM A276.

b. Strips shall be ¼ inch thick by 2 inches wide. Random lengths are acceptable.

202.2 Expansion Anchors:

a. Expansion anchors shall be stud type with a single piece three section wedge and zinc plated in accordance with ASTM B633. Wedges shall be manufactured from ANSI Type 304 stainless steel. Hilti Kwik Bolt 3 Expansion Anchors, or equal, are acceptable.

b. Minimum yield strength of 60,000 psi for wedge-type anchors and a minimum tensile strength of 65,000 psi for stud type anchors.

c. Anchors shall be 3/8 inch diameter by 3 1/2 inch long.

d. Washers for anchors shall be Type 18-8 stainless steel flat washers for 3/8 inch bolt size.

202.3 Neoprene Gasket:

a. Neoprene gaskets shall be 1/4 inch thick by 2 inches wide closed cell neoprene sponge sealing strips. Operating temperature range of neoprene shall be –40°F to +220°F.

b. Neoprene gaskets placed against concrete shall have a pressure sensitive adhesive on the side of the gasket placed against the concrete.

PART 3 - EXECUTION

301. ONSITE HANDLING AND STORAGE

301.1 Receipt/Unloading:

a. Unloading and storage of materials shall be the responsibility of the Geomembrane Manufacturer.

b. The unloading and other handling of materials shall be performed by the Geomembrane Manufacturer to ensure that the material is handled with care and not damaged.

301.2 Storage:

a. The GW Contractor shall provide temporary on-site storage space in a location near the area to be covered such that on-site transportation and handling are minimized. The GW Contractor shall be responsible for protecting stored material from theft and vandalism.

b. The rolls of geomembrane shall be placed on a smooth surface free of rocks and standing water.

301.3 Inspection:

a. Upon delivery of the material to the project site, the Geosynthetics Contractor shall conduct a visual inspection of all rolls of geomembrane for damage or defects. This inspection shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

b. Any damage or defects shall be noted and immediately reported to the Owner, the Geomembrane Manufacturer, and to the carrier that transported the material. Any roll or portion thereof, which, in the judgement of the Owner, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Owner.

302. PREPARATION OF SURFACES TO BE COVERED

302.1 General:

a. The Earthwork Contractor shall be responsible for preparing and maintaining the surfaces to be covered as specified in Section 312205 prior to placement of the geomembrane.

b. The Geosynthetics Contractor shall confirm the conditions of the finished surfaces to be covered prior to placement of the liner.

302.2 Grading Requirements:

a. The subgrade surface on which a lining is to be placed shall be graded to elevations shown on the Design Drawings. Tolerances shall be as specified in Section 312205.

302.3 Preparation of Concrete Surfaces:

a. All portions of concrete walls, curbs and foundations that will come in contact with a geomembrane shall be free of sharp edges or rough spots that can puncture or abrade the geomembrane. Where necessary, the concrete shall be ground smooth by the Earthwork Contractor. Where specified on the Design Drawings, one or more layers of geomembrane scuff strips shall be placed between the concrete and the geomembrane to act as a protective layer for the geomembrane cap.

302.4 Subgrade Acceptance:

a. See Section 312205 regarding inspection and acceptance of surfaces to be covered.

303. FIELD PLACEMENT OF THE GEOMEMBRANE COVER

303.1 General Requirements:

a. Placement Procedure: The placement procedure used for the geomembrane cover shall include the conditions listed below.

b. Weather:

b1. Geomembrane shall not be placed when the air temperature is above 104°F or below 41°F unless it can be demonstrated to the approval of the Owner by trial welds that acceptable welds can be made at the prevailing temperature. Trial welds shall be as described in Paragraph 303.2.c.

b2. Geomembrane shall not be placed when there is any rainfall or snowfall, in the presence of excessive moisture due to fog or dew, in ponded water, on a frozen subgrade, or during high winds.

c. Panel Layout:

c1. The panels shall be placed in accordance with the Geomembrane Manufacturer's panel layout drawing to ensure that they are placed in the proper direction for seaming.

c2. If panels are installed in a location other than indicated on the Geomembrane Manufacturer's panel layout drawing, the revised location shall be indicated on an "as-built" layout drawing. The "as-built" record drawing shall be submitted to the Owner at the completion of the project.

d. Panel Deployment:

d1. Only the panels that can be anchored and seamed together in one shift shall be unrolled.

d2. Unroll and layout panels in as close to the final position as possible. Pulling geomembrane panels should be minimized to reduce the chance of permanent tension.

d3. The methods and equipment used to deploy the panels shall not damage the geomembrane or the supporting surface.

d4. Wrinkles shall be minimized. However, enough slack shall be provided in both directions so that there will be no tension in the geomembrane at the lowest expected operating temperature.

e. Precautions to Prevent Wind Damage:

e1. If possible, work shall be oriented in the direction of the prevailing wind.

e2. Provide adequate temporary loading and/or anchoring of the geomembrane by the use of sandbags, tires or other means which will not damage the geomembrane, to prevent uplift of the geomembrane by wind.

f. Other Precautions to Prevent Damage:

f1. Protection of the geomembrane from damage due to foot traffic on the slopes shall be provided.

f2. Provisions of facilities for safe entrance and egress of employees from sloped depressions is required.

g. Replacement of Damaged Geomembrane:

g1. Any area of a panel, which, in the judgement of the Owner, becomes seriously damaged (torn, twisted, or crimped permanently) shall be replaced at no additional cost to the Owner.

303.2 Field Seaming:

a. Method of Seaming:

a1. The primary welding procedure for seams shall be double wedge fusion welding.

a2. Extrusion welding shall be used only for repairs, detail work, and for seaming where double wedge fusion welding is not possible.

a3. The rods used for extrusion welding shall be the same type of resin as the geomembrane, unless otherwise approved by the Owner.

a4. The use of solvents or adhesives is not permitted.

b. General Requirements for Seaming:

b1. On slopes steeper than 10 horizontal to 1 vertical, seams shall be oriented parallel to the line of maximum slope (oriented up and down, not across the slope) when possible. No seams oriented across the slope shall be used unless approved by the Owner.

b2. Seams parallel to the toe of the slope shall be located a minimum of 5 feet from the toe.

b3. Seams parallel to the crest of the slope shall be located a minimum of 2 feet from the crest.

b4. Seams at the bottom of a slope shall be overlapped so that the upslope sheet is positioned above the downslope sheet.

b5. Seaming shall extend to the outside edge of panels to be placed in the anchor trench. Seams at sheet corners of three or four sheets shall be completed with a patch having a minimum dimension of 24 inches, and extrusion welded to the parent sheets.

b6. All cross seams between the two rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of geomembrane.

c. Trial Welds Prior to Beginning Seaming:

c1. Trial welds are required for pre-qualification of personnel, equipment, and procedures for making seams on identical geomembrane material under the same climatic conditions as the actual field production seams will be made.

c2. Trial welds shall be made as follows:

c2.1 Prior to each seaming period.

c2.2 Every 4 to 5 hours (i.e., at the beginning of the work shift and after the lunch break).

c2.3 Whenever personnel or equipment are changed.

c2.4 When climatic conditions result in wide changes in geomembrane temperature.

c2.5 When requested by the CQA Geomembrane Inspector for any seaming crew or piece of welding equipment if problems are suspected.

c3. Once qualified by passing a trial weld, welding technicians shall not change parameters without performing another trial weld.

c4. Trial welds shall be made on both double wedge fusion welds and on extrusion welds.

c5. A test strip shall be prepared by joining two pieces of geomembrane, each piece shall be at least 6 inches wide. The length of double wedge fusion welded seams shall be a minimum of 10 feet long. The length of an extrusion welded seam shall be a minimum of 4 feet long. The CQA Geomembrane Inspector shall witness the fabrication of each test strip.

c6. All test welds shall be tested by destructive testing. Testing can be done as soon as the seam cools.

c7. A minimum of three (3) one (1) inch wide sample strips shall be cut from each test strip, one from each end and one from the middle. The location of each sample shall be selected by the CQA Geomembrane Inspector. The test strips shall be tested in peel at

2 inches per minute using a field tensiometer. The CQA Geomembrane Inspector shall witness all tests.

c8. If any of the test specimens fail, a new test strip shall be fabricated and the tests repeated for the new strip. If additional specimens fail, the seaming apparatus and the seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and successful trial welds have been achieved.

c9. The trial weld is considered acceptable if, when tested for peel adhesion using the field tensiometer, all three specimens meet the criteria specified for both the peel and shear under Bonded Seam Strength in Table 319022-1 (non-textured geomembrane specimens), Table 319022-2 (textured geomembrane specimens), or Table 319022-3 (structured geomembrane specimens), or the three specimens exhibit Film Tear Bond (FTB) (yielding of the parent material before seam failure). In the case of double wedge fusion welded seams, both welds must pass in order to be considered acceptable.

c10. If the specimens pass the tests, production seaming operations can begin.

c11. The GW Contractor shall document all data on each trial weld, including:

c11.1 Date.

c11.2 Time.

c11.3 Operator.

c11.4 Machine number.

c11.5 Ambient temperature.

c11.6 Operating temperature.

c11.7 Speed setting.

c11.8 Pass/Fail designation.

d. Preparation for Seaming:

d1. Prior to seaming, the surface of the geomembrane shall be wiped with a clean cloth to ensure that it is clean and free from moisture, grease, dust, dirt, and debris of any kind before seam welding is started.

d2. The panels shall be adjusted so that the seams are aligned to eliminate wrinkles and fish mouths. Where necessary, fish mouths and wrinkles shall be cut to achieve flat overlap.

e. Seaming:

e1. Seaming shall be performed in accordance with the Geomembrane Manufacturer's accepted procedure.

e2. Double Wedge Fusion Welds:

e2.1 The panels shall be overlapped a minimum of 4 inches prior to welding.

e2.2 Vehicle mounted automated hot wedge welding apparatus shall be used to make the seam.

e3. Extrusion Fillet Welding:

e3.1 Geomembrane overlap shall be a minimum of 3 inches for extrusion welding.

e3.2 Geomembrane panels shall be temporarily bonded using a hot air device prior to extrusion welding.

e3.3 The edge of the geomembrane to be fillet welded shall be pre-beveled before heat-tacking the seam in place.

e3.4 The seam overlap shall be ground (abraded) no more than one hour prior to welding.

e3.5 Grinding shall be performed in accordance with the Geomembrane Manufacturer's instructions in a manner that does not damage the geomembrane.

e3.6 Grinding shall not extend more than 1/4 inch past the area to be covered with extrudate during welding.

e3.7 All grind marks shall be covered with extrudate.

e3.8 Geomembrane overlap shall be a minimum of 3 inches for extrusion welding.

303.3 Non-Destructive Field Testing:

a. General:

a1. All non-destructive field testing shall be performed and documented by the Geosynthetics Contractor.

a2. The CQA Geomembrane Inspector shall observe all non-destructive test procedures.

a3. One hundred (100) percent of the seam length shall be tested using non-destructive procedures to check the continuity of the field seams. Non-destructive testing is not meant to qualify seam strength.

a4. Air pressure testing shall be performed in accordance with ASTM D5820 and GRI GM6.

a5. Vacuum box testing shall be performed in accordance with ASTM D5641 and as specified herein.

a6. Continuity testing shall be performed as seaming progresses or as soon as a suitable length of seam is available, not at the completion of all field seaming.

b. Double Wedge Fusion Welded Seams:

b1. Double fusion welded seams shall be tested using air pressure testing.

b2. The procedure for testing shall be as specified in GRI GM6 for the type and thickness of geomembrane in use.

b3. The following test pressures are applicable to non-textured, textured, and structured HDPE geomembrane. After an initial 2 minute pressure stabilization period, the pressure shall be maintained between 27 and 30 psi for 60 mil HDPE and 30 and 35 psi for 100 mil HDPE. The pressure shall be sustained for a minimum of 5 minutes. The loss of pressure shall not exceed a maximum of 3 psi in 5 minutes. If the pressure does not stabilize in the first two minutes or the pressure loss exceeds the loss specified, the seam test shall be considered a failure.

b4. The leak or suspected leak shall be located and repaired.

b5. The repaired seam shall be re-tested as required until all leaks are identified, and repaired, and the seam passes a subsequent air pressure test.

b6. When the geometry of a double wedge fusion weld makes air testing impossible or impractical, vacuum testing may be used to test the seam.

c. Extrusion Welded Seams:

c1. Extrusion welded seams shall be tested using vacuum chamber testing in accordance with ASTM D5641.

c2. The completed seam shall exhibit no leakage when tested between 4 and 8 psi minimum vacuum for approximately 10 seconds.

c3. If leaks are discovered during testing, they shall be located, marked, and repaired.

c4. The repaired area shall be re-tested and exhibit no leakage.

d. Inaccessible Seams:

d1. Where extrusion welded seam, locations make use of vacuum box testing impractical, then the electric wire method of testing shall be used or the seam shall be cap stripped as approved by the Owner.

d2. If cap stripping is approved by the Owner, the seams shall be cap stripped as described in Paragraph 304.4, with strips of the same type and thickness of geomembrane being installed. The cap stripping shall be performed in the presence of the Owner.

d3. The electric wire test method shall consist of placing a 24 gauge copper wire 1/8 inch beneath the top sheet overlap of the two sheets prior to welding with the extruder. The wire shall be imbedded in the seam. After welding, a holiday spark detector, operating at 20,000 volts, shall be connected to one end of the wire, and slowly moved over the length of the seam. A seam defect between the probe and the embedded wire shall result in an audible alarm indicating where the defect is located.

e. Test Reports:

e1. Test reports for all air pressure tests shall contain all data specified in ASTM D5820 and GRI GM6.

e2. Test reports for vacuum box testing shall contain all the data specified in ASTM D5641.

e3. Test reports for other types of non-destructive tests shall contain as a minimum for each test:

e3.1 Location.

e3.2 Type of test.

e3.3 Test parameters.

e3.4 Test data.

e3.5 Test number.

e3.6 Name of tester.

e3.7 Outcome of the test.

303.4 Destructive Testing:

a. Testing:

a1. Destructive testing shall be performed by an independent third party laboratory employed by the CQA Contractor on samples cut from production welds in the field by the Geosynthetics Contractor.

a2. Samples shall be taken by the Geosynthetics Contractor to the third party laboratory and tested for shear strength and peel adhesion. For double wedge seam samples, both welds shall be tested for peel adhesion.

b. Location and Frequency:

b1. Test locations shall be determined after seaming. The location where the test samples shall be marked by the CQA Geomembrane Inspector. Locations may be prompted by the appearance of excessive heating, contaminations, offset welds, or a suspected defect. Destructive test samples shall be taken at a minimum average frequency of one per every 500 linear feet of seam length.

b2. The Method of Attributes described in GRI GM14 may be exercised to minimize the number of test samples taken if more than 100 destructive seam samples will be required based on the sampling strategy given in Paragraph 303.4.b1.

b3. Each sample location shall be numbered and marked with permanent identification and the location of the sample and the locations shall be indicated on a plan drawing prepared and maintained by the Geosynthetics Contractor. The following shall be recorded for each sample:

b3.1 Date and time.

b3.2 Ambient temperature.

b3.3 Seam number and location.

b3.4 Welding apparatus used.

b3.5 Name of Master Geomembrane Seamer.

b3.6 Reason for taking the sample.

b3.7 Size of sample.

b3.8 Test results.

b3.9 Name of tester.

b4. Samples shall be cut by the Geosynthetics Contractor. The CQA Geomembrane Inspector shall witness test sample cutting.

b5. Test samples shall be cut every shift and taken by the Geosynthetics Contractor to the third party laboratory the same day that the sample is prepared.

c. Sample Size:

c1. The minimum sample size shall be 12 inches wide with a seam 16 inches long centered length wise in the sample. As agreed, to with Owner, a sample may be increased in size to accommodate the requirements of the testing laboratory.

d. Field Testing:

d1. A one-inch wide specimen shall be cut from each end of each sample for field testing.

d2. Each one-inch wide specimen shall be tested with a field tensiometer for peel adhesion.

d3. The CQA Geomembrane Inspector shall witness each field test.

d4. A test is considered acceptable if a specimen meets the criteria for both peel and shear under Bonded Seam Strength specified in Table 319022-1 (non-textured geomembrane specimen), Table 319022-2 (textured geomembrane specimen), or Table 319022-3 (structured geomembrane specimen), or exhibits Film Tear Bond (FTB). For double wedge fusion welds, both welds must pass the test. If either sample fails the field test, it shall be assumed that the seam will not pass the specified laboratory testing and the sample shall be given a fail designation.

e. Laboratory Testing:

e1. Full size (12 inch minimum length) samples shall be taken to an independent third-party laboratory for testing.

e2. Samples shall be tested for shear strength and peel adhesion in accordance with ASTM D6392. Five specimens shall be tested for each test method. All samples shall meet minimum requirements for shear strength and peel adhesion given under Bonded Seam Strength in Table 319022-1 (non-textured geomembrane specimens), Table 319022-2 (textured geomembrane specimens), or Table 319022-3 (structured geomembrane specimens).

f. Test Results:

f1. Verbal test results shall be given to the Geosynthetics Contractor within 24 hours of receipt of the samples. Written results shall follow within one week.

f2. All test locations shall be marked with a pass/fail designation on the liner and on the drawings maintained by the Geosynthetics Contractor for submittal to the Owner after construction is complete.

g. Re-Testing if Failure Occurs:

g1. If a seam fails testing, one additional sample shall be taken 10 feet on each side of the location of the failed test. Additional samples shall continue to be taken at 10 foot intervals until tests show that seam strength is adequate and the zone in which the seam requires reconstruction is identified.

g2. All passing seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

g3. The entire seam length failing strength tests shall be reconstructed at no additional cost to the Owner.

g4. If the length of reconstructed seam exceeds 150 feet, a sample shall be taken of the reconstructed seam every 150 feet and shall pass destructive testing.

303.5 Inspection:

a. After seaming is complete, the Geosynthetics Contractor and the CQA Geomembrane Inspector shall conduct a detailed walk-down to visually check all seams and non-seam areas of the geomembrane.

b. All defects, holes, blisters, tears, signs of damage during installation, areas of undispersed carbon and holes from destructive or non-destructive testing shall be marked and repaired.

304. REPAIR OF DEFECTS AND SEAMS

304.1 Patching:

a. Patching shall be used to repair large holes, tears, and destructive sample locations.

b. All patches shall be round, oval, or shall have rounded corners.

c. All patches shall be made of the base geomembrane material and shall extend a minimum of 3 inches beyond the edges of the defect.

d. Patches shall be extrusion welded to the base sheet.

304.2 Grinding and Welding:

a. Grinding and welding shall be used to repair sections of extruded fillet seams with small defects.

304.3 Spot Welding:

a. Spot welding shall be used to repair small tears, pinholes, or other minor localized flaws.

304.4 Capping:

a. Capping shall be used to repair lengths of extrusion welded seams with large defects and to repair double wedge fusion welded seams.

b. Cap strips shall be made with strips of the same type and thickness of geomembrane being installed. Strips shall extend a minimum of 6 inches beyond the weld and shall have rounded corners.

c. Cap strips shall be extrusion welded to the base sheet.

304.5 Cut Out and Replacement:

a. When approved by the Owner, a length of defective seam may be cut out and replaced with a strip of new material seamed into place.

304.6 Verification of Repairs:

a. All repairs shall be non-destructive tested using one of the procedures described in Paragraph 303.3.

b. Repairs, which pass the non-destructive test, shall be deemed acceptable.

c. Repairs of a seam in excess of 150 feet in length shall have one destructive seam test per 150 feet in length.

305. ANCHOR TRENCH EXCAVATION AND BACKFILLING

305.1 Excavation and Shaping:

a. Unless specified otherwise on the Design Drawings, the geomembrane cover shall be anchored in an anchor trench at the bottom of the slope. The anchor trench shall be excavated by the Earthwork Contractor to the lines and widths shown on the Design Drawings prior to placement of the geomembrane cover.

b. A slightly rounded corner shall be provided in the trench where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench.

c. The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open.

305.2 Backfilling:

a. See Section 311522 for anchor trench backfill requirements.

306. ATTACHMENT TO CONCRETE

306.1 Geomembrane shall be attached to concrete using batten strips in accordance with details on the Design Drawings.

END OF SECTION 319022

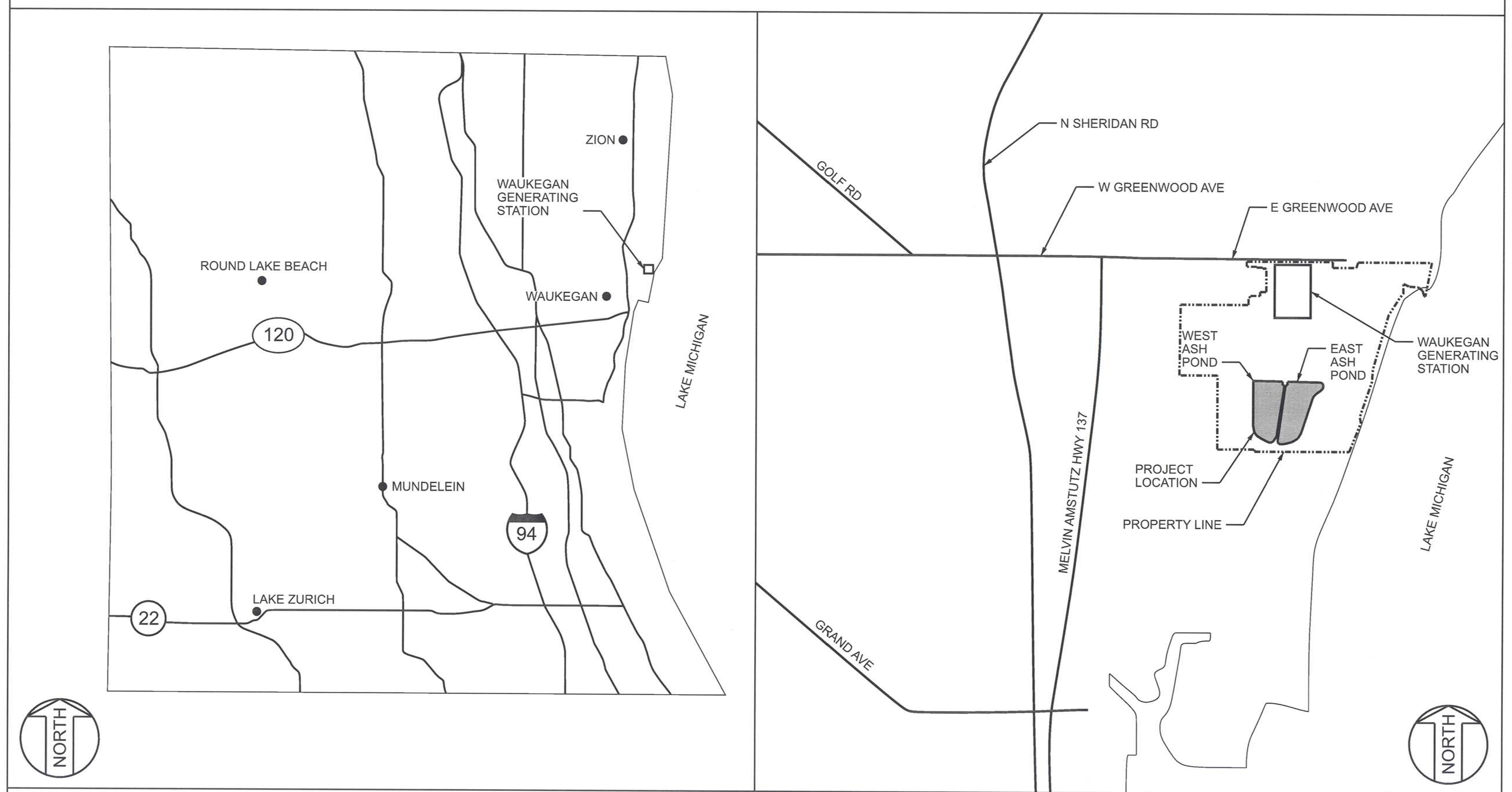
ATTACHMENT 2

DESIGN DRAWINGS

DRAWING NO.	REV.	TITLE
WKG-AP-CSK-001	C	ASH POND CLOSURE COVER SHEET
WKG-AP-CSK-002	C	ASH POND CLOSURE GENERAL NOTES
WKG-AP-CSK-003	C	WEST ASH POND EXISTING CONDITIONS
WKG-AP-CSK-004	C	WEST ASH POND EXCAVATION PLAN
WKG-AP-CSK-005	C	WEST ASH POND EXCAVATION SECTIONS & DETAILS
WKG-AP-CSK-006	C	EAST ASH POND EXISTING CONDITIONS
WKG-AP-CSK-007	C	EAST ASH POND DEMOLITION & REMOVAL PLAN
WKG-AP-CSK-008	C	EAST ASH POND FINAL COVER SYSTEM GRADING PLAN
WKG-AP-CSK-009	C	EAST ASH POND FINAL COVER SYSTEM SECTIONS & DETAILS

MIDWEST GENERATION, LLC
WAUKEGAN GENERATING STATION
ASH POND CLOSURE PROJECT

VICINITY MAP



LAKE COUNTY MAP (N.T.S) | SITE LOCATION ENLARGED PLAN (N.T.S)

PREPARED FOR:
MIDWEST GENERATION, LLC
WAUKEGAN GENERATING STATION
401 E. GREENWOOD AVE.
WAUKEGAN, IL 60087

PREPARED BY:
SARGENT & LUNDY
55 E. MONROE ST.
CHICAGO, IL 60603

WAUKEGAN ASH POND CLOSURE DRAWING LIST	
DWG NO.	DRAWING TITLE
WKG-AP-CSK-001	ASH POND CLOSURE COVER SHEET
WKG-AP-CSK-002	ASH POND CLOSURE GENERAL NOTES
WKG-AP-CSK-003	WEST ASH POND EXISTING CONDITIONS
WKG-AP-CSK-004	WEST ASH POND EXCAVATION PLAN
WKG-AP-CSK-005	WEST ASH POND EXCAVATION SECTIONS & DETAILS
WKG-AP-CSK-006	EAST ASH POND EXISTING CONDITIONS
WKG-AP-CSK-007	EAST ASH POND DEMOLITION & REMOVAL PLAN
WKG-AP-CSK-008	EAST ASH POND FINAL COVER SYSTEM GRADING PLAN
WKG-AP-CSK-009	EAST ASH POND FINAL COVER SYSTEM SECTIONS & DETAILS

FOR PERMIT
NOT FOR CONSTRUCTION

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

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

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

HOLD INFORMATION	
NO.	DESCRIPTION

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

RELEASE INFORMATION		
REV.	DATE	DESCRIPTION
A	11-02-2021	FOR CLIENT COMMENT
B	11-15-2021	FOR PUBLIC COMMENT
C	01-27-2022	FOR PERMIT

ISSUE PURPOSE: PERMIT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF ILLINOIS.

THOMAS DEHLIN
01-27-2022

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

MY LICENSE RENEWAL DATE IS: 11-30-2023
PAGES OR SHEETS COVERED BY THIS SEAL:
THIS DOCUMENT ONLY.

CERTIFICATE OF AUTHORIZATION (WHEN REQ'D)

CAD FILE NAME: WKG-AP-CSK-001.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. PACKARD
APPROVED BY: T. DEHLIN

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY, IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY.

Sargent & Lundy LLC

SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation, LLC

PROJECT

MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

ASH POND CLOSURE
COVER SHEET

DRAWING NUMBER	REVISION
WKG-AP-CSK-001	C
SHEET 1 OF 1	

PL12793/0M1864/S:#2-Waukegan- CCR#Ash Pond Closure Conceptual Drawings#Drawings#WKG-AP-CSK-001.dgn
Form GDG-0401-01-08. ANSI (Imperial) MicroStation Border - Size E - 34 x 44
Revision 11A. Revision Date: 04-30-2010

1/26/2022 11:20:43 AM
...#Drawings#WKG-AP-CSK-001.dgn

GENERAL NOTES

1. ALL WORK SHALL BE PERFORMED ACCORDING TO THE REQUIREMENTS OF SPECIFICATION W-7900 UNLESS OTHERWISE NOTED ON THE DESIGN DRAWINGS.
2. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR AND HAVE CONTROL AND CHARGE OF CONSTRUCTION MEANS, METHODS, TECHNIQUES, WORK SEQUENCING, AND PROCEDURES IN CONNECTION WITH THE WORK. THE CONTRACTOR SHALL CARRY OUT THE WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, COMPOSED OF THE DESIGN DRAWINGS AND SPECIFICATIONS.
3. ALL WORK DONE BY CONTRACTOR/INSTALLER PURSUANT TO THESE DRAWINGS SHALL: (A) CONFORM TO THE GOVERNING CONTRACT DOCUMENTS; (B) BE PERFORMED EXCLUSIVELY BY ITS TRAINED, COMPETENT PERSONNEL OR, WHERE PERMITTED, THAT OF ITS SUBCONTRACTOR(S); AND (C) COMPLY WITH ALL APPLICABLE SAFETY LAWS, REGULATIONS, PROGRAMS AND PRACTICES TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING THE CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUBCONTRACTOR(S)) PERFORMING THE WORK.
4. THE CONTRACTOR SHALL PERFORM INSTALLATION AND REMOVAL WORK IN A NEAT AND SKILLFUL MANNER, CAREFULLY TERMINATING WORK NEAR MATERIAL TO REMAIN IN PLACE. PRECAUTIONS SHALL BE TAKEN NOT TO DAMAGE OR DEFACE WORK, EXISTING FACILITIES, AND/OR MATERIAL TO REMAIN IN PLACE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY SUCH DAMAGE OR REPAIR THEREOF.
5. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE REQUIREMENTS OF FEDERAL, STATE OR LOCAL CODES, STANDARDS AND SPECIFICATIONS.
6. COMPACTION:

   SEE SPECIFICATION W-7900 FOR COMPACTION AND EARTHWORK REQUIREMENTS UNLESS OTHERWISE NOTED.
7. SOIL EROSION AND SEDIMENTATION CONTROL:

   PROPER SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSTALLED TO MEET THE APPLICABLE REGULATORY CODES AND THE PERMIT REQUIREMENTS.
8. CONSTRUCTION QUALITY ASSURANCE:

   ANY WORK FOUND DEFECTIVE OR NOT IN COMPLIANCE WITH THE REQUIREMENTS OF THE PROJECT SPECIFICATIONS OR THE DESIGN DRAWINGS SHALL BE REPLACED/FIXED AT NO ADDITIONAL COST TO THE OWNER.
9. TOPOGRAPHIC MAP & COORDINATES:
   - A. THE TOPOGRAPHIC MAP OF THE PLANT SITE SHOWN ON THE DESIGN DRAWINGS WAS PREPARED IN 2014.
   - B. THE PLANT COORDINATE SYSTEM SHOWN ON THE DESIGN DRAWINGS IS BASED ON THE ILLINOIS STATE PLANE, EAST ZONE, NORTH AMERICAN DATUM OF 1983 (2011) (NAD 83/2011), U.S. SURVEY FEET.
10. HORIZONTAL AND VERTICAL CONTROL:
    - A. THE BASIS FOR HORIZONTAL CONTROL IS AS DESCRIBED IN NOTE 9.
    - B. THE BASIS FOR VERTICAL CONTROL IS THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
    - C. PRIOR TO BEGINNING ANY POND CLOSURE WORK, THE CONTRACTOR SHALL:
      - I. MAKE A TOPOGRAPHICAL ASSESSMENT TO VERIFY THE ACCURACY OF THE EXISTING SURVEY DATA SHOWN ON THE DESIGN DRAWINGS. CONTRACTOR SHALL NOTIFY THE OWNER OF THE RESULTS OF THIS ASSESSMENT IN WRITING, AND SHALL IDENTIFY ANY DIFFERENCES BETWEEN THE 2014 SURVEY AND THE CONTRACTOR'S SURVEY THAT MIGHT AFFECT THE WORK SHOWN ON THE DESIGN DRAWINGS.
      - II. FURNISH AND INSTALL A MINIMUM OF FOUR BENCHMARK MONUMENTS TO PERFORM THE WORK. CONTRACTOR SHALL PROVIDE A BENCHMARK PLAN IDENTIFYING THE LOCATIONS AND TYPES OF BENCHMARKS TO BE INSTALLED FOR OWNER REVIEW AND APPROVAL. CONTRACTOR SHALL LAY OUT LINES AND GRADES FROM THESE CONTRACTOR-FURNISHED BENCHMARKS.
11. GEOTECHNICAL WORK:

    A STRUCTURAL STABILITY AND FACTOR OF SAFETY ASSESSMENT FOR THE EAST AND WEST ASH PONDS WAS PREPARED BY GEOSYNTEC CONSULTANTS IN OCTOBER 2016. SITE SPECIFIC SOIL DATA AND GEOTECHNICAL RECOMMENDATIONS ARE PROVIDED AND REFERENCED THEREIN.
12. EXISTING CONDITIONS:
    - A. DIMENSIONS OF EXISTING WORK SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO THE START OF WORK IN ACCORDANCE WITH THE SPECIFICATION AS FIELD CONDITIONS MAY VARY FROM INFORMATION SHOWN ON THE DESIGN DRAWINGS. DIMENSIONS NOTED FOR REFERENCE (REF) INDICATE NOMINAL DIMENSIONS FOR THE EXISTING STRUCTURE, UTILITY, ETC. NEW WORK SHALL NOT BE LOCATED BASED ON THE REFERENCE DIMENSIONS.
    - B. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL EXAMINE THE AREAS AND CONDITIONS UNDER WHICH THE CLOSURE WORK IS TO TAKE PLACE, AND NOTIFY THE OWNER IN WRITING OF CONDITIONS WHICH MAY IMPACT THE PROPER AND TIMELY COMPLETION OF THE WORK.
    - C. UNDERGROUND OR EMBEDDED UTILITIES MAY EXIST WITHIN THE AREA OF AND ADJACENT TO THE LIMITS OF THE WORK. THE LOCATION OR IDENTIFICATION OF SUCH UTILITIES HAS NOT BEEN VERIFIED BY THE OWNER OR BY S&L. CONTRACTOR/INSTALLER IS RESPONSIBLE FOR FIELD LOCATING AND IDENTIFYING UNDERGROUND OR EMBEDDED UTILITIES AND ANY OTHER UNDERGROUND OR EMBEDDED UTILITY DIMENSIONS.
    - D. REFERENCES USED HAVE BEEN IDENTIFIED ON EXCAVATION/FOUNDATION/DEMOLITION DRAWINGS AND HAVE BEEN PROVIDED TO ASSIST THE CONTRACTOR/INSTALLER IN THE FIELD LOCATING EXISTING UTILITIES AND OTHER POTENTIAL UNDERGROUND OR EMBEDDED INTERFERENCES. THESE REFERENCES ONLY SHOW THE APPROXIMATE LOCATION OF POTENTIAL UNDERGROUND OR EMBEDDED UTILITIES AND MAY NOT INDICATE OR REFLECT ALL EXISTING UNDERGROUND OR EMBEDDED UTILITIES OR THEIR ACTUAL LOCATIONS.
    - E. REFERENCES IDENTIFIED SHALL NOT SUBSTITUTE FOR THE CONTRACTOR'S/INSTALLER'S OBLIGATION TO FIELD LOCATE ANY UNDERGROUND OR EMBEDDED UTILITIES OR INTERFERENCES THAT MAY AFFECT THE WORK.
    - F. DUE CAUTION SHALL BE TAKEN DURING ANY EXCAVATION/FOUNDATION/DEMOLITION WORK WITHIN THE AREA OF, AND ADJACENT TO THE LIMITS OF THE WORK DUE TO POSSIBLE INTERFERENCES THAT MAY NOT BE REFLECTED ON THE REFERENCES IDENTIFIED.
    - G. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PRESERVATION AND RESTORATION OF THE EXISTING UTILITIES IF DAMAGED DURING CONSTRUCTION AT NO ADDITIONAL COST TO THE OWNER.

ABBREVIATIONS

ROAD AND GRADING

T/RD	TOP OF ROAD ELEVATION
EL OR ELEV	GRADE ELEVATION
INV	INVERT ELEVATION
HP	HIGH POINT
LP	LOW POINT
HPFS	HIGH POINT FINISH SURFACING
BC	BEGINNING OF CURVE (HORIZONTAL CURVE)
EC	END OF CURVE (HORIZONTAL CURVE)
PI	POINT OF INTERSECTION (HORIZONTAL CURVE)
PT	POINT OF TANGENT
PC	POINT OF CURVE
STA	STATION
VC	VERTICAL CURVE
BVC	BEGINNING OF VERTICAL CURVE
EVC	END OF VERTICAL CURVE
PIVC	POINT OF INTERSECTION OF VERT. CURVE
PRC	POINT OF REVERSE CURVE
PCC	POINT OF COMPOUND CURVE
R	RADIUS
T	TANGENT
L	LENGTH OF CURVE
D	DEGREE OF CURVE
I	INTERIOR/DEFLECTION ANGLE OF CURVE
UN	UNLESS NOTED
ROW	RIGHT OF WAY
OHL	OVERHEAD LINE
OC	ON CENTER
WL	WATER LEVEL
HWL	HIGH WATER LEVEL
YR	YEAR
DS	DOWNSTREAM
US	UPSTREAM
CL	CENTERLINE
AC	ACRE
N.T.S.	NOT TO SCALE
LWL	LOW WATER LEVEL

SYMBOLS

	CENTERLINE OF NATURAL DRAINAGE PATTERN
	VALLEY LINE OR "V" DITCH
	SWALE
	CENTERLINE OF TRAPEZOIDAL DRAINAGE
	TRAPEZOIDAL DRAINAGE DITCH WITH BOTTOM WIDTH GREATER THAN 2'. BOTTOM WIDTH AND SIDE SLOPE SHOWN ON PLAN OR DETAIL
	RIPRAP EROSION PROTECTION
C-1	PIPE CULVERT CULVERT NUMBER SHOWN
DOWN	TOP OF EMBANKMENT SLOPE OR DITCH SIDE SLOPE AND DIRECTION OF SLOPE
3:1	HORIZONTAL TO VERTICAL SLOPE WHEN SLOPE IS CONSTANT
SLOPE VARIES	SLOPE IS NOT CONSTANT
1%	DIRECTION OF ROAD OR AREA SLOPE. PERCENT OF SLOPE SHOWN WHERE APPLICABLE
	TOP OF DIKE
R=50'	RADIUS OF CURVATURE
1	SECTION NUMBER (FIRST NUMBER=DRAWING SECOND NUMBER=SECTION NUMBER)
	CHAIN LINK FENCE
PLAN SECTION	WATER LINE
—G—G—	BURIED GAS LINE
—E—E—	BURIED ELECTRICAL CABLE
	INDEX CONTOUR
	INTERMEDIATE CONTOUR
— 405 —	ELEVATION CONTOUR
	EXISTING DEPRESSION
x 408.8	SPOT ELEVATION
x	VERTICAL CONTROL POINT
	HORIZONTAL CONTROL POINT
	EXISTING FIRE HYDRANT
	EXISTING UTILITY POLE
	EXISTING UTILITY POLE WITH GUY
	WOOD OR BRUSH OUTLINE
	GRATING
	SINGLE SIGN ON POST
	DOUBLE SIGN ON POST
	GUARD POST

SYMBOLS & ABBREVIATIONS

EROSION CONTROL SYMBOLS

— S —	SILT FENCE
— IP —	INLET PROTECTION
	ROCK CHECK

SEWERS AND UNDERGROUND PIPE

CB	CATCH BASIN
C0	CLEANOUT
MH	MANHOLE
RE	RIM ELEVATION
℄	CENTERLINE
S	SLOPE
BOP	BOTTOM OF PIPE
PVC	POLY VINYL CHLORIDE PIPE
HDPE	HIGH DENSITY POLYETHYLENE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
CHDPE	CORRUGATED HIGH DENSITY POLYETHYLENE PIPE
CISP	CAST IRON SOIL PIPE
DIWP	DUCTILE IRON WATER PIPE
STL	CARBON STEEL PIPE
IP	IN PLACE
SWS	STORM WATER SEWER
OWS	OILY WATER SEWER
SAN	SANITARY SEWER
PWS	PROCESS WASTE SEWER
C.S.	CARBON STEEL

ROAD, PAVEMENT AND SURFACING SYMBOLS

	ASPHALT OR CONCRETE PAVED ROAD. OUTER LINES SHOW OVERALL WIDTH. INTERIOR LINES SHOW EDGES OF PAVEMENT.
	ROCK SURFACED ROAD
— I —	ISOLATION JOINT
— IT —	THICKENED EDGE ISOLATION JOINT
— TE —	THICKENED EDGE EXPANSION JOINT
— T —	PAVEMENT THICKENED EDGE
— C —	CONTRACTION JOINT
	CONCRETE PAVING
	CRUSHED ROCK SURFACING
	ASPHALT PAVEMENT
	6" THICK CRUSHED STONE GROUND COVER SURFACING
	4" THICK SEEDED TOPSOIL

FOR PERMIT
NOT FOR CONSTRUCTION

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

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

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

HOLD INFORMATION

NO.	DESCRIPTION

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RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	11-02-2021	FOR CLIENT COMMENT
B	11-15-2021	FOR PUBLIC COMMENT
C	01-27-2022	FOR PERMIT

ISSUE PURPOSE: PERMIT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF ILLINOIS.

THOMAS DEHLIN
01-27-2022

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

MY LICENSE RENEWAL DATE IS: 11-30-2023
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CAD FILE NAME: WKG-AP-CSK-002.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. PACKARD
APPROVED BY: T. DEHLIN

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MWG
Midwest Generation, LLC

PROJECT

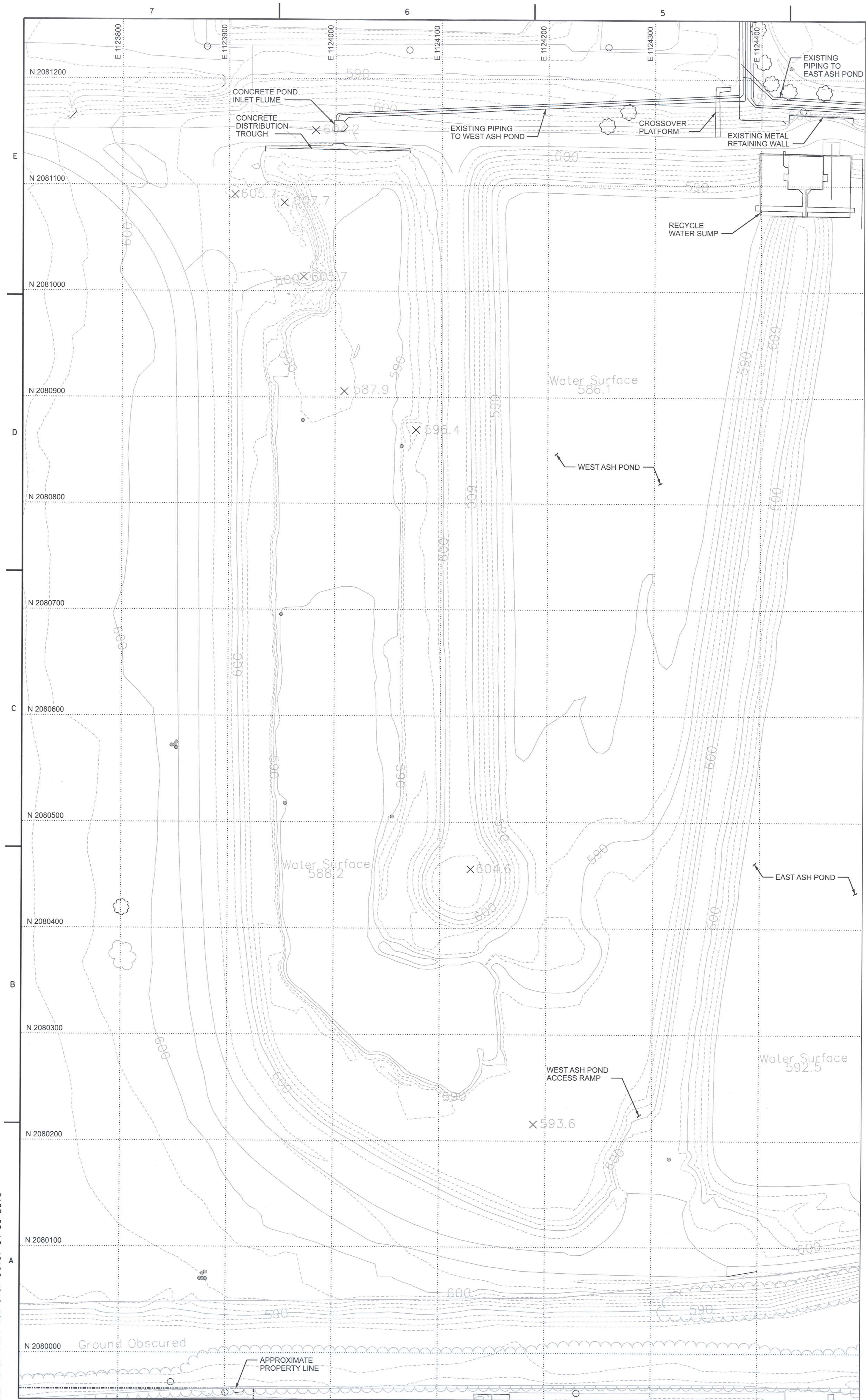
MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

ASH POND CLOSURE
GENERAL NOTES

DRAWING NUMBER	REVISION
WKG-AP-CSK-002	C

SHEET 1 OF 1



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REVIEWED BY: T. DEHLIN / D. PACKARD
APPROVED BY: T. DEHLIN

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CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation, LLC

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE FURNISHED AND INSTALLED BY SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. EXISTING CONDITIONS FOR THE WEST ASH POND ARE BASED ON TOPOGRAPHIC DATA COLLECTED IN 2014. PRIOR TO BEGINNING ANY POND CLOSURE WORK, THE CONTRACTOR SHALL MAKE A TOPOGRAPHIC ASSESSMENT TO VERIFY THE ACCURACY OF THE EXISTING CONDITIONS SHOWN PER NOTE 10 ON DRAWING WKG-AP-CSK-002.

REFERENCE DRAWINGS

5082-C-5006	ASH POND DETAIL PLAN
5082-C-5007	ASH POND SECTIONS AND DETAILS
5082-C-5001	WASTE WATER TREATMENT FACILITIES ASH POND SUMP PLAN, SECTIONS AND DETAILS
5082-C-5502	ASH POND SUMP WEIR PLAN, SECTIONS & DETAILS
5082-C-5503	ASH POND SUMP AND WEIR MISCELLANEOUS SECTIONS AND DETAILS
5082-C-5507	ASH POND INLET FLUME & DISTRIBUTION TROUGH DETAILS
B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS

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

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PROJECT

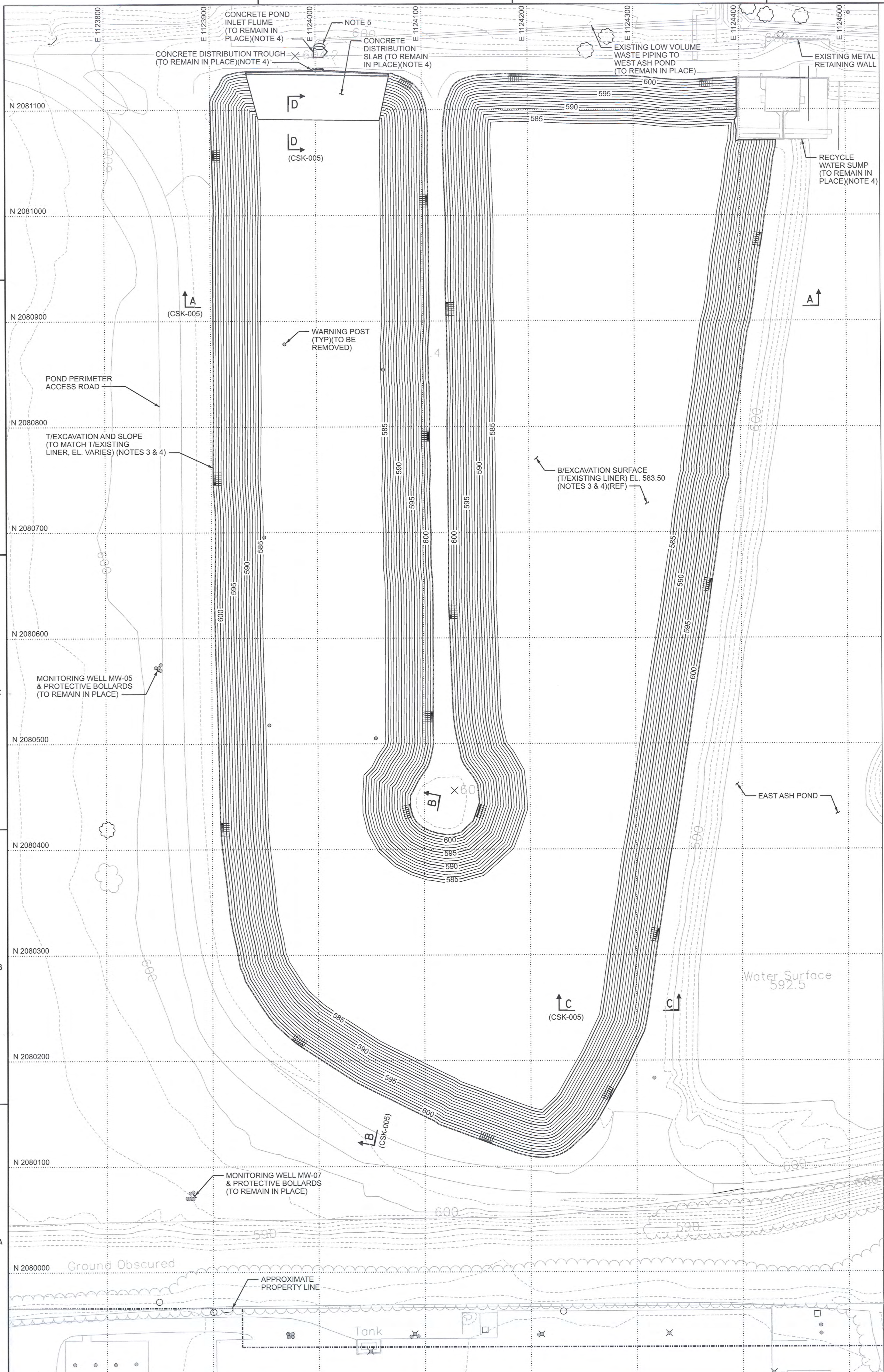
MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

WEST ASH POND EXISTING CONDITIONS

DRAWING NUMBER	REVISION
WKG-AP-CSK-003	C

SHEET 1 OF 1



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NORTH

40' 0' 40' 80'
GRAPHIC SCALE

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE PERFORMED IN ACCORDANCE WITH SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. MATERIAL REMOVAL / EXCAVATION:
   A. ALL MATERIAL ABOVE THE EXISTING GEOMEMBRANE LINER SHALL BE REMOVED. BOTTOM-OF-EXCAVATION (I.E., TOP-OF-EXISTING LINER SURFACE) SHOWN ON THIS DRAWING IS APPROXIMATE AND REPRESENTS THE FLOOR AND SIDE SURFACES OF THE POND THAT ARE ASSUMED TO HAVE BEEN INSTALLED BASED ON THE WEST ASH POND'S HISTORY OF CONSTRUCTION (GEOSYNTEC, 2016).
   B. DURING REMOVAL OF MATERIAL FROM / DEMOLITION WORK WITHIN THE WEST ASH POND, GW CONTRACTOR SHALL TAKE NECESSARY PRECAUTIONS TO AVOID DAMAGING THE POND'S EXISTING GEOMEMBRANE LINER. GW CONTRACTOR SHALL PROVIDE ADEQUATE TEMPORARY LOADING AS NECESSARY TO PREVENT UPLIFT OF THE GEOMEMBRANE BY WIND BY THE USE OF SANDBAGS AND/OR OTHER MEANS WHICH WILL NOT DAMAGE THE GEOMEMBRANE. FOR ALL AREAS OF EXISTING LINER THAT ARE DAMAGED, THE GW CONTRACTOR SHALL:
      I. TAKE APPROPRIATE MEASURES TO PREVENT ANY FLUID OR SOLID MATERIALS FROM ENTERING THE SUBGRADE BELOW THE LINER.
      II. NOTIFY THE OWNER IMMEDIATELY.
      III. INSPECT THE EXPOSED SOILS BELOW THE LINER TO DETERMINE WHETHER ANY FLUIDS, CCR CONSTITUENTS, OR CCR-MIXED SOILS HAVE BEEN RELEASED INTO THE POND SUBGRADE. IF SUCH MATERIAL HAS BEEN RELEASED INTO THE POND SUBGRADE, THE GW CONTRACTOR SHALL REMOVE THE IMPACTED SOILS UNTIL THE AFFECTED AREA HAS BEEN DECONTAMINATED. CONTAMINATED SOILS REMOVED FROM THE POND SUBGRADE SHALL BE REPLACED WITH STRUCTURAL FILL IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
      IV. REPAIR THE DAMAGED GEOMEMBRANE LINER AREA IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
   C. MATERIAL REMOVED FROM THE WEST ASH POND AREA SHALL BE DISPOSED OF AS FOLLOWS:
      I. ALL DRY WASTE SHALL BE DISPOSED OF IN AN OFF-SITE DISPOSAL FACILITY PERMITTED TO RECEIVE CCR WASTE. ALL OFF SITE TRANSPORTATION OF MATERIAL REMOVED FROM THE WEST ASH POND SHALL BE PERFORMED IN ACCORDANCE WITH 35 ILL. ADM. CODE 845.740(C)(1).
      II. ALL LIQUID WASTE SHALL BE DISPOSED OF IN THE EAST ASH POND.
   D. GW CONTRACTOR SHALL DEVELOP AND IMPLEMENT FUGITIVE DUST CONTROLS DURING MATERIAL REMOVAL AND DEMOLITION WORK WITHIN THE WEST ASH POND AREA IN ACCORDANCE WITH 35 ILL. ADM. CODE 845.740(C)(2).
   E. GW CONTRACTOR SHALL DEVELOP AND IMPLEMENT MEASURES TO PREVENT CONTAMINATION OF SURFACE WATER, GROUNDWATER, SOIL, AND SEDIMENTS DURING MATERIAL REMOVAL AND DEMOLITION WORK WITHIN THE WEST ASH POND AREA IN ACCORDANCE WITH 35 ILL. ADM. CODE 845.740(C)(4).
   F. AT THE END OF EACH MONTH DURING WHICH MATERIAL REMOVAL AND DEMOLITION WORK IS PERFORMED WITHIN THE WEST ASH POND AREA, GW CONTRACTOR SHALL PREPARE A REPORT DOCUMENTING THE GW CONTRACTOR'S PROGRESS IN REMOVING CCR AND CCR-MIXED SOILS FROM THE AREA. THE MONTHLY REPORT SHALL BE PREPARED IN ACCORDANCE WITH THE RECORDKEEPING REQUIREMENTS STIPULATED IN 35 ILL. ADM. CODE 845.740(D).
4. LINER & CONCRETE DECONTAMINATION :
   A. AFTER REMOVAL OF MATERIAL ABOVE THE EXISTING GEOMEMBRANE LINER AND REPAIR OF ANY DAMAGED AREAS, THE GW CONTRACTOR SHALL DECONTAMINATE THE LINER AND POND APPURTENANT STRUCTURES REMAINING IN PLACE. AT A MINIMUM, THE EXPOSED GEOMEMBRANE SHALL BE PRESSURE WASHED IN A SYSTEMATIC MANNER TO REMOVE ALL CCR AND RESIDUALS OF CCR. WASH AND RINSE WATER SHALL BE COLLECTED AND DISPOSED OF IN THE EAST ASH POND OR AS OTHERWISE DIRECTED BY THE OWNER.
   B. AS AN AREA WITHIN THE WEST ASH POND IS DECONTAMINATED, THE GW CONTRACTOR AND CQA CONTRACTOR (W-7901) SHALL VISUALLY INSPECT THE SUBJECT AREA WITH THE OWNER'S REPRESENTATIVE(S) TO ENSURE THE AREA IS NO LONGER CONTAMINATED WITH CCR CONSTITUENTS AND REMAINS COMPETENT FOR RE-USE (I.E., NO REPAIRS ARE REQUIRED).
   C. UPON COMPLETION OF DECONTAMINATION ACTIVITIES FOR A GIVEN AREA OF EXISTING GEOMEMBRANE LINER BY THE GW CONTRACTOR, THE CQA CONTRACTOR (W-7901) SHALL:
      I. PERFORM AN ELECTRICAL LEAK LOCATION SURVEY OVER THE DECONTAMINATED LINER AREA IN ACCORDANCE WITH ASTM D7953. IF THE SURVEY LOCATES A BREACH (HOLE, PUNCTURE, TEAR, DEFECT, ETC.) IN THE GEOMEMBRANE, THE CQA CONTRACTOR SHALL NOTIFY THE OWNER AND GW CONTRACTOR IMMEDIATELY, AND THE GW CONTRACTOR SHALL ADDRESS THE BREACH IN ACCORDANCE WITH NOTE 3.B.
      II. CUT-OUT AND REMOVE SAMPLES OF THE DECONTAMINATED GEOMEMBRANE LINER AT A MINIMUM FREQUENCY OF ONE PER ACRE OF LINER. THE GW CONTRACTOR SHALL REPAIR THE GEOMEMBRANE LINER AT ALL SAMPLE LOCATIONS IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
      III. ALL SAMPLES SHALL BE ANALYZED BY A CERTIFIED LABORATORY IN ACCORDANCE WITH EPA SW-846 TEST METHOD 1311: TOXICITY CHARACTERISTIC LEACHING PROCEDURE. IF THE CONCENTRATIONS OF CCR CONSTITUENTS MEASURED BY THIS TEST METHOD MEET THE GROUNDWATER PROTECTION STANDARDS SPECIFIED IN THE OPERATING PERMIT ISSUED BY THE ILLINOIS EPA FOR THE WEST ASH POND, THEN THE AREA OF EXISTING GEOMEMBRANE LINER REPRESENTATED BY THAT SAMPLE IS CONSIDERED TO BE DECONTAMINATED. OTHERWISE, THAT AREA OF EXISTING GEOMEMBRANE LINER IS NOT CONSIDERED TO BE DECONTAMINATED.
   D. GW CONTRACTOR SHALL RECLEAN ANY AREAS THAT ANALYTICAL TESTING INDICATES ARE NOT DECONTAMINATED (I.E., ANALYTICAL TESTING OF A COLLECTED SAMPLE DETECTS AT LEAST ONE CCR CONSTITUENT EXCEEDS THE CONSTITUENT'S GROUNDWATER PROTECTION STANDARD LISTED IN IN THE OPERATING PERMIT ISSUED BY THE ILLINOIS EPA FOR THE WEST ASH POND). AFTER RECLEANING A GIVEN AREA, THE CQA CONTRACTOR (W-7901) SHALL COLLECT AND TEST ONE ADDITIONAL SAMPLE FROM THE AREA PER NOTE 4.C.
   E. LINER DECONTAMINATION IS CONSIDERED COMPLETE WHEN ALL COLLECTED LINER SAMPLES MEET THE DECONTAMINATION CRITERIA IN NOTE 4.C.III.

REFERENCE DRAWINGS

B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS

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SPECIFICATION: W-7900
PROJECT NO.: 12661-098

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THOMAS DEHLIN
01-27-2022

LICENSED PROFESSIONAL ENGINEER THOMAS J. DEHLIN 062-069314 OF ILLINOIS

MY LICENSE RENEWAL DATE IS: 11-30-2023
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CAD FILE NAME: WKG-AP-CSK-004.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. PACKARD
APPROVED BY: T. DEHLIN

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Sargent & Lundy LLC
SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation, LLC

PROJECT
MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE
WEST ASH POND EXCAVATION PLAN

DRAWING NUMBER	REVISION
WKG-AP-CSK-004	C

SHEET 1 OF 1

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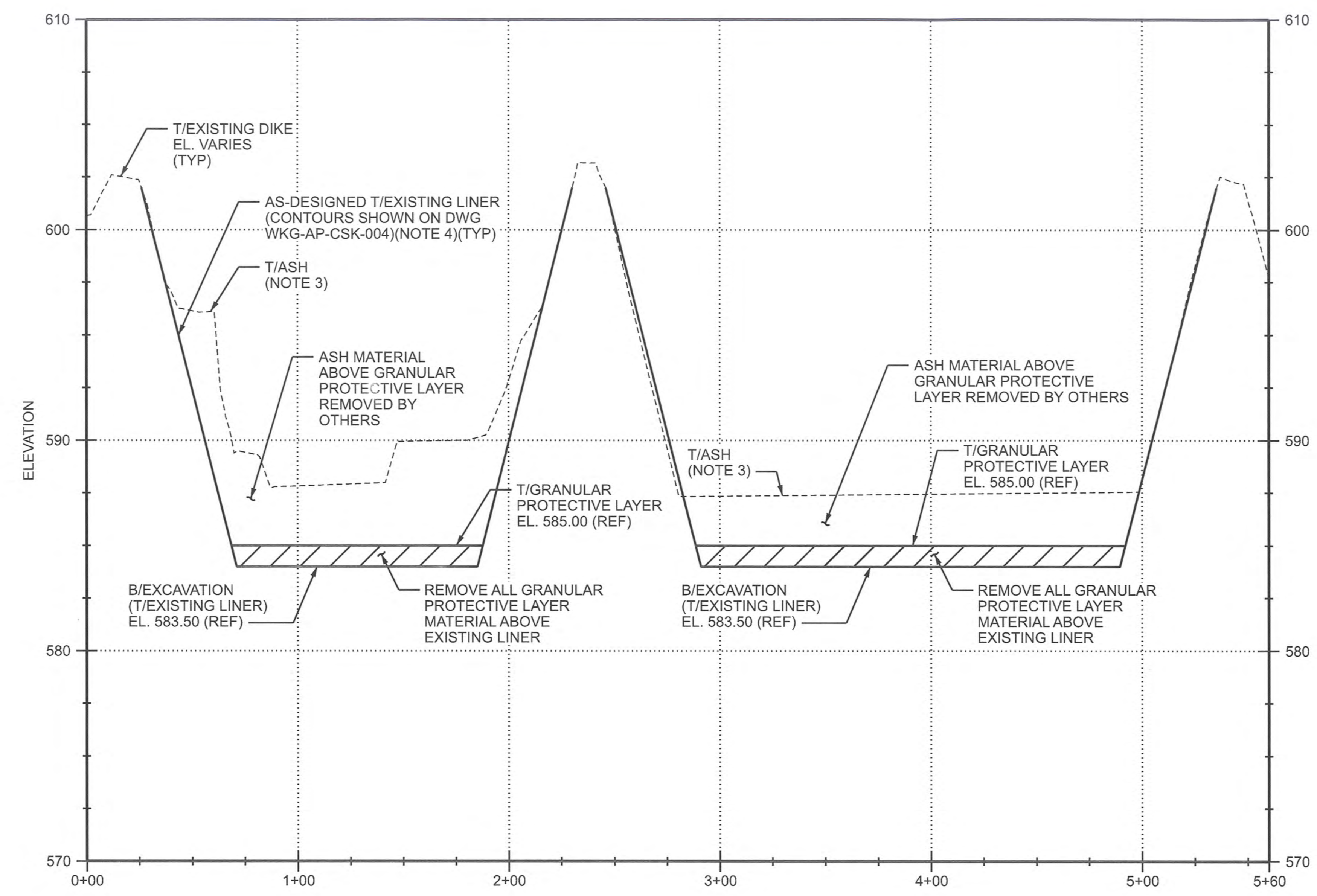
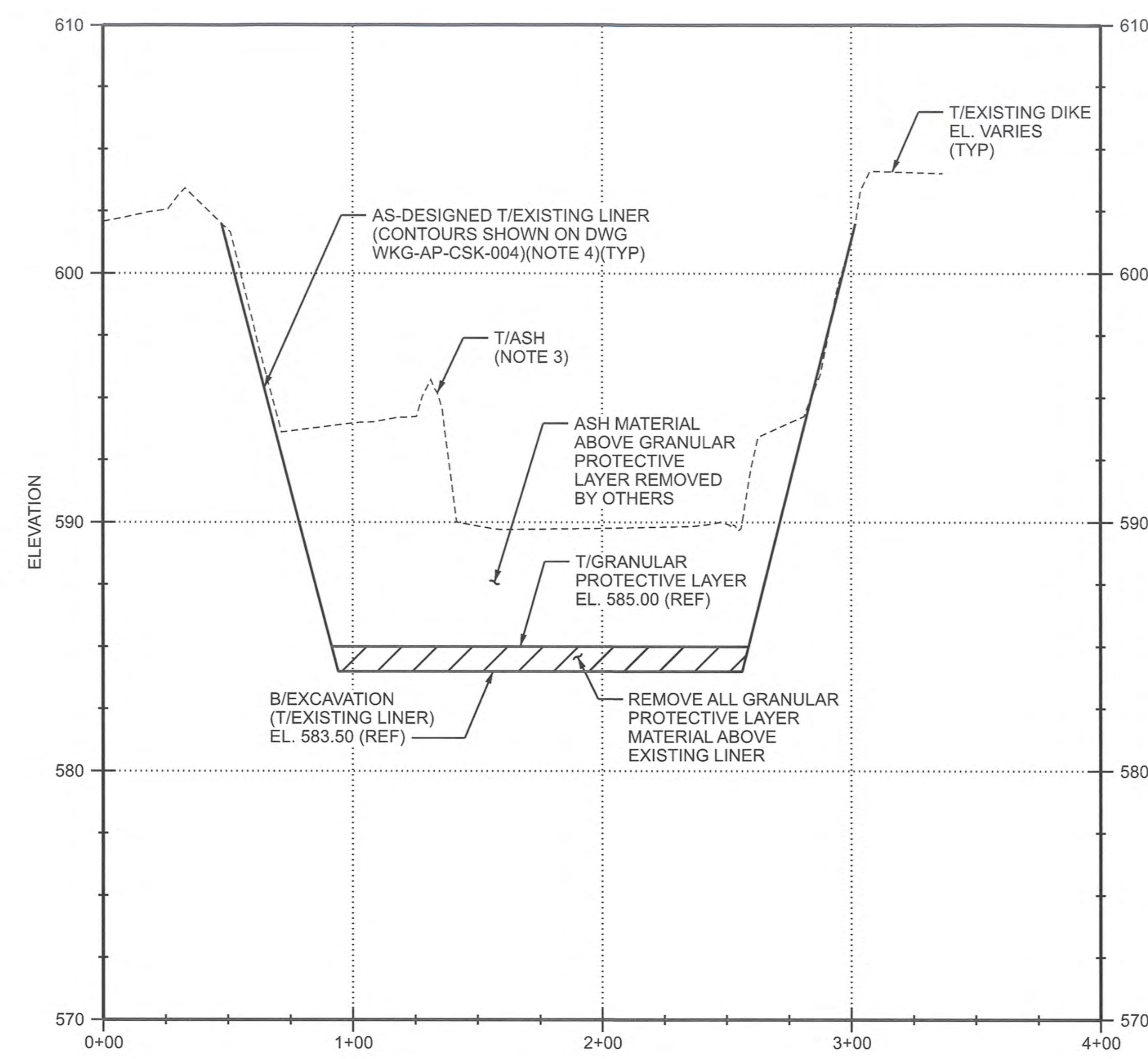
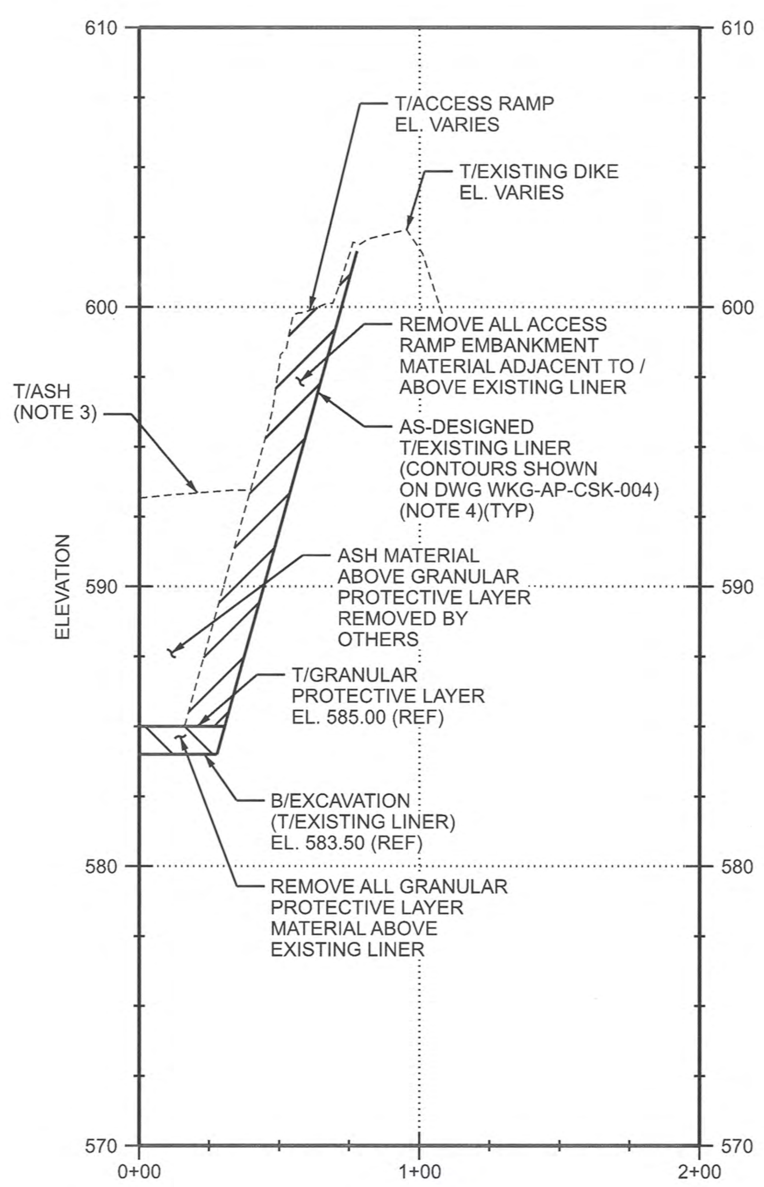
Revision 11A, Revision Date: 04-30-2010



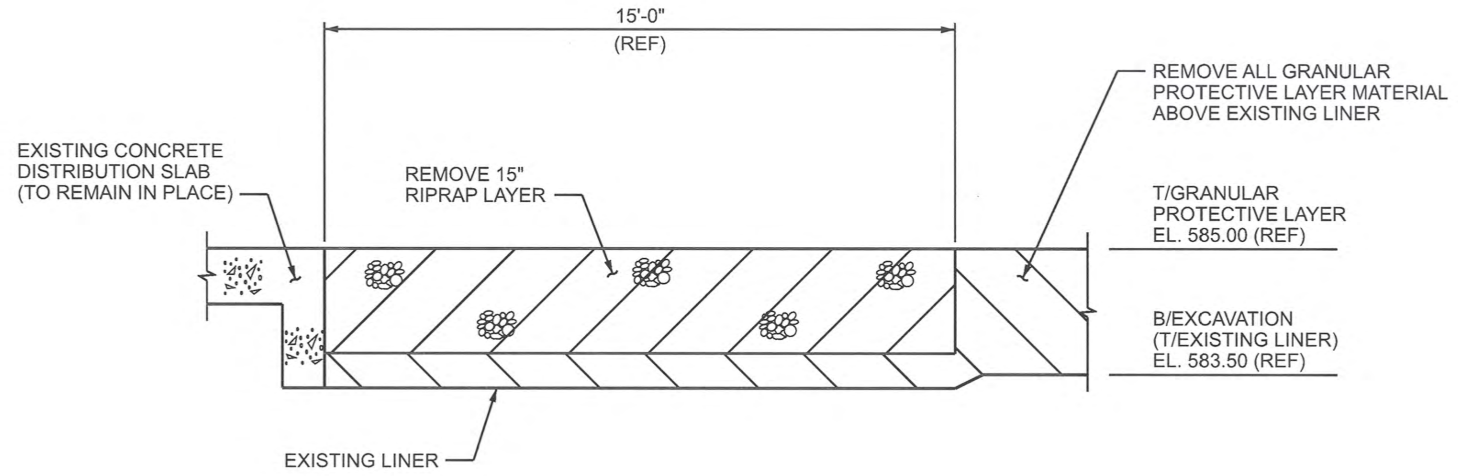
SECTION A
HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=4'
(CSK-004)



SECTION B
HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=4'
(CSK-004)



SECTION C
HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=4'
(CSK-004)



SECTION D
SCALE: N.T.S.
(CSK-004)

FOR PERMIT
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NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE PERFORMED IN ACCORDANCE WITH SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. TOP-OF-ASH SURFACE SHOWN REPRESENTS THE ASH STORED IN THE POND DURING THE 2014 SURVEY OF THE SITE. THIS ASH MATERIAL HAS BEEN REMOVED FROM THE POND BY OTHERS.
4. THE AS-DESIGNED TOP-OF-EXISTING LINER SURFACE REPRESENTS THE FLOOR AND SIDE SURFACES OF THE POND THAT ARE ASSUMED TO HAVE BEEN INSTALLED BASED ON THE WEST ASH POND'S HISTORY OF CONSTRUCTION (GEOSYNTEC, 2016).

REFERENCE DRAWINGS

B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
CSK-004	WEST ASH POND EXCAVATION PLAN

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RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	11-02-2021	FOR CLIENT COMMENT
B	11-15-2021	FOR PUBLIC COMMENT
C	01-27-2022	FOR PERMIT

ISSUE PURPOSE: PERMIT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF ILLINOIS.

T. Dehlin
THOMAS DEHLIN
01-27-2022

LICENSED PROFESSIONAL ENGINEER THOMAS J. DEHLIN 062-066314 OF ILLINOIS

MY LICENSE RENEWAL DATE IS: 11-30-2023
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CERTIFICATE OF AUTHORIZATION (WHEN REQ'D)

CAD FILE NAME: WKG-AP-CSK-005.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. PACKARD
APPROVED BY: T. DEHLIN

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CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation, LLC

PROJECT

MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

WEST ASH POND
EXCAVATION SECTIONS & DETAILS

DRAWING NUMBER	REVISION
WKG-AP-CSK-005	C

SHEET 1 OF 1

PL12793/OM1864/S:#2-Waukegan- CCR#Ash Pond Closure Conceptual Drawings#Drawings#WKG-AP-CSK-005.dgn
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Revision 11A, Revision Date: 04-30-2010

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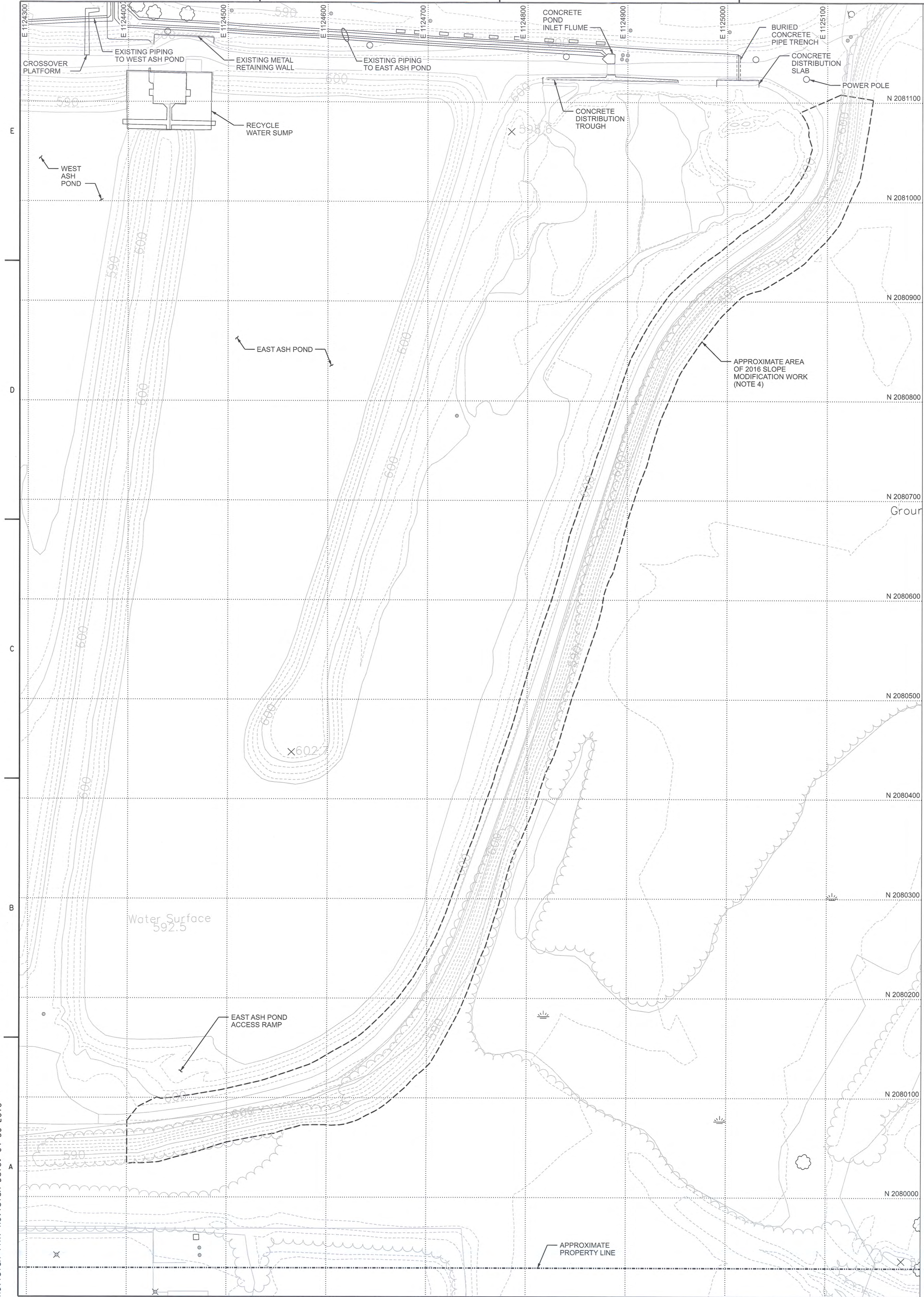

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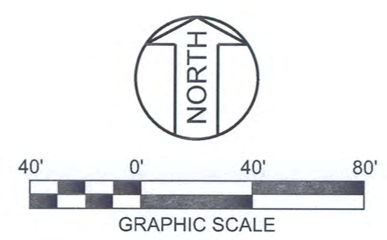

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE FURNISHED AND INSTALLED BY SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. EXISTING CONDITIONS FOR THE EAST ASH POND ARE BASED ON TOPOGRAPHIC DATA COLLECTED IN 2014. PRIOR TO BEGINNING ANY POND CLOSURE WORK, THE CONTRACTOR SHALL MAKE A TOPOGRAPHIC ASSESSMENT TO VERIFY THE ACCURACY OF THE EXISTING CONDITIONS SHOWN PER NOTE 10 ON DRAWING WKG-AP-CSK-002.
4. IN 2016, THE DOWNSTREAM SLOPE OF THE EAST ASH POND'S EAST DIKE WAS LOWERED TO AN APPROXIMATE CREST ELEVATION OF 600 FEET AND REGRADED TO A FLATTER GRADE THAN SHOWN. SEE GEOSYNTEC DRAWINGS SW0251-11-01 - 07 FOR THE 2016 SLOPE MODIFICATION DESIGN PLANS, SECTIONS, AND DETAILS.

REFERENCE DRAWINGS

5082-C-5006	ASH POND DETAIL PLAN
5082-C-5007	ASH POND SECTIONS AND DETAILS
5082-C-5001	WASTE WATER TREATMENT FACILITIES ASH POND SUMP PLAN, SECTIONS AND DETAILS
5082-C-5502	ASH POND SUMP WEIR PLAN, SECTIONS & DETAILS
5082-C-5503	ASH POND SUMP AND WEIR MISCELLANEOUS SECTIONS AND DETAILS
5082-C-5507	ASH POND INLET FLUME & DISTRIBUTION TROUGH DETAILS
B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
SW0251-11-01 - 07	EAST ASH BASIN SLOPE MODIFICATION

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SPECIFICATION: W-7900

PROJECT NO.: 12661-098

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01-27-2022

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CAD FILE NAME: WKG-AP-CSK-006.DGN

PREPARED BY: J. CHAVEZ

REVIEWED BY: T. DEHLIN / D. NIELSON

APPROVED BY: T. DEHLIN

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CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation, LLC

PROJECT

MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

EAST ASH POND
EXISTING CONDITIONS

DRAWING NUMBER	REVISION
WKG-AP-CSK-006	C

SHEET 1 OF 1

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NORTH

40' 0' 40' 80'
GRAPHIC SCALE

NOTES

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4. IN 2016, THE DOWNSTREAM SLOPE OF THE EAST ASH POND'S EAST DIKE WAS LOWERED TO AN APPROXIMATE CREST ELEVATION OF 600 FEET AND REGRADED TO A FLATTER GRADE THAN SHOWN. SEE GEOSYNTEC DRAWINGS SW0251-11-01 - 07 FOR THE 2016 SLOPE MODIFICATION DESIGN PLANS, SECTIONS, AND DETAILS.
5. DISCONNECT ALL PIPES FROM INLET FLUME, REMOVE PIPE SLEEVES, AND REMOVE PIPES TO LIMITS OF FINAL COVER SYSTEM SHOWN ON DRAWING WKG-AP-CSK-008. CAP ENDS OF PIPES REMAINING IN PLACE. PLACE REMOVED PIPE SLEEVES AND PIPE SECTIONS IN ONSITE STOCKPILE AREA DESIGNATED BY OWNER.

REFERENCE DRAWINGS

5082-C-5006	ASH POND DETAIL PLAN
5082-C-5007	ASH POND SECTIONS AND DETAILS
5082-C-5001	WASTE WATER TREATMENT FACILITIES ASH POND SUMP PLAN, SECTIONS AND DETAILS
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B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
SW0251-11-01 - 07	EAST ASH BASIN SLOPE MODIFICATION

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SPECIFICATION: W-7900
PROJECT NO.: 12661-098

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THOMAS DEHLIN
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CAD FILE NAME: WKG-AP-CSK-007.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: T. DEHLIN

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CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation, LLC

PROJECT
MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE
EAST ASH POND
DEMOLITION & REMOVAL PLAN

DRAWING NUMBER	REVISION
WKG-AP-CSK-007	C

SHEET 1 OF 1

PL12793/OM1864/Si#2-Waukegan- CCR#Ash Pond Closure Conceptual Drawings#Drawings#WKG-AP-CSK-007.dgn
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Revision 11A, Revision Date: 04-30-2010

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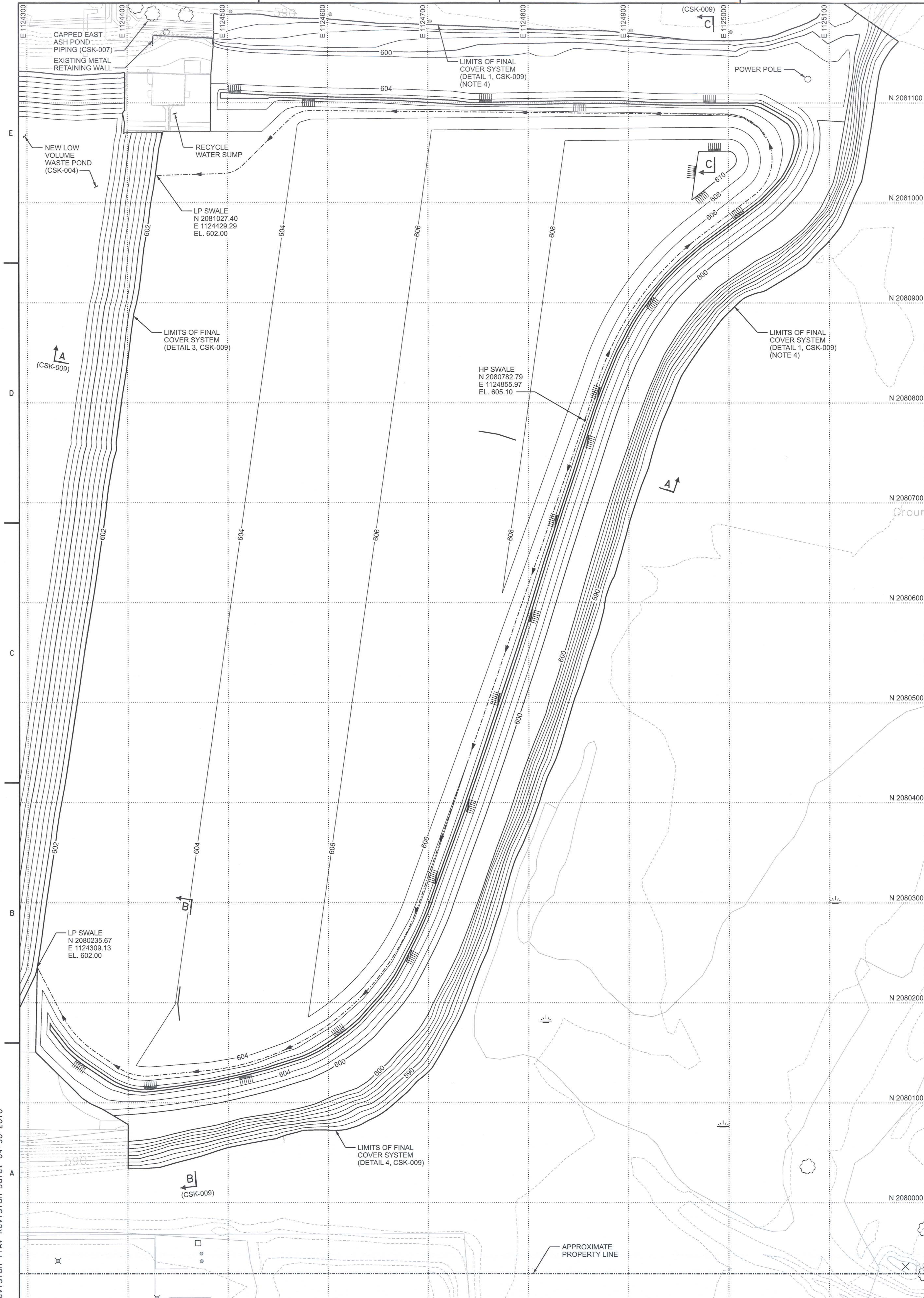

FOR PERMIT
NOT FOR CONSTRUCTION

NORTH

40' 0' 40' 80'
GRAPHIC SCALE

LEGEND

—610—	MAJOR CONTOUR (10')
—608—	MINOR CONTOUR (2')
-·-·◄-·-·	DRAINAGE PATH

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE PERFORMED IN ACCORDANCE WITH SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. INSTALL FINAL COVER SYSTEM OVER EAST ASH POND PER DETAIL 1 ON DRAWING WKG-AP-CSK-009.
4. AT TOES OF EAST ASH POND DIKES, FINAL COVER SYSTEM COMPONENTS SHALL BE ANCHORED IN ANCHOR TRENCHES PER DETAIL 2 ON DRAWING WKG-AP-CSK-009.

REFERENCE DRAWINGS

B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
CSK-004	WEST ASH POND EXCAVATION PLAN
CSK-009	EAST ASH POND FINAL COVER SYSTEM SECTIONS & DETAILS

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REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: T. DEHLIN

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MWG
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PROJECT

MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

EAST ASH POND
FINAL COVER SYSTEM
GRADING PLAN

DRAWING NUMBER	REVISION
WKG-AP-CSK-008	C

SHEET 1 OF 1

PL12793/OM1864/Si#2-Waukegan- CCR#Ash Pond Closure Conceptual Drawings#Drawings#WKG-AP-CSK-008.dgn
Form GDG-0401-01-08, ANSI (Imperial) MicroStation Border - Size E - 34 x 44
Revision 11A, Revision Date: 04-30-2010

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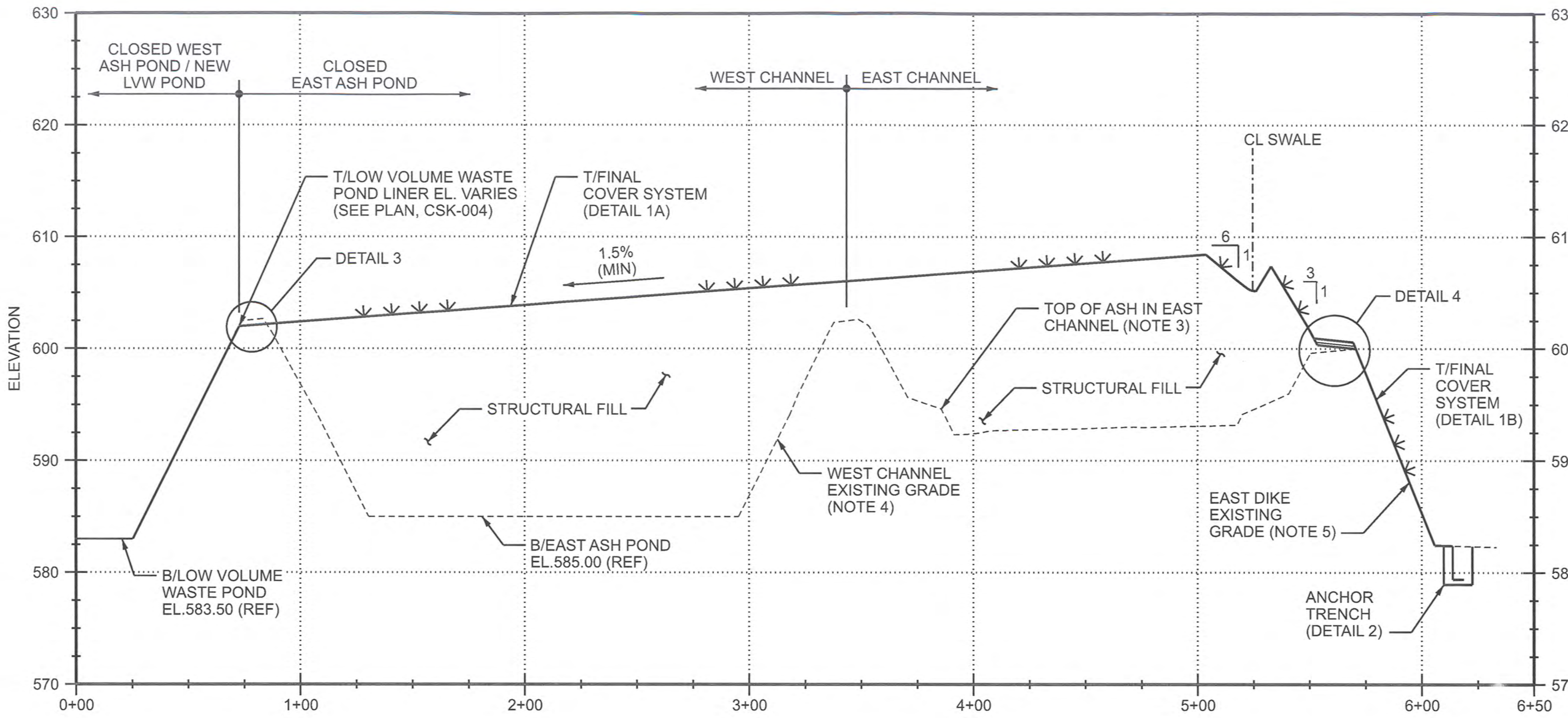
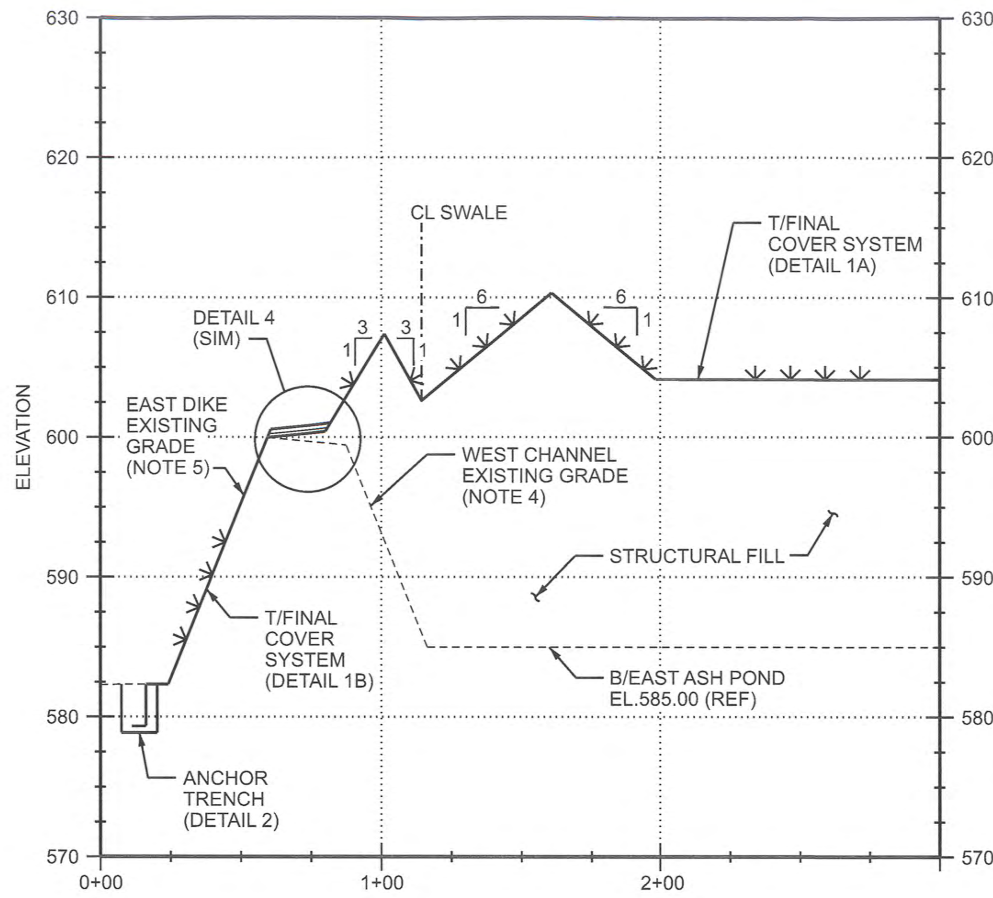


SECTION A
HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=5'
(CSK-008)



SECTION B
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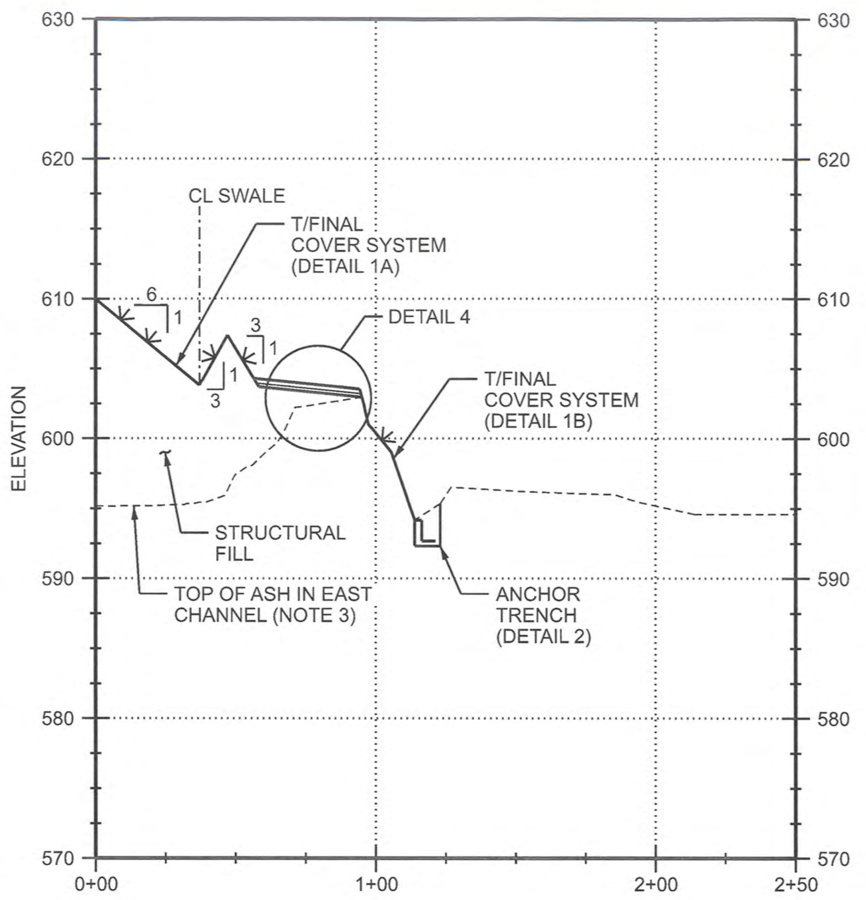
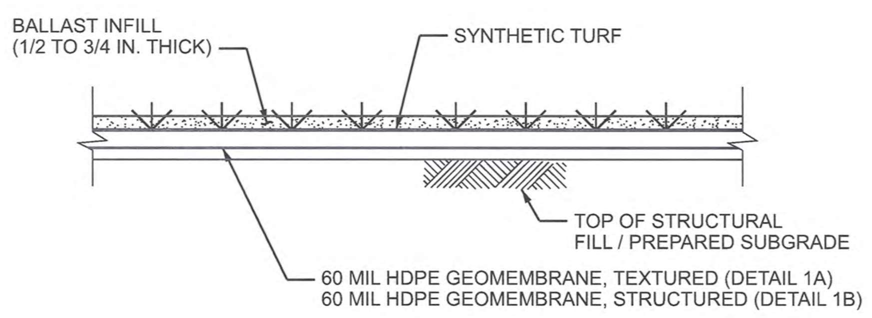
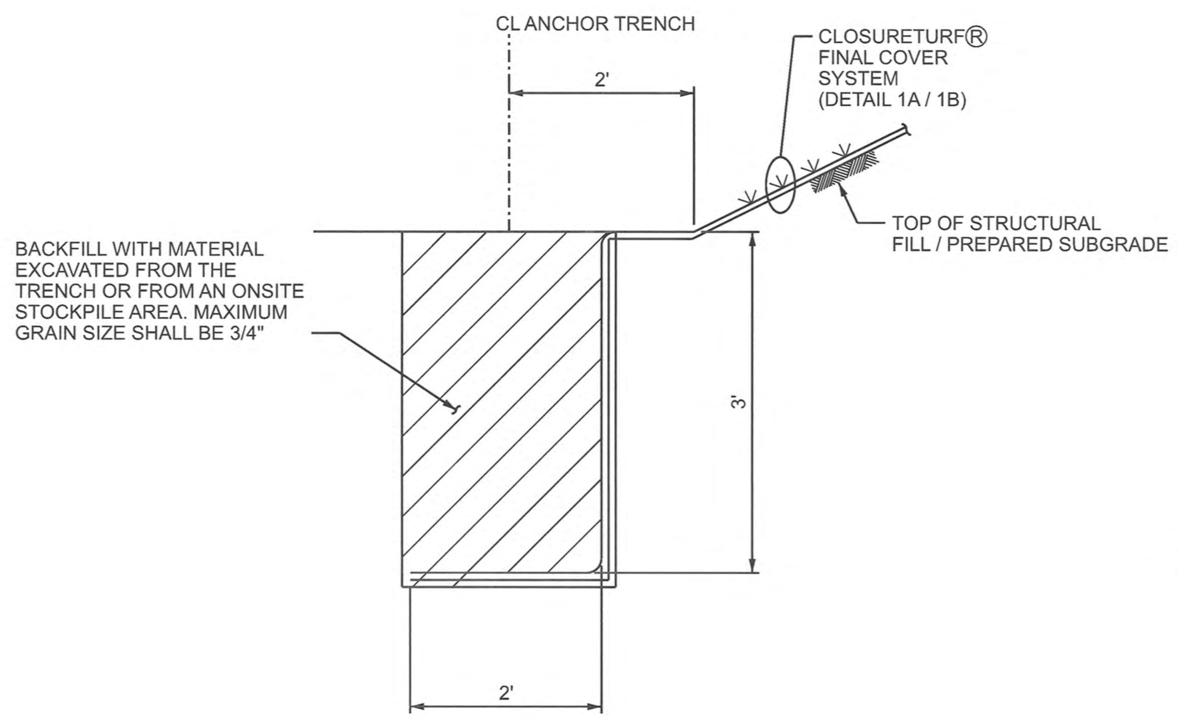
VERTICAL SCALE 1"=5'
(CSK-008)



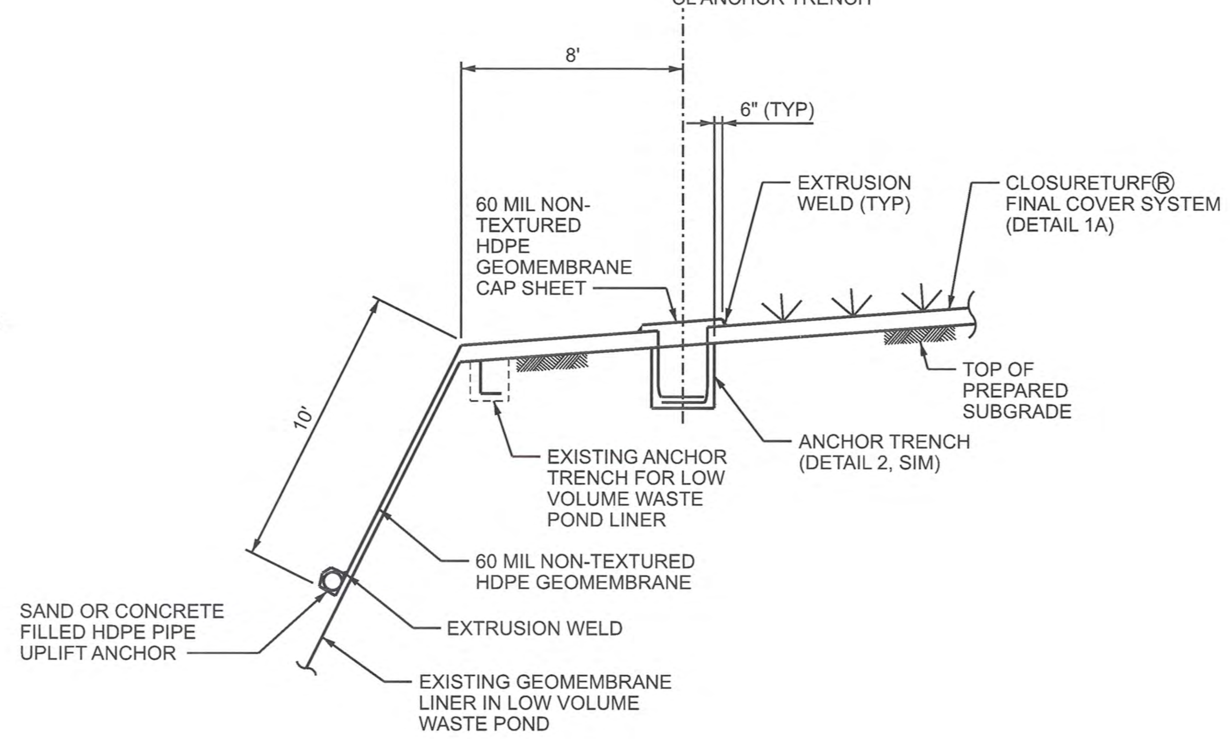
SECTION C
HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=5'
(CSK-008)



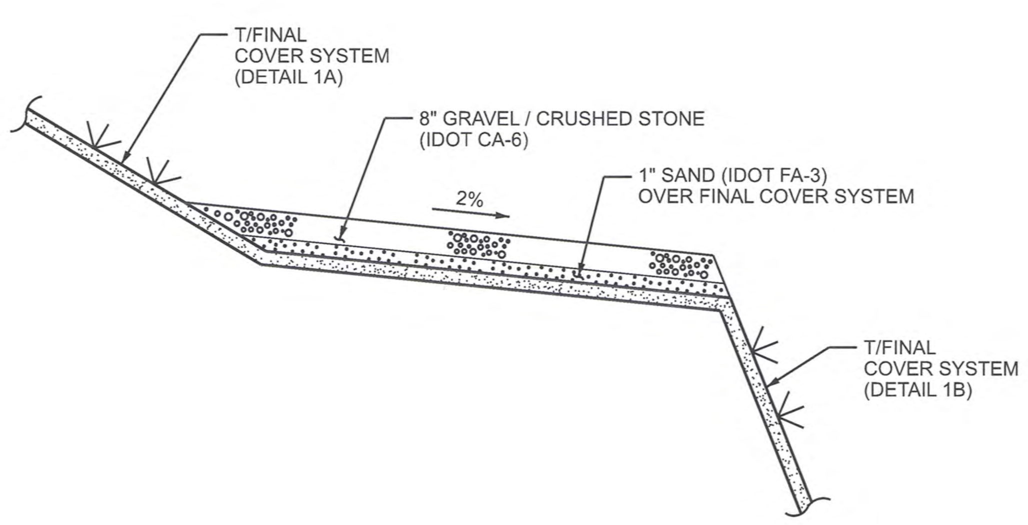
CLOSURETURF® FINAL COVER SYSTEM
DETAIL 1
N.T.S.



TYPICAL ANCHOR TRENCH
DETAIL 2
N.T.S.



GEOMEMBRANE LINER TRANSITION AT NEW LOW VOLUME WASTE POND
DETAIL 3
N.T.S.



FINAL COVER ACCESS ROAD
DETAIL 4
N.T.S.

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3. TOP-OF-ASH SURFACE SHOWN IN THE EAST CHANNEL REPRESENTS THE ASH STORED IN THE POND DURING THE 2014 SURVEY OF THE SITE AND MAY NOT BE REPRESENTATIVE OF CURRENT CONDITIONS.
4. EXISTING GRADE SHOWN IN THE WEST CHANNEL REPRESENTS THE FLOOR AND SIDE SURFACES OF THE WEST CHANNEL THAT ARE ASSUMED TO HAVE BEEN INSTALLED BASED ON THE EAST ASH POND'S HISTORY OF CONSTRUCTION (GEOSYNTEC, 2016).
5. EXISTING GRADE SHOWN FOR THE DOWNSTREAM SLOPE OF THE EAST ASH POND'S EAST DIKE REPRESENTS THE SIDE SURFACE ASSUMED TO HAVE BEEN INSTALLED IN ACCORDANCE WITH THE SLOPE MODIFICATION WORK DONE IN 2016 (REF. DWGS. SW0251-11-01 THROUGH -07).

REFERENCE DRAWINGS

B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
CSK-008	EAST ASH POND FINAL COVER SYSTEM GRADING PLAN
SW0251-11-01 - 07	EAST ASH BASIN SLOPE MODIFICATION

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REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: T. DEHLIN

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GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

EAST ASH POND
FINAL COVER SYSTEM
SECTIONS & DETAILS

DRAWING NUMBER	REVISION
WKG-AP-CSK-009	C

SHEET 1 OF 1

ATTACHMENT 6
FACILITY/COMPONENT PLANS AND SPECIFICATIONS

Attachment 6 – No Attachment

<u>ATTACHMENT 7</u>
<u>CLOSURE CONSTRUCTION</u>

Attachment 7-1 East Pond Closure Plan

MWG

Midwest Generation, LLC

Waukegan Generating Station

Final Written Closure Plan for East Ash Pond

Revision 2

January 27, 2022

Issue Purpose: Use

Project No.: 12661-098

55 East Monroe Street
Chicago, IL 60603-5780 USA
312-269-2000
www.sargentlundy.com

Sargent & Lundy

TABLE OF CONTENTS

1.0 PURPOSE & SCOPE

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(b)
Federal CCR Rule Reference: 40 CFR 257.102(b)

1.1 PURPOSE

The East Ash Pond at Midwest Generation, LLC's (MWG) Waukegan Generating Station ("Waukegan" or the "Station") is an existing coal combustion residual (CCR) surface impoundment that is regulated by the Illinois Pollution Control Board's "Standards for the Disposal of Coal Combustion Residuals in CCR Surface Impoundments." These regulations are codified in Part 845 to Title 35 of the Illinois Administrative Code (35 Ill. Adm. Code 845, Ref. 1) and are also referred to herein as the "Illinois CCR Rule." The East Ash Pond is also regulated by the U.S. Environmental Protection Agency's (EPA) "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 40 CFR Part 257 Subpart D (Ref. 2), also referred to herein as the "Federal CCR Rule."

Pursuant to 35 Ill. Adm. Code 845.720(b) and 40 CFR 257.102(b), this document provides the final written closure plan for the East Ash Pond at Waukegan. MWG intends to close this CCR surface impoundment by leaving the impounded CCR in place and installing a final cover system over the impoundment in accordance with 35 Ill. Adm. Code 845.750 and 40 CFR 257.102(d). This plan describes the steps necessary to close the East Ash Pond in this manner.

1.2 SCOPE

Per the 2016 Water Infrastructure Improvements for the Nation (WIIN) Act, the East Ash Pond will continue to be subject to both the Illinois and Federal CCR Rules until the U.S. EPA approves the Illinois EPA's CCR permit program. The Illinois EPA has yet to publish a timeline for submitting its proposed CCR permit program to the U.S. EPA for approval, and so this final written closure plan has been prepared pursuant to both sets of regulations.

2.0 CLOSURE PLAN NARRATIVE DESCRIPTION

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(1)(A) & 845.750(a)
Federal CCR Rule Reference: 40 CFR 257.102(b)(1)(i) & 257.102(d)(1)

Pursuant to 35 Ill. Adm. Code 845.750(a) and 40 CFR 257.102(d), the East Ash Pond will be closed by leaving the CCR stored in the pond in place and installing a final cover system over the impoundment. The final cover system will be designed in accordance with the requirements specified in 35 Ill. Adm. Code 845.750(c) and 40 CFR 257.102(d)(3) and as described in the following sections of this closure plan.

The anticipated closure in-place of the East Ash Pond will be performed in accordance with the following sequential steps:

1. Ceasing all CCR and non-CCR inflows to the pond;
2. Drawing down the free surface water in the pond by evaporation and by draining water into the Recycle Water Sump in the northwest corner of the pond;
3. Once the water elevation is below the Recycle Water Sump's overflow weir elevation, promoting additional drainage and dewatering by:
    a. Excavating sumps and trenches within the ash material,
    b. Using portable pumps as necessary to remove additional water by pumping water over the weir into the Recycle Water Sump, and/or
    c. Utilizing earthmoving equipment to move the ash within the pond;
4. Upon completion of dewatering and stabilization of the impounded ash, establishing the slopes for the final cover system by:
    a. Grading the stabilized ash material, and
    b. Placing and grading structural fill material over the stabilized ash to establish the slopes for the final cover system;
5. Installing an engineered final cover system (ClosureTurf®), which consists of:
    a. Structured geomembrane as the system's low permeability layer, and
    b. Synthetic turf and specialized sand infill as the system's final protective layer; and
6. Initiating post-closure monitoring of groundwater and final cover system integrity.

3.0 FINAL COVER SYSTEM DESCRIPTION

Illinois CCR Rule References: 35 Ill. Adm. Code 845.720(a)(1)(C) & 845.750(a)
Federal CCR Rule References: 40 CFR 257.102(b)(1)(iii) & 257.102(d)(1)

Pursuant to the closure performance standards prescribed in 35 Ill. Adm. Code 845.750(a) and 40 CFR 257.102(d)(1), the final cover system encapsulating the CCR in the East Ash Pond will:

1. Minimize the post-closure infiltration of liquid into the CCR;
2. Minimize the risk of release of CCR or contaminated run-off to the ground or surface waters, or to the atmosphere;
3. Preclude the probability of future impoundment of water, sediment, or slurry;
4. Provide major slope stability to prevent sloughing of the final cover system during the closure and post-closure care period;
5. Minimize future maintenance; and
6. Allow closure activities to be completed as quickly as practical consistent with recognized and generally accepted good engineering practices.

In addition to the preceding performance criteria, the final cover system installed over the East Ash Pond must meet the design criteria promulgated by 35 Ill. Adm. Code 845.750(c) and 40 CFR 257.102(d)(3), both of which require the final cover system to consist of at least two layers: a lower, low-permeability layer for infiltration control and an upper, final protective layer for erosion control and for protecting the low permeability layer. MWG plans to install an engineered final cover system developed by Watershed Geosynthetics, LLC (Watershed Geo) called ClosureTurf®, which will provide the performance metrics stipulated for both the low-permeability and final protective layers promulgated by the Illinois and Federal CCR Rules. ClosureTurf® consists of a structured geomembrane under an engineered synthetic turf with a specialized sand infill. It should be noted that the products used to manufacture these materials are free of per- and polyfluoroalkyl substances (PFAS). Moreover, Watershed Geo has designed its ClosureTurf® product specifically for environmental containment applications and has been tested to ensure long-term compliance with the performance criteria discussed in the following subsections.

3.1 ESTABLISH GRADE & SUPPORT FOR FINAL COVER SYSTEM

Illinois CCR Rule References: 35 Ill. Adm. Code 845.750(a)(2), 845.750(a)(3), & 845.750(c)(3))
Federal CCR Rule References: 40 CFR 257.102(d)(1)(ii), 257.102(d)(1)(iii), & 257.102(d)(3)(i)(D)

To accomplish the performance requirements stipulated by 35 Ill. Adm. Code 845.750 and 40 CFR 257.102(d), the CCR remaining in the East Ash Pond will be graded to direct non-contact storm water run-off to a new low volume waste pond being installed within the footprint of the existing West Ash Pond west of and adjacent to the East Ash Pond. Structural fill material will be placed over the stabilized CCR in the pond to establish the lines and grades for this storm water management scheme. The slopes of this foundation layer for the pond's final cover system will be steep enough to prevent storm water from ponding over the cap but flat enough to limit erosion caused by the storm water run-off. These slopes will also be designed to accommodate potential settling and subsidence while maintaining a positive drainage strategy. In addition, the foundation layer's slopes (and the final cover system in general) will also include measures that provide slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period. Finally, the foundation layer surface will be prepared such that it is free from large, protruding, or sharp materials that could otherwise cause damage to the overlying low permeability layer.

3.2 LOW PERMEABILITY LAYER

Illinois CCR Rule References: 35 Ill. Adm. Code 845.750(a)(1) & 845.750(c)(1)
Federal CCR Rule References: 40 CFR 257.102(d)(1)(i) & 257.102(d)(3)(ii)(A)

The structured geomembrane component of the ClosureTurf® system will be placed on top of the graded CCR and fill in the East Ash Pond to minimize the infiltration of liquids through the pond during its post-closure life. This low permeability layer will control stormwater run-off from the final cover system and will minimize 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.

Table 1 lists the design criteria for the low permeability layer of a final cover system installed over a CCR surface impoundment as promulgated by the Illinois and Federal CCR Rules. By comparison, the Illinois CCR Rule's design criteria for the low permeability layer are either as protective or more protective of human health and the environment than the design criteria promulgated by the Federal CCR Rule. Accordingly, the structured geomembrane component of the ClosureTurf® system for the East Ash Pond will be designed in accordance with the design criteria promulgated by the Illinois CCR Rule for a low permeability layer in a final cover system.

Table 1 – Comparison of Illinois and Federal CCR Rules' Design Criteria for Low Permeability Layer in a CCR Surface Impoundment's Final Cover System

Construction Material	Parameter	Illinois CCR Rule Design Criterion (35 Ill. Adm. Code 845.750(c)(1))	Federal CCR Rule Design Criterion (40 CFR 257.102(d)(3))
Earthen Material	Thickness	3 feet minimum	1.5 feet minimum
	Hydraulic Conductivity	Least of: • Permeability of any bottom liner system or natural subsoils • 1×10^{-7} cm/sec	Least of: • Permeability of any bottom liner system or natural subsoils • 1×10^{-5} cm/sec
	Compaction	Minimize void spaces	--
Geomembrane	Thickness	40 mil	--
	Hydraulic Flux	Equivalent or superior reduction in infiltration as a low permeability layer constructed with earthen material	Equivalent or superior reduction in infiltration as a low permeability layer constructed with earthen material
	Prepared Subgrade	Free from sharp objects and other materials that may cause damage	--

The East Ash Pond has a 60-mil HDPE geomembrane liner on its floor and sides; therefore, the low permeability layer in the pond's final cover system must have a permeability that is equal to or less than the effective permeability of the existing liner. Accordingly, MWG plans to specify a 60-mil HDPE, structured geomembrane for the ClosureTurf® system installed over the pond pursuant to 35 Ill. Adm. Code 845.750(c)(1)(B) and 40 CFR 257.102(d)(3)(ii)(A).

As required by 35 Ill. Adm. Code 845.750(c)(1)(B)(i) and 40 CFR 257.102(d)(3)(ii)(A), Table 2 demonstrates that a 60-mil HDPE geomembrane will provide a superior reduction in infiltration when compared to a 3-foot-thick layer of earthen material with a hydraulic conductivity of 1×10^{-7} cm/sec. The liquid flow rate through a 3-foot-thick layer of earthen material is calculated using the equation derived from Darcy's Law for gravity flow through porous media that is specified by the Illinois and Federal CCR Rules as the basis for demonstrating compliance with both rules' alternative composite liner design criteria (Ref. 1, §845.400(c)(3); Ref. 2, Eq. 1). Meanwhile, the liquid flow rate through a geomembrane liner is calculated using Bernoulli's equation for free flow through an orifice based on the assumption that one 2-mm-diameter hole is present in the geomembrane for every acre (4,000 m^2) of liner (Ref. 3). Both liquid flow rates calculated in Table 2 are based on the assumption that 4.37 inches (0.11 meter) of hydraulic head is present on the low permeability layer, which is the estimated 25-year, 24-hour precipitation depth at the Station (Ref. 4). This is a conservative assumption because the final cover system will be sloped to preclude the build-up of liquid on the low permeability layer.

Table 2 – Liquid Flow Rate Comparison Between Low Permeability Layers Constructed Using Geomembrane & Earthen Material

Parameter	Symbol	Value
Liquid Flow Rate Through Earthen Material		
Hydraulic Conductivity	k	1×10^{-9} m/sec
Hydraulic Head Above Layer	h	0.11 m
Layer Thickness	t	3 ft = 0.91 m
Hydraulic Gradient Through Earthen Material	$i = h / t$	0.12
Liquid Flow Rate Through Layer per Acre of Final Cover System (Ref. 1, §845.400(c)(3); Ref. 2, Eq. 1).	$q = k \times (i + 1)$	1.12×10^{-9} $m^3/sec/m^2$
Liquid Flow Rate Through Geomembrane		
Hole Area in Geomembrane	a	3.1 mm^2 / 4000 m^2
Acceleration Due to Gravity	g	9.81 m/sec^2
Hydraulic Head Above Layer	h	0.11 m
Liquid Flow Rate Through Layer per Unit Area (Ref. 3)	$q = 0.6a(2gh)^{0.5}$	6.83×10^{-10} $m^3/sec/m^2$

3.3 FINAL PROTECTIVE LAYER

Illinois CCR Rule References: 35 Ill. Adm. Code 845.750(c)(2)
Federal CCR Rule Reference: 40 CFR 257.102(d)(3)(ii)(B)

To minimize wind and water erosion, the ClosureTurf® system features an engineered synthetic turf with a thin (0.5- to 0.75-in. thick) layer of specialized sand infill that is installed over the structured geomembrane. The artificial turf component consists of a double-layer, woven geotextile base through which tufts of polyethylene fibers are inserted. This engineered synthetic turf and specialized sand infill will cover the entire low permeability layer (*i.e.*, structured geomembrane) and will be installed as soon as possible after placement of the low permeability layer.

Research and testing performed by Watershed Geo has demonstrated that ClosureTurf® provides superior protection against wind and water erosion than a traditional final protective layer consisting of vegetated topsoil or other earthen materials (Ref. 5). Specifically, the engineered synthetic turf component has been tested at hurricane-level wind speeds (using a wind tunnel) and at storm rainfall intensities of more than 6 inches per hour. By comparison, the 500-year, 1-hour rainfall depth for Lake County, Illinois, where the Station is located, is approximately 5.28 inches (Ref. 6). The most significant rainfall event to date at a site with a ClosureTurf® cap occurred in 2014 in Pensacola, Florida, where 22 inches of rain fell over 24 hours, and no damage to the final cover system was observed during the inspections that immediately followed the storm event. By comparison, the 500-year, 24-hour rainfall depth for Lake County, Illinois is 11.24 inches (Ref. 6), or approximately 51% of the aforementioned 2014 storm event.

The aforementioned wind tunnel testing conducted on ClosureTurf® at hurricane-level wind speeds by Watershed Geo has also demonstrated that the 0.5- to 0.75-in.-thick, specialized sand infill layer provides weight to prevent wind from lifting the ClosureTurf® cap and subsequently exposing the underlying CCR to the atmosphere. The hydraulic performance of ClosureTurf® also is not affected by freezing temperatures and freeze-thaw conditions (Ref. 6). Because the final protective layer will consist of synthetic turf, the risk of roots penetrating the underlying geomembrane cap also is not a concern. Therefore, the engineered synthetic turf and specialized sand infill components of the proposed ClosureTurf® final cover system for the East Ash Pond will provide equivalent or superior performance as the 3-foot-thick final protective layer specified in 35 Ill. Adm. Code 845.750(c)(2).

Finally, in addition to providing superior protection against wind and water erosion than a traditional cover system, ClosureTurf® also does not require as much maintenance as a vegetated final protective layer which needs to be mowed regularly and may need to be reseeded, refertilized, and/or regraded throughout the pond's post-closure life.

4.0 ESTIMATED MAXIMUM INVENTORY OF CCR

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(1)(D)
Federal CCR Rule Reference: 40 CFR 257.102(b)(1)(iv)

Detailed records of the maximum inventory of CCR ever stored in the East Ash Pond are not available. For the purposes of this closure plan, the maximum CCR inventory for the East Ash Pond is conservatively based on its estimated maximum capacity, which is 184,000 cubic yards.

5.0 ESTIMATED COVER SURFACE AREA

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(1)(E)
Federal CCR Rule Reference: 40 CFR 257.102(b)(1)(v)

The estimated final cover surface area for the East Ash Pond is 13.5 acres. It is estimated that this area represents the largest surface area that will ever require a final cover at any point over the pond's active life.

6.0 CLOSURE SCHEDULE

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(1)(F)
Federal CCR Rule Reference: 40 CFR 257.102(b)(1)(vi)

Closure activities for the East Ash Pond will commence after the West Ash Pond has been closed and repurposed as a new low-volume waste pond and are estimated to be completed in 2024. Table 3 lists the major milestones necessary for closing the East Ash Pond and the expected duration for completing each milestone.

Table 3 – Planning Level Schedule for Closing the East Ash Pond

Activity	Estimated Duration
Prepare Closure Construction Design Documents	Complete
Obtain Closure Construction Permit from Illinois EPA	12 Months
Hire Contractor to Complete Closure Activities in Accordance with Illinois EPA Permit	4 Months
Close West Ash Pond and Repurpose as Low Volume Waste Pond	10 Months
Dewater Pond & Impounded Ash	6 Months

Activity	Estimated Duration
Grade Dewatered Ash, Place and Grade Structural Fill	3.5 Months
Install Final Cover System	1.5 Months
Submit Closure Report and Certification to Illinois EPA	2 Weeks
Obtain Approval of Closure Report and Certification from Illinois EPA	3 Months
Complete and Certify Closure of the East Ash Pond	--

7.0 AMENDMENTS TO CLOSURE PLAN

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(3)
Federal CCR Rule Reference: 40 CFR 257.102(b)(3)

This closure plan will be amended in accordance with 35 Ill. Adm. Code 845.720(a)(3) and 40 CFR 257.102(b)(3) if a change in the operation of the East Ash Pond would substantially affect this closure plan or if an unanticipated event necessitates a revision to this closure plan. Any and all amendments to this closure plan will be certified by a qualified professional engineer registered in the State of Illinois in accordance with 35 Ill. Adm. Code 845.720(a)(4) and 40 CFR 257.102(b)(4).

8.0 COMPLETION OF CLOSURE ACTIVITIES

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.760
Federal CCR Rule Reference: 40 CFR 257.102(f)

Upon completion of all closure activities required by 35 Ill. Adm. Code Part 845 and 40 CFR 257.102(d) and approved by the Illinois EPA in a construction permit, a closure report and a closure certification for the East Ash Pond will be submitted to the Illinois EPA in accordance with 35 Ill. Adm. Code 845.760(e). The closure report will include (1) the engineering and hydrogeology reports containing any monitoring well completion reports, boring logs, all construction quality assurance (CQA) reports, certifications, designations of CQA officers-in-absentia required by 35 Ill. Adm. Code 845.290; (2) photographs with time, date, and location information relied upon for documentation of construction activities; (3) a written summary of the closure requirements and completed activities as stated in the closure plan in effect and 35 Ill. Adm. Code Part 845; and (4) any other information relied upon by the qualified professional engineer for certification. Pursuant to 35 Ill. Adm. Code 845.760(e)(2) and 40 CFR 257.102(f)(3), the certification will be prepared by an independent, qualified professional engineer licensed in the State of Illinois and will verify that the East Ash Pond has been closed in accordance with the closure plan in effect at the time of the closure work, the requirements of 35 Ill. Adm. Code Part 845, and the requirements of 40 CFR 257.102. Finally, within 30 days of the Illinois EPA approving the closure report and closure certification, a notification of completion of closure will be prepared in accordance with 35 Ill. Adm. Code 845.760(f).

9.0 CERTIFICATION

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(4)
Federal CCR Rule Reference: 40 CFR 257.102(b)(4)

I certify that:

- This final written closure plan for the East Ash Pond was prepared by me or under my direct supervision.
- The work was conducted in accordance with the requirements of 35 Ill. Adm. Code Part 845 and with the requirements of 40 CFR 257.102.
- I am a registered professional engineer under the laws of the State of Illinois.

Certified By: Thomas J. Dehlin   Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

10.0 REFERENCES

1. Illinois Pollution Control Board. “Standards for Disposal of Coal Combustion Residuals in CCR Surface Impoundments.” 35 Ill. Adm. Code 845. Accessed January 26, 2022.

2. U.S. Environmental Protection Agency. “Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.” 40 CFR Part 257 Subpart D. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-257/subpart-D. Accessed January 26, 2022.

3. Giroud, J.P. and Bonaparte, R. “Leakage through liners Constructed with Geomembranes—Part I. Geomembrane Liners.” *Geotextiles and Geomembranes*. Vol. 8. pp. 27–67. 1989.

4. National Oceanic and Atmospheric Administration. “Point Precipitation Frequency (PF) Estimates.” NOAA Atlas 14, Volume 2, Version 3. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html. Accessed January 27, 2022.

5. Watershed Geosynthetics, LLC. “ClosureTurf® Overview: Superior Performance When Compared to EPA Subtitle D Landfill Final Covers.” https://watershedgeo.com/products/closureturf/. Accessed January 27, 2022.

6. Lake County Stormwater Management Commission. “Watershed Development Ordinance.” October 13, 2020.

7. Hsuan, Y. *et al*. “Cold Temperatures and Free[ze]-Thaw Cycling Behavior of Geomembranes and Their Seams.” GSI White Paper #28. Geosynthetic Institute. June 17, 2013.

<u>Attachment 7-2 West Pond Closure Plan</u>

Midwest Generation, LLC

Waukegan Generating Station

Final Written Closure Plan for West Ash Pond

Revision 2

January 27, 2022

Issue Purpose: Use

Project No.: 12661-098

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Chicago, IL 60603-5780 USA
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Sargent & Lundy

TABLE OF CONTENTS

1.0 PURPOSE & SCOPE

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(b)
Federal CCR Rule Reference: 40 CFR 257.102(b)

1.1 PURPOSE

The West Ash Pond at Midwest Generation, LLC's (MWG) Waukegan Generating Station ("Waukegan" or the "Station") is an existing coal combustion residual (CCR) surface impoundment that is regulated by the Illinois Pollution Control Board's "Standards for the Disposal of Coal Combustion Residuals in CCR Surface Impoundments." These regulations are codified in Part 845 to Title 35 of the Illinois Administrative Code (35 Ill. Adm. Code 845, Ref. 1) and are also referred to herein as the "Illinois CCR Rule." The West Ash Pond is also regulated by the U.S. Environmental Protection Agency's (EPA) "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 40 CFR Part 257 Subpart D (Ref. 2), also referred to herein as the "Federal CCR Rule."

Pursuant to 35 Ill. Adm. Code 845.720(b) and 40 CFR 257.102(b), this document provides the final written closure plan for the West Ash Pond at Waukegan. MWG intends to close this CCR surface impoundment by removing CCR and CCR-mixed materials remaining in the pond at the time of closure and decontaminating affected areas pursuant to 35 Ill. Adm. Code 845.740(a) and 40 CFR 257.102(c). MWG then intends to repurpose the area as a new low volume waste pond for the Station. This plan describes the steps necessary to close and subsequently repurpose the West Ash Pond in this manner.

1.2 SCOPE

Per the 2016 Water Infrastructure Improvements for the Nation (WIIN) Act, the West Ash Pond will continue to be subject to both the Illinois and Federal CCR Rules until the U.S. EPA approves the Illinois EPA's CCR permit program. The Illinois EPA has yet to publish a timeline for submitting its proposed CCR permit program to the U.S. EPA for approval, and so this final written closure plan has been prepared pursuant to both sets of regulations.

2.0 CLOSURE PLAN NARRATIVE DESCRIPTION

Illinois CCR Rule References: 35 Ill. Adm. Code 845.720(a)(1)(A) & 845.740(a)
Federal CCR Rule References: 40 CFR 257.102(b)(1)(i) & 257.102(c)

MWG plans to close the West Ash Pond by removing CCR and CCR-mixed materials remaining in the pond at the time of closure and decontaminating affected areas pursuant to 35 Ill. Adm. Code 845.740(a) and 40 CFR 257.102(c). The West Ash Pond closure will be executed according to the following sequential steps:

1. Obtaining a construction permit from the Illinois EPA for closing the pond;
2. Removing the remaining CCR and the protective granular fill layer over the existing geomembrane liner from the pond and transporting the CCR and soil materials to a permitted disposal facility;
3. Inspecting and decontaminating the pond's existing geomembrane liner and appurtenant structures (*e.g.*, concrete inlet and outlet structures) for re-use in accordance with the closure construction permit issued by the Illinois EPA, including submittal of visual inspection documentation and analytical testing results to demonstrate the existing liner and structures are no longer contaminated with CCR constituents;[1]
4. Sampling the groundwater at the pond site to verify the groundwater monitoring concentrations do not exceed the groundwater protection standards established for constituents in accordance with the operating permit issued by the Illinois EPA for the pond; and
5. Certifying (via a qualified professional engineer licensed in the State of Illinois) that the CCR has been removed from the pond and the CCR surface impoundment has been decontaminated in accordance with the closure plan in effect at the time of closure and in accordance with the corresponding construction permit issued by the Illinois EPA.

3.0 CCR REMOVAL & DECONTAMINATION PROCEDURES

Illinois CCR Rule References: 35 Ill. Adm. Code 845.720(a)(1)(B) & 845.740(a)
Federal CCR Rule References: 40 CFR 257.102(b)(1)(ii) & 257.102(c)

The plan for closing the West Ash Pond is to follow the sequential steps outlined in Section 2.0.

In June 2020, Waukegan took the West Ash Pond out of service for routine cleaning. MWG then began removing ash stored above the granular protective layer covering the pond's existing geomembrane liner in accordance with historical cleaning practices in the Station's ash pond maintenance program where ash is periodically removed from the pond to recover storage capacity. In September 2021, it was noted that most of the CCR previously stored in the West Ash Pond had been removed and minimal surface water remained

[1] MWG has filed a Petition for an Adjusted Standard with the Illinois Pollution Control Board so that it may reuse the liner and ancillary equipment in the West Ash Pond. *In the Matter of Midwest Generation, LLC (Waukegan)*, PCB 21-03.

in the pond. Final closure activities will be performed in accordance with the closure plan in effect at the time of the closure work and the corresponding construction permit issued by the Illinois EPA.

Upon receipt of the construction permit from the Illinois EPA for closing the West Ash Pond, MWG will first remove the minimal CCR remaining in the pond and the 18-in.-thick granular protective layer covering the pond's existing geomembrane liner. These materials will then be loaded onto trucks and transported to a permitted disposal facility. The trucks transporting these materials off-site will carry manifests pursuant to 35 Ill. Adm. Code 845.740(c)(1)(A) and as specified in 35 Ill. Adm. Code 809. In addition, a CCR transportation plan will be prepared in accordance with 35 Ill. Adm. Code 845.740(c)(1)(B) which will include:

- Identification of the transportation method selected;
- The frequency, time of day, and routes of CCR transportation;
- Any measures to minimize noise, traffic, and safety concerns caused by the transportation of the CCR;
- Measures to limit fugitive dust from any transportation of CCR;
- Installation and use of a vehicle washing station;
- A means of covering the CCR for any mode of CCR transportation;
- A requirement that the CCR is transported by a permitted special waste hauler under 35 Ill. Adm. Code 809.201.

On-site fugitive dust control measures will also be implemented as necessary to minimize airborne CCR particulates while CCR and CCR-mixed materials are being handled. Pursuant to 35 Ill. Adm. Code 845.740(c)(2)(A), these dust control measures will include a water spray, commercial dust suppressant, or a combination of these.

Prior to the removal of the granular protective layer covering the West Ash Pond's existing geomembrane liner, signage will be posted at the Station's entrance warning of the hazards of CCR dust inhalation in accordance with 35 Ill. Adm. Code 845.740(c)(3)(A). Pursuant to 35 Ill. Adm. Code 845.740(c)(3)(B), a written notice will be issued to each of the local governments through which the CCR-mixed materials will be transported. This written notice will include an explanation of the hazards of CCR dust inhalation, the aforementioned CCR transportation plan, and a tentative transportation schedule.

After the granular protective layers in the pond have been removed, MWG will begin decontaminating the West Ash Pond's existing geomembrane liner to be re-used when the pond is repurposed as a new low volume waste pond for the Station. The pond's inlet trough, outlet structure, associated piping, *etc*. will also be decontaminated. At a minimum, decontamination procedures will include pressure washing of the geomembrane liner and pond appurtenances in a systematic manner to remove all CCR and residuals of CCR. Following decontamination, the existing geomembrane liner will be visually inspected and an electrical leak location survey will be conducted to ensure the liner is competent. Analytical tests will also be conducted in accordance with the construction permit issued by the Illinois EPA at the time of the closure work to demonstrate that the liner is no longer contaminated with CCR constituents. The results from the visual inspection and analytical tests will be submitted to the Illinois EPA for approval of re-using the existing geomembrane liner when the West Ash Pond is repurposed as a new low volume waste pond.

In accordance with 35 Ill. Adm. Code 845.740(e) and 40 CFR 257.102(c), CCR removal and decontamination will be complete when constituent concentrations throughout the West Ash Pond and areas that may have been affected by releases from the pond have been removed and groundwater monitoring concentrations do not exceed the groundwater protection standards established under 35 Ill. Adm. Code 845.600. After CCR removal and decontamination of the West Ash Pond has been completed, MWG will submit a report documenting the completion of CCR removal and decontamination of the unit, which will include a certification from a qualified professional engineer licensed in the State of Illinois that CCR removal and decontamination was completed in accordance with 35 Ill. Adm. Code 845.740.

In accordance with 35 Ill. Adm. Code 845.740(b), MWG will continue groundwater monitoring in accordance with Subpart F of the Illinois CCR Rule (“Groundwater Monitoring and Corrective Action”) for three years after the completion of CCR removal and decontamination. After groundwater monitoring has been completed, MWG will submit a report documenting the completion of groundwater monitoring, which will include a certification from a qualified professional engineer licensed in the State of Illinois that groundwater monitoring was completed in accordance with 35 Ill. Adm. Code 845.740.

4.0 ESTIMATED MAXIMUM INVENTORY OF CCR

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(1)(D)
Federal CCR Rule Reference: 40 CFR 257.102(b)(1)(iv)

Detailed records of the maximum inventory of CCR ever stored in the West Ash Pond are not available. For the purposes of this closure plan, the maximum inventory of CCR ever on-site over the active life of the West Ash Pond is conservatively based on the estimated maximum capacity of the pond: 223,000 cubic yards.

5.0 CLOSURE SCHEDULE

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(1)(F)

Federal CCR Rule Reference: 40 CFR 257.102(b)(1)(vi)

Closure activities for the West Ash Pond are expected to be completed in 2023. Table 1 lists the major milestones necessary for closing the pond and the expected duration for completing each milestone.

Table 1 – Planning Level Schedule for Closing the West Ash Pond

Activity	Estimated Duration
Prepare Closure Construction Design Documents	Complete
Obtain Closure Construction Permit from Illinois EPA	12 Months
Hire Contractor to Complete Closure Activities in Accordance with Illinois EPA Permit	4 Months
Remove Protective Granular Layers Above Existing Liner	1 Month
Decontaminate Existing Liner and Pond Appurtenances (Including Laboratory Testing)	2 Months
Obtain Approval from Illinois EPA to Re-Use Existing Liner for New Low Volume Waste Pond	3 Months
Submit Completion of CCR Removal and Decontamination Report and Certification to Illinois EPA	2 Weeks
Obtain Approval of Completion of CCR Removal and Decontamination Report from Illinois EPA	3 Months
Complete and Certify Closure of the West Ash Pond	--

6.0 AMENDMENTS TO CLOSURE PLAN

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(3)
Federal CCR Rule Reference: 40 CFR 257.102(b)(3)

This closure plan will be amended in accordance with 35 Ill. Adm. Code 845.720(a)(3) and 40 CFR 257.102(b)(3) if a change in the operation of the West Ash Pond would substantially affect this closure plan or if an unanticipated event necessitates a revision to this closure plan. Any and all amendments to this closure plan will be certified by a qualified professional engineer registered in the State of Illinois in accordance with 35 Ill. Adm. Code 845.720(a)(4) and 40 CFR 257.102(b)(4).

7.0 COMPLETION OF CLOSURE ACTIVITIES

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.760
Federal CCR Rule Reference: 40 CFR 257.102(f)

Upon completion of all CCR removal and decontamination activities required by 35 Ill. Adm. Code Part 845 and 40 CFR 257.102(c) and approved by the Illinois EPA in a construction permit, a closure report and a closure certification for the West Ash Pond will be submitted to the Illinois EPA in accordance with 35 Ill. Adm. Code 845.760(e). The closure report will include (1) the engineering and hydrogeology reports containing any monitoring well completion reports, boring logs, all construction quality assurance (CQA) reports, certifications, designations of CQA officers-in-absentia required by 35 Ill. Adm. Code 845.290; (2) photographs with time, date, and location information relied upon for documentation of construction activities; (3) a written summary of the closure requirements and completed activities as stated in the closure plan in effect and 35 Ill. Adm. Code Part 845; and (4) any other information relied upon by the qualified professional engineer for the certification. Pursuant to 35 Ill. Adm. Code 845.760(e)(2) and 40 CFR 257.102(f)(3), the certification will be prepared by an independent, qualified professional engineer licensed in the State of Illinois and will verify that the West Ash Pond has been closed in accordance with the closure plan in effect at the time of the closure work, the requirements of 35 Ill. Adm. Code Part 845, and the requirements of 40 CFR 257.102. Finally, within 30 days of the Illinois EPA approving the closure report and closure certification, a notification of completion of closure will be prepared in accordance with 35 Ill. Adm. Code 845.760(f).

8.0 CERTIFICATION

<u>Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.720(a)(4)</u>
<u>Federal CCR Rule Reference: 40 CFR 257.102(b)(4)</u>

I certify that:

- This final written closure plan for the West Ash Pond was prepared by me or under my direct supervision.
- The work was conducted in accordance with the requirements of 35 Ill. Adm. Code Part 845 and with the requirements of 40 CFR 257.102.
- I am a registered professional engineer under the laws of the State of Illinois.

Certified By: Thomas J. Dehlin   Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

9.0 REFERENCES

1. Illinois Pollution Control Board. "Standards for Disposal of Coal Combustion Residuals in CCR Surface Impoundments." 35 Ill. Adm. Code 845. Accessed January 26, 2022.
2. U.S. Environmental Protection Agency. "Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments." 40 CFR Part 257 Subpart D. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-257/subpart-D. Accessed January 26, 2022.

Attachment 7-3 – Closure Alternatives Analysis

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January 28, 2022

AECOM Project No.
60669161

Jill Buckley
Midwest Generation, LLC
Will County Generating Station
529 E. 135th Street
Romeoville, IL 60446

Closure Alternatives Analysis for the East and West Ash Ponds at the Waukegan Generating Station in Waukegan, IL

Dear Ms. Buckley,

This letter report presents the Closure Alternatives Analysis (CAA) for the East and West Ash Ponds (Basins) located at the Midwest Generation, LLC (MWG) Waukegan Station located west of Lake Michigan in Waukegan, Illinois. The CAA for this project involved developing ash basin closure strategies and evaluating these options relative to each other to determine a solution which is protective of the environment and addresses input from the community. After selection of the preferred alternative, a more detailed engineering and closure plan will be developed. The strategies discussed in the CAA are representative of the range of possible approaches for basin closure. The following sections of this letter report provide the project understanding, the considered closure options, approach used for the CAA, narratives addressing items listed in 35 IAC 845.710 regarding the different closure alternatives and ranking of closure options for each item.

Project Understanding

The MWG Waukegan Station is located adjacent to Lake Michigan in Waukegan, IL. The facility currently generates electricity through coal combustion as well as gas fired boilers. It is our understanding that coal fired generation is expected to cease at the facility in June of 2022. Under the 35 IAC 845 (Part 845) regulation, a number of submittals and permits are required for submission to the State of Illinois. As part of those submittals, a closure alternatives analysis, as presented in this letter report, of the East and West Ash Ponds is required. The East and West Ash Ponds are located south of the generating facilities at the station and are each approximately 11 acres in plan. Based on current Coal Combustion Residual (CCR) volumes present within each unit, we understand that the current plan for the facility is to close the West Pond by removal of all CCR and the basin will then be repurposed as a non-CCR low volume wastewater pond. The East Ash Pond will be closed by removal or closed in place based on the outcome of the CAA required under 35 IAC 845.710. AECOM further understands that neither the West nor East Ash Ponds exhibit Statistically Significant Levels (SSLs) of Appendix IV groundwater constituents which exceed Groundwater Protection Standards (GWPS).

Closure Options

For the MWG Waukegan Station, AECOM considered the following closure options for the East Ash Basin (EAB) and West Ash Basin (WAB):

- Option 1: WAB Closure-by-Removal
- Option 2: WAB Closure-in-Place
- Option 3: EAB Closure-by-Removal
- Option 4: EAB Closure-in-Place Option 1
- Option 5: EAB Closure-in-Place Option 2
- Option 6: EAB Closure-in-Place Option 3

In general, the options being considered for each ash basin are Closure-by-Removal or Closure-in-Place. For the Closure-by-Removal options, the in-place CCR material will be excavated and transported to a commercial landfill. Based on conversations with state landfills, the closest facility able to accept the CCR material is located in Joliet, IL. The landfill in Zion, IL will not accept the CCR due to concerns related to the generation of hydrogen sulfide (H2S) which can cause odor and the Countryside Landfill in Grayslake, IL does not have capacity available to accept the volume of CCR which requires disposal. Currently, there is not an identified end user for beneficial reuse of the CCR material in the East Ash Basin and the material remaining in the West Ash Basin is not suitable for beneficial reuse. Also, MWG does not have an alternative offsite facility that can accept the existing CCR material and does not have enough space on site to accommodate the construction of a new CCR impoundment or landfill. After removal of all CCR material, the existing basin geomembrane liner would be decontaminated and reused for the non-CCR impoundment. For the West Ash Basin, MWG is considering reusing it as a stormwater and wastewater holding area. If this option is chosen, the basin would need to have a new geomembrane liner placed if the existing one is removed or not decontaminated.

For the Closure-in-Place options, the CCR material will be capped with a composite system consisting of either a geomembrane liner with cover soil or geomembrane liner with engineered turf. Drawings of the closure options for the East and West Ash Basins under consideration at the MWG Waukegan Station are provided as Attachment A. The grading plans and representative drawings included for Options 1 through 5 were developed by AECOM. The grading plan and representative drawings for Option 6 were developed by Sergeant & Lundy. After placement of the final cover system, placement of solar panels, native vegetation, or converting the surface to a park were considered for the long-term use of the closed CCR impoundment.

Closure Alternatives Analysis (CAA) Approach

For the CAA approach, each Regulatory Comparison Criteria (item) presented in 35 IAC 845.710 was addressed for the different closure options. A narrative for each item is presented in the following section. In general, the narratives respond to each item when considering Closure-in-place or Closure-by-Removal for the West and East Ash Basins. After addressing each item identified in 35 IAC 845.710, a rank was given to each closure option. The ranking system gave each basin closure option a rank between 1 and 5, where 1 as the least desired and applicable and 5 as the most desired and applicable. The rankings for each item are presented on the spreadsheet included as Attachment D.

35 IAC 845.710 Comparison Criteria Narratives

Long- and Short-term Effectiveness and Protectiveness of Closure Method [845.710(b)(1)]

845.710(b)(1)(A)
Magnitude of reduction of existing risks

For CCR impoundments, the greatest risk to the surrounding environment is the release of material from structural or stability failure, or contaminant transport into the underlying groundwater system by infiltration through the base liner. For the Closure-by-Removal option, CCR material is removed from the site and the existing base liner system is removed or decontaminated. By removing the material and decontaminating the base liner, the contaminant source is removed, therefore the potential of environmental contamination by CCR is presumably eliminated. Also, for complete closure and removal of both basins, it is assumed that the interior and perimeter containment dikes will be removed, therefore the site would be graded with minimal surface relief and slope stability would not be an issue. For the instance where the closed basin is reused for stormwater or wastewater retention, the in-place decontaminated geomembrane liner would remain or be replaced. In regard to stability, the basin used for stormwater and wastewater retention would not change assuming similar loading conditions as when evaluated as a CCR impoundment.

For Closure-in-Place, the construction of an impervious barrier over the in-place CCR material would divert stormwater away from the impoundment, therefore decreasing the ability of contaminate transport by infiltration. The final cover would also be graded to divert stormwater away from the closed impoundment and eliminate the ability of water to pond on the cap. The cap system would be designed to be less permeable than the underlying liner system which would further reduce the infiltration of stormwater into the capped CCR. In addition, the existing groundwater monitoring plan would continue as part of the required 30-year post-closure plan. Regarding stability, the existing perimeter dikes would be evaluated against required minimum factors of safety presented in 35 IAC 845.460(a). It should be noted that global stability analyses for Closure-in-place were not performed as part of this CAA. It is assumed that the grades proposed for the final cover will not result in a factor of safety below the minimum required. Slopes of the proposed capping grades have been based on previous experience with other CCR closures. After the final closure plan is selected, a global stability analysis will be performed to evaluate factors of safety.

845.710(b)(1)(B)
Magnitude of residual risks in terms of likelihood of future releases of CCR.

Residual risk of future release of CCR material is eliminated at the site for the Closure-by-Removal option. For the Closure-in-Place, release from perimeter dike failure is present, but the risk is greatly reduced by maintaining minimum grades of the final cover and addition of vegetation or engineered turf to prevent erosion. Final design of the closure will include a geotechnical stability analysis of proposed final grades to ensure factors of safety meet industry standards and regulatory requirements.

845.710(b)(1)(C)
Type and degree of long-term management required, including monitoring, operation, and maintenance.

For Closure-by-Removal options where perimeter and interior dikes are removed, maintenance is limited to surface cosmetic repair as applicable. If perimeter dikes remain and the basin is used for stormwater and wastewater containment, annual inspections of perimeter dikes and base geomembrane of the basin interior would be implemented. For long-term maintenance, cleanout of drainage pipes, replacement of deteriorated drainage pipes, fixing potential erosion issues along exterior slopes, and compliance issues noted during the annual inspections would be addressed as needed.

For Closure-in-Place, long-term management of the closed CCR impoundment would include annual inspections of the cover and perimeter containment dike slopes for erosion and stability. If native grass is used for the final cover, annual maintenance would include removal of woody vegetation or invasive species, revegetation, and repair of erosion or ponding of water.

845.710(b)(1)(D)
Short-term risks that might be posed to the community or the environment during implementation of such a closure, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants.

For Closure-by-Removal, removal of the CCR material will follow procedures presented in 35 IAC 845.740. During construction, the in-place CCR material will need to be transported from the site to a commercial landfill licensed to accept CCR and CCR impacted materials. During excavation and movement of material, there is an increased chance for CCR particulates entering the atmosphere, creating potential degradation to the local environment and worker respiratory health. To mitigate dispersion of particulates, CCR material will be sprayed with water to limit dust and be in a moist state during loading and transport. In addition, workers will wear appropriate personal protective equipment (PPE) for the task being completed. During transport of CCR material to the final receiving facility, potential for particulate release will be mitigated by covering the material with a tarp. Additionally, increased truck traffic will be present on the roadway in the surrounding communities during transport of material. This creates health risks to the public by an increase in air pollution from exhaust and exposure to particulates. This risk can be mitigated by utilizing truck routes that avoid communities and areas of normally high traffic. All material transported from the site will follow procedures presented in 35 IAC 845.740(c)(1).

For Closure-in-Place, capping of the CCR material will follow the procedures presented in 35 IAC 85.750. The proposed capping system for the final cover will consist of either a geocomposite with cover soil or a structured geomembrane with engineered turf protection. The final cover will be constructed to minimize or eliminate infiltration of liquids into the CCR material and be graded to promote surface drainage and avoid ponding. Since the CCR material will remain in-place, risk to environment and public health during transport of CCR material is eliminated. Health risks are limited to the workers performing construction operations during the closure process. To mitigate risk from exposure to particulates during movement of material, dust control efforts using water will be implemented. In addition, workers will wear appropriate PPE for the task being completed. After placement of the final cover, the interface between the CCR material and the atmosphere is removed, therefore release of CCR particulates to the atmosphere is eliminated.

For long-term final closure, addition of solar panels provides an alternative energy source at the facility. Health and environmental impacts to the local community are limited. Native vegetation added to the final cover reduces erosion of cover material and adds carbon sink to the landscape. If engineered turf is used as an alternative to native vegetation, potential for sediment transport from the cover to nearby waterways from stormwater flow is nearly eliminated. For the park after closure option, increase risk to public health includes interaction with nearby industrial facilities, resulting in exposure to air pollution and heavy equipment traffic.

845.710(b)(1)(E)
Time until closure and post-closure care or the completion of groundwater monitoring pursuant to Section 845.740(b) is completed.

For Closure-by-Removal, the following groundwater monitoring program will be implemented:

- Groundwater monitoring for three (3) years after completion of closure or for three years after groundwater monitoring does not show exceedance established under 35 IAC 845.600.

For Closure-in-Place, the following groundwater monitoring program will be implemented:

- Continuation of groundwater monitoring plan as outlined in 35 IAC 845.650 as part of the 30-year-post-closure care period.

845.710(b)(1)(F)
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.

For Closure-by-Removal, CCR material will be removed, and the existing basin geomembrane liner will be decontaminated or replaced, therefore the source for CCR contamination has been removed. Regarding groundwater flow, infiltration of stormwater may affect flow paths if a geomembrane liner is no longer present. For the option where the ash basin is repurposed as a stormwater and wastewater containment basin, the geomembrane liner that would be installed would create an impervious layer, therefore groundwater flow would not be connected to the basin.

For Closure-in-Place, the CCR material will be covered with an impervious geomembrane liner and contained within the existing perimeter dikes. With the CCR material capped and contained, exposure after closure to the environment would only occur if the material were to be removed at a later date or in the unlikely event that a failure of the cap or perimeter dikes were to occur. With the addition of an impervious cap, groundwater flow may be affected due to infiltration from runoff. During current operations, rainwater is collected in the Ash Basin. With the placement of the cap, rainwater that was previously collected by the basin would now be diverted to nearby surfaces and infiltrate naturally or will be diverted into the stormwater collection system for the facility.

845.710(b)(1)(G)
Long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities.

For Closure-by-Removal, the in-place CCR material and basin base liner will be removed, decontaminated, or replaced, therefore no source of contamination will remain on site. Site groundwater will be monitored for three (3) years after completion of closure or until groundwater monitoring does not show exceedances as established under 35 IAC 845.600.

For Closure-in-Place, the following engineering and institutional controls will be implemented:

- Final cover will be designed to minimize infiltration and erosion as presented in 35 IAC 845.750(c)
- Final cover will be constructed in accordance with the procedures presented in 35 IAC 845.750.
- Final cover grades will consider potential settlement to maintain stable slopes.
- The geomembrane and soils used for the final cover system will be tested to verify conformance to the material properties presented in 35 IAC 845.750.
- During construction of the final cover, construction oversight will be performed by a third party for documentation and quality control purposes.
- After construction, the final cover will be inspected annually for erosion, grade reversals, and slope displacement. Any discrepancies will be brought to attention to the owner and the respective repairs will be completed as soon as possible.
- Groundwater monitoring will continue as part of the 30-year-post-closure care period.

For both closure types, no apparent destabilizing activities adjacent to the East and West Ash Basin footprints are made apparent. If destabilizing activities become apparent during the design, construction, and/or post closure phases, the destabilizing activity, and its effects on the closed CCR impoundment will be addressed accordingly to maintain stability and the regulatory requirements imposed at the time this CAA was performed.

845.710(b)(1)(H)
Potential need for future corrective action of the closure alternative.

For Closure-by-Removal, the CCR material and existing base liner will be removed, eliminating the source for CCR contamination. If the former ash basin is to be reused as a stormwater and wastewater containment basin, the existing geomembrane liner will be decontaminated or replaced. If the basin is repurposed for stormwater and wastewater containment, annual inspections of the geomembrane liner, water conveyance structures, and containment slopes will be performed. Possible future corrective post Closure-by-Removal actions include geomembrane liner replacement, maintenance of divider dike slopes, and maintenance of stormwater and wastewater structures.

For Closure-in-Place, the CCR material will remain in-place and a final cover will be constructed to prevent infiltration of rainwater into the CCR material. Additionally, the final cover will be sloped to promote drainage away from covered material and avoid ponding of water on the cap. After construction, groundwater monitoring will be performed as part of the 30-year-post-closure plan. Annual inspections of the final cover and perimeter dike slopes for erosion and ponding will be completed. Possible future corrective actions include maintenance of the final cap slopes. In the event that groundwater contamination is detected, remedial actions, such as construction of bentonite barrier trenches or removal of material, will be completed as needed.

After construction of the final cover system, potential use options for the covered CCR impoundment space include installation of solar panels, native vegetation, or public park. Future corrective actions for solar panels include maintenance and replacement of solar structures as needed and infilling of cap ponding areas due to induced CCR settlement by additional cover loading. For the native vegetation, future corrective actions would likely only pertain to erosion or ponding on the final cover. For the public park, maintenance and replacement of structures and aesthetics would be future corrective actions to consider.

Controlling Future Releases [845.710(b)(2)]

845.710(b)(2)(A)
Extent to which containment practices will reduce further releases.

For Closure-by-Removal, the CCR material will be removed, and the basin base liner will be removed, decontaminated, or replaced, therefore the potential for future CCR release is eliminated.

For Closure-in-Place, the CCR material will remain on-site, but will be capped with an impervious final cover system. To reduce further release, the following will be implemented as part of the Closure-in-Place options:

- Slope stability analyses will be performed or revisited to identify if the proposed final cover system and perimeter dike slopes meet minimum required factors of safety as presented in 35 IAC 845.460(a).
- Final grades of the cover system will be constructed to account for settlement and maintain slopes that meet required minimum factors of safety presented in 35 IAC 845.460(a).
- After placement of the final cover system, a topsoil layer will be added with vegetation to decrease erosional affects.
- Any erosion to the cap or perimeter dikes identified during the annual inspections will be addressed accordingly.

845.710(b)(2)(B)
Extent to which treatment technologies may be used.

For Closure-by-Removal, the CCR material will be removed, and the basin liner system will be removed, decontaminated, or replaced with a new geomembrane. Since the CCR material is being removed from the site, no treatment technologies are anticipated.

For Closure-in-Place, the final cover system will create an impervious barrier between the impounded CCR material and the atmosphere. Additionally, the impervious barrier will prevent infiltration into the in-place CCR material, alleviating the potential for contaminant transfer to the underlying groundwater system. Further, before installation of the final cover, the CCR material will be dewatered and prepared for capping in accordance with the procedures presented in 35 IAC 845.750(b). Since the CCR material will be free of liquids and covered with an impervious barrier, no additional treatment technologies are anticipated.

Implementation of Potential Closure Method [845.710(b)(3)]

845.710(b)(3)(A)
Degree of difficulty associated with constructing the technology.

For Closure-by-Removal, anticipated construction challenges include dewatering, transport of CCR material, and avoiding puncture of existing geomembrane if it is to be decontaminated and reused for stormwater and wastewater containment. For dewatering of CCR material, contaminated water will need to be pumped from the basin in a manner that avoids environmental release and protects health of workers. Challenges regarding transport of material will be dependent on available routes and distance to the nearest certified disposal facility. If the geomembrane liner is punctured, repairs by a certified installer will be completed. If the geomembrane liner is replaced, the new liner will be installed by a certified installer. Of the mentioned challenges associated with Closure-by-Removal, the degree of difficulty is moderate to moderately hard.

For Closure-in-Place, anticipated construction challenges include dewatering CCR material, final grading, geosynthetic liner installation, and placement of final cover soils. For dewatering of CCR material, contaminated water will need to be pumped from the basin in a manner that avoids environmental release and protects health of workers. For final grading, fill material will need to be placed over the in-place CCR material prior to final capping. MWG has an available stockpile of sand material at the station which will be used for capping the CCR material in place and achieving the final closure grades for the site. For the final cover installation, the geomembrane liner will need to be installed by a certified installer and will depend on site weather conditions during construction. Of the mentioned challenges associated with Closure-in-Place, the degree of difficulty is moderate.

845.710(b)(3)(B)
Expected operational reliability of the technologies.

For Closure-by-Removal, CCR material and base liner system will be removed from site. If the basin is reused as a stormwater and wastewater containment basin, the existing geomembrane liner will be decontaminated or replaced. Regarding reliability, geomembranes exposed to ultraviolet radiation from direct sunlight have anticipated minimum life expectance of 30 years. The longevity increases dramatically if ultraviolet radiation from direct sunlight is avoided by covering with layer of soil or other material. Additionally, conformance testing will be performed on geomembrane used for the basin liner to ensure required material specifications are met. Implementation of an annual inspection of the geomembrane liner and perimeter containment dike slopes will identify potential issues that can be addressed accordingly.

For Closure-in-Place, the CCR material will be dewatered and caped with an impervious final cover system. The impervious final cover system will be a composite system consisting of a geomembrane liner and final cover soil layer. Prior to installation, the geomembrane liner will be tested for conformance to required material specifications and the properties required by 35 IAC 845.750(c)(1)(B). During geomembrane liner installation, oversight for quality control will be performed to confirm installation is completed in accordance with applicable standards. Since the geomembrane liner will be covered with soil or alternative barrier system, longevity is anticipated to be a minimum of 400 years.

845.710(b)(3)(C)
Need to coordinate with and obtain necessary approvals and permits from other agencies.

The following approvals and permits are anticipated for each closure option:

---40 CFR---

- Written Closure Plan [257.102(b)]
- Amendments to written closure plan, as applicable [257.102(b)(3)].
- Owner or operator must prepare a notification of intent to close CCR unit [257.102(g)].
- Within 30 days of completion of closure of the CCR unit, owner or operator must prepare a notification of closure the CCR unit [257.102(h)].
- Following closure, owner or operator must update deed notifications [257.102(i)]

---35 IAC---

- Public notice and participation [845.260(a)]
- Agency issued construction permit needed prior to work [845.200(a)(4)]
- Operating permit must be maintained until the completion of the post-closure care when the CCR surface impoundment is closed with a final cover system [845.200(a)(5)(A)].
- Operating permit must be maintained until completion of groundwater monitoring under 35 IAC 845.740(b) when CCR surface impoundment is closed by removal [845.200(a)(5)(B)].

In addition to the above permits associated with the State and Federal CCR rules, a National Pollutant Discharge Elimination System (NPDES) Construction General Permit for stormwater management will also likely be required for the project. Modifications may also be necessary to the Site's NPDES Operating Permit.

845.710(b)(3)(D)
Availability of necessary equipment and specialists.

For Closure-by-Removal, the following contractors and equipment will be applicable:

- Earthwork contractor using excavators, dozers, and other applicable earth moving equipment.
- Equipment for dewatering CCR material prior to removal.
- Certified hauler for transporting CCRs and other materials to appropriate accepting facility. Material will be transported using dump trucks and/or tractor-trailers.
- If existing geomembrane liner remains in-place, decontamination contractor will be needed. If existing geomembrane liner is replaced, certified geomembrane liner installation contractor will be needed.
- Certified geosynthetic laboratory to perform material testing for conformance of the geomembrane liner.
- Construction oversight for documentation and quality control.

- Certifying engineer to ensure closure process was completed according to applicable specifications and regulations.

For Closure-in-Place, the following contractors and equipment will be applicable:

- Earthwork contractor using excavators, dozers, rollers, and other applicable earth moving equipment for grading of material.
- Equipment for dewatering CCR material prior to final grading and final cover system placement.
- Certified geomembrane liner installation contractor.
- Certified geosynthetic and soil laboratories for conformance testing.
- Construction oversight for documentation and quality control of grading material placement and compaction, installation of the geomembrane liner, and placement of final cover soils.
- Certifying engineer to ensure closure process was completed according to applicable specifications and regulations.

845.710(b)(3)(E)
Available capacity and location of needed treatment, storage, and disposal services.

For Closure-by-Removal, no other locations on site are available for consolidation or disposal. After dewatering of CCR material is completed, the materials will be transported to a certified commercial landfill facility. Handling and transport of the CCR and CCR contaminated materials will be performed following the procedures presented in 35 IAC 845.740(c).

For Closure-in-Place, the CCR material will remain at the facility, be dewatered, and capped with an impervious final cover system, therefore transport for beneficial reuse or disposal is not needed.

Local Community Impacts [845.710(b)(4)]

845.710(b)(4)
The degree to which the concerns of the residents living within communities where the CCR will be handled, transported, and disposed are addressed by the closure method.

For Closure-by-Removal, local communities will be affected by increased traffic and possible exposure to CCR particulates during transport of material. Mitigation efforts previously discussed include creating transport routes that avoid local community centers, and fugitive dust mitigation measures that include covering material during transport with a tarp.

For Closure-in-Place, transport of the CCR and CCR impacted materials is eliminated, therefore direct exposure to CCRs is limited to the local community near the Waukegan Station. During construction, there is potential of CCR material being released into the atmosphere and traveling to nearby residential areas by wind. To mitigate potential release, fugitive dust control measures, such as wetting, will be implemented during construction.

Additional Considerations – Transportation and Disposal [845.710(c)]

The following subsections address items the owner or operator of the CCR surface impoundment must consider in the CAA as presented in 35 IAC 845.710(c).

845.710(c)(1)
Analyze complete removal of the CCR as one closure alternative, along with the modes for transporting the removed CCR, including by rail, barge, low-polluting trucks, or a combination of these transportation modes.

For transport of CCR and CCR contaminated material, the preferred method is by truck. For Closure-by-Removal, the CCR and CCR contaminated material would be excavated and placed onto dump trucks and/or tractor-trailers for transport to the nearest commercial landfill facility. Based on conversations with state landfills, the closest facility that can accept the CCR material from the site is located in Joliet, IL which is approximately 80 miles from the site. Two landfills originally considered in the CCA were Zion Landfill (Zion, IL) and Countryside Landfill (Grayslake, IL). After discussions with the landfill owners, Zion Landfill will not accept CCR material and Countryside Landfill cannot accept the volumes anticipated for the closure. Alternative transport methods considered include heavy rail or barge. Transportation by rail or barge have not historically been used for managing CCR material at the MWG Waukegan Station and would require the design, permitting and construction of new infrastructure. The MWG Waukegan Station has rail spurs from the main railroad line, but the current system was designed to transfer coal in one direction, from railcar to generating station. To efficiently move CCR from the impoundment and load into a rail car, a conveyor system would need to be installed and permitted. Similar to rail, transport of CCR by barge would require new infrastructure to be installed and the addition of extensive environmental permitting, such as NPDES, stormwater, air construction permits, and permits from the Illinois Department of Natural Resources (IDNR) and United States Army Corp. of Engineers (USACE), would be needed. Due to additional construction and permitting, rail and barge transport of the material are not viable options at the site. Instead, based on the site's proximity to a CCR and CCR contaminated materials accepting facility, transport by truck is the preferred method.

845.710(c)(2)
Identify 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.

The MWG Waukegan Station currently does not have an on-site landfill that can legally accept CCR materials. Also, limited space and timing inhibits possible construction of a CCR landfill meeting legal requirements.

845.710(c)(3)
Include any other closure method in the alternatives analysis if requested by the Agency.

No additional alternative analysis requests by the Agency were provided at the time this letter report was written.

Additional Considerations – Cost Estimate, Groundwater, and Surface Waters [845.710(d)]

The following subsections address items the owner or operator of the CCR surface impoundment must consider in the CAA as presented in 35 IAC 845.710(d).

845.710(d)(1)
Meet or exceed a class 4 estimate under the AACE Classification Standard, incorporated by reference in Section 845.150, or a comparable classification practice as provided in the AACE Classification Standard.

For the CAA, an Association for the Advancement of Cost Engineering (AACE) Class 4 estimate for each closure option was completed. Per AACE, a Class 4 estimate is typically used for a feasibility study with level of project definition at 1 to 15 percent. Costs for each closure option using Class 4 level estimate criteria and the considerations outlined in this letter report are presented in Table 1. A breakdown of the costs for each option are included as Attachment B. Please note that the estimated costs for Closure-in-Place Options 2, 4, and 5 consider a final cover constructed with soils over the geomembrane and Option 6 considers a final cover consisting of a geomembrane liner with engineered turf. Rates presented in the cost estimate are based on historical information, experience from similar type projects, and engineering judgement.

Table 1. Summary of Current Estimates (AACE Class 4)

Option	Closure Option	Estimated Total Closure Cost (2021 US Dollars)	Estimated Total Post-Closure Cost[(1)] (2021 US Dollars)	Estimated Total Cost (2021 US Dollars)
1	West Ash Basin – Closure-by-Removal	$15,983,824	$206,250	$16,190,074
2	West Ash Basin – Closure-in-Place, final cover with soils	$13,229,065	$3,196,875	$16,425,940
3	East Ash Basin – Closure-by-Removal	$16,002,765	$206,250	$16,209,015
4	East Ash Basin – Closure-in-Place (Option 1), (final cover with soils)	$13,120,943	$3,196,875	$16,317,818
5	East Ash Basin – Closure-in-Place (Option 2), final cover with soils	$16,459,417	$3,196,875	$19,656,292
6	East Ash Basin – Closure-in-Place (Option 3), final cover with engineered turf	$16,300,238	$3,196,875	$19,497,133

Note:
1. Post-closure cost for “Closure by Removal” assumes 3-year post-closure-plan and “Closure in Place” assumes 30-year-post-closure plan.

845.710(d)(2)
Contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards.

A groundwater model depicting potential flow based on surface changes for each closure option was completed. The groundwater model was developed by KPRG and Associates, Inc. (KPRG) and BAS Groundwater Consulting (BAS). A groundwater modeling report is provided under separate cover. For reference, the cover page of the groundwater modeling report is included as Attachment C.

845.710(d)(3)
Include a description of the fate and transport of contaminants with the closure alternative over time, including consideration of seasonal variations.

The groundwater modeling report by KPRG and BAS discusses contaminant transport based on the groundwater models developed for the site. The groundwater modeling report is provided under separate cover. For reference, the cover page of the groundwater modeling report is included as Attachment C.

845.710(d)(4)
Assess impacts to waters in State

Based on available aerial images of the site, the East and West Ash Basins are situated adjacent to a possible wetland. Additionally, the Lake Michigan shoreline is located approximately 690 to 850 feet east and downslope of the East and West Ash Basin footprint.

For Closure-by-Removal, CCR material will be removed, and the base liner removed, decontaminated, or replaced, therefore no source for CCR contamination would be present.

For Closure-in-Place, the CCR material will be capped with an impervious final cover system, therefore runoff from storm events would not encounter CCR material. CCR material would be dewatered, and the cap would prevent infiltration from rain events, therefore connection between the CCR material and the underlying groundwater system would be limited. Additionally, with a groundwater monitoring plan being implemented as part of the 30-year-post-closure plan, CCR contaminants would be detected, and the appropriate remediation measure could be implemented.

Discussion

Two public meetings for the Waukegan Generating Station's East and West Ash Basins were held on December 15 and 16, 2021. During the public meetings, MWG presented the preferred option of Closure-in-Place for the East Ash Basin and Closure-by-Removal for the West Ash Basin. Closure-in-Place for the East Ash Basin would include a final cover system utilizing engineered turf (ClosureTurf®). A document recording the issues and questions raised during the public meetings was provided upon request and posted for public view by MWG. The following paragraphs provide summaries of the issues and questions discussed during the public meetings.

During the public meetings, questions were raised regarding the current condition of the East and West Ash Basin base liners. Based on current federal and state CCR regulations, the East and West Ash Basin base liners do not meet federal or state CCR regulations of having a minimum 2-feet of compacted clay below the geomembrane. The purpose of the 2-foot clay layer is to serve as a redundant unit in case the overlying geomembrane leaks. Based on current groundwater monitoring of the site, no indication of a leaking geomembrane liner is apparent. Additionally, with the placement of an Illinois EPA approved geomembrane final cover system, infiltration of rainwater into the CCR material will be minimized and runoff will be diverted away from the closed ash basin.

In regard to groundwater, many questions were raised concerning the groundwater monitoring well network and groundwater flow model. An existing groundwater monitoring well network for the East and West Ash Basins consisting of three (3) upgradient (i.e., background) wells and five (5) downgradient wells has been in use since 2015. MWG has been using the existing network to specifically monitor for releases of coal ash constituents under the federal CCR rules. Based on consistency of the data from the downgradient monitoring wells that indicate little spatial variability in the results, the existing network is sufficient to monitor groundwater interacting with the East and West Ash Basins. As part of the approval process, MWG submitted the groundwater monitoring network to the Illinois EPA as part of its Illinois CCR Rule operating permit application on November 1, 2021. In addition to the existing groundwater monitoring well network, a groundwater model was created to estimate transport of potential constituents.

The results from the groundwater model show that for the closure options considered, all are equally protective of groundwater. Results from the groundwater modeling are provided in the report as Attachment C. A full groundwater modeling report will be submitted with the construction permit application submitted to the Illinois EPA (February 1, 2022). The permit application will also be posted to MWG's website within 14 days of the permit submittal.

In addition to groundwater, questions regarding drinking water quality were also asked during the public meetings. MWG's analysis of groundwater on the eastern edge of the property indicates that there is little risk to Lake Michigan by the CCR surface impoundments, since concentrations of constituents are below Lake Michigan surface water standards. Both Illinois EPA and the City of Waukegan have concluded that the Lake Michigan water is suitable for drinking water. The Illinois EPA stated in its 2021 Integrated Water Quality Report that Lake Michigan "fully supports" the drinking water use. The City of Waukegan also reported in 2021 that its drinking water, which draws from Lake Michigan, complies with all standards. The City further states that there is "low susceptibility to shoreline contaminants due to mixing and dilution" because the water supply intake is 6,200 feet into the lake.

For the Closure-in-Place with ClosureTurf® alternative, questions regarding reliability, support for natural vegetation, impacts to local wildlife, and predictive leakage rate of material were raised. ClosureTurf® is an engineered cap system designed by Watershed Geo that consists of a structured geomembrane below synthetic turf with sand infill. The ClosureTurf® system is used as an alternative to topsoil and natural vegetation. The artificial turf component has been tested at hurricane-level wind speeds and at storm rainfall intensities of over 6 inches per hour, providing more robust protection when compared to topsoil and native vegetation. Historically, ClosureTurf® has been installed at more than 80 locations within the United States. Based on ongoing research, the structured geomembrane and artificial turf components of the proposed ClosureTurf® cap are anticipated to last over 400 and 100 years, respectively. Additionally, the materials used for ClosureTurf® are free of per- and polyfluoroalkyl substances (PFAS). In regard to wildlife, the sand infill placed on the artificial turf is approximately ½ to ¾ inch thick, therefore risk of burrowing animals being trapped or killed is minimal. A monitoring program will also be implemented to ensure integrity of the ClosureTurf® system and that it is not compromised by local wildlife activities. Any discrepancies or damage to the cover system noted during annual monitoring will be addressed accordingly.

The estimated liquid flow rate through the structured geomembrane component of the ClosureTurf® system for the East Ash Basin is 6.3×10^{-10} $m^3/sec/m^2$. For inquiries regarding the liquid flow rate calculation, please refer to Section 3.2 of the Preliminary Written Closure Plan for the East Ash Basin on MWG's Illinois CCR Rule compliance website. It is important to note that the estimated liquid flow rate is based on the following assumptions: 1) a 2-mm-diameter hole is present for every acre of liner placed, and 2) 4.37 inches of rainwater is present on the liner. The first assumption is based on research completed by others that indicated geomembrane liners with construction quality assurance programs implemented during installation are not expected to have more than one unaddressed defect per acre. The second assumption is based on a 25-year, 24-hour precipitation event for Lake County, Illinois and is considered conservative since the final cover system will be designed to provide positive drainage to prevent accumulation of ponding water on the structured geomembrane.

During the public meeting, questions were asked regarding shoreline erosion and how the East Ash Basin's final cover system may be impacted by loss of land between it and Lake Michigan. The concern for loss of shoreline was related to a study that estimated Illinois Beach State Park has lost 27 to 62 feet of shoreline between 2010 and 2012. The study was referenced in a *Chicago Tribune* article on May 30, 2017 titled "Lake Michigan Shoreline Erosion Could be Getting Worse, Research Shows." Within the article, it is stated that the northern portion of Illinois Beach State Park has retreated more than 600 feet between 1939 and 2014. Alternatively, it is also stated that the breakwater at Waukegan Harbor has extended into the lake, growing at a rate of 11 feet each year. The Waukegan Generating Station is located approximately 1.5 miles north of Waukegan Harbor and 4.5 miles south of the Illinois Beach State Park Northern Unit. Accordingly, the conditions at the Waukegan Generating Station are similar to those at Waukegan Harbor, as evidence by the regular dredging of sand that accumulates in the Station's Intake Channel.

A September 2020 study conducted by the Illinois Department of Natural Resources (IDNR) Coastal Management Program (CMP) and the Illinois State Geological Survey (ISGS) through the Prairie Research Institute indicated that the shoreline along the Illinois Beach State Park's North Unit has retreated by as much as 820 feet between 1939 and 2017. In the same study, it was concluded that the shoreline along Illinois Beach State Park's South Unit had advanced lakeward by as much as 1,100 feet during the same time period. Additionally, a USACE Chicago District's environmental assessment published in September 2019 for the ongoing Waukegan Harbor Dredging project indicated that shoreline gain along the southern part of Illinois Beach State Park is occurring at a rate "at or near what likely occurred in the natural setting." Based on the 2017 *Chicago Tribune* article, the 2019 USACE environmental assessment for the Waukegan Harbor Dredging project, and the 2020 IDNR CMP and ISGS study, it is anticipated that the shoreline located near the East Ash Basin is more likely to advance lakeward than to lose land via erosion. As part of MWG's anticipated regular inspections of the East Ash Basin final cover system during its post-closure care program, MWG will monitor the Lake Michigan shoreline east of the East Ash Basin to determine if any shoreline losses are occurring, and if so, whether the loses would have a negative impact on the East Ash Basin final cover system. If negative impacts are anticipated, the appropriate remediation measures will be taken.

Questions regarding financial assurance and closure costs were asked during the public meetings. Owners of CCR surface impoundments are required to provide financial assurance to ensure completion of closure and post-closure activities, as applicable. MWG has provided such financial assurance in the form of performance bonds to the Illinois EPA. Costs regarding which closure option would be priority were not considered a determinative factor by MWG in the CAA.

Questions were raised during the public meetings regarding the proposed closure methods for the two impoundments. Questions were posed as to if closure by removal would be more protective of the environment than the proposed preferred methods of closure by removal and repurposing of the West Ash Basin and Closure in Place of the East Ash Basin. The analyses which have been performed indicate that closure in place of the East Ash Basin is equally protective to groundwater as closure by removal. Capping the East Ash Basin and removing the free water from within the ash basin will minimize infiltration of water into the CCR and will minimize infiltration into the underlying ground which could impact groundwater. Planned inspection and maintenance of the closed basin will address concerns related to the potential for erosion and loss of shoreline adjacent to it. Studies also indicate that long term loss of shoreline adjacent to the impoundments is unlikely. The proposed preferred closure methods are protective of the environment, meet the requirements of the state and federal regulations and limit offsite hauling of CCR from the East Ash Basin.

Closing

We appreciate this opportunity to be of services to you. If there are any questions regarding the information contained in this letter report, or if we may be of further assistance, please feel free to contact us.

Yours sincerely,

AECOM Technologies Inc.

Matthew Bloecher
Geotechnical Engineer
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Jeremy Thomas, P.E. (IL)
Associate
jeremy.thomas@aecom.com

Attachments

A – Closure Alternatives Analysis Drawings (not for construction)
B – CCR Impoundment Estimates for Waukegan Station
C – Numerical Groundwater Flow Model Report Cover (for reference)
D – Alternatives Ranking Matrix

JEREMY MICHAEL THOMAS
062-061572
LICENSED PROFESSIONAL ENGINEER OF ILLINOIS

1-29-2022
EXP. 11-30-2023

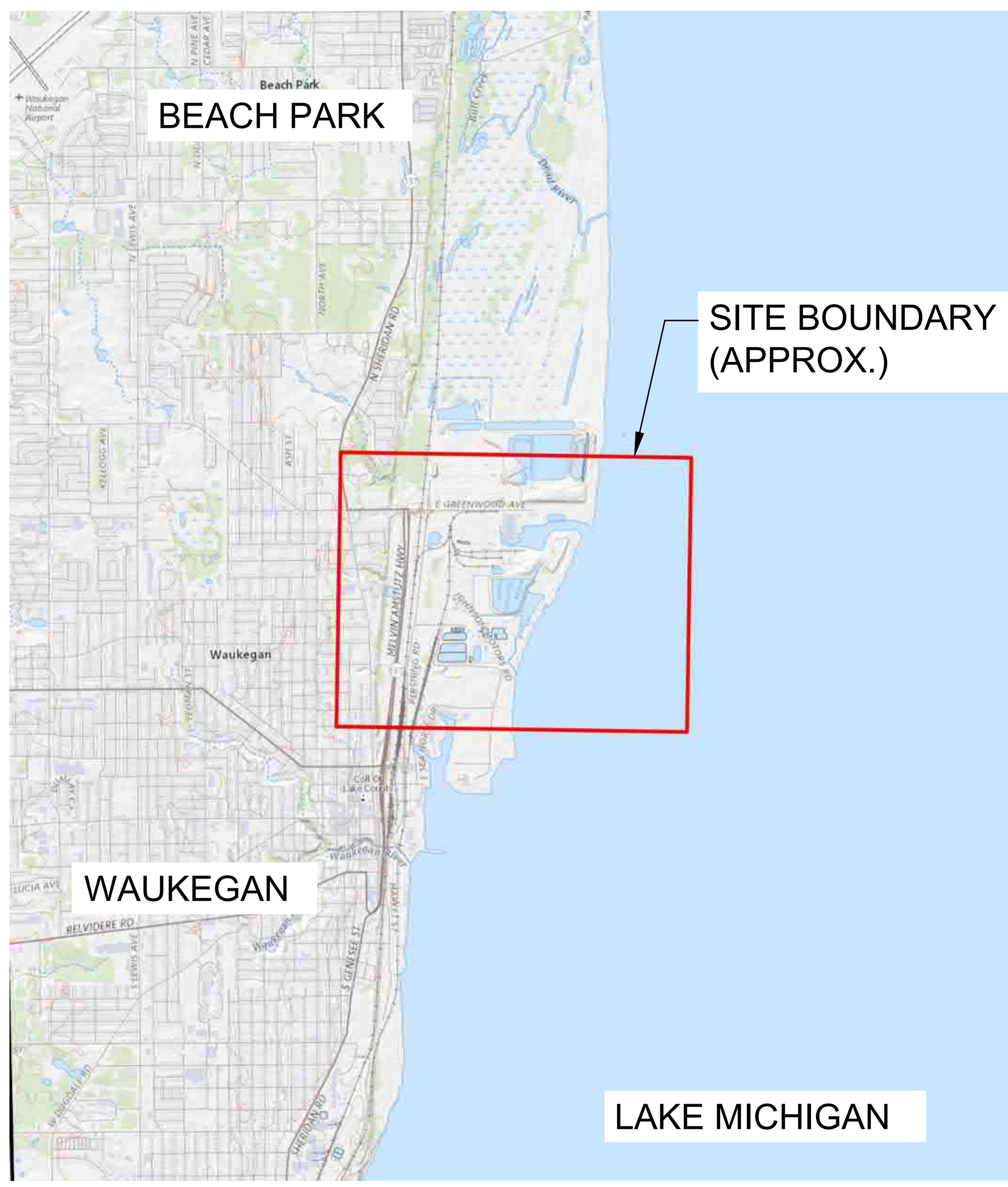
AECOM

ATTACHMENT A

MIDWEST GENERATION, LLC
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS DRAWINGS
WAUKEGAN, ILLINOIS

ISSUED FOR REVIEW

NOVEMBER 15, 2021



SITE LOCATION MAP

0 50,000 100,000 200,000
GRAPHIC SCALE (IN FEET)

N

DRAWING LIST	
DRAWING NO.	DRAWING TITLE
01	TITLE SHEET
02	ESTIMATED BOTTOM OF ASH GRADES
03	EXISTING CONDITIONS PLAN
04	WEST ASH BASIN - CLOSURE BY REMOVAL
05	WEST ASH BASIN - CLOSURE IN PLACE
06	EAST ASH BASIN - CLOSURE BY REMOVAL
07	EAST ASH BASIN - CLOSURE IN PLACE (OPTION 1)
08	EAST ASH BASIN - CLOSURE IN PLACE (OPTION 2)
09	CROSS SECTIONS - WEST ASH BASIN - CLOSURE BY REMOVAL
10	CROSS SECTIONS - WEST ASH BASIN - CLOSURE IN PLACE
11	CROSS SECTIONS - EAST ASH BASIN - CLOSURE BY REMOVAL
12	CROSS SECTIONS - EAST ASH BASIN - CLOSURE IN PLACE (OPTION 1)
13	CROSS SECTIONS - EAST ASH BASIN - CLOSURE IN PLACE (OPTION 2)
14	DETAILS

FOR EAST ASH BASIN - CLOSURE IN PLACE (OPTION #3) REFER TO SARGENT AND LUNDY DRAWINGS WKG-AP-CSK-008 AND WKG-AP-CSK-009

SITE OVERVIEW MAP

0 200 400 600
GRAPHIC SCALE (IN FEET)

N

NOT FOR CONSTRUCTION

PREPARED FOR:
MIDWEST GENERATION, LLC

PREPARED BY:
AECOM

REV	DATE	JOB NO.	PROJECT TYPE	DES	DFTR	CHKD	ENG		DESCRIPTION

AECOM

TITLE SHEET

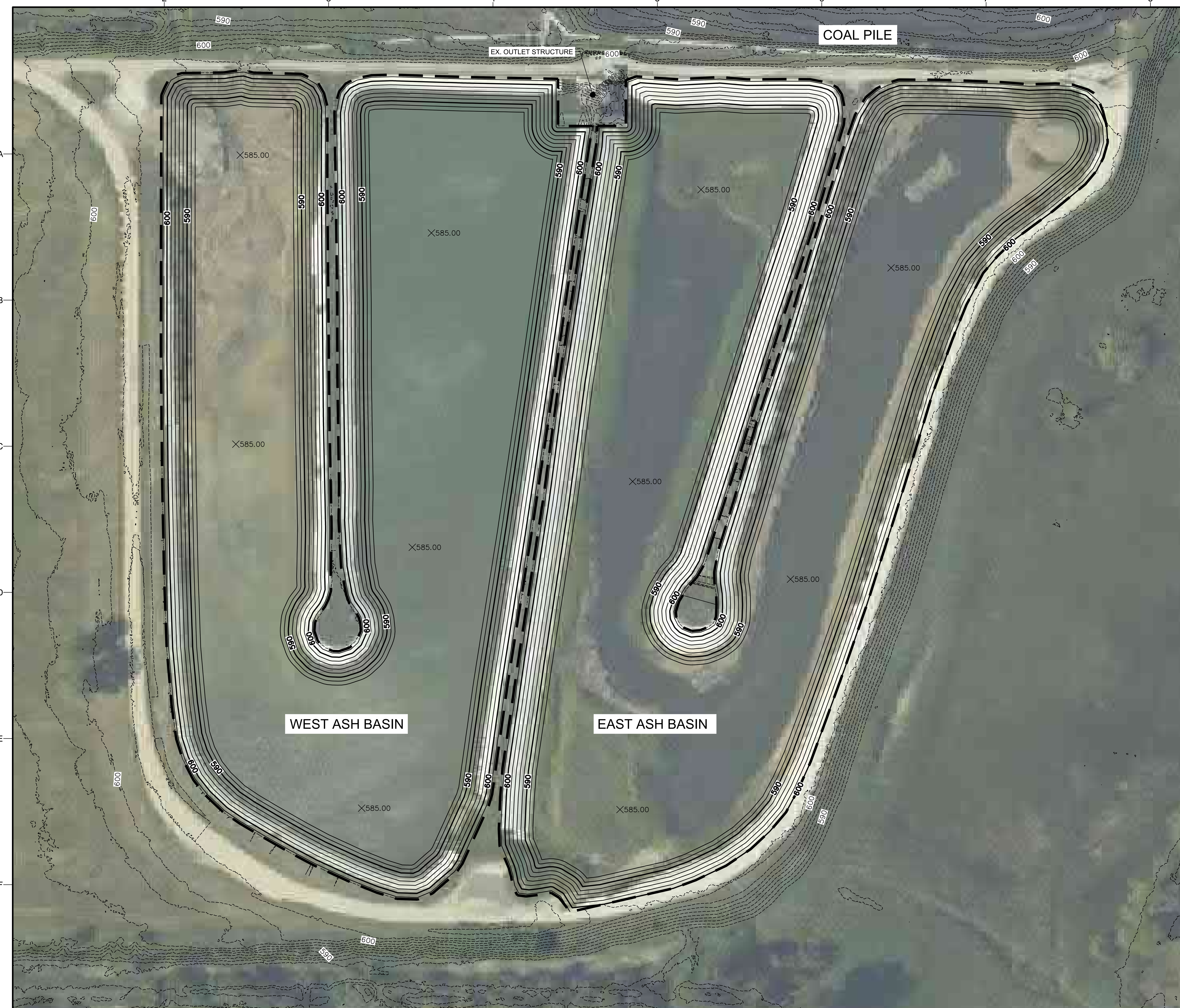
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

SEAL

SCALE:	AS SHOWN	DES:	MR
DWG TYPE:	.DWG	DFTR:	PK
JOB NO:	60669161	CHKD:	RB
DATE:	11/02/2021	ENGR:	JT
FILENAME:	COVER SHEET.DWG	APPD:	JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	01	A



LEGEND

- 600 — EXISTING MAJOR TOPOGRAPHIC CONTOUR
- EXISTING MINOR TOPOGRAPHIC CONTOUR
- ASH BASIN WASTE BOUNDARY (APPROX.)
- 600 — ESTIMATED BOTTOM OF ASH MAJOR TOPOGRAPHIC CONTOUR
- ESTIMATED BOTTOM OF ASH MINOR TOPOGRAPHIC CONTOUR

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. ESTIMATED BOTTOM OF ASH GRADES ARE BASED ON INFORMATION FOUND IN THE HISTORY OF CONSTRUCTION REPORT, PREPARED BY GEOSYNTEC CONSULTANTS AND DATED OCTOBER 2016.
2. SEE SHEET 03 FOR ADDITIONAL DRAWING REFERENCES.

N

0 60 120 180
GRAPHIC SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

ESTIMATED BOTTOM OF ASH GRADES

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN	DES: MR
DWG TYPE: .DWG	DFTR: PK
JOB NO: 60669161	CHKD: RB
DATE: 11/15/2021	ENGR: JT
FILENAME: ESTIMATED BOTTOM OF ASH GRADES.DWG	APPD: JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	02	A

02 REV. A

LEGEND

600 EXISTING MAJOR TOPOGRAPHIC CONTOUR
EXISTING MINOR TOPOGRAPHIC CONTOUR
ASH BASIN WASTE BOUNDARY (APPROX.)

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. AERIAL IMAGE WAS OBTAINED FROM MICROSOFT BING (2021).
2. ASH BASIN WASTE BOUNDARY IS BASED ON AERIAL IMAGERY AND IS APPROXIMATE.
3. EXISTING TOPOGRAPHY IS BASED ON 2017 LIDAR DATA OBTAINED FROM THE STATE OF ILLINOIS GEOSPATIAL DATA CLEARINGHOUSE.

N

0 60 120 180
GRAPHIC SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

EXISTING CONDITIONS PLAN

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN		DES:	MR
DWG TYPE: .DWG		DFTR:	PK
JOB NO: 60669161		CHKD:	RB
DATE: 11/15/2021		ENGR:	JT
FILENAME: EXISTING CONDITIONS PLAN.DWG		APPD:	JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	03	A

LEGEND

- 600 — EXISTING MAJOR TOPOGRAPHIC CONTOUR
- EXISTING MINOR TOPOGRAPHIC CONTOUR
- ASH BASIN WASTE BOUNDARY (APPROX.)
- 600 — PROPOSED MAJOR TOPOGRAPHIC CONTOUR
- PROPOSED MINOR TOPOGRAPHIC CONTOUR
- DRAINAGE ARROWS

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.
2. PROPOSED GRADING REPRESENTS CLOSURE BY REMOVAL GRADES (I.E., ESTIMATED BOTTOM OF ASH GRADES) IN THE WEST ASH BASIN.
3. CUT SLOPES SHOWN ARE 2.5H:1V.
4. SEE SHEET 10 FOR CROSS SECTIONS.
5. QUANTITIES WERE ESTIMATED BY COMPARING EXISTING GRADES TO PROPOSED GRADES UTILIZING AUTOCAD CIVIL 3D (VERSION 2018).

REFERENCES

1. SEE SHEET 03 FOR DRAWING REFERENCES.

ESTIMATED QUANTITIES	
CCR MATERIAL TO BE REMOVED	93,000 CY

N

0 60 120 180
GRAPHIC SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

WEST ASH BASIN - CLOSURE BY REMOVAL
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN		DES:	MR
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JOB NO: 60669161		CHKD:	RB
DATE: 11/15/2021		ENGR:	JT
FILENAME: WEST BASIN CBR.DWG		APPD:	JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	04	A

04 REV. A

LEGEND

600 (dashed)	EXISTING MAJOR TOPOGRAPHIC CONTOUR
(dashed)	EXISTING MINOR TOPOGRAPHIC CONTOUR
(heavy dashed)	ASH BASIN WASTE BOUNDARY (APPROX.)
600 (solid)	PROPOSED MAJOR TOPOGRAPHIC CONTOUR
(solid)	PROPOSED MINOR TOPOGRAPHIC CONTOUR
(arrows)	DRAINAGE ARROWS

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.
2. PROPOSED GRADING REPRESENTS TOP OF CLOSURE IN PLACE GRADES FOR THE WEST ASH BASIN.
3. CUT AND FILL SLOPES ARE 6H:1V UNLESS OTHERWISE NOTED.
4. SEE SHEET 11 FOR CROSS SECTIONS.
5. QUANTITIES WERE ESTIMATED BY COMPARING EXISTING GRADES TO PROPOSED GRADES UTILIZING AUTOCAD CIVIL 3D (VERSION 2018) AND ASSUMING A 3-FOOT THICK FINAL COVER SYSTEM.

REFERENCES

1. SEE SHEET 03 FOR DRAWING REFERENCES.

ESTIMATED QUANTITIES	
ASH TO BE REGRADED	5,000 CY
ADDITIONAL FILL NEEDED TO ACHIEVE SUBGRADE GRADES	68,000 CY
FILL NEEDED FOR FINAL COVER SYSTEM	50,000 CY
FINAL COVER SYSTEM GEOSYNTHETICS	50,000 SY

N

0 60 120 180
GRAPHIC SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

WEST ASH BASIN - CLOSURE IN PLACE

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR
ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN	DES: MR	
DWG TYPE: .DWG	DFTR: PK	
JOB NO: 60669161	CHKD: RB	
DATE: 11/15/2021	ENGR: JT	
FILENAME: WEST BASIN CIP.DWG	APPD: JT	
DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	05	A

04 REV. A

LEGEND

- 600 — EXISTING MAJOR TOPOGRAPHIC CONTOUR
- EXISTING MINOR TOPOGRAPHIC CONTOUR
- ASH BASIN WASTE BOUNDARY (APPROX.)
- 600 — PROPOSED MAJOR TOPOGRAPHIC CONTOUR
- PROPOSED MINOR TOPOGRAPHIC CONTOUR
- DRAINAGE ARROWS

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.
2. PROPOSED GRADING REPRESENTS CLOSURE BY REMOVAL GRADES (I.E., ESTIMATED BOTTOM OF ASH GRADES) IN THE EAST ASH BASIN.
3. CUT SLOPES SHOWN ARE 2.5H:1V.
4. SEE SHEET 12 FOR CROSS SECTIONS.
5. QUANTITIES WERE ESTIMATED BY COMPARING EXISTING GRADES TO PROPOSED GRADES UTILIZING AUTOCAD CIVIL 3D (VERSION 2018).

REFERENCES

1. SEE SHEET 03 FOR DRAWING REFERENCES.

ESTIMATED QUANTITIES	
CCR MATERIAL TO BE REMOVED	70,000 CY

N

0 60 120 180
GRAPHIC SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

EAST ASH BASIN - CLOSURE BY REMOVAL

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN		DES:	MR
DWG TYPE: .DWG		DFTR:	PK
JOB NO: 60669161		CHKD:	RB
DATE: 11/15/2021		ENGR:	JT
FILENAME: EAST BASIN CBR.DWG		APPD:	JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	06	A

06 REV. A

LEGEND

- 600 (dashed) — EXISTING MAJOR TOPOGRAPHIC CONTOUR
- EXISTING MINOR TOPOGRAPHIC CONTOUR
- ASH BASIN WASTE BOUNDARY (APPROX.)
- 600 — PROPOSED MAJOR TOPOGRAPHIC CONTOUR
- PROPOSED MINOR TOPOGRAPHIC CONTOUR
- DRAINAGE ARROWS

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.
2. PROPOSED GRADING REPRESENTS TOP OF CLOSURE IN PLACE GRADES FOR THE EAST ASH BASIN.
3. CUT AND FILL SLOPES ARE 6H:1V UNLESS OTHERWISE NOTED.
4. SEE SHEET 13 FOR CROSS SECTIONS.
5. QUANTITIES WERE ESTIMATED BY COMPARING EXISTING GRADES TO PROPOSED GRADES UTILIZING AUTOCAD CIVIL 3D (VERSION 2018) AND ASSUMING A 3-FOOT THICK FINAL COVER SYSTEM.

REFERENCES

1. SEE SHEET 03 FOR DRAWING REFERENCES.

ESTIMATED QUANTITIES	
FILL NEEDED TO ACHIEVE SUBGRADE GRADES	108,000 CY
FILL NEEDED FOR FINAL COVER SYSTEM	51,000 CY
FINAL COVER SYSTEM GEOSYNTHETICS	51,000 SY

N

0 60 120 180
GRAPHIC SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

EAST ASH BASIN - CLOSURE IN PLACE (OPTION 1)

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR
ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN	DES: MR		
DWG TYPE: .DWG	DFTR: PK		
JOB NO: 60669161	CHKD: RB		
DATE: 11/15/2021	ENGR: JT		
FILENAME: EAST BASIN CIP MINIMUM.DWG	APPD: JT		
DWG SIZE	DRAWING NO.	REVISION	
ANSI D 22.0"x34.0"	07	A	

0 INCHES 1 2 3 TENTHS 10 20 30

07 REV. A

LEGEND

- EXISTING MAJOR TOPOGRAPHIC CONTOUR (600)
- EXISTING MINOR TOPOGRAPHIC CONTOUR
- ASH BASIN WASTE BOUNDARY (APPROX.)
- PROPOSED MAJOR TOPOGRAPHIC CONTOUR (600)
- PROPOSED MINOR TOPOGRAPHIC CONTOUR
- DRAINAGE ARROWS

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.
2. PROPOSED GRADING REPRESENTS TOP OF CLOSURE IN PLACE GRADES FOR THE EAST ASH BASIN.
3. CUT AND FILL SLOPES ARE 6H:1V UNLESS OTHERWISE NOTED.
4. SEE SHEET 14 FOR CROSS SECTIONS.
5. QUANTITIES WERE ESTIMATED BY COMPARING EXISTING GRADES TO PROPOSED GRADES UTILIZING AUTOCAD CIVIL 3D (VERSION 2018) AND ASSUMING A 3-FOOT THICK FINAL COVER SYSTEM.

REFERENCES

1. SEE SHEET 03 FOR DRAWING REFERENCES.

ESTIMATED QUANTITIES	
FILL NEEDED TO ACHIEVE SUBGRADE GRADES	368,000 CY
FILL NEEDED FOR FINAL COVER SYSTEM	53,000 CY
FINAL COVER SYSTEM GEOSYNTHETICS	53,000 SY

N

GRAPHIC SCALE 0 60 120 180 (IN FEET)

NOT FOR CONSTRUCTION

AECOM

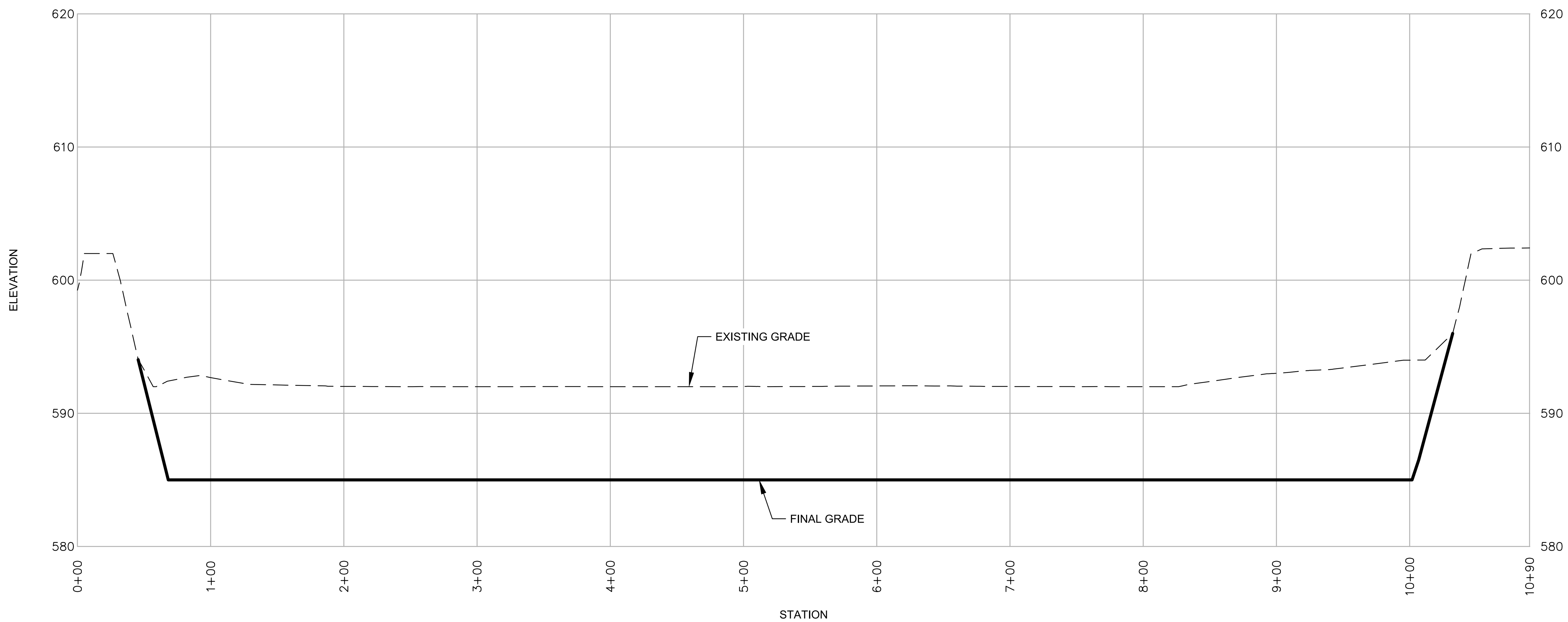
EAST ASH BASIN - CLOSURE IN PLACE (OPTION 2)

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

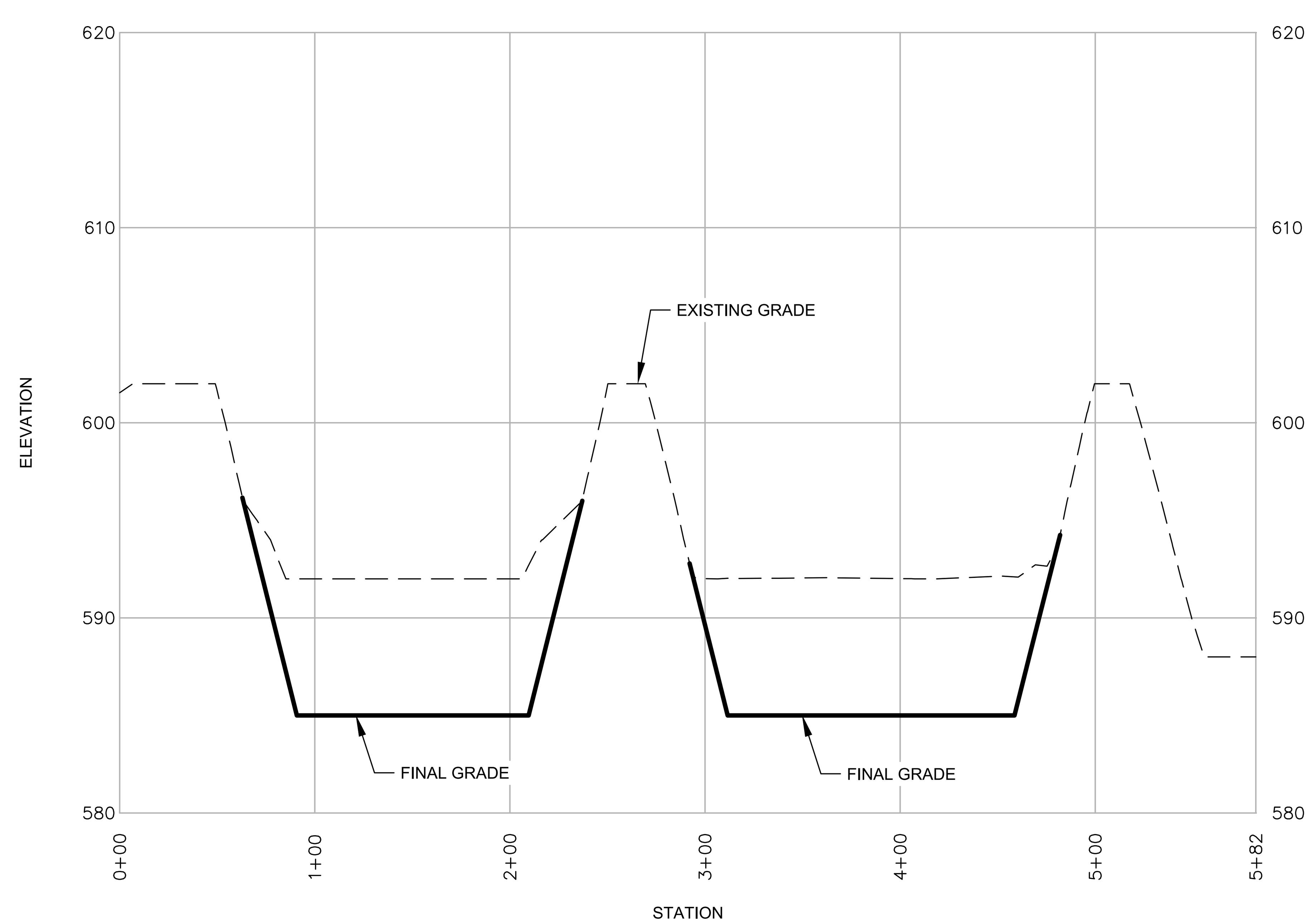
FOR: ISSUED FOR REVIEW

SEAL

SCALE: AS SHOWN	DES: MR	
DWG TYPE: .DWG	DFTR: PK	
JOB NO: 60669161	CHKD: RB	
DATE: 11/15/2021	ENGR: JT	
FILENAME: EAST BASIN CIP MAXIMUM.DWG	APPD: JT	
DWG SIZE: ANSI D 22.0"x34.0"	DRAWING NO.: 08	REVISION: A



West Ash Basin A-A



West Ash Basin B-B

LEGEND

- EXISTING GRADE
- FINAL GRADE
- ESTIMATED BOTTOM OF ASH GRADE

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. SEE SHEETS 02 AND 03 FOR DRAWING REFERENCES.

VERTICAL SCALE 0 6 12 18 (IN FEET)

HORIZONTAL SCALE 0 60 120 180 (IN FEET)

NOT FOR CONSTRUCTION

AECOM

CROSS SECTIONS - WEST ASH BASIN - CLOSURE BY REMOVAL

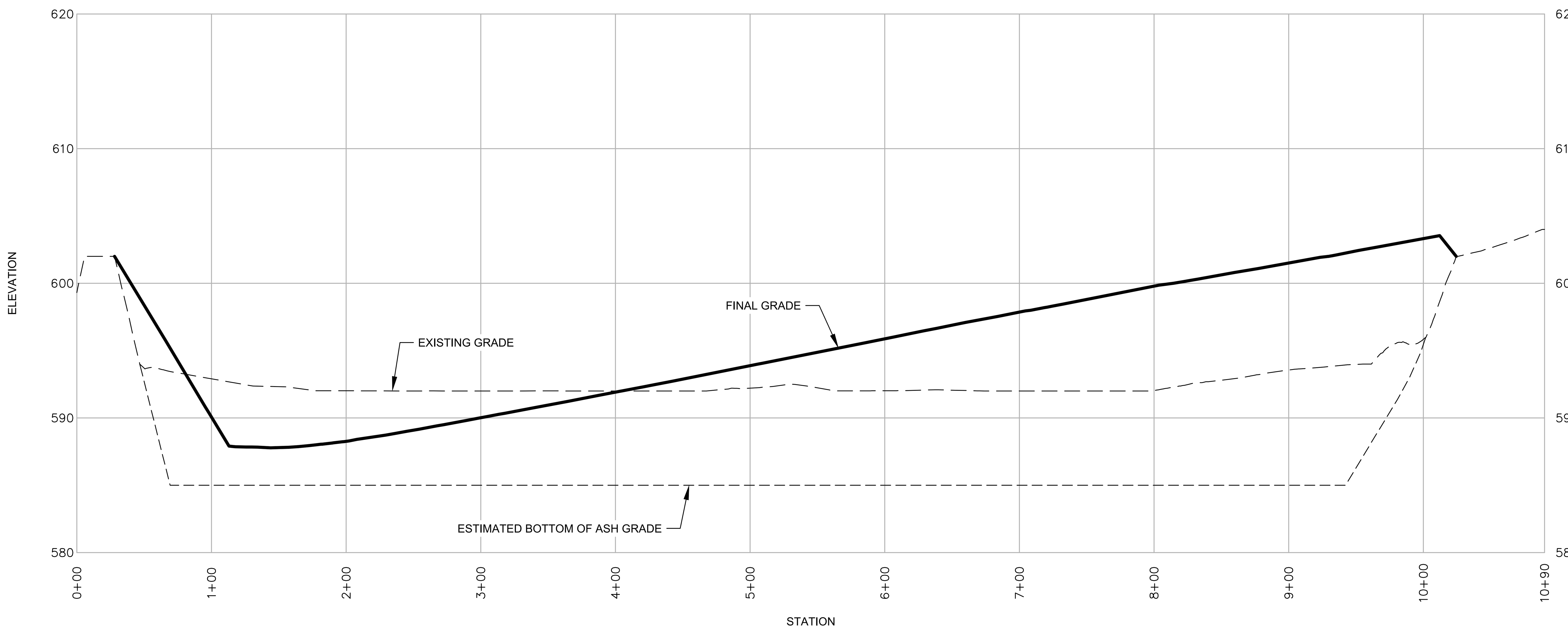
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR ISSUED FOR REVIEW

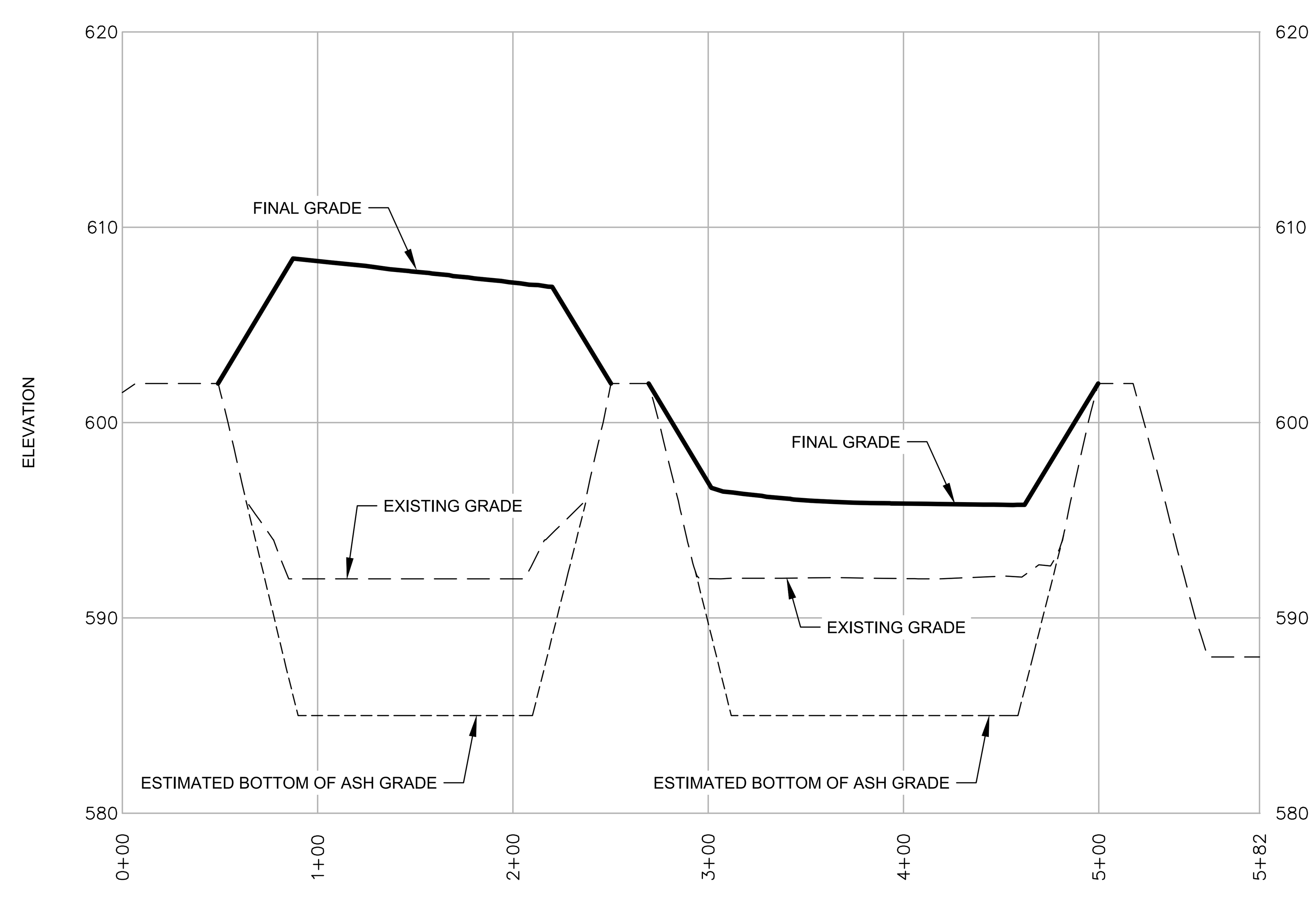
SEAL

SCALE: AS SHOWN	DES: MR
DWG TYPE: .DWG	DFTR: PK
JOB NO: 60669161	CHKD: RB
DATE: 11/15/2021	ENGR: JT
FILENAME: CROSS SECTIONS.DWG	APPD: JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	09	A



West Ash Basin C-C



West Ash Basin D-D

LEGEND

EXISTING GRADE

FINAL GRADE

ESTIMATED BOTTOM OF ASH GRADE

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. SEE SHEETS 02 AND 03 FOR DRAWING REFERENCES.

0 6 12 18
VERTICAL SCALE (IN FEET)

0 60 120 180
HORIZONTAL SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

CROSS SECTIONS - WEST ASH BASIN - CLOSURE IN PLACE

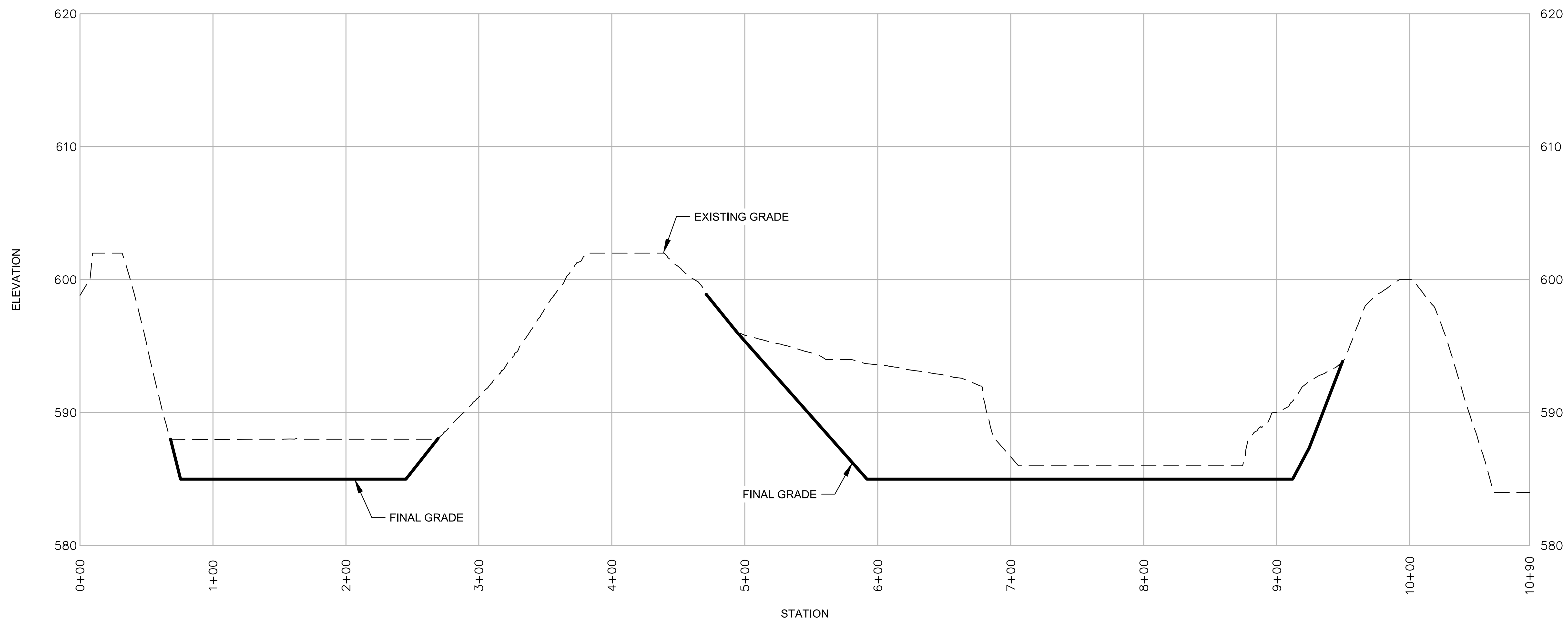
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

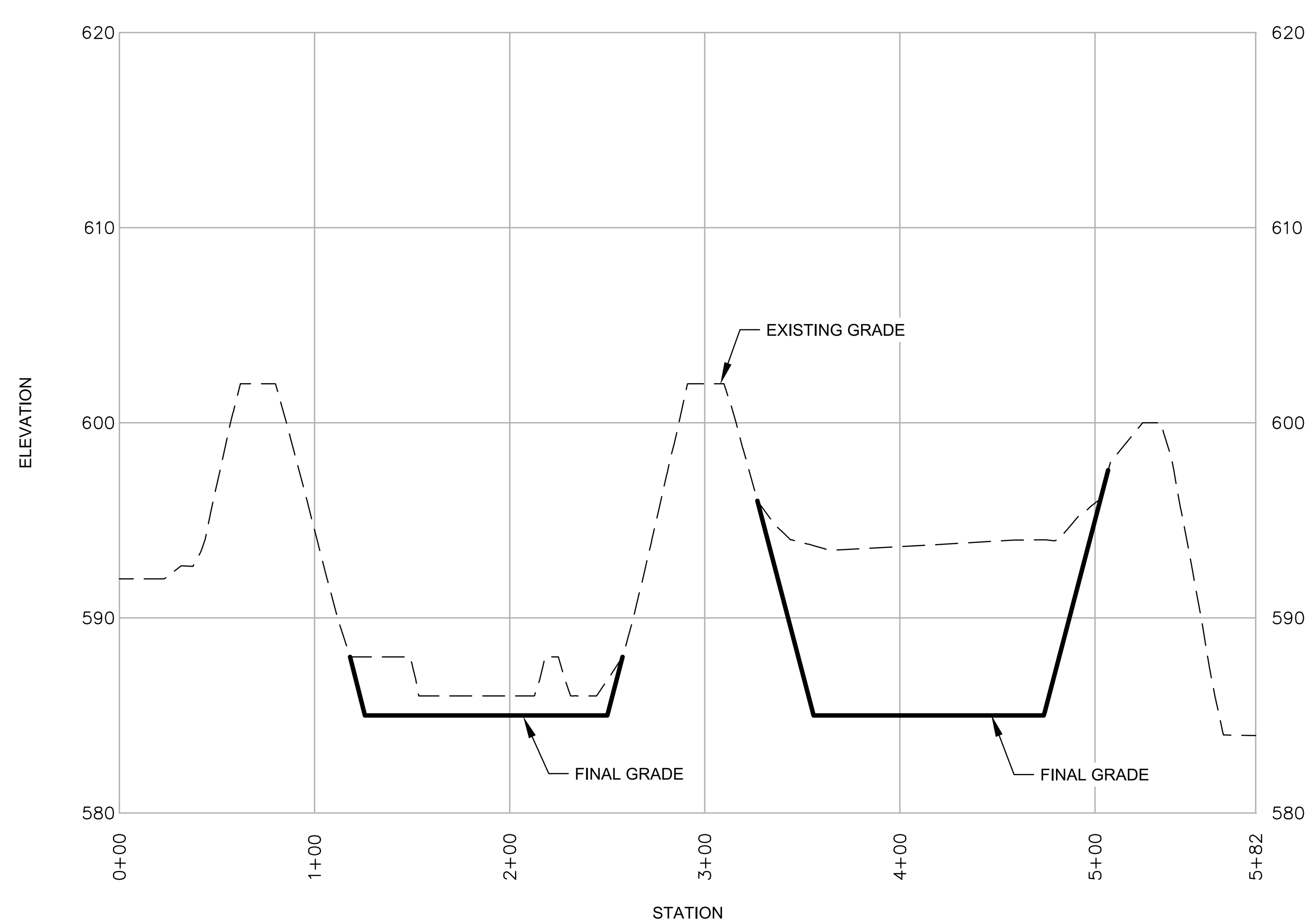
SEAL

SCALE: AS SHOWN	DES: MR
DWG TYPE: .DWG	DFTR: PK
JOB NO: 60669161	CHKD: RB
DATE: 11/15/2021	ENGR: JT
FILENAME: CROSS SECTIONS.DWG	APPD: JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	10	A



East Ash Basin E-E



East Ash Basin F-F

LEGEND

- EXISTING GRADE
- FINAL GRADE
- ESTIMATED BOTTOM OF ASH GRADE

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. SEE SHEETS 02 AND 03 FOR DRAWING REFERENCES.

0 6 12 18
VERTICAL SCALE (IN FEET)

0 60 120 180
HORIZONTAL SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

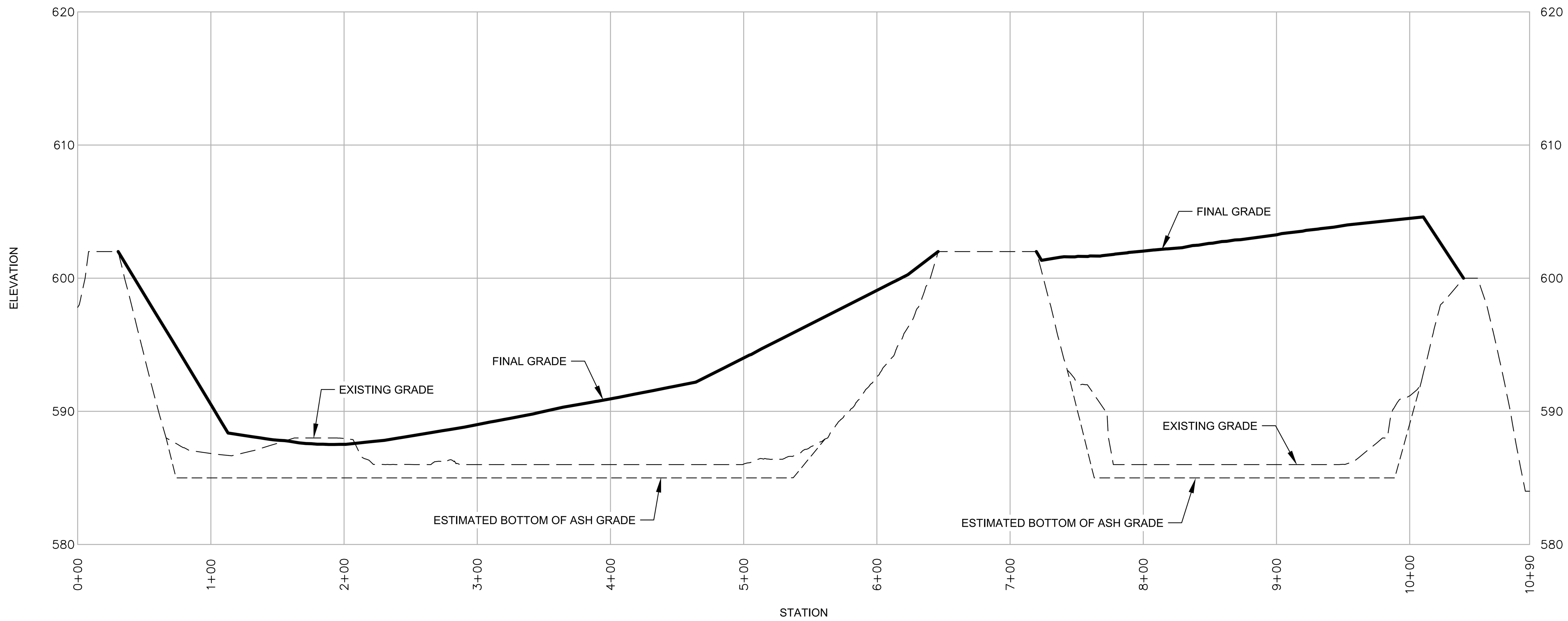
CROSS SECTIONS - EAST ASH BASIN - CLOSURE BY REMOVAL
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR **ISSUED FOR REVIEW**

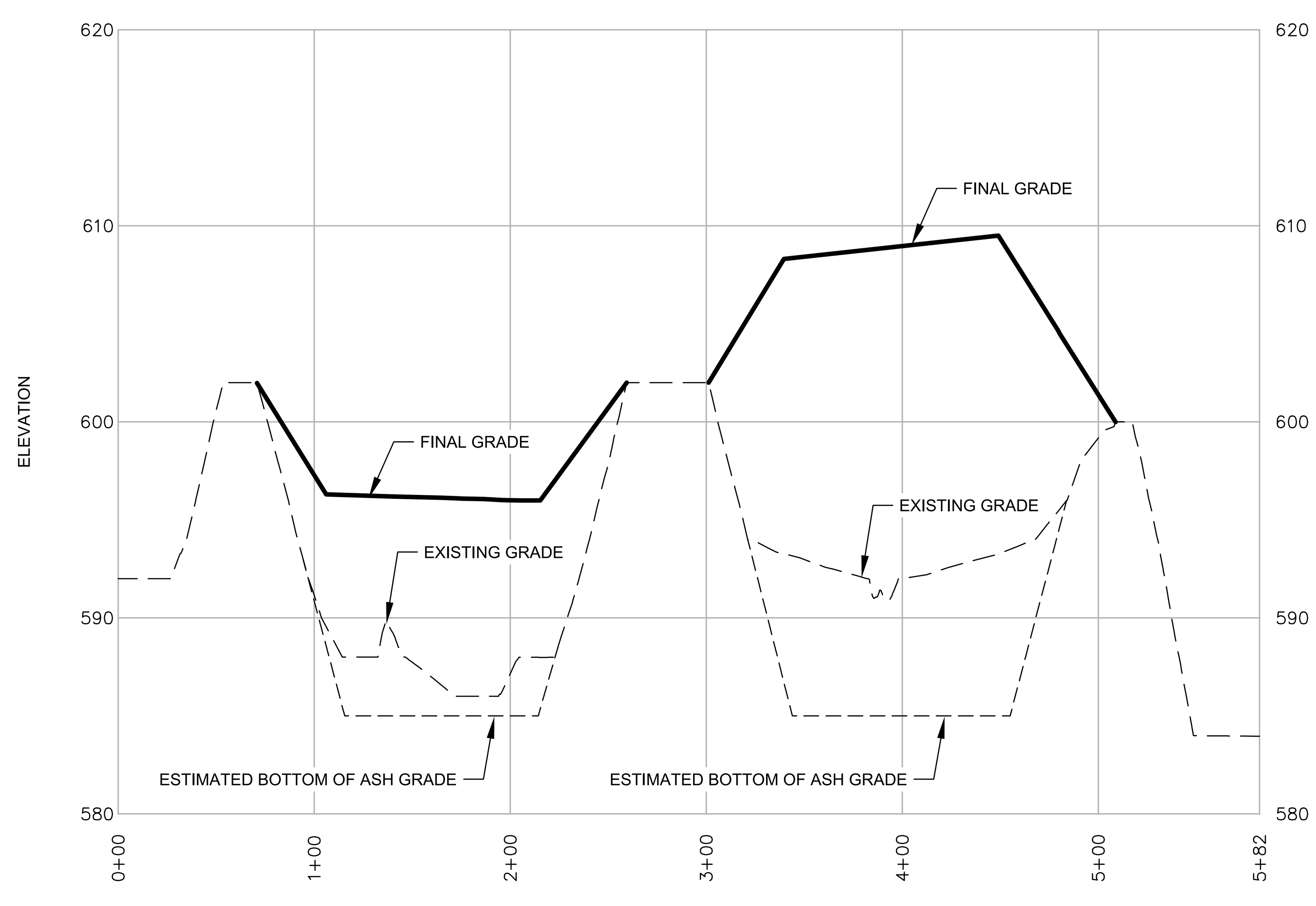
SEAL

SCALE: AS SHOWN	DES: MR
DWG TYPE: .DWG	DFTR: PK
JOB NO: 60669161	CHKD: RB
DATE: 11/15/2021	ENGR: JT
FILENAME: CROSS SECTIONS.DWG	APPD: JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	11	A



East Ash Basin G-G



East Ash Basin H-H

LEGEND

- EXISTING GRADE
- FINAL GRADE
- ESTIMATED BOTTOM OF ASH GRADE

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. SEE SHEETS 02 AND 03 FOR DRAWING REFERENCES.

0 6 12 18
VERTICAL SCALE (IN FEET)

0 60 120 180
HORIZONTAL SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

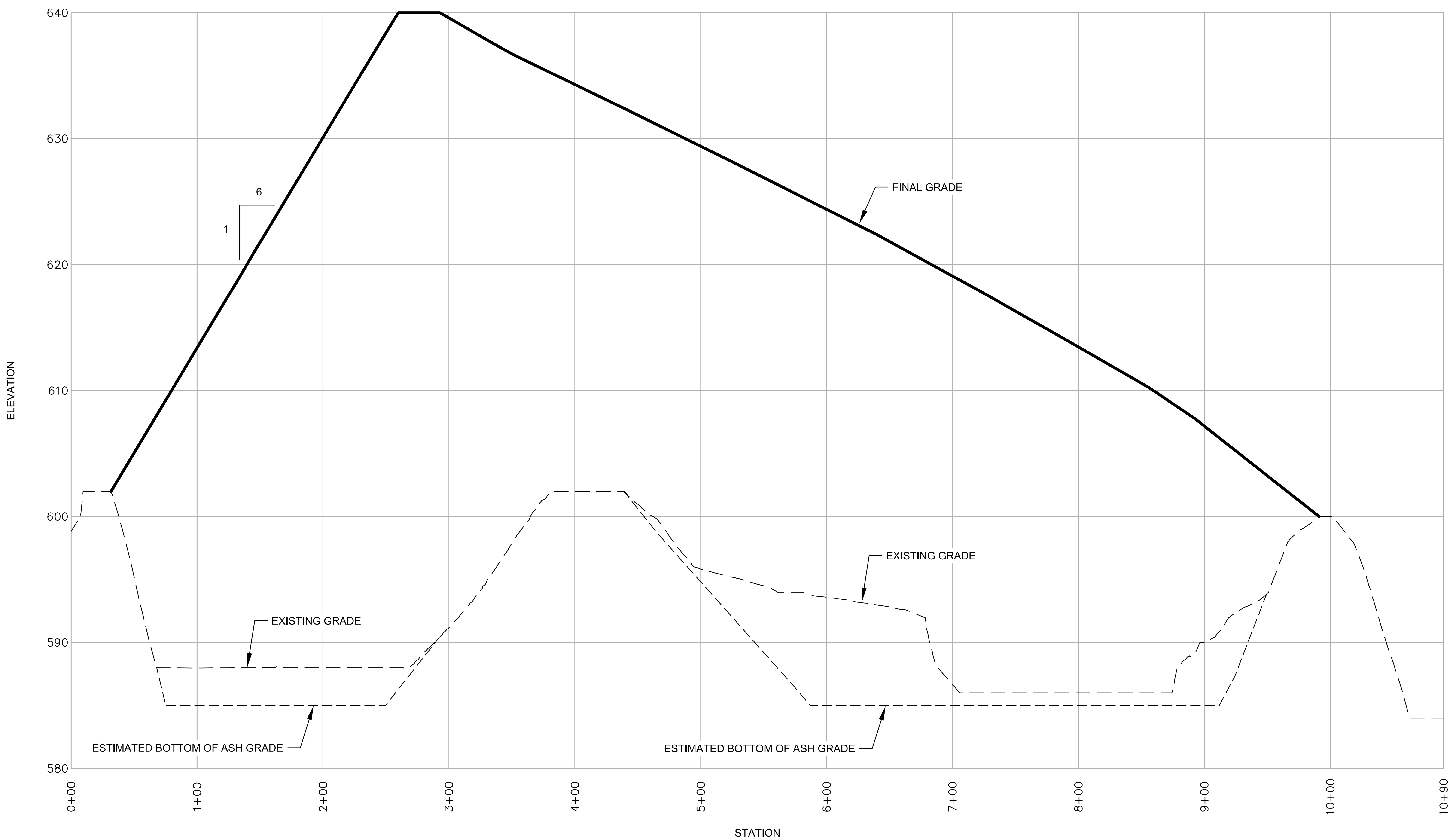
CROSS SECTIONS - EAST ASH BASIN - CLOSURE IN PLACE (OPTION 1)
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR
ISSUED FOR REVIEW

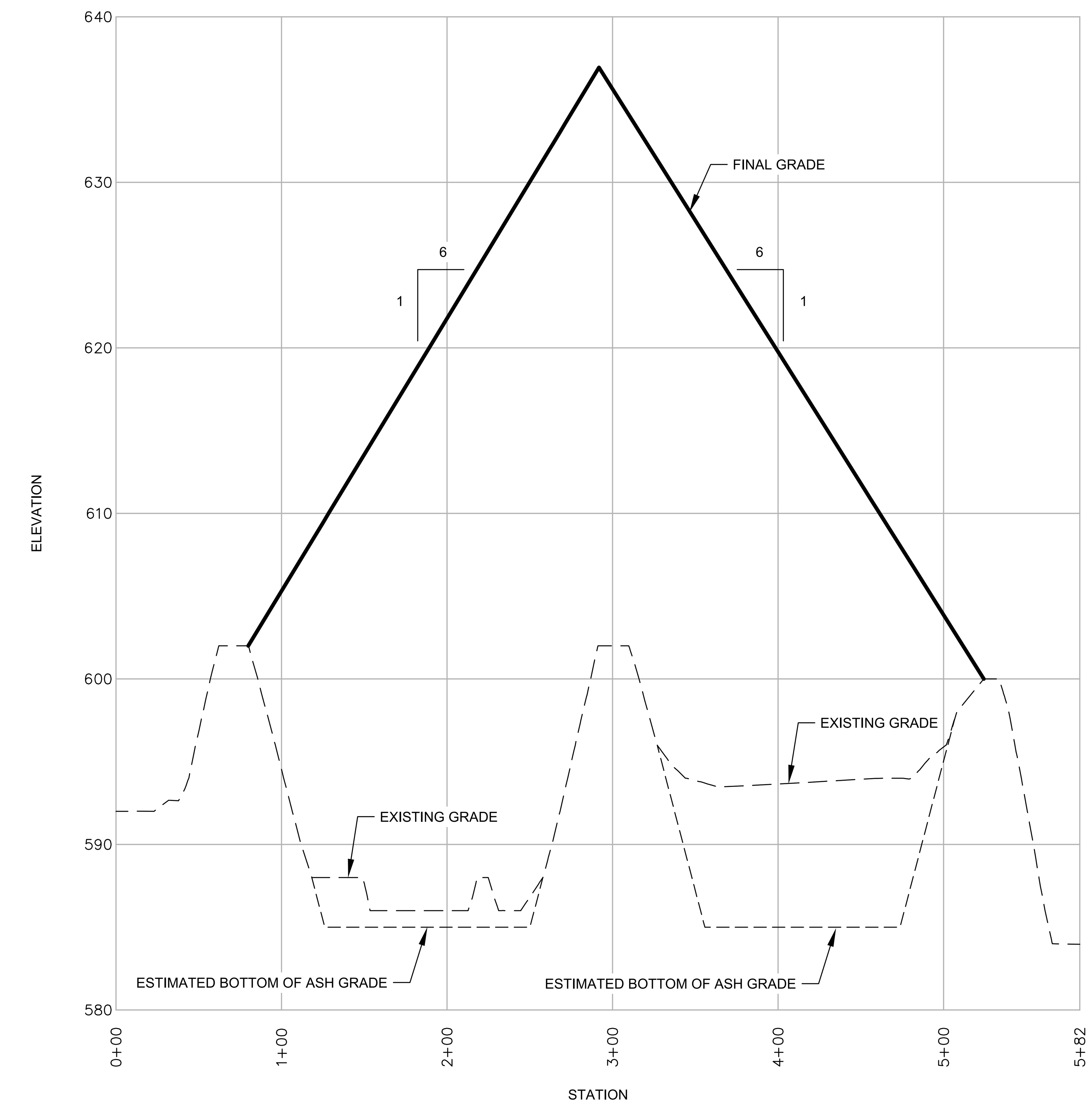
SEAL

SCALE: AS SHOWN	DES: MR
DWG TYPE: .DWG	DFTR: PK
JOB NO: 60669161	CHKD: RB
DATE: 11/15/2021	ENGR: JT
FILENAME: CROSS SECTIONS.DWG	APPD: JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	12	A



East Ash Basin I-I



East Ash Basin J-J

LEGEND

- EXISTING GRADE
- FINAL GRADE
- ESTIMATED BOTTOM OF ASH GRADE

NOTES

1. BASIS OF BEARINGS: NAD83 ILLINOIS STATE PLANES, EAST ZONE. ELEVATIONS ARE BASED ON NAVD88.

REFERENCES

1. SEE SHEETS 02 AND 03 FOR DRAWING REFERENCES.

0 6 12 18
VERTICAL SCALE (IN FEET)

0 60 120 180
HORIZONTAL SCALE (IN FEET)

NOT FOR CONSTRUCTION

AECOM

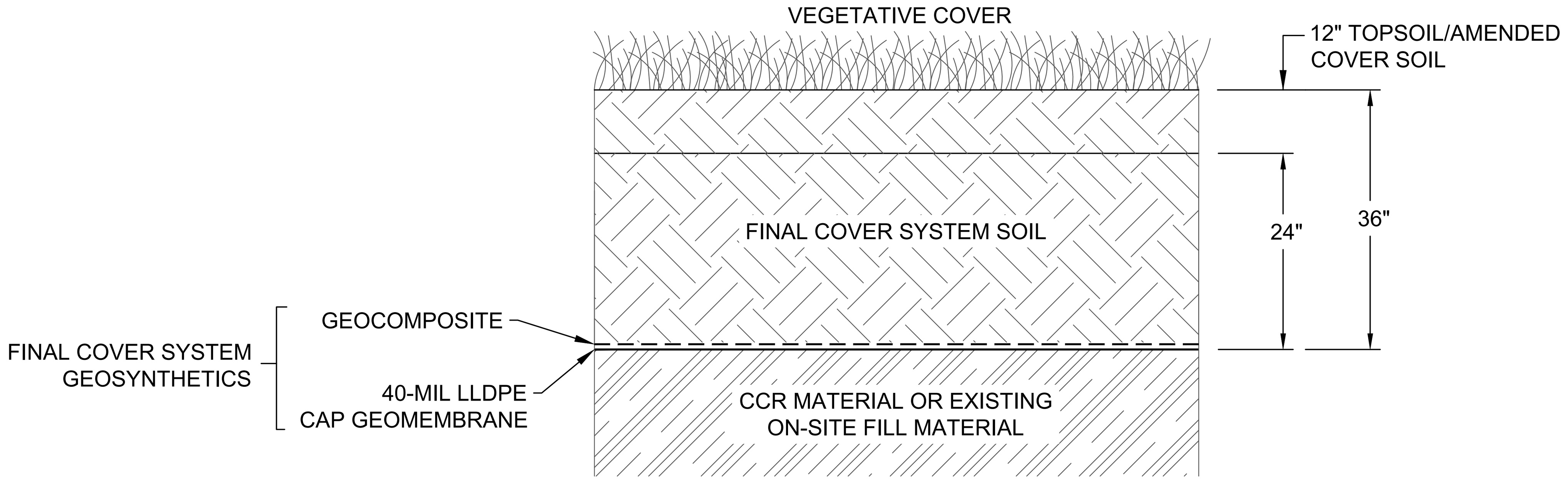
CROSS SECTIONS - EAST ASH BASIN - CLOSURE IN PLACE (OPTION 2)
WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR **ISSUED FOR REVIEW**

SEAL

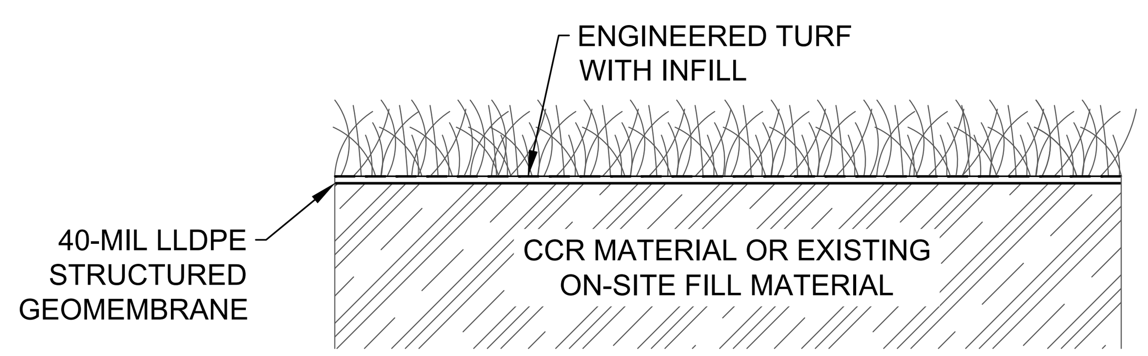
SCALE: AS SHOWN	DES: MR
DWG TYPE: .DWG	DFTR: PK
JOB NO: 60669161	CHKD: RB
DATE: 11/15/2021	ENGR: JT
FILENAME: CROSS SECTIONS.DWG	APPD: JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	13	A



1/16 TYPICAL FINAL COVER SYSTEM

NOT TO SCALE



2/16 TYPICAL FINAL COVER SYSTEM - ENGINEERED TURF

NOT TO SCALE

NOT FOR CONSTRUCTION

AECOM

DETAILS

WAUKEGAN GENERATING STATION
CLOSURE ALTERNATIVES ANALYSIS
WAUKEGAN, ILLINOIS

FOR: ISSUED FOR REVIEW

SEAL

SCALE:	AS SHOWN	DES:	MR
DWG TYPE:	.DWG	DFTR:	PK
JOB NO:	60669161	CHKD:	RB
DATE:	11/15/2021	ENGR:	JT
FILENAME:	DETAILS.DWG	APPD:	JT

DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	14	A

FOR PERMIT
NOT FOR CONSTRUCTION

NORTH

40' 0' 40' 80'
GRAPHIC SCALE

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE FURNISHED AND INSTALLED BY SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. EXISTING CONDITIONS FOR THE EAST ASH POND ARE BASED ON TOPOGRAPHIC DATA COLLECTED IN 2014. PRIOR TO BEGINNING ANY POND CLOSURE WORK, THE CONTRACTOR SHALL MAKE A TOPOGRAPHIC ASSESSMENT TO VERIFY THE ACCURACY OF THE EXISTING CONDITIONS SHOWN PER NOTE 10 ON DRAWING WKG-AP-CSK-002.
4. IN 2016, THE DOWNSTREAM SLOPE OF THE EAST ASH POND'S EAST DIKE WAS LOWERED TO AN APPROXIMATE CREST ELEVATION OF 600 FEET AND REGRADED TO A FLATTER GRADE THAN SHOWN. SEE GEOSYNTEC DRAWINGS SW0251-11-01 - 07 FOR THE 2016 SLOPE MODIFICATION DESIGN PLANS, SECTIONS, AND DETAILS.

REFERENCE DRAWINGS

5082-C-5006	ASH POND DETAIL PLAN
5082-C-5007	ASH POND SECTIONS AND DETAILS
5082-C-5001	WASTE WATER TREATMENT FACILITIES ASH POND SUMP PLAN, SECTIONS AND DETAILS
5082-C-5502	ASH POND SUMP WEIR PLAN, SECTIONS & DETAILS
5082-C-5503	ASH POND SUMP AND WEIR MISCELLANEOUS SECTIONS AND DETAILS
5082-C-5507	ASH POND INLET FLUME & DISTRIBUTION TROUGH DETAILS
B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
SW0251-11-01 - 07	EAST ASH BASIN SLOPE MODIFICATION

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

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

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

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

HOLD INFORMATION

NO.	DESCRIPTION

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

RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	11-11-2021	FOR CLIENT COMMENT

ISSUE PURPOSE: CLIENT COMMENT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

CAD FILE NAME: WKG-AP-CSK-006.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: --

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY, IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY.

Sargent & Lundy LLC

SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

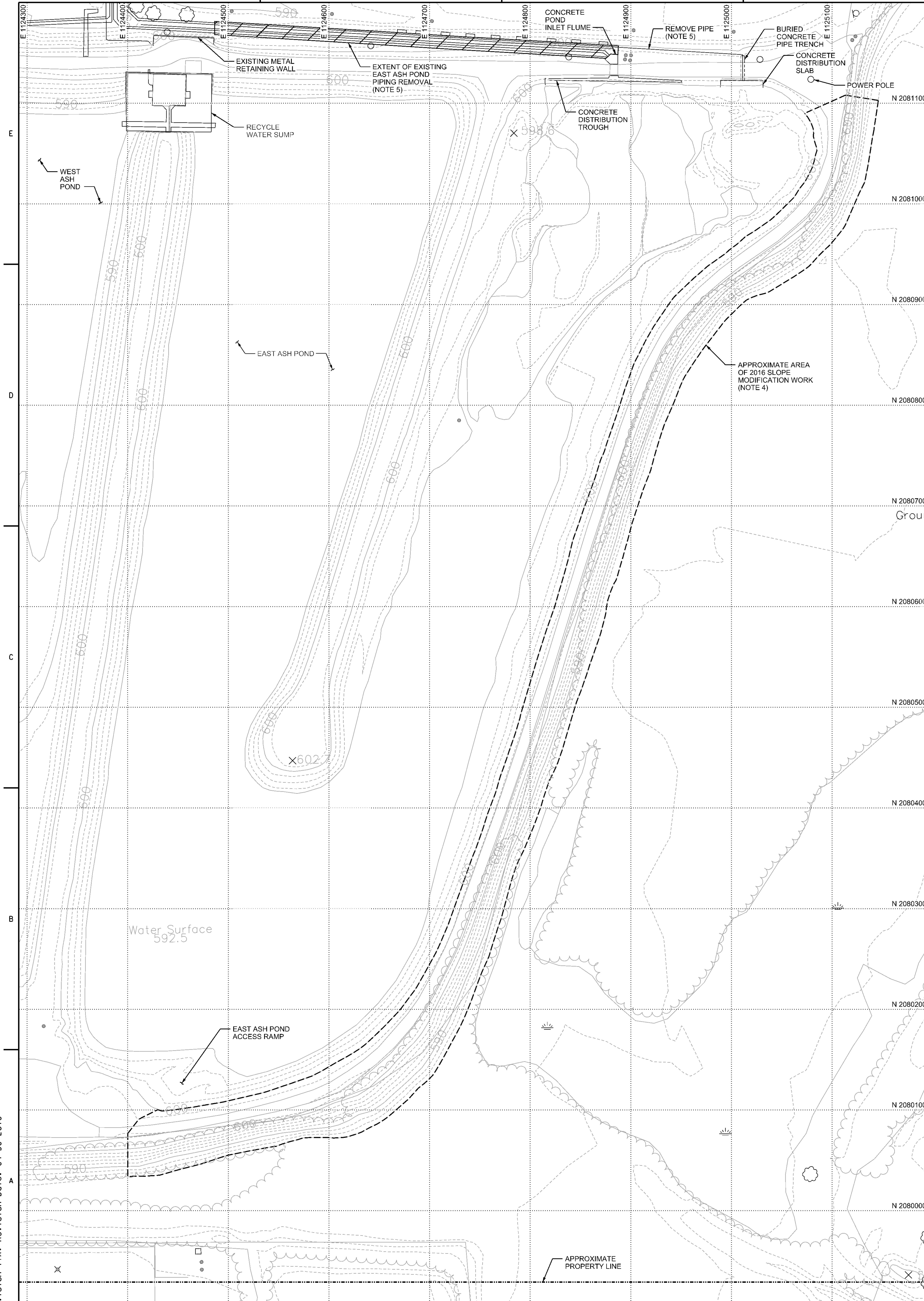
MWG
Midwest Generation LLC.

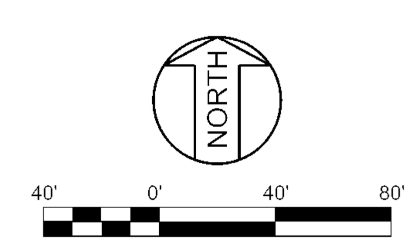
PROJECT
MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE
EAST ASH POND
EXISTING CONDITIONS

DRAWING NUMBER	REVISION
WKG-AP-CSK-006	A

SHEET 1 OF 1





FOR PERMIT
NOT FOR CONSTRUCTION

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE FURNISHED AND INSTALLED BY SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. EXISTING CONDITIONS FOR THE EAST ASH POND ARE BASED ON TOPOGRAPHIC DATA COLLECTED IN 2014. PRIOR TO BEGINNING ANY POND CLOSURE WORK, THE CONTRACTOR SHALL MAKE A TOPOGRAPHIC ASSESSMENT TO VERIFY THE ACCURACY OF THE EXISTING CONDITIONS SHOWN PER NOTE 10 ON DRAWING WKG-AP-CSK-002.
4. IN 2016, THE DOWNSTREAM SLOPE OF THE EAST ASH POND'S EAST DIKE WAS LOWERED TO AN APPROXIMATE CREST ELEVATION OF 600 FEET AND REGRADED TO A FLATTER GRADE THAN SHOWN. SEE GEOSYNTEC DRAWINGS SW0251-11-01 - 07 FOR THE 2016 SLOPE MODIFICATION DESIGN PLANS, SECTIONS, AND DETAILS.
5. DISCONNECT ALL PIPES FROM INLET FLUME, REMOVE PIPE SLEEVES, AND REMOVE PIPES TO LIMITS OF FINAL COVER SYSTEM SHOWN ON DRAWING WKG-AP-CSK-008. CAP ENDS OF PIPES REMAINING IN PLACE. PLACE REMOVED PIPE SLEEVES AND PIPE SECTIONS IN ONSITE STOCKPILE AREA DESIGNATED BY OWNER.

REFERENCE DRAWINGS

5082-C-5006	ASH POND DETAIL PLAN
5082-C-5007	ASH POND SECTIONS AND DETAILS
5082-C-5001	WASTE WATER TREATMENT FACILITIES ASH POND SUMP PLAN, SECTIONS AND DETAILS
5082-C-5502	ASH POND SUMP WEIR PLAN, SECTIONS & DETAILS
5082-C-5503	ASH POND SUMP AND WEIR MISCELLANEOUS SECTIONS AND DETAILS
5082-C-5507	ASH POND INLET FLUME & DISTRIBUTION TROUGH DETAILS
B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
SW0251-11-01 - 07	EAST ASH BASIN SLOPE MODIFICATION

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

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

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

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

HOLD INFORMATION

NO.	DESCRIPTION

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

RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	11-11-2021	FOR CLIENT COMMENT

ISSUE PURPOSE: CLIENT COMMENT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

CAD FILE NAME: WKG-AP-CSK-007.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: --

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY, IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY.

Sargent & Lundy LLC
SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation LLC.

PROJECT

MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

EAST ASH POND
DEMOLITION & REMOVAL PLAN

DRAWING NUMBER	REVISION
WKG-AP-CSK-007	A

SHEET 1 OF 1

11/11/2021 1:42:15 PM
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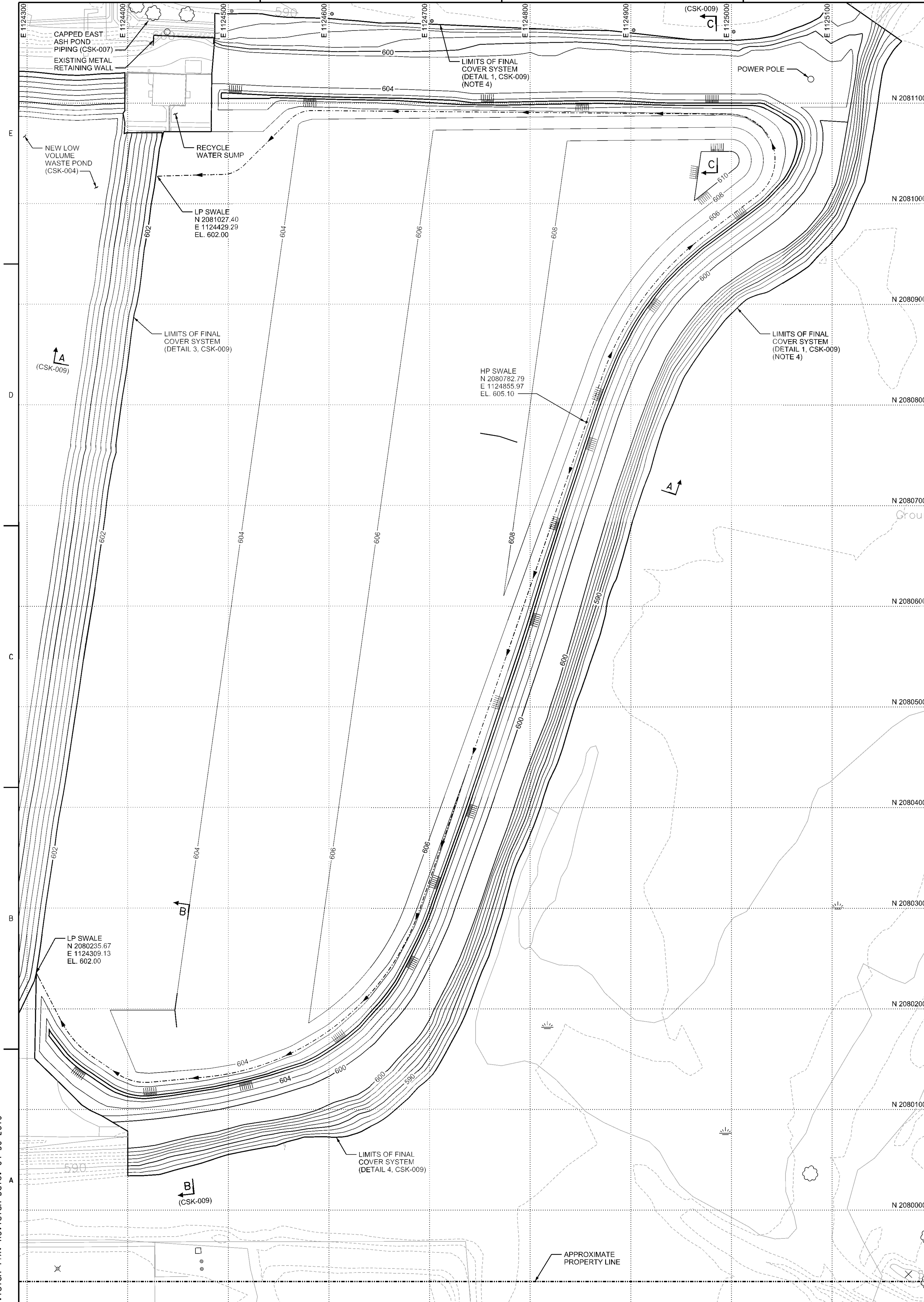
Revision 11A, Revision Date: 04-30-2010



FOR PERMIT
NOT FOR CONSTRUCTION

LEGEND

610	MAJOR CONTOUR (10')
608	MINOR CONTOUR (2')
	DRAINAGE PATH

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE PERFORMED IN ACCORDANCE WITH SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. INSTALL FINAL COVER SYSTEM OVER EAST ASH POND PER DETAIL 1 ON DRAWING WKG-AP-CSK-009.
4. AT TOES OF EAST ASH POND DIKES, FINAL COVER SYSTEM COMPONENTS SHALL BE ANCHORED IN ANCHOR TRENCHES PER DETAIL 2 ON DRAWING WKG-AP-CSK-009.

REFERENCE DRAWINGS

B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
CSK-004	WEST ASH POND EXCAVATION PLAN
CSK-009	EAST ASH POND FINAL COVER SYSTEM SECTIONS & DETAILS

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

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

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

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

NORTH

40' 0' 40' 80'
GRAPHIC SCALE

HOLD INFORMATION

NO.	DESCRIPTION

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

RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	11-11-2021	FOR CLIENT COMMENT

ISSUE PURPOSE: CLIENT COMMENT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

CAD FILE NAME: WKG-AP-CSK-008.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: --

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY, IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY.

Sargent & Lundy LLC
SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation LLC.

PROJECT
MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE
EAST ASH POND
FINAL COVER SYSTEM
GRADING PLAN

DRAWING NUMBER	REVISION
WKG-AP-CSK-008	A

SHEET 1 OF 1

11/11/2021 2:13:31 PM
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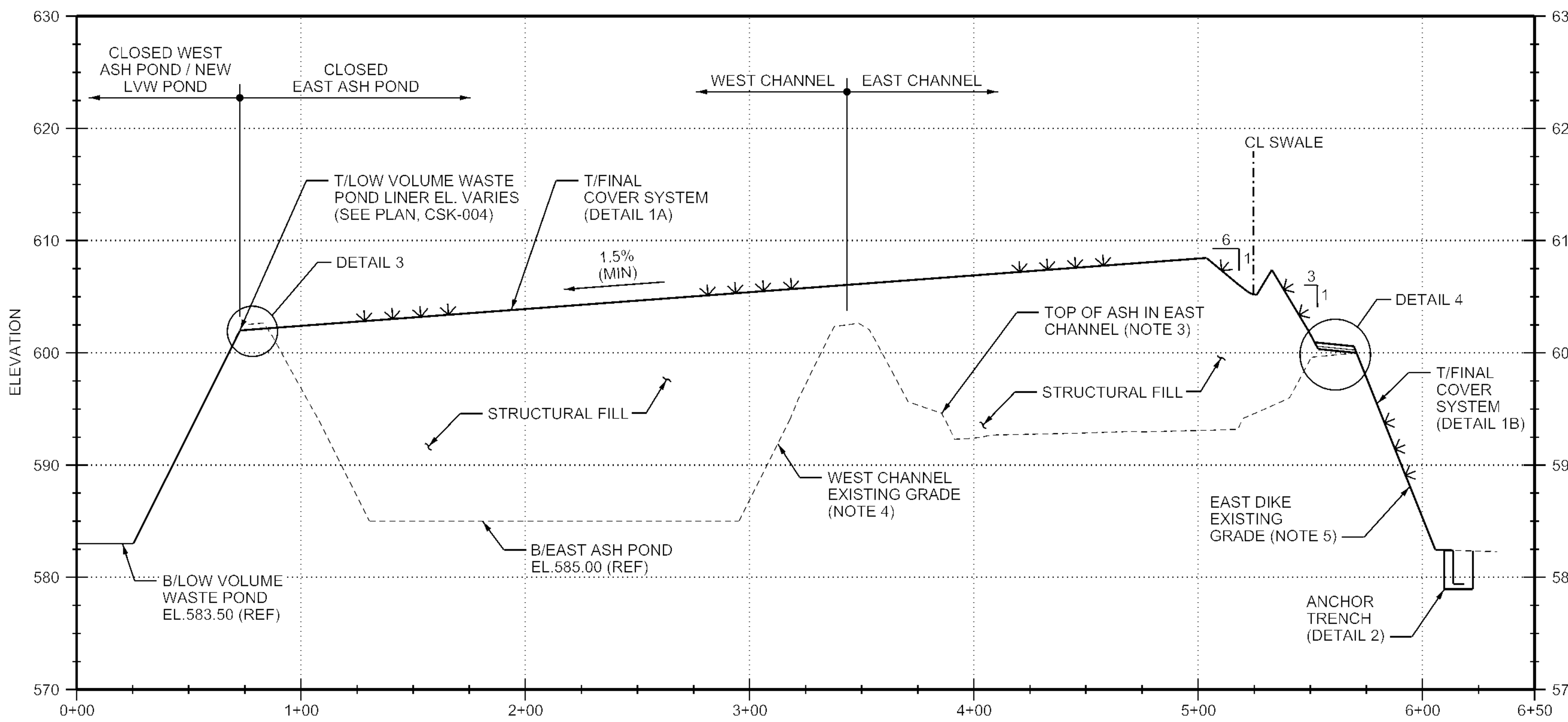
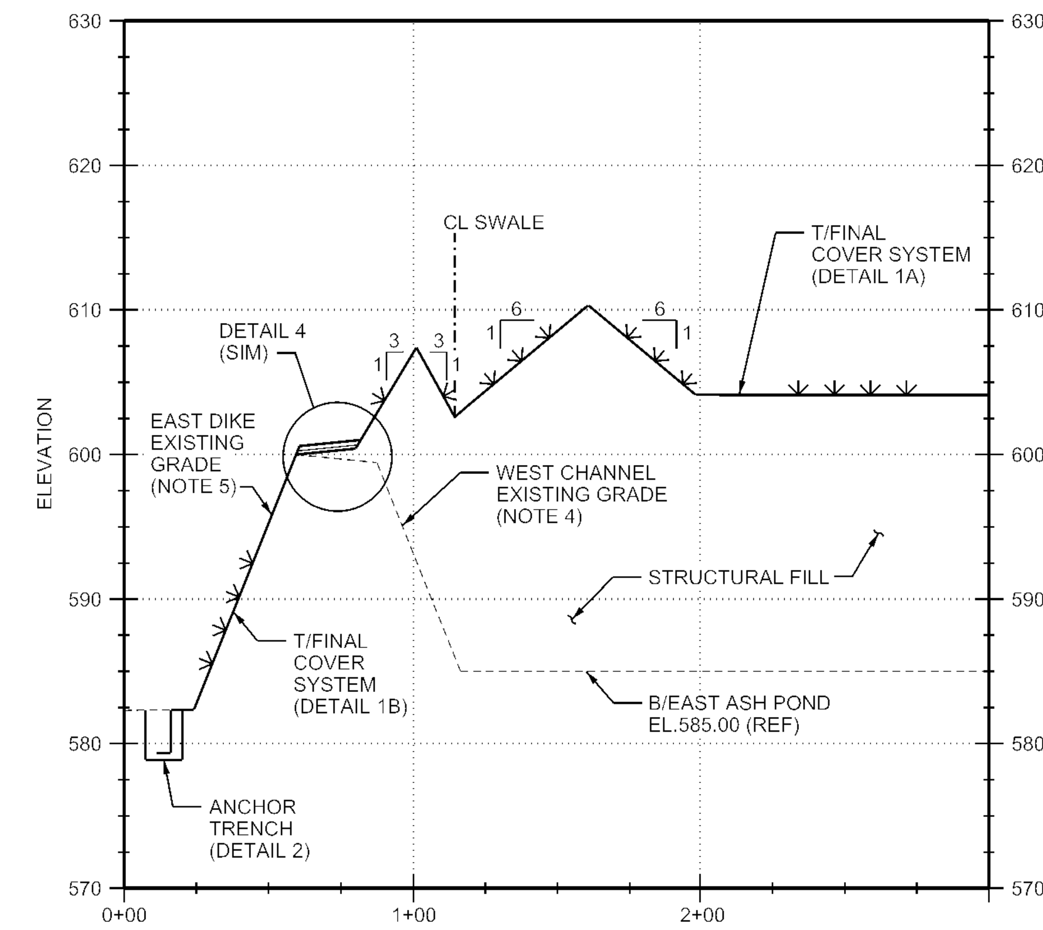
Revision 11A, Revision Date: 04-30-2010



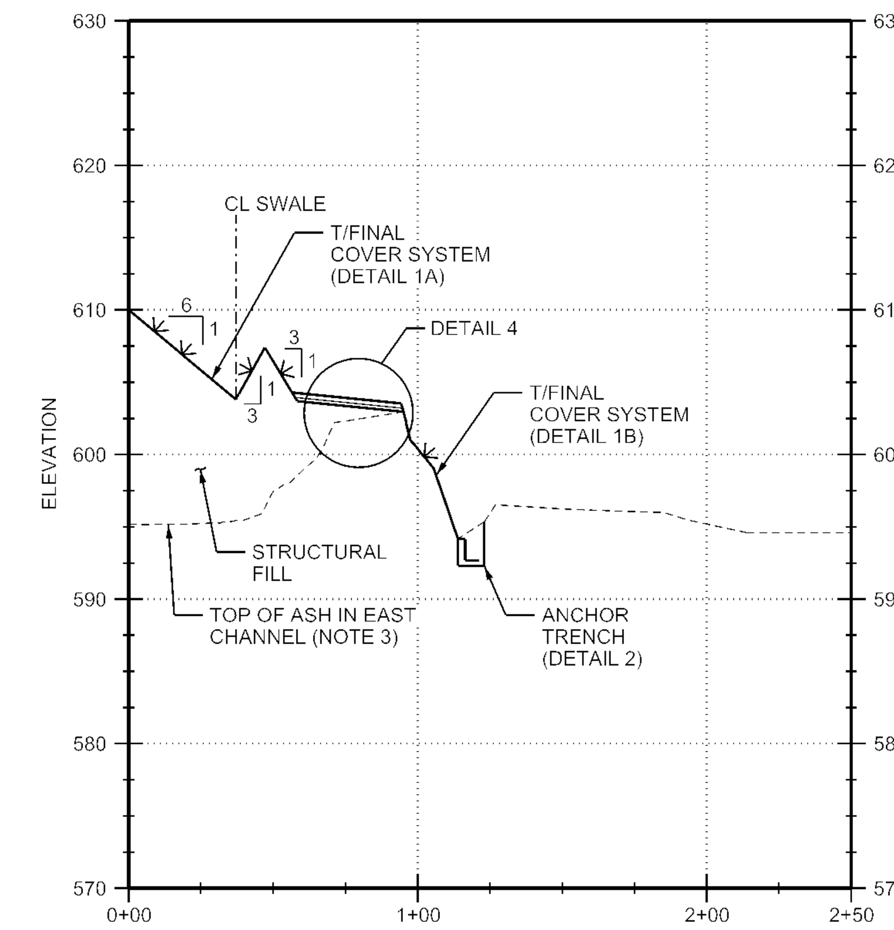
SECTION A

HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=5'
(CSK-008)



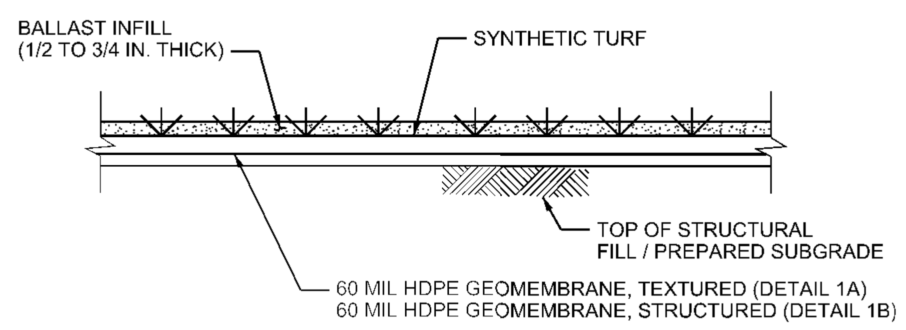
SECTION B

HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=5'
(CSK-008)



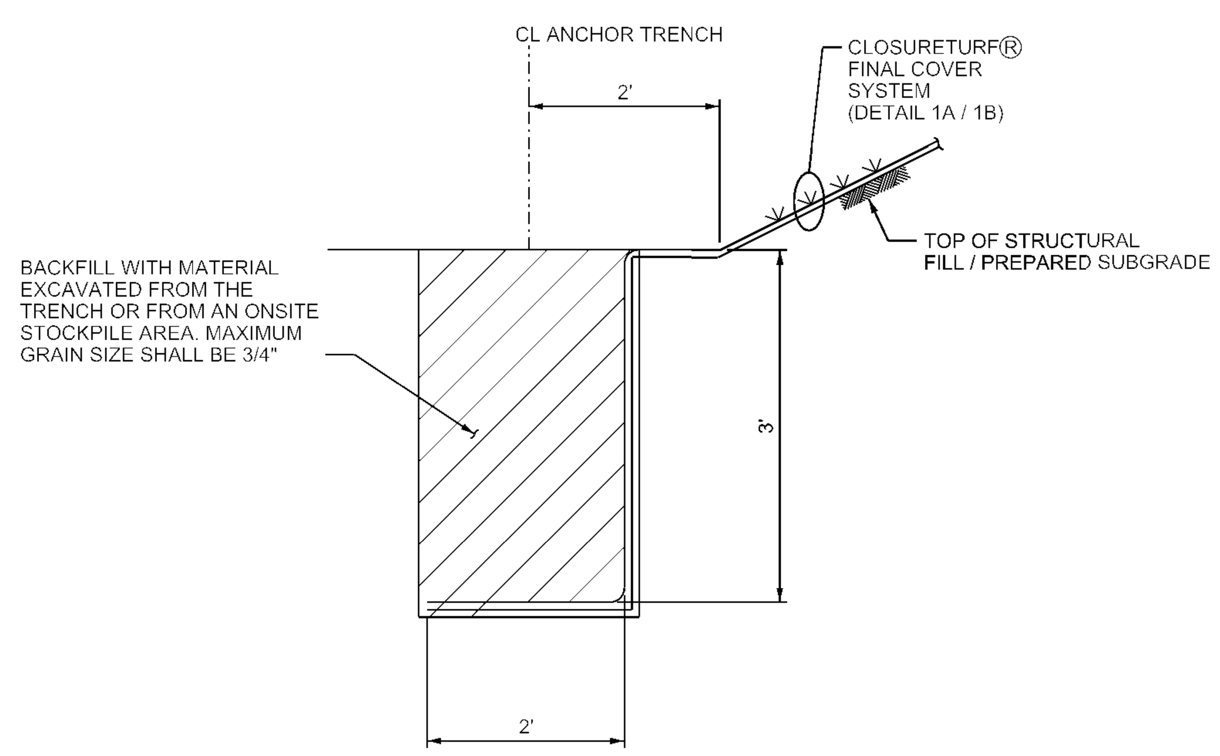
SECTION C

HORIZONTAL SCALE 1"=40'
VERTICAL SCALE 1"=5'
(CSK-008)



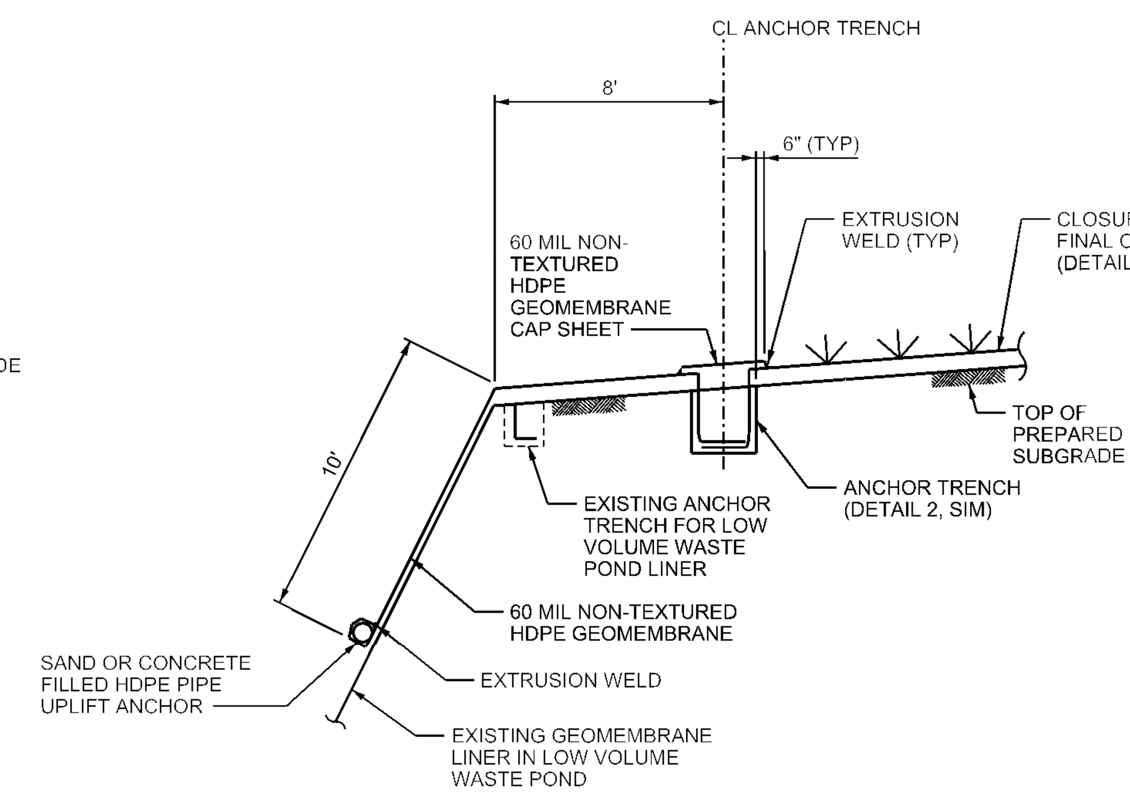
CLOSURETURF® FINAL COVER SYSTEM DETAIL 1

N.T.S.



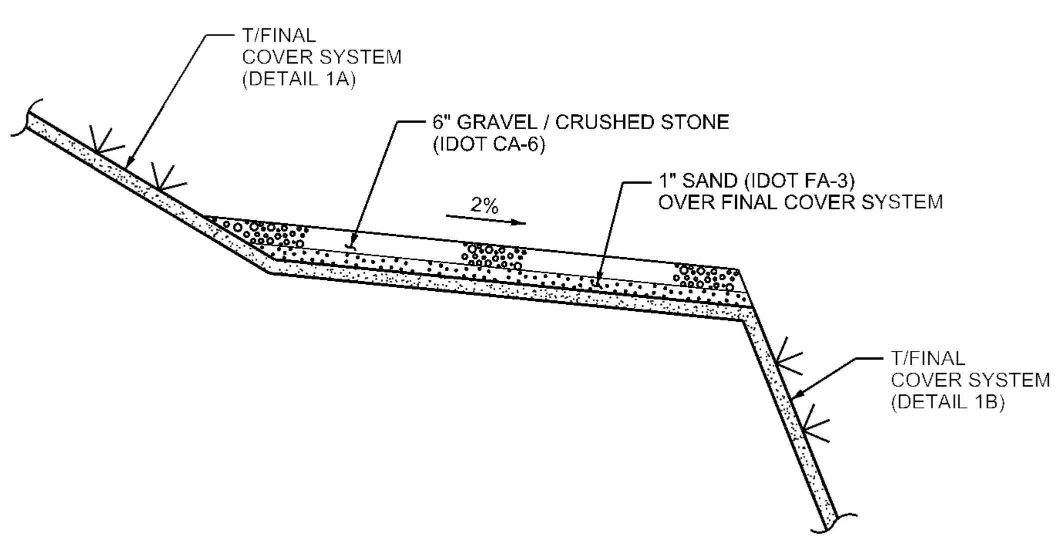
TYPICAL ANCHOR TRENCH DETAIL 2

N.T.S.



GEOMEMBRANE LINER TRANSITION AT NEW LOW VOLUME WASTE POND DETAIL 3

N.T.S.



FINAL COVER ACCESS ROAD DETAIL 4

N.T.S.

NOTES

1. ALL WORK SHOWN ON THIS DRAWING SHALL BE PERFORMED IN ACCORDANCE WITH SPECIFICATION W-7900 UNLESS NOTED OTHERWISE.
2. FOR GENERAL NOTES, ABBREVIATIONS, AND SYMBOLS, SEE DRAWING WKG-AP-CSK-002.
3. TOP-OF-ASH SURFACE SHOWN IN THE EAST CHANNEL REPRESENTS THE ASH STORED IN THE POND DURING THE 2014 SURVEY OF THE SITE AND MAY NOT BE REPRESENTATIVE OF CURRENT CONDITIONS.
4. EXISTING GRADE SHOWN IN THE WEST CHANNEL REPRESENTS THE FLOOR AND SIDE SURFACES OF THE WEST CHANNEL THAT ARE ASSUMED TO HAVE BEEN INSTALLED BASED ON THE EAST ASH POND'S HISTORY OF CONSTRUCTION (GEOSYNTEC, 2016).
5. EXISTING GRADE SHOWN FOR THE DOWNSTREAM SLOPE OF THE EAST ASH POND'S EAST DIKE REPRESENTS THE SIDE SURFACE ASSUMED TO HAVE BEEN INSTALLED IN ACCORDANCE WITH THE SLOPE MODIFICATION WORK DONE IN 2016 (REF. DWGS. SW0251-11-01 THROUGH -07).

REFERENCE DRAWINGS

B739	EAST AND WEST ASH POND LINER REPLACEMENT PLANS, SECTIONS AND DETAILS
CSK-008	EAST ASH POND FINAL COVER SYSTEM GRADING PLAN
SW0251-11-01 - 07	EAST ASH BASIN SLOPE MODIFICATION

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

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

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

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

FOR PERMIT
NOT FOR CONSTRUCTION

HOLD INFORMATION

NO.	DESCRIPTION

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

RELEASE INFORMATION

REV.	DATE	DESCRIPTION
A	11-11-2021	FOR CLIENT COMMENT

ISSUE PURPOSE: CLIENT COMMENT
SPECIFICATION: W-7900
PROJECT NO.: 12661-098

CAD FILE NAME: WKG-AP-CSK-009.DGN
PREPARED BY: J. CHAVEZ
REVIEWED BY: T. DEHLIN / D. NIELSON
APPROVED BY: --

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY AN ORGANIZATION OTHER THAN SARGENT & LUNDY, IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY.

Sargent & Lundy LLC

SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

MWG
Midwest Generation LLC.

PROJECT

MIDWEST GENERATION, LLC
WAUKEGAN
GENERATING STATION
ASH POND CLOSURE PROJECT

DRAWING TITLE

EAST ASH POND
FINAL COVER SYSTEM
SECTIONS & DETAILS

DRAWING NUMBER	REVISION
WKG-AP-CSK-009	A

SHEET 1 OF 1

PL12793/OM1864/S:#2-1
Form GDG-0401-01-08, ANSI (Imperial) MicroStation Border - Size E - 34 x 44
Revision 11A, Revision Date: 04-30-2010

11/11/2021 4:03:42 PM
...#Drawings#WKG-AP-CSK-009.dgn

ATTACHMENT B

CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG Waukegan	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-Removal	SHEET: Cost Summary	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: West Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-by-Removal Cost Estimate for CCR Impoundment	CLOSURE OPTION: West - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/4/2021	REVIEWED BY: Rob Boeing

Waukegan West Ash Basin: Closure by Removal
Closure & Post-Closure Cost Summary

Close-by-Removal Tasks	Cost (2021 Dollars)
Mobilization / Site Prep / Demobilization	**$1,247,924**
Achieve Closure-by-Removal / Convey Material	**$7,245,000**
Stormwater Management / E&S Controls / Site Restoration	**$294,135**
Contingency (25%)	**$2,196,765**
Engineering Support (Design & CQA)	**$5,000,000**
Total Closure Cost of CCR Impoundment =	**$15,983,824**

Post-Closure Tasks	Cost (2021 Dollars)
Groundwater Monitoring	**$150,000**
Operations & Maintenance (O&M)	**$0**
Contingency (25%)	**$37,500**
Engineering Costs (10%)	**$18,750**
Total Post-Closure of CCR Impoundment =	**$206,250**

Total Closure & Post-Closure of CCR Impoundment Cost =	**$16,190,074**

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG Waukegan	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-Removal	SHEET: Close-by-Removal Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: West Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY Close-by-Removal Costs: Closure-by-Removal Cost Estimate for CCR Impoundment	CLOSURE OPTION: West - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	6
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	2
TOTAL CLOSURE-BY-REMOVAL AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	3,910,000
VOLUME OF ASH IN CLOSURE-BY-REMOVAL AREA (CY)	93,000		PERIMETER OF CLOSURE-BY-REMOVAL AREA (L.F.)	3,000

CLOSE-BY-REMOVAL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION / SITE PREP / DEMOBILIZATION	MOBILIZATION / SITE PREP / DEMOBILIZATION						
	1	MOBILIZATION / DEMOBILIZATION	LS	1	$97,924	$97,924	Mob/Demob & insurance: (1% of Total EPC Bid Price) includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	MODIFICATIONS OF OUTLET STRUCTURES / PIPING	LS	1	$250,000	$250,000	Assume outlet structures and piping will be modified.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	9	$100,000	$900,000	Based on Initiation time
ACHIEVE CLOSURE-BY-REMOVAL / CONVEY MATERIAL	ACHIEVE CLOSURE-BY-REMOVAL / CONVEY MATERIAL						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	12	$100,000	$1,200,000	STEP 1: Start dewaterting for Construction time. Based on Construction Time.
	5	EXCAVATE ASH FOR CLOSURE-BY-REMOVAL / STOCKPILE ASH	CY	93,000	$8.00	$744,000	Step 2: Assume CCR material must be stockpiled within impoundment area to decant prior to loading. Done in conjunction with Step 1. Decant water collected and treated along with pore water from Step 1.
	8	EXCAVATE / LOAD / HAUL CCR MATERIAL (OFF-SITE LF)	CY	93,000	$57.00	$5,301,000	Assume disposal of CCRs at an off-site landfill (assume density of 1.2 tons/cy).
	STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION						
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	9	SITE EROSION AND SEDIMENT CONTROL	ACRE	11	$2,000	$22,000	Assume total area to be restored will require site erosion and sediment control.
	10	TOPSOIL	CY	17,746	$13.00	$230,698	Assume 12 inches of top soil needed (obtained off-site) to establish vegetative stabilization over total closed-by-removal area and not covered by the Industrial Landfill
	11	SEED / FERTILIZE / MULCH	ACRE	11	$3,767.00	$41,437	Assume total area of disturbance will be mulched, fertilized, and seeded.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG Waukegan	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-Removal	SHEET: Close-by-Removal Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: West Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Close-by-Removal Costs: Closure-by-Removal Cost Estimate for CCR Impoundment	CLOSURE OPTION: West - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	6
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	2
TOTAL CLOSURE-BY-REMOVAL AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	3,910,000
VOLUME OF ASH IN CLOSURE-BY-REMOVAL AREA (CY)	93,000		PERIMETER OF CLOSURE-BY-REMOVAL AREA (L.F.)	3,000

CLOSE-BY-REMOVAL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
CONTINGENCY / ENGINEERING SUPPORT	CONTINGENCY / ENGINEERING SUPPORT						
	12	CONTINGENCY (25%)	LS	1	$2,196,765	$2,196,765	
	13	ENGINEERING SUPPORT (DESIGN AND CQA 10%)	LS	1	$1,103,253	$1,103,253	
POST-CLOSURE	POST-CLOSURE						
	14	GROUNDWATER MONITORING	ANNUAL	3	$50,000	$150,000	Annual groundwater monitoring costs for each CCR impoundment are based on current groundwater monitoring system.
	15	OPERATIONS & MAINTENANCE (O&M)	ANNUAL	0	$27,500	$0	Annual O&M costs are $2500/acre/yr (includes leachate collection system maintenance). Based on Q3 2018 Post Closure Maintenance data.
POST CLOSURE CONTINGENCY / ENGINEERING COST	CONTINGENCY / ENGINEERING COST						
	16	CONTINGENCY (25%)	LS	1	$37,500	$37,500	
	17	ENGINEERING COST (10%)	LS	1	$18,750	$18,750	
		TOTAL				**$12,293,327**	

AECOM CALCULATION SHEET	PROJECT **CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG Waukegan**	**PLANT NAME:** Waukegan	**CLOSURE TYPE:** Closure-by-Removal	**SHEET** Close-by-Removal Assumptions	**REV. NO.** A
	SUBJECT Preliminary Project Costs Sheets	**IMPOUNDMENT NAME:** West Ash Basin			**AECOM JOB NO.** 60669161
	ACTIVITY **Close-by-Removal Assumptions**	**CLOSURE OPTION:** West - Closure-by-Removal	**LAST UPDATED BY:** PAK	**DATE LAST MODIFIED:** 11/04/21	**REVIEWED BY:** Rob Boeing

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:	
1	The cost estimates were prepared using 2021 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	Interstitial water treatment was assumed to continue until construction is completed.
5	Assumed all CCR material excavated must be stockpiled in close proximity to the impoundment to be decanted. After decanting, the material will be excavated, loaded, and hauled off-site for disposal.
6	Groundwater monitoring costs are for a reduced groundwater network system as compared to the existing system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
7	O&M costs include, but are not limited to, the maintenance/repair of the groundwater monitoring system and general maintenance of the former CCR impoundment area.
8	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: **CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN**	**PLANT NAME:** Waukegan	**CLOSURE TYPE:** Closure-in-Place	**SHEET:** Cost Summary	**REV. NO.:** A
	SUBJECT: Preliminary Project Costs Sheets	**IMPOUNDMENT NAME:** West Ash Basin			**AECOM JOB NO.:** 60669161
	ACTIVITY: **Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment**	**CLOSURE OPTION:** Close-in-Place	**LAST UPDATED BY:** PAK	**DATE LAST MODIFIED:** 11/4/2021	**REVIEWED BY:** Rob Boeing

Waukegan West Ash Basin: Close-in-Place Closure & Post-Closure Cost Summary

Close-in-Place Tasks	Cost (2021 Dollars)
Mobilization / Site Prep	**$1,242,064**
Dewatering / Earthwork / Subgrade Prep.	**$2,348,700**
Closure System Construction	**$1,158,751**
Stormwater Management / E&S Controls / Site Restoration	**$3,513,737**
Contingency (25%)	**$2,065,813**
Engineering Support (Design & CQA)	**$2,900,000**
Total Closure Cost of CCR Impoundment =	**$13,229,065**

Post-Closure Tasks	Cost (2021 Dollars)
Groundwater Monitoring	**$1,500,000**
Operations & Maintenance (O&M)	**$825,000**
Contingency (25%)	**$581,250**
Engineering Costs (10%)	**$290,625**
Total Post-Closure of CCR Impoundment =	**$3,196,875**
Total Closure & Post-Closure of CCR Impoundment Cost =	**$16,425,940**

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: West Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	2
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	3,910,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	93,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION / SITE PREP	**MOBILIZATION / SITE PREP**						
	1	MOBILIZATION	LS	1	$92,064	$92,064	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	MODIFY OUTLET STRUCTURES / PIPING	LS	1	$250,000	$250,000	Final existing outlet structures and piping.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	9	$100,000	$900,000	
DEWATERING / EARTHWORK / SUBGRADE PREP	**DEWATERING / EARTHWORK / SUBGRADE PREP**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	12	$100,000	$1,200,000	Based on Construction Time
	5	ASH REGRADING TO ESTABLISH CROWN	CY	117,000	$9.50	$1,111,500	Quantity of earthwork (cut-to-fill) using existing ash to achieve positive slope prior to installation of closure system. Quantity calculated using AutoCAD.
	6	PERIMETER DITCH / TEMP. DIVERSION BERM GRADING	L.F.	3,100	$12.00	$37,200	Linear feet around the perimeter of impoundment.
	7	CONTACT STORM WATER TREATMENT	GAL				
CLOSURE SYSTEM CONSTRUCTION	**CLOSURE SYSTEM CONSTRUCTION**						
	8	24" FINAL COVER SOIL	CY	35,493	$11.00	$390,427	24 inches of common soil placed over close-in-place area (assume on-site soils available)
	9	12" TOPSOIL	CY	17,747	$13.00	$230,707	12 inches of topsoil (obtained off-site) placed over closure-by-removal area.
	10	FLEXIBLE MEMBRANE LINER (FML)	SQ. FT.	527,076	$0.42	$221,372	Alternate Cap System Only: Flexible membrane liner placed over close-in-place area. Assume quantity needed is 10% more than close-in-place area.
	11	GEOCOMPOSITE DRAINAGE LAYER	SQ. FT.	527,076	$0.60	$316,246	Alternate Cap System Only: Geocomposite drainage layer placed over close-in-place area. Assume quantity needed is 10% more than close-in-place area.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: West Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	2
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	3,910,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	93,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	**STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION**						
	12	SITE EROSION AND SEDIMENT CONTROL	ACRE	11	$2,000	$22,000	Assume total area to be restored will require site erosion and sediment control.
	13	STORMWATER MANAGEMENT / CHANNELS / LET-DOWNS	L.F.	4,650	$742	$3,450,300	Assume rip-rap lined stormwater conveyance channels and rip-rap lined let-downs off of cap. Assume 3500 LF of stormwater channels / let downs.
	14	SEED / FERTILIZE / MULCH	ACRE	11	$3,767	$41,437	Assume total area to be restored will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	**CONTINGENCY / ENGINEERING SUPPORT**						
	15	CONTINGENCY (25%)	LS	1	$2,065,813	$2,065,813	
	16	ENGINEERING SUPPORT (DESIGN AND CQ 10%)	LS	1	$1,035,237	$1,035,237	
POST-CLOSURE	**POST-CLOSURE**						
	17	GROUNDWATER MONITORING FOR ASH BASIN	ANNUAL	30	$50,000	$1,500,000	Annual groundwater monitoring costs for each CCR impoundment
	18	OPERATIONS & MAINTENANCE (O&M) FOR CLOSURE-IN-PLACE CAP AREA	ANNUAL	30	$27,500	$825,000	Annual O&M costs are $2500/acre/yr for the total closed area with cap.
POST CLOSURE CONTINGENCY / ENGINEERING COST	**POST CLOSURE CONTINGENCY / ENGINEERING COST**						
	19	CONTINGENCY (25%)	LS	1	$581,250	$581,250	
	20	ENGINEERING COST (10%)	LS	1	$290,625	$290,625	
		TOTAL				**$14,561,177**	

AECOM CALCULATION SHEET	PROJECT **CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN**	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET Close-in-Place Assumptions	REV. NO. A
	SUBJECT Preliminary Project Costs Sheets	IMPOUNDMENT NAME: West Ash Basin			AECOM JOB NO. 60669161
	ACTIVITY **Close-in-Place Assumptions**	CLOSURE OPTION: Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:	
1	The cost estimates were prepared using 2021 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	Interstitial water treatment was assumed to continue until construction is completed.
5	To establish the positive slopes, assume existing ash will be utilized to establish crown.
6	Cap cross section for the CCR impoundment will consist of flexible membrane liner, geocomposite drianage layer, and 24-inches of final cover soil overlain by 12-inches of topsoil.
7	Final cover soil assumed to be available onsite and topsoil would come from offsite
8	Groundwater monitoring costs are for the existing network system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
9	O&M costs include, but are not limited to, the monitoring and maintenance/repair of the groundwater monitoring system, cap system, and storm water controls.
10	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-removal	SHEET: Cost Summary	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-by-Removal Cost Estimate for CCR Impoundment	CLOSURE OPTION: East - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/4/2021	REVIEWED BY: Rob Boeing

Waukegan East Ash Basin: Closure-by-Removal
Closure & Post-Closure Cost Summary

Close-by-Removal Tasks	Cost (2021 Dollars)
Mobilization / Site Prep / Demobilization	**$1,248,093**
Achieve Closure-by-Removal / Convey Material	**$7,259,984**
Stormwater Management / E&S Controls / Site Restoration	**$294,135**
Contingency (25%)	**$2,200,553**
Engineering Support (Design & CQA)	**$5,000,000**
Total Closure Cost of CCR Impoundment =	**$16,002,765**

Post-Closure Tasks	Cost (2021 Dollars)
Groundwater Monitoring	**$150,000**
Operations & Maintenance (O&M)	**$0**
Contingency (25%)	**$37,500**
Engineering Costs (10%)	**$18,750**
Total Post-Closure of CCR Impoundment =	**$206,250**

Total Closure & Post-Closure of CCR Impoundment Cost =	**$16,209,015**

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-removal	SHEET: Close-by-Removal Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Close-by-Removal Costs: Closure-by-Removal Cost Estimate for CCR Impoundment	CLOSURE OPTION: East - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL CLOSURE-BY-REMOVAL AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN CLOSURE-BY-REMOVAL AREA (CY)	70,000		PERIMETER OF CLOSURE-BY-REMOVAL AREA (L.F.)	3,100

CLOSE-BY-REMOVAL ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION / SITE PREP / DEMOBILIZATION	MOBILIZATION / SITE PREP / DEMOBILIZATION						
	1	MOBILIZATION / DEMOBILIZATION	LS	1	$98,093	$98,093	Mob/Demob & insurance: (1% of Total EPC Bid Price) includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	MODIFICATIONS OF OUTLET STRUCTURES / PIPING	LS	1	$250,000	$250,000	Assume outlet structures and piping will be modified.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	9	$100,000	$900,000	
ACHIEVE CLOSURE-BY-REMOVAL / CONVEY MATERIAL	ACHIEVE CLOSURE-BY-REMOVAL / CONVEY MATERIAL						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	12	$225,832	$2,709,984	STEP 1: Start dewaterting for Construction time. Based on Construction Time.
	5	EXCAVATE ASH FOR CLOSURE-BY-REMOVAL / STOCKPILE ASH	CY	70,000	$8.00	$560,000	Step 2: Assume CCR material must be stockpiled within impoundment area to decant prior to loading. Done in conjunction with Step 1. Decant water collected and treated along with pore water from Step 1.
	6	EXCAVATE / LOAD / HAUL CCR MATERIAL (OFF-SITE LF)	CY	70,000	$57.00	$3,990,000	Assume disposal of CCRs at an off-site landfill (assume density of 1.2 tons/cy).

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-removal	SHEET: Close-by-Removal Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Close-by-Removal Costs: Closure-by-Removal Cost Estimate for CCR Impoundment	CLOSURE OPTION: East - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL CLOSURE-BY-REMOVAL AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN CLOSURE-BY-REMOVAL AREA (CY)	70,000		PERIMETER OF CLOSURE-BY-REMOVAL AREA (L.F.)	3,100

	CLOSE-BY-REMOVAL ESTIMATED COSTS						
	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION						
	7	SITE EROSION AND SEDIMENT CONTROL	ACRE	11	$2,000	$22,000	Assume total area to be restored will require site erosion and sediment control.
	8	TOPSOIL	CY	17,746	$13.00	$230,698	Assume 12 inches of top soil needed (obtained off-site) to establish vegetative stabilization over total closed-by-removal area and not covered by the Industrial Landfill
	9	SEED / FERTILIZE / MULCH	ACRE	11	$3,767	$41,437	Assume total area of disturbance will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	CONTINGENCY / ENGINEERING SUPPORT						
	10	CONTINGENCY (25%)	LS	1	$2,200,553	$2,200,553	
	11	ENGINEERING SUPPORT (DESIGN AND CQA)	LS	1	$1,105,145	$1,105,145	
POST-CLOSURE	POST-CLOSURE						
	12	GROUNDWATER MONITORING	ANNUAL	3	$50,000	$150,000	Annual groundwater monitoring costs for each CCR impoundment are based on current groundwater monitoring system.
	13	OPERATIONS & MAINTENANCE (O&M)	ANNUAL	0	$27,500	$0	Annual O&M costs are $2,500/acre/yr for the landfill cap area (includes leachate collection system maintenance). Based on Q3 2018 Post Closure Maintenance data.
POST CLOSURE CONTINGENCY / ENGINEERING COST	CONTINGENCY / ENGINEERING COST						
	14	CONTINGENCY (25%)	LS	1	$37,500	$37,500	
	15	ENGINEERING COST (10%)	LS	1	$18,750	$18,750	
		TOTAL				**$12,314,160**	

AECOM CALCULATION SHEET	PROJECT **CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN**	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-by-removal	SHEET Close-by-Removal Assumptions	REV. NO. A
	SUBJECT Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO. 60669161
	ACTIVITY **Close-by-Removal Assumptions**	CLOSURE OPTION: East - Closure-by-Removal	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:

1	The cost estimates were prepared using 2021 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	Interstitial water treatment was assumed to continue until construction is completed.
5	Assumed all CCR material excavated must be stockpiled in close proximity to the impoundment to be decanted. After decanting, the material will be excavated, loaded, and hauled off-site for disposal.
6	Groundwater monitoring costs are for a reduced groundwater network system as compared to the existing system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
7	O&M costs include, but are not limited to, the maintenance/repair of the groundwater monitoring system and general maintenance of the former CCR impoundment area.
8	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Cost Summary	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 1 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/4/2021	REVIEWED BY: Rob Boeing

Waukegan East Ash Basin: Close-in-Place Option 1
Closure & Post-Closure Cost Summary

Close-in-Place Tasks	Cost (2021 Dollars)
Mobilization / Site Prep	**$1,241,067**
Dewatering / Earthwork / Subgrade Prep.	**$2,263,200**
Closure System Construction	**$1,158,751**
Stormwater Management / E&S Controls / Site Restoration	**$3,513,737**
Contingency (25%)	**$2,044,189**
Engineering Support (Design & CQA)	**$2,900,000**
Total Closure Cost of CCR Impoundment =	**$13,120,943**

Post-Closure Tasks	Cost (2021 Dollars)
Groundwater Monitoring	**$1,500,000**
Operations & Maintenance (O&M)	**$825,000**
Contingency (25%)	**$581,250**
Engineering Costs (10%)	**$290,625**
Total Post-Closure of CCR Impoundment =	**$3,196,875**

Total Closure & Post-Closure of CCR Impoundment Cost =	**$16,317,818**

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: **Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment**	CLOSURE OPTION: Option 1 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	70,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION / SITE PREP	**MOBILIZATION / SITE PREP**						
	1	MOBILIZATION	LS	1	$91,067	$91,067	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	MODIFY OUTLET STRUCTURES / PIPING	LS	1	$250,000	$250,000	Modify existing outlet structures and piping.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	9	$100,000	$900,000	
DEWATERING / EARTHWORK / SUBGRADE PREP	**DEWATERING / EARTHWORK / SUBGRADE PREP**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	12	$100,000	$1,200,000	Based on Construction Time
	5	ASH REGRADING TO ESTABLISH CROWN	CY	108,000	$9.50	$1,026,000	Quantity of earthwork (cut-to-fill) using existing ash to achieve positive slope prior to installation of closure system. Quantity calculated using AutoCAD.
	6	PERIMETER DITCH / TEMP. DIVERSION BERM GRADING	L.F.	3,100	$12.00	$37,200	Linear feet around the perimeter of impoundment.
	7	CONTACT STORM WATER TREATMENT	GAL				
CLOSURE SYSTEM CONSTRUCTION	**CLOSURE SYSTEM CONSTRUCTION**						
	8	24" FINAL COVER SOIL	CY	35,493	$11.00	$390,427	24 inches of common soil placed over close-in-place area (assume on-site soils available)
	9	12" TOPSOIL	CY	17,747	$13.00	$230,707	12 inches of topsoil (obtained off-site) placed over closure-by-removal area.
	10	FLEXIBLE MEMBRANE LINER (FML)	SQ. FT.	527,076	$0.42	$221,372	Alternate Cap System Only: Flexible membrane liner placed over close-in-place area. Assume quantity needed is 10% more than close-in-place area.
	11	GEOCOMPOSITE DRAINAGE LAYER	SQ. FT.	527,076	$0.60	$316,246	Alternate Cap System Only: Geocomposite drainage layer placed over close-in-place area. Assume quantity needed is 10% more than close-in-place area.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 1 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	70,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION						
	12	SITE EROSION AND SEDIMENT CONTROL	ACRE	11	$2,000	$22,000	Assume total area to be restored will require site erosion and sediment control.
	13	STORMWATER MANAGEMENT / CHANNELS / LET-DOWNS	L.F.	4,650	$742	$3,450,300	Assume rip-rap lined stormwater conveyance channels and rip-rap lined let-downs off of cap. Assume 1.5* length of peremeter LF of stormwater channels / let downs.
	14	SEED / FERTILIZE / MULCH	ACRE	11	$3,767	$41,437	Assume total area to be restored will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	CONTINGENCY / ENGINEERING SUPPORT						
	15	CONTINGENCY (25%)	LS	1	$2,044,189	$2,044,189	
	16	ENGINEERING SUPPORT (DESIGN AND CQA 10%)	LS	1	$1,021,000	$1,021,000	
POST-CLOSURE	POST-CLOSURE						
	17	GROUNDWATER MONITORING FOR ASH BASIN	ANNUAL	30	$50,000	$1,500,000	Annual groundwater monitoring costs for each CCR impoundment
	18	OPERATIONS & MAINTENANCE (O&M) FOR CLOSURE-IN-PLACE CAP AREA	ANNUAL	30	$27,500	$825,000	Annual O&M costs are $2500/acre/yr for the total closed area with cap. Based on Q3 2018 Post Closure Maintenance data
CONTINGENCY / ENGINEERING COST	CONTINGENCY / ENGINEERING COST						
	19	CONTINGENCY (25%)	LS	1	$581,250	$581,250	
	20	ENGINEERING COST (10%)	LS	1	$290,625	$290,625	
		TOTAL				**$14,438,818**	

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Assumptions	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: **Close-in-Place Assumptions**	CLOSURE OPTION: Option 1 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:

1	The cost estimates were prepared using 2021 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	Interstitial water treatment was assumed to continue until construction is completed.
5	To establish positive slopes, assume existing ash and on-site fill will be utilized to establish crown
6	Cap cross section for the CCR impoundment will consist of flexible membrane liner, geocomposite drianage layer, and 24-inches of final cover soil overlain by 12-inches of topsoil.
7	Final cover soil assumed to be available onsite and topsoil would come from offsite.
8	Groundwater monitoring costs are for the existing network system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
9	O&M costs include, but are not limited to, the monitoring and maintenance/repair of the groundwater monitoring system, cap system, and storm water controls.
10	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Cost Summary	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 2 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/4/2021	REVIEWED BY: Rob Boeing

Waukegan East Ash Basin: Close-in-Place Option 2
Closure & Post-Closure Cost Summary

Close-in-Place Tasks	Cost (2021 Dollars)
Mobilization / Site Prep	**$1,270,846**
Dewatering / Earthwork / Subgrade Prep.	**$4,904,200**
Closure System Construction	**$1,158,751**
Stormwater Management / E&S Controls / Site Restoration	**$3,513,737**
Contingency (25%)	**$2,711,883**
Engineering Support (Design & CQA)	**$2,900,000**
Total Closure Cost of CCR Impoundment =	**$16,459,417**

Post-Closure Tasks	Cost (2021 Dollars)
Groundwater Monitoring	**$1,500,000**
Operations & Maintenance (O&M)	**$825,000**
Contingency (25%)	**$581,250**
Engineering Costs (10%)	**$290,625**
Total Post-Closure of CCR Impoundment =	**$3,196,875**

Total Closure & Post-Closure of CCR Impoundment Cost =	**$19,656,292**

AECOM CALCULATION SHEET	PROJECT: **CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN**	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: **Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment**	CLOSURE OPTION: Option 2 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	70,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION / SITE PREP	**MOBILIZATION / SITE PREP**						
	1	MOBILIZATION	LS	1	$120,846	$120,846	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	MODIFY OUTLET STRUCTURES / PIPING	LS	1	$250,000	$250,000	Modify existing outlet structures and piping.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	9	$100,000	$900,000	
DEWATERING / EARTHWORK / SUBGRADE PREP	**DEWATERING / EARTHWORK / SUBGRADE PREP**						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	12	$100,000	$1,200,000	Based on Construction Time
	5	ASH REGRADING TO ESTABLISH CROWN	CY	386,000	$9.50	$3,667,000	Quantity of earthwork (cut-to-fill) using existing ash to achieve positive slope prior to installation of closure system. Quantity calculated using AutoCAD.
	6	PERIMETER DITCH / TEMP. DIVERSION BERM GRADING	L.F.	3,100	$12.00	$37,200	Linear feet around the perimeter of impoundment.
	7	CONTACT STORM WATER TREATMENT	GAL				
CLOSURE SYSTEM CONSTRUCTION	**CLOSURE SYSTEM CONSTRUCTION**						
	8	24" FINAL COVER SOIL	CY	35,493	$11.00	$390,427	24 inches of common soil placed over close-in-place area (assume on-site soils available)
	9	12" TOPSOIL	CY	17,747	$13.00	$230,707	12 inches of topsoil (obtained off-site) placed over closure-by-removal area.
	10	FLEXIBLE MEMBRANE LINER (FML)	SQ. FT.	527,076	$0.42	$221,372	Alternate Cap System Only: Flexible membrane liner placed over close-in-place area. Assume quantity needed is 10% more than close-in-place area.
	11	GEOCOMPOSITE DRAINAGE LAYER	SQ. FT.	527,076	$0.60	$316,246	Alternate Cap System Only: Geocomposite drainage layer placed over close-in-place area. Assume quantity needed is 10% more than close-in-place area.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: **Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment**	CLOSURE OPTION: Option 2 - Close-in-Place	LAST UPDATED BY: PAK	DATE LAST MODIFIED: 11/04/21	REVIEWED BY: Rob Boeing

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	70,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

	CLOSE-IN-PLACE ESTIMATED COSTS						
	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION						
	12	SITE EROSION AND SEDIMENT CONTROL	ACRE	11	$2,000	$22,000	Assume total area to be restored will require site erosion and sediment control.
	13	STORMWATER MANAGEMENT / CHANNELS / LET-DOWNS	L.F.	4,650	$742	$3,450,300	Assume rip-rap lined stormwater conveyance channels and rip-rap lined let-downs off of cap. Assume 1.5* length of peremeter LF of stormwater channels / let downs.
	14	SEED / FERTILIZE / MULCH	ACRE	11	$3,767	$41,437	Assume total area to be restored will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	CONTINGENCY / ENGINEERING SUPPORT						
	15	CONTINGENCY (25%)	LS	1	$2,711,883	$2,711,883	
	16	ENGINEERING SUPPORT (DESIGN AND CQA 10%)	LS	1	$1,357,869	$1,357,869	
POST-CLOSURE	POST-CLOSURE						
	17	GROUNDWATER MONITORING FOR ASH BASIN	ANNUAL	30	$50,000	$1,500,000	Annual groundwater monitoring costs for each CCR impoundment
	18	OPERATIONS & MAINTENANCE (O&M) FOR CLOSURE-IN-PLACE CAP AREA	ANNUAL	30	$27,500	$825,000	Annual O&M costs are $2500/acre/yr for the total closed area with cap.
POST CLOSURE CONTINGENCY / ENGINEERING COST	POST CLOSURE CONTINGENCY / ENGINEERING COST						
	19	CONTINGENCY (25%)	LS	1	$581,250	$581,250	
	20	ENGINEERING COST (10%)	LS	1	$290,625	$290,625	
		TOTAL				**$18,114,161**	

AECOM	PROJECT	PLANT NAME:	CLOSURE TYPE:	SHEET	REV. NO.
CALCULATION SHEET	**CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN**	Waukegan	Closure-in-Place	Close-in-Place Assumptions	A
	SUBJECT	**IMPOUNDMENT NAME:**			**AECOM JOB NO.**
	Preliminary Project Costs Sheets	East Ash Basin			60669161
	ACTIVITY	**CLOSURE OPTION:**	**LAST UPDATED BY:**	**DATE LAST MODIFIED:**	**REVIEWED BY:**
	Close-in-Place Assumptions	Option 2 - Close-in-Place	PAK	11/04/21	Rob Boeing

KEY ASSUMPTIONS	
The following key assumptions and limitations are associated with the project design, implementation and performance:	
1	The cost estimates were prepared using 2021 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	Interstitial water treatment was assumed to continue until construction is completed.
5	To establish the posititve slopes, assume existing ash and on-site fill will be utilized to establish crown.
6	Cap cross section for the CCR impoundment will consist of flexible membrane liner, geocomposite drianage layer, and 24-inches of final cover soil overlain by 12-inches of topsoil.
7	Final cover soil assumed to be available onsite and topsoil would come from offsite
8	Groundwater monitoring costs are for the existing network system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
9	O&M costs include, but are not limited to, the monitoring and maintenance/repair of the groundwater monitoring system, cap system, and storm water controls.
10	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Cost Summary	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 3 - Close-in-Place	LAST UPDATED BY: MLB	DATE LAST MODIFIED: 11/23/2021	REVIEWED BY: Jeremy Thomas

Waukegan East Ash Basin: Close-in-Place Option 3
Closure & Post-Closure Cost Summary

Close-in-Place Tasks	Cost (2021 Dollars)
Mobilization / Site Prep	**$1,268,991**
Dewatering / Earthwork / Subgrade Prep.	**$4,372,200**
Closure System Construction	**$1,617,165**
Stormwater Management / E&S Controls / Site Restoration	**$3,461,834**
Contingency (25%)	**$2,680,048**
Engineering Support (Design & CQA)	**$2,900,000**
Total Closure Cost of CCR Impoundment =	**$16,300,238**

Post-Closure Tasks	Cost (2021 Dollars)
Groundwater Monitoring	**$1,500,000**
Operations & Maintenance (O&M)	**$825,000**
Contingency (25%)	**$581,250**
Engineering Costs (10%)	**$290,625**
Total Post-Closure of CCR Impoundment =	**$3,196,875**

Total Closure & Post-Closure of CCR Impoundment Cost =	**$19,497,113**

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 3 - Close-in-Place	LAST UPDATED BY: MLB	DATE LAST MODIFIED: 11/23/21	REVIEWED BY: Jeremy Thomas

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	70,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
MOBILIZATION / SITE PREP	MOBILIZATION / SITE PREP						
	1	MOBILIZATION	LS	1	$118,991	$118,991	Mob/Demob & insurance: (1% of Total EPC Bid Price includes administration (mtgs, health & safety, trailer, phone/fax/electricity, temporary facilities, utilities, roll off boxes, waste disposal, and cleanup).
	2	MODIFY OUTLET STRUCTURES / PIPING	LS	1	$250,000	$250,000	Modify existing outlet structures and piping.
	3	REMOVAL & FILTRATION OF FREE WATER	MONTHS	9	$100,000	$900,000	
DEWATERING / EARTHWORK / SUBGRADE PREP	DEWATERING / EARTHWORK / SUBGRADE PREP						
	4	REMOVAL & TREATMENT OF PORE WATER WITHIN ASH	MONTHS	12	$100,000	$1,200,000	Based on Construction Time
	5	ASH REGRADING TO ESTABLISH CROWN	CY	330,000	$9.50	$3,135,000	Quantity of earthwork (cut-to-fill) using existing ash to achieve positive slope prior to installation of closure system. Quantity calculated using AutoCAD.
	6	PERIMETER DITCH / TEMP. DIVERSION BERM GRADING	L.F.	3,100	$12.00	$37,200	Linear feet around the perimeter of impoundment.
	7	CONTACT STORM WATER TREATMENT	GAL				
CLOSURE SYSTEM CONSTRUCTION	CLOSURE SYSTEM CONSTRUCTION						
	8	FINAL COVER SYSTEM - ENGINEERED TURF	SF	588,060	$2.75	$1,617,165	

AECOM CALCULATION SHEET	PROJECT: CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET: Close-in-Place Costs	REV. NO.: A
	SUBJECT: Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO.: 60669161
	ACTIVITY: Cost Summary: Close-in-Place Cost Estimate for CCR Impoundment	CLOSURE OPTION: Option 3 - Close-in-Place	LAST UPDATED BY: MLB	DATE LAST MODIFIED: 11/23/21	REVIEWED BY: Jeremy Thomas

BASIS OF THE ESTIMATE				
YEAR COST BASIS	2021		AREA OF OPEN FREE WATER IN IMPOUNDMENT (AC)	3
TOTAL AREA TO BE RESTORED (AC)	11		AVG. DEPTH OF FREE WATER (FT)	1.5
TOTAL IMPOUNDMENT AREA (AC)	11		VOLUME OF FREE WATER IN IMPOUNDMENT (GAL)	2,000,000
VOLUME OF ASH IN IMPOUNDMENT (CY)	70,000		PERIMETER OF IMPOUNDMENT (L.F.)	3,100

CLOSE-IN-PLACE ESTIMATED COSTS

	TASK	ITEM	UNIT	QUANTITY	INSTALLED UNIT COST	IMPOUNDMENT CLOSURE COST	NOTES
STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION	STORMWATER MANAGEMENT / E&S CONTROLS / SITE RESTORATION						
	9	SITE EROSION AND SEDIMENT CONTROL	ACRE	2	$2,000	$4,000	Assume total area to be restored will require site erosion and sediment control.
	10	STORMWATER MANAGEMENT / CHANNELS / LET-DOWNS	L.F.	4,650	$742	$3,450,300	Assume rip-rap lined stormwater conveyance channels and rip-rap lined let-downs off of cap. Assume 1.5* length of peremeter LF of stormwater channels / let downs.
	11	SEED / FERTILIZE / MULCH	ACRE	2	$3,767	$7,534	Assume total area to be restored will be mulched, fertilized, and seeded.
CONTINGENCY / ENGINEERING SUPPORT	CONTINGENCY / ENGINEERING SUPPORT						
	12	CONTINGENCY (25%)	LS	1	$2,680,048	$2,680,048	
	13	ENGINEERING SUPPORT (DESIGN AND CQA 10%)	LS	1	$1,297,900	$1,297,900	
POST-CLOSURE	POST-CLOSURE						
	14	GROUNDWATER MONITORING FOR ASH BASIN	ANNUAL	30	$50,000	$1,500,000	Annual groundwater monitoring costs for each CCR impoundment
	15	OPERATIONS & MAINTENANCE (O&M) FOR CLOSURE-IN-PLACE CAP AREA	ANNUAL	30	$27,500	$825,000	Annual O&M costs are $2500/acre/yr for the total closed area with cap.
POST CLOSURE CONTINGENCY / ENGINEERING COST	POST CLOSURE CONTINGENCY / ENGINEERING COST						
	16	CONTINGENCY (25%)	LS	1	$581,250	$581,250	
	17	ENGINEERING COST (10%)	LS	1	$290,625	$290,625	
		TOTAL				$17,895,013	

AECOM CALCULATION SHEET	PROJECT CCR IMPOUNDMENT CLOSURE ESTIMATES FOR NRG WAUKEGAN	PLANT NAME: Waukegan	CLOSURE TYPE: Closure-in-Place	SHEET Close-in-Place Assumptions	REV. NO. A
	SUBJECT Preliminary Project Costs Sheets	IMPOUNDMENT NAME: East Ash Basin			AECOM JOB NO. 60669161
	ACTIVITY **Close-in-Place Assumptions**	CLOSURE OPTION: Option 3 - Close-in-Place	LAST UPDATED BY: MLB	DATE LAST MODIFIED: 11/23/21	REVIEWED BY: Jeremy Thomas

KEY ASSUMPTIONS

The following key assumptions and limitations are associated with the project design, implementation and performance:	
1	The cost estimates were prepared using 2021 dollars and do not include any escalation.
2	A 25% contingency has been included for this cost estimate.
3	Engineering design and CQA cost has been included for this cost estimate based on reasonable assumptions.
4	Interstitial water treatment was assumed to continue until construction is completed.
5	To establish the positive slopes, assume existing ash and on-site fill will be utilized to establish crown.
6	Cap cross section for the CCR impoundment will consist of flexible membrane liner, geocomposite drianage layer, and 24-inches of final cover soil overlain by 6-inches of topsoil.
7	Final cover soil assumed to be available onsite and topsoil would come from offsite
8	Groundwater monitoring costs are for the existing network system. Groundwater monitoring costs do not include costs incurred for any additional well installation. Maintenance costs for wells are included in post-closure O&M costs.
9	O&M costs include, but are not limited to, the monitoring and maintenance/repair of the groundwater monitoring system, cap system, and storm water controls.
10	Statements of Probable Construction Cost prepared by AECOM represent AECOM's judgment as a design professional familiar with the construction industry. It is recognized, however, that neither AECOM nor the Owner has control over the cost of labor, materials or equipment nor over the contractor's methods of determining the bid price or other competitive bidding, market, or negotiating conditions. Accordingly, AECOM cannot and does not warrant or represent that proposals, bids or actual construction costs will not vary from any statement of Probable Construction Cost or other estimates or evaluations prepared by AECOM.

ATTACHMENT C

REPORT

NUMERICAL GROUNDWATER FLOW MODEL

Groundwater Flow Modeling in Support of CCR Compliance and Permitting

Midwest Generation, LLC
Waukegan Generating Station
Waukegan, Illinois

Submitted to:

KPRG and Associates, Inc.
14665 W. Lisbon Road, Suite 1A
Brookfield, WI 53005

and:

Midwest Generation, LLC
Waukegan Generating Station
401 E. Greenfield Ave.
Waukegan, IL 60087

Prepared by:

BAS Groundwater Consulting Inc.
3649 Evergreen Parkway Ste 1510
Evergreen, Colorado 80437
+1 720 334-8249

January 27, 2022

ATTACHMENT D

CLOSURE ALTERNATIVES RANKING MATRIX
MWG WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Options
1) West Ash Basin -- Closure-by-Removal
2) West Ash Basin -- Closure-in-Place
3) East Ash Basin -- Closure-by-Removal
4) East Ash Basin -- Closure-in-Place (Option 1)
5) East Ash Basin -- Closure-in-Place (Option 2)
6) East Ash Basin -- Closure-in-Place (Option 3)

		Ranking					
Part 845 Reference Section	Regulatory Comparison Criteria	*Option 1*	*Option 2*	*Option 3*	*Option 4*	*Option 5*	*Option 6*
845.710(b)(1)(A)	Magnitude of reduction of existing risks.	5	4	5	4	4	4
845.710(b)(1)(B)	Magnitude of residual risks in terms of likelihood of future releases of CCR.	5	4	5	4	4	4
845.710(b)(1)(C)	Type and degree of long-term management required, including monitoring, operation, and maintenance.	5	4	5	4	4	4
845.710(b)(1)(D)	Short-term risks that might be posed to the community or the environment during implementation of such a closure, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminants.	3	5	3	5	5	5
845.710(b)(1)(E)	Time until closure and post-closure care or the completion of groundwater monitoring pursuant to Section 845.740(b) is completed.	5	4	5	4	4	4
845.710(b)(1)(F)	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.	4	5	4	5	5	5
845.710(b)(1)(G)	Long-term reliability of the engineering and institutional controls, including an analysis of any off-site, nearby destabilizing activities.	5	5	5	5	5	5
845.710(b)(1)(H)	Potential need for future corrective action of the closure alternative.	5	4	5	4	4	4
845.710(b)(2)(A)	Extent to which containment practices will reduce further releases.	5	5	5	5	5	5
845.710(b)(2)(B)	Extent to which treatment technologies may be used.	5	5	5	5	5	5
845.710(b)(3)(A)	Degree of difficulty associated with constructing the technology.	5	5	5	5	5	5
845.710(b)(3)(B)	Expected operational reliability of the technologies.	5	5	5	5	5	5
845.710(b)(3)(C)	Need to coordinate with and obtain necessary approvals and permits from other agencies.	5	5	5	5	5	5
845.710(b)(3)(D)	Availability of necessary equipment and specialists.	5	5	5	5	5	5
845.710(b)(3)(E)	Available capacity and location of needed treatment, storage, and disposal services.	4	5	4	5	5	5
845.710(b)(4)	The degree to which the concerns of the residents living within communities where the CCR will be handled, transported and disposed are addressed by the closure method.						
845.710(d)(1)	Analyze complete removal of the CCR as one closure alternative, along with the modes for transporting the removed CCR, including by rail, barge, low-polluting trucks, or a combination of these transportation modes.	5	5	5	5	5	5
845.710(d)(2)	Identify 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.	4	5	4	5	5	5
845.710(d)(3)	Include any other closure method in the alternatives analysis if requested by the Agency.	-	-	-	-	-	-
845.710(d)(1)	Meet or exceed a class 4 estimate under the AACE Classification Standard, incorporated by reference in Section 845.150, or a comparable classification practice as provided in the AACE Classification Standard.	5	5	5	5	5	5
845.710(d)(2)	Contain the results of groundwater contaminant transport modeling and calculations showing how the closure alternative will achieve compliance with the applicable groundwater protection standards.	5	5	5	5	5	5
845.710(d)(3)	Include a description of the fate and transport of contaminants with the closure alternative over time, including consideration of seasonal variations.	5	5	5	5	5	5
845.710(d)(4)	Assess impacts to waters in State.	5	5	5	5	5	5
	Total	100	100	100	100	100	100

Attachment 7-4 – East Pond Post-Closure Plan

MWG
Midwest Generation, LLC

Waukegan Generating Station

Post-Closure Care Plan for East Ash Pond

Revision 2

January 27, 2022

Issue Purpose: Use

Project No.: 12661-098

55 East Monroe Street
Chicago, IL 60603-5780 USA
312-269-2000
www.sargentlundy.com

Sargent & Lundy

TABLE OF CONTENTS

1.0 PURPOSE & SCOPE

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(d)
Federal CCR Rule Reference: 40 CFR 257.104(d)

1.1 PURPOSE

The East Ash Pond at Midwest Generation, LLC's (MWG) Waukegan Generating Station ("Waukegan" or the "Station") is an existing coal combustion residual (CCR) surface impoundment that is regulated by the Illinois Pollution Control Board's "Standards for the Disposal of Coal Combustion Residuals in CCR Surface Impoundments." These regulations are codified in Part 845 to Title 35 of the Illinois Administrative Code (35 Ill. Adm. Code 845, Ref. 1) and are also referred to herein as the "Illinois CCR Rule." The East Ash Pond is also regulated by the U.S. Environmental Protection Agency's (EPA) "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 40 CFR Part 257 Subpart D (Ref. 2), also referred to herein as the "Federal CCR Rule."

Pursuant to 35 Ill. Adm. Code 845.780(d) and 40 CFR 257.104(d), this document provides the written post-closure care plan for the East Ash Pond at Waukegan. MWG intends to close this CCR surface impoundment by leaving the impounded CCR in place and installing a final cover system over the impoundment in accordance with 35 Ill. Adm. Code 845.750 and 40 CFR 257.102(d). Following completion of all closure activities, MWG will conduct post-closure care for the East Ash Pond in accordance with the requirements of 35 Ill. Adm. Code 845.780 and 40 CFR 257.104(b). This plan describes the post-closure care activities MWG anticipates performing throughout the post-closure care period for the East Ash Pond.

1.2 SCOPE

Per the 2016 Water Infrastructure Improvements for the Nation (WIIN) Act, the East Ash Pond will continue to be subject to both the Illinois and Federal CCR Rules until the U.S. EPA approves the Illinois EPA's CCR permit program. The Illinois EPA has yet to publish a timeline for submitting its proposed CCR permit program to the U.S. EPA for approval, and so this written post-closure care plan has been prepared pursuant to both sets of regulations.

2.0 POST-CLOSURE MONITORING & MAINTENANCE ACTIVITIES

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(d)(1)(A)
Federal CCR Rule Reference: 40 CFR 257.104(d)(1)(i)

Post-closure monitoring for the East Ash Pond will include (1) maintaining the integrity and effectiveness of the final cover system, (2) maintaining the groundwater monitoring system, and (3) monitoring the groundwater at the site. Table 1 summarizes the post-closure monitoring activities planned to meet these objectives and the corresponding frequencies at which these activities will be performed (at a minimum).

Table 1 – Post-Closure Monitoring Frequency

Monitoring Activity	Description	Monitoring Frequency	Action Items
Final Cover Monitoring	Visually inspect final cover for surface erosion.	Weekly, and following each 25-year, 24-hour storm event if the storm event occurs more than 48 hours before the next scheduled weekly inspection.	Replace synthetic turf infill as needed.
	Visually inspect final cover for settlement, subsidence, and vertical cracking.		Repair holes, depressions, *etc*. as needed to prevent standing water and infiltration into covered ash.
	Monitor eastern embankment area for signs of distress caused by potential erosion of Lake Michigan shoreline.	As necessary.	If necessary, evaluate potential remediation measures and implement corrective measures as appropriate.
Groundwater Monitoring	Monitor groundwater quality at the East Ash Pond.	Quarterly for constituents and monthly for groundwater elevations, switching to semi-annually after five years of post-closure monitoring if approved by the Illinois EPA.	If necessary, implement corrective action remedies to achieve compliance with groundwater protection standards.

2.1 FINAL COVER SYSTEM MONITORING & MAINTENANCE

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(b)(1)
Federal CCR Rule Reference: 40 CFR 257.104(b)(1)

Throughout the post-closure care period, MWG will maintain the integrity and effectiveness of the East Ash Pond's final cover system by regularly inspecting the cap for evidence of surface erosion, settlement, subsidence, or other events. These inspections will be performed by a qualified person in accordance with 35 Ill. Adm. Code 845.540(a) and will occur at least once a week and after each 25-year, 24-hour storm event if the latter occurs more than 48 hours before the next scheduled weekly inspection. If inspections reveal problems, appropriate corrective measures will be taken to remedy effects of surface erosion, settlement, subsidence, or other events.

In addition to monitoring the East Ash Pond's final cover system for issues caused by large storm events and other potential on-site issues, MWG will monitor the eastern embankment area for signs of distress caused by potential erosion of the Lake Michigan shoreline east of the site. Based on the latest aerial image available on Google Earth for the East Ash Pond site (taken in late May 2021), the pond is approximately 690 to 850 feet west of Lake Michigan's apparent shoreline. The pond site is also located approximately 1.5 miles north of Waukegan Harbor, less than a mile south of Illinois State Beach Park's South Unit, and over

4.5 miles south of Illinois State Beach Park's North Unit. A September 2020 study conducted by the Illinois Department of Natural Resources (IDNR) Coast Management Program (CMP) and the Illinois State Geological Survey (ISGS) through the Prairie Research Institute (Ref. 3) determined that the shoreline of Lake Michigan along the Illinois Beach State Park's North Unit has retreated by as much as 820 feet between 1939 and 2017. Conversely, the study also concluded that the shoreline along the park's South Unit has advanced lakeward by as much as 1,100 feet during the same time period. Per the U.S. Army Corps of Engineers (USACE), Chicago District's environmental assessment published in September 2019 for the ongoing Waukegan Harbor dredging project (Ref. 4), the shoreline gain along the southern part of Illinois Beach State Park is occurring at a rate "at or near what likely occurred in the natural setting."

Based on these 2019 USACE and 2020 IDNR CMP and ISGS studies, the portion of Lake Michigan's shoreline east of the East Ash Pond is more likely to gain land than to lose land via erosion based on its proximity to the Waukegan Harbor and the Illinois State Beach Park's South Unit. However, as previously stated, MWG will monitor the East Ash Pond's eastern embankment for signs of distress caused by potential losses of Lake Michigan's shoreline. If negative impacts to the East Ash Pond's final cover system are anticipated, potential remediation measures will be evaluated, and the appropriate corrective measures will be implemented.

2.2 GROUNDWATER MONITORING

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(b)(3)
Federal CCR Rule Reference: 40 CFR 257.104(b)(3)

MWG will maintain the East Ash Pond's groundwater monitoring system and will continue to monitor groundwater at the site throughout the post-closure care period in accordance with the requirements of 35 Ill. Adm. Code Part 845 Subpart F ("Groundwater Monitoring and Corrective Action") and 40 CFR 257.90 through 40 CFR 257.98. During the first five years of the pond's post-closure care period, groundwater monitoring will be performed quarterly for constituents and monthly for groundwater elevations. After five years of post-closure care, groundwater monitoring may be switched to a semi-annual basis if approved by the Illinois EPA.

3.0 FACILITY CONTACT DURING POST-CLOSURE CARE PERIOD

Illinois CCR Rule Reference: 35 Ill. Adm. 845.780(d)(1)(B)

Federal CCR Rule Reference: 40 CFR 257.104(d)(1)(ii)

The name, address, telephone number, and e-mail address of the person to contact about the East Ash Pond during the post-closure care period are presented below:

Name:	Paulo Rocha, Plant Manager
Address:	Waukegan Generating Station 401 E. Greenwood Ave. Waukegan, IL 60087
Telephone Number:	(847) 599-2212
E-mail Address:	paulo.rocha@nrg.com

4.0 PROPERTY USE DURING POST-CLOSURE CARE PERIOD

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(d)(1)(C)

Federal CCR Rule Reference: 40 CFR 257.104(d)(1)(iii)

As of the date of this plan, MWG's intent for the East Ash Pond site is for it to remain undisturbed during the post-closure care period. MWG plans to limit access to the site only for inspecting the condition of the final cover system, making repairs to the final cover system (as needed), and for accessing the groundwater monitoring wells (if necessary).

5.0 AMENDMENTS TO POST-CLOSURE CARE PLAN

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(d)(3)

Federal CCR Rule Reference: 40 CFR 257.104(d)(3)

This post-closure care plan will be amended in accordance with 35 Ill. Adm. Code 845.780(d)(3) and 40 CFR 257.104(d)(3) if a change in the operation of the East Ash Pond would substantially affect this plan or if an unanticipated event necessitates a revision to this plan.

6.0 CERTIFICATION

Illinois CCR Rule Reference: 35 Ill. Adm. Code 845.780(d)(4)
Federal CCR Rule Reference: 40 CFR 257.102(d)(4)

I certify that:

- This written post-closure care plan for the East Ash Pond was prepared by me or under my direct supervision.
- The work was conducted in accordance with the requirements of 35 Ill. Adm. Code 845.780 and with the requirements of 40 CFR 257.104.
- I am a registered professional engineer under the laws of the State of Illinois.

Certified By: Thomas J. Dehlin   Date: January 27, 2022

Seal:

LICENSED PROFESSIONAL ENGINEER
THOMAS J DEHLIN
062-069314
OF ILLINOIS

Th. Dehlin
1/27/2022
Exp. 11/30/2023

7.0 REFERENCES

1. Illinois Pollution Control Board. "Standards for Disposal of Coal Combustion Residuals in CCR Surface Impoundments." 35 Ill. Adm. Code 845. Accessed January 26, 2022.

2. U.S. Environmental Protection Agency. "Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments." 40 CFR Part 257 Subpart D. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-257/subpart-D. Accessed January 26, 2022.

3. Illinois State Geological Survey. "Illinois Beach State Park: A Dynamic Shoreline." https://univofillinois.maps.arcgis.com/apps/MapSeries/index.html?appid=d77327796e4a425d9c1f4d12be53bd9f. Accessed January 7, 2022.

4. U.S. Army Corps of Engineers, Chicago District. *Waukegan Harbor Maintenance Dredging and Placement, Waukegan, Illinois.* "Environmental Assessment, Appendix A - Section 404(b)(1) Analysis." June 2019.

ATTACHMENT 8
GROUNDWATER MODELING REPORT

REPORT

NUMERICAL GROUNDWATER FLOW MODEL

Groundwater Flow Modeling in Support of CCR Compliance and Permitting

Midwest Generation, LLC
Waukegan Generating Station
Waukegan, Illinois

Submitted to:

KPRG and Associates, Inc.
14665 W. Lisbon Road, Suite 1A
Brookfield, WI 53005

and:

Midwest Generation, LLC
Waukegan Generating Station
401 E. Greenfield Ave.
Waukegan, IL 60087

Prepared by:

BAS Groundwater Consulting Inc.
3649 Evergreen Parkway Ste 1510
Evergreen, Colorado 80437
+1 720 334-8249

January 27, 2022

NUMERICAL GROUNDWATER FLOW MODEL

Groundwater Flow Modeling in Support of CCR Compliance and Permitting

Midwest Generation, LLC
Waukegan Generating Station
Waukegan, Illinois

BAS Project Number 21141101

Submitted to:

KPRG and Associates, Inc.
14665 W. Lisbon Road, Suite 1A
Brookfield, WI 53005

and:

Midwest Generation, LLC
Waukegan Generating Station
401 E. Greenfield Ave.
Waukegan, IL 60087

Prepared by:

BAS Groundwater Consulting Inc.
3649 Evergreen Parkway Ste 1510
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January 27, 2022

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Senior GIS Analyst/*BAS Groundwater Consulting Inc.*
Rochelle Destrampe, RG
Senior Hydrogeologist/*BAS Groundwater Consulting Inc.*

Distribution List

Midwest Generation, LLC

KPRG and Associates, Inc.

Executive Summary

This report documents the results of a numerical groundwater modeling analysis of groundwater flow in the vicinity of the East and West Ash Ponds at the Midwest Generation, LLC (Midwest Generation) Waukegan Generating Station (Waukegan Station). The purpose of the numerical groundwater modeling was to create a tool capable of evaluating groundwater flow paths in the vicinity of the East and West Ash Ponds and to provide a platform upon which proposed engineering scenarios for pond closures can be overlain and evaluated for their short and long-term effectiveness relative to improvements of groundwater quality. The results of the modeling are intended for input into the engineering considerations and evaluations of various closure alternatives being evaluated for the two ponds. This modeling is a requirement under Illinois Administrative Code Title 35 Part 845.220(d)(3).

The model has a uniform grid spacing of 50 feet and has six layers. The groundwater flow model was run in the software MODFLOW-NWT and the transport model was run with the software MT3D-USGS. The model represents the regional flow direction to Lake Michigan to the east with constant head boundaries on the west and east sides of the model.

The model was calibrated to water levels measured in monitoring wells upgradient and downgradient of the ash ponds. The model achieved a good calibration, with a scaled root mean squared error in the site wells of less than 10 percent. The model was the most sensitive to the modeled values of hydraulic conductivity and less sensitive to the regional recharge rate.

The existing groundwater quality data do not suggest that the East and West Ponds are the source of the elevated concentrations of constituents in groundwater at the site. Therefore, to meet the modeling requirements of Part 845.220(d)(3), a hypothetical initial situation was created in which a constant source of a surrogate mass (relative concentration of “1”) was modeled at the ash ponds and allowed to discharge freely to groundwater. The resulting hypothetical distribution of concentrations served as the initial concentrations to predictive scenarios of pond closure alternatives. The pond closure model scenarios indicate that any of the hypothetically introduced mass in groundwater attributed to the ash ponds should be flushed through the system immediately east of the ponds within 10 to 30 years, depending on the exact location.

Table of Contents

Tables

Figures

Table of Abbreviations

Abbreviation	Definition
A	Cross sectional area
ADAMP	Adaptive damping solution method
amsl	Above mean sea level
af/yr	Acre-feet per year
CCR	Coal Combustion Residuals
cfd	Cubic feet per day
cm/s	Centimeters per second
dh/dl	Hydraulic gradient
ft/d	Feet per day
ft^2	Square feet
ft/ft	Feet per feet
GHB	General head boundary
GIS	Geographic information system
gpm	Gallons per minute
GWPS	Groundwater Protection Standard
ISGS	Illinois State Geological Survey
ILWATER	Illinois Water Well Database
ISWS	Illinois State Water Survey
in/yr	Inches per year
LINMETH	XMD linear solution method
K	Hydraulic conductivity
MAP	Mean annual precipitation
mg/l	Milligrams per liter
PCGn	Preconditioned Conjugate Gradient
Q	Darcy Flux
RMS	Root mean square
%	Percent

1.0 INTRODUCTION

This report documents the results of a numerical groundwater modeling analysis of groundwater flow in the vicinity of the East and West Ash Ponds at the Midwest Generation, LLC (Midwest Generation) Waukegan Generating Station (Waukegan Station). The numerical groundwater flow and transport modeling was conducted as required under the Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals (CCR) in Surface Impoundments (State CCR Rule) Section 845.220(d)(3).

2.0 BACKGROUND

The Waukegan Station is an active coal power generating station located along the western shore of Lake Michigan in Section 15, Township 45 North, Range 12 East, in the City of Waukegan, Lake County, Illinois. The locations of the facility and ash ponds are shown on Figure 1. The Waukegan Station is bordered on the north by the former Johns Manville Superfund site, on the west by old industrial property (formerly the Giess-Pfleger Tannery) that has been recently redeveloped as an electrical distribution substation, on the south by the North Shore Water Reclamation District facility, and on the east by Lake Michigan. The site has two active, lined ash ponds named West Pond and East Pond. There are 15 monitoring wells located on site, eight of which are part of the CCR monitoring program (MW-1 through -4, MW-9, MW-11, MW-14, and MW-16). The locations of the 15 monitor wells are shown on Figure 2.

The purpose of the numerical groundwater modeling was to create a tool capable of evaluating groundwater flow paths near the ash ponds and to then use this model to overlay various pond closure scenarios to assist in evaluating short and long-term changes to associated downgradient groundwater quality.

3.0 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- Section 4.0: Conceptual Model – This section provides information that was used to refine the conceptual model of groundwater flow at Waukegan Station. The conceptual model formed the basis for construction and calibration of the numerical model.
- Section 5.0: Numerical Groundwater Flow Model – This section provides a description of the numerical model construction, calibration, and sensitivity analysis. The calibrated groundwater flow model was used as the basis to conduct predictive analyses of engineering closure alternatives to assist in the engineering evaluations.
- Section 6.0: Predictive Model Simulations – This section provides results of predictive analyses that were used to evaluate changes to the water table, groundwater flow paths, and constituent concentrations beneath and adjacent to the ash ponds.
- Section 7.0: Conclusions – This section provides a summary of the modeling and predictive analysis.

- Section 8.0: References – This section provides a list of references used in the analysis documented in this report.

Figures and tables follow the main text of the report.

4.0 CONCEPTUAL MODEL

Site data were compiled as part of this modeling study and used to update the conceptual model of groundwater flow at the Waukegan Station. The numerical model was constructed to represent the updated conceptual model.

Components of the conceptual model of groundwater flow include:

- climate
- lithology and geologic framework
- aquifer properties
- nature of groundwater flow
- water budget

Each of these components of the conceptual model is presented below.

4.1 Climate

Waukegan Station is located within the humid continental climate zone with warm to hot and humid summers and cold and snowy winters. There are three weather stations located relatively near Waukegan Station that provide data to evaluate long-term trends in precipitation. These stations are Waukegan, IL, Waukegan 2.2E, IL, and Waukegan No.2 (Figure 3). Precipitation data from these three stations were averaged for monthly and annual averages and are provided in Table 1. Long-term average monthly precipitation has ranged from just over 1 inch in January and February to over 3 inches in late Spring and Summer (April through September). The long-term mean annual precipitation (MAP) from these data is 32.6 inches.

4.2 Geology

The geology at Waukegan Station was summarized in the Application for Initial Operating Permit submitted to IEPA on October 31, 2021 (MWG, 2021), as approximately 90 to 115 feet of unconsolidated deposits underlain by approximately 360 feet of Silurian Dolomite. The Dolomite is underlain by the Maquoketa Shale which is considered to be a regional aquitard separating the shallow groundwater within the sands and Silurian Dolomite from the deeper, underlying Cambro-Ordovician aquifers. The site lithology from site boreholes is described as 9.5 to 24 feet of fill consisting of fine to medium sand with some gravel and silt seams including ash, cinders, slag, and occasional coal and wood fragments, and an undetermined thickness of well graded, fine to medium sand with localized gravel seams and discontinuous lenses of peat and silt.

Surficial geology was obtained from the Zion and Waukegan Quadrangle Maps (Barnhardt M. , 2009) (Barnhardt M. , 2010) and is shown on Figure 4. Borehole logs for the site wells were compiled along with logs for nearby wells from the Illinois State Geological Survey's (ISGS) Water and Related Wells Database (ILWATER) and are presented in Table 2 and Figure 5. Lithology in the borehole logs is displayed in three dimensions on Figure 6 and includes the groups:

- Loam
- Fill
- Clay, and Sandy Clay
- Clay, Sand, and Gravel
- Sand, and Sand and Gravel
- Silt and Clay
- Hardpan
- Peat
- Carbonate
- Shale

Near the site the lithology is dominated by sand, clay, and gravel. The lithologic intervals provided guidance on initial model calibration through the definition of zones of hydraulic conductivity that were later modified as discussed further in Section 5.2.1.

4.3 Aquifer Properties

Aquifer properties of hydraulic conductivity (K) and storage are important controls of groundwater movement and behavior and are necessary parameters to define in a numerical model. Hydraulic conductivity values were initially estimated for monitor wells MW-1, -3, and -5 from slug tests (Patrick Engineering, 2011). The geometric mean of the test data for these wells was approximately 350 feet per day (ft/d), as calculated by (Patrick Engineering, 2011). The slug test data were reviewed as part of this current modeling study and the data were reanalyzed using corrected input values for the well casing and borehole dimensions and effective porosity of the sand filter pack material. The revised hydraulic conductivity estimated values are summarized in Table 3 for comparison. The revised geometric mean of the test data for these wells decreased to approximately 155 ft/d.

4.4 Nature of Groundwater Flow

Groundwater occurs under unconfined conditions with depth to water ranging from approximately 3.5 feet at monitor well MW-12 to approximately 28 feet at monitor well MW-16. Figures 9-7 through 9-10 of the above referenced Application for Initial Operating Permit (MWG, 2021) illustrate recent groundwater flow elevations in the vicinity of the ash ponds with groundwater flow beneath the ponds being generally to the east toward Lake Michigan.

Groundwater level measurements from 15 site wells since June 2011 were provided by KPRG. Wells with available groundwater data are shown on Figure 7. A summary of these data is provided in Table 4 including minimum and maximum measured water level elevations and the average water level elevation from the 1st and 3rd quartiles to eliminate statistical outliers. These average water levels were used as the water level calibration targets. These data from the site wells were supplemented with water levels in shallow wells obtained from ILWATER (Illinois State Geological Survey, 2021) (Table 4). These data are older, typically representing the depth to water at the time the well was drilled. These water level data were deemed much less reliable and were given a low weight during model calibration.

4.5 Impacted Groundwater

As required under the Federal CCR Rule, groundwater sampling has been conducted in monitoring wells upgradient and downgradient of the East Pond and West Pond CCR surface impoundments. Monitoring wells MW-09, MW-11, and MW-14 are considered upgradient monitoring wells and wells MW-1 through MW-4 and MW-16 are downgradient monitoring wells. CCR sampling under the Federal Rule was initiated in 2015 for the identified Appendix III and Appendix IV parameters and quarterly detection monitoring under that program is ongoing for Appendix III parameters. Also, starting in second quarter 2021, sampling under the new State CCR Rule was initiated quarterly for all Federal CCR Rule Appendix III/IV parameters plus turbidity since the State Rule does not distinguish between detection and assessment monitoring parameter lists.

Relative to the most recent and more comprehensive sampling under the State CCR Rule, concentrations of all 22 monitored water quality parameters in the five ash pond downgradient monitoring wells were below the Proposed Groundwater Protection Standards (GWPSs) presented in the above referenced Application for Initial Operating Permit (MWG, 2021). In addition, all parameters were at concentrations below the Part 845.600(a) groundwater quality standards with the exception of boron in all five wells and arsenic at well location MW-01. The available sampling data from August 2021 indicated boron in the five downgradient monitoring wells ranged from 2.7 to 4.1 milligrams per liter (mg/l) and the Part 845.600 standard is 2.0 mg/l. The arsenic in downgradient well MW-01 was 0.02 mg/l and the Part 845.600(a) standard is 0.01 mg/l (no other downgradient wells had arsenic detections above the standard). The boron and noted arsenic detections have been determined to be associated with sources other than the subject ash ponds (i.e., the ash ponds are not leaking and are not the source of the noted boron and arsenic impacts).

4.6 Water Budget

A conceptual water budget was developed for Waukegan Station to provide context of the results of the calibrated model water budget (ASTM D5447-17, 2017). The identified and estimated components of the conceptual water budget included:

- recharge to groundwater
- inflow of groundwater from the west
- discharge of groundwater to the inlet north of the ash ponds and coal pile
- discharge of groundwater to Lake Michigan

The conceptualized estimate for each of these components of the water budget is discussed below. The conceptual water budget was used as an initial definition of the water budget in the numerical model, and components were adjusted during model calibration.

4.6.1 Recharge to Groundwater

Recharge from the infiltration of precipitation to the water table has been estimated in a regional, general context for northeastern Illinois:

- A groundwater/surface water model for the Upper Fox River Basin in Southeastern Wisconsin estimated recharge of approximately 4 to 4.4 inches/year (in/yr) (Feinstein, Fienen, Kennedy, Buchwald, & Greenwood, 2012).
- A groundwater model of Kane County and Northeastern Illinois estimated recharge near Waukegan, Illinois at approximately 1 in/yr (Meyer, Roadcap, Lin, & Walker, 2009)
- The Illinois State Water Survey (ISWS) estimated shallow groundwater recharge using a geographic information system (GIS) approach coupled with pattern recognition (Interagency Coordinating Committee on Groundwater, 2010). A generalized map of potential recharge at Illinois power plants shows 'moderately low to low" recharge potential for Waukegan Station.

Recharge from precipitation was initially assumed in the groundwater model at 1 in/yr, which equates to approximately 3 percent of MAP. This rate over the model domain (Section 5.1) equates to approximately 49 acre-feet per year (af/yr) (5,890 cubic feet per day (cfd)).

4.6.2 Groundwater Inflow from the West

The boundaries to the groundwater model are discussed below in Section 5.1.3. Groundwater flow into the model domain from the west was estimated using Darcy's Law:

$$Q = KA\frac{dh}{dl}$$

where Q is the Darcy Flux, K is the hydraulic conductivity (ft/d), A is the cross-sectional area (square feet (ft^2)), and dh/dl is the hydraulic gradient (ft/ft). Using the length of the western model boundary (6,000 feet), an assumed thickness of 100 feet, an assumed hydraulic conductivity of 50 ft/d, and a hydraulic gradient of 0.00122 ft/ft estimated from the water level contours, a rough estimate of groundwater flow from the west in the unconsolidated sediments above the carbonate was calculated as 307 af/yr (36,585 cfd).

4.6.3 Discharge to Lake Michigan

Groundwater flow east to Lake Michigan was likewise estimated using Darcy's Law. Similar assumptions were made for the parameters except a lower value of hydraulic conductivity to account for potentially finer grained lake sediments, and a hydraulic gradient of 0.01 ft/ft, estimated from the groundwater elevation contours shown in figures in the Application for Initial Operating Permit (KPRG, 2021) and the distance and hydraulic head/lake elevation between the contours and Lake Michigan. A rough estimate of groundwater flow to Lake Michigan in the modeled area is approximately 503 af/yr (60,000 cfd).

This discussion of the conceptual water budget is an order-of-magnitude, first approximation to estimate the components of the water budget that will be represented in the numerical model. The conceptual water budget will be used to compare to the modeled water budget, and to provide initial estimates for defined boundary conditions.

5.0 NUMERICAL GROUNDWATER FLOW MODEL

A numerical groundwater flow model was constructed for the vicinity of the ash ponds at Waukegan Station. This section describes the construction and calibration of the numerical model.

5.1 Model Construction

The numerical model was created to cover the area of the ash ponds at Waukegan Station (Figure 8). The model domain extends west from Midwest Generation property approximately one-quarter mile to Pershing Road, north and south from Midwest Generation property approximately one-quarter mile, and east to Lake Michigan. The selection of lateral boundaries to the model is further described below. The overall, active model area is approximately one square mile.

5.1.1 Software Selection

The groundwater flow system was simulated with MODFLOW-NWT (Niswonger, 2011), an advanced version of the widely used MODFLOW software. Groundwater Vistas (Version 8.0) (Environmental Simulations Inc. (ESI), 2020) a graphical user interface, was used to parameterize the model input, write MODFLOW files, and visualize results. MODFLOW-NWT was considered over MODFLOW-2000, MODFLOW-2005, or MODFLOW-USG because it has enhanced solvers that employ upstream weighting for non-linear problems, it is a relatively recent, widely used, and non-proprietary release of MODFLOW, and it is coupled with the widely used and non-proprietary transport model MT3DMS (Zheng, 2012), which was used for the transport simulations.

5.1.2 Model Grid and Layering

The model has a uniform grid spacing of 50 feet and has 131 rows and 162 columns and six layers, for a total of 127,332 active cells. The MODFLOW-NWT model was constructed with length and time units of feet and days, respectively. The coordinate system State Plane Illinois East, NAD 83, FIPS 1201 was used for all coordinates and for GIS data management. The model grid has an origin at coordinates 1,119,113, 2,078,345, without rotation.

Lithology data was compiled from site well logs and ISGS drill logs and organized into geological units as described in Section 4.2. Contacts were used to create surfaces of the top of the carbonate unit and of the top of the Maquoketa Shale using Seequent Leapfrog™ software (Seequent Limited, 2021), as well as to visualize the borehole lithology. Model layers one through five represent the unconsolidated materials, and model layer six represents the carbonate unit. The top of model layer 6 was defined from the created carbonate surface and the bottom of the model was defined from the created surface of the Maquoketa Shale.

The top of the model was defined with surface topography from the U.S. Geological Survey (U.S. Geological Survey, 2021). The volume of aquifer above the carbonate unit was divided into five model layers to simulate groundwater flow through the unconsolidated sediments. Model layers one through five range in thickness from 10 to 50 feet. Representative sections through the model domain are provided on Figure 10 to show the layering in an east-west model row (row 71) and a north-south model column (column 103) through the site.

The West and East Ponds fall within model layer 1. These model cells were simulated with a relatively low value of hydraulic conductivity (1E-04 ft/d) to represent the pond liners.

5.1.3 Model Boundaries

The outside edges of the model domain must be defined with model boundaries to describe how groundwater inside the model domain interacts with groundwater outside the model domain. Additionally, boundaries can be defined interior to the model domain to represent sources and sinks of groundwater such as pumping wells or infiltration through a pond. Exterior boundaries of the numerical model are shown on Figure 8 and include:

- Constant head boundary along the western edge of the model domain, generally aligned with Pershing Road.
- Constant head boundary along the eastern edge of the model domain, aligned with Lake Michigan.
- No-flow boundaries along the north and south edges of the model

The constant head boundary along the western edge of the model allows for groundwater from the west to flow into the model domain. The boundary was generally aligned with Pershing Road to be far enough upgradient from the site to allow the entire Midwest Generation property to be included in the model but without being directly located on the property and potentially influence model results. The constant head boundary elevation was defined between elevations of 585 and 595 feet, as 2.4 feet less than the modeled top of model layer 1 in each model cell. These elevations were determined by comparing the two upgradient-most site wells' (MW-11 and MW-14) average groundwater elevation to the elevation of the top of model layer 1, giving an average depth to water of 2.4 feet for these two locations. This depth to water is slightly less than the average depth to water in these wells as measured in the field (6 feet) but represents keeping depth to water consistent with the averaging of the surface topography into the model grid.

The constant head boundary along the eastern edge of the model allows for groundwater to discharge to Lake Michigan, consistent with the conceptualized direction of groundwater flow. The eastern constant head boundary was defined with an elevation of 575 feet from surface topographic data.

The northern and southern model boundaries were defined with no flow boundaries to represent streamlines (groundwater flow directions) as expected from the conceptualized direction of groundwater flow.

5.1.4 Model Stresses

In addition to the exterior model boundaries described in Section 5.1.3, MODFLOW boundaries and properties were used in the interior of the model domain to simulate stresses (inflows and outflows) on the groundwater system as follows:

- General head boundaries (GHB) were defined in the northern part of the model domain representing the inlet of Lake Michigan. The GHB was defined in model layer 1 at an elevation of 575 feet consistent with the constant head boundary representing Lake Michigan, and a conductance set from the dimensions of the model cells and assumed hydraulic conductivity of 50 ft/d and thickness of 1 foot.
- GHB were defined along a narrow ditch along the southern model boundary in model layer 1 to allow groundwater to discharge in this area. This is a small boundary area that has little impact on the model results. The GHB was defined at an elevation of 580 feet consistent with topographic data, and a conductance set from the dimensions of the model cells and assumed hydraulic conductivity of 50 ft/d and thickness of 1 foot.
- Recharge from precipitation was defined throughout the model domain using MODFLOW's recharge package. Recharge was simulated at approximately 1 in/yr (2.2E-04 ft/d) or approximately 3 percent MAP, consistent with the conceptual model discussion in Section 4.5.1. No recharge from precipitation was assigned below the inlet of Lake Michigan that is covered by the GHB or in the footprint of the ash ponds which are lined. Recharge up to 10 in/yr was tested during model calibration.

5.1.5 Numerical Parameters

The Preconditioned Conjugate Gradient (PCGn) package was used with MODFLOW-NWT to solve the system of equations within the model domain. The type of solver was tested in early model runs and the PCGn solver provided a stable solution in a fast computational time compared to other solvers available with MODFLOW. The solver was used with adaptive damping (ADAMP) and the XMD linear solution method (LINMETH), again to provide a stable and computationally quick solution.

Optimal settings for the PCGn with XMD were found during model calibration. Key numerical parameters were a head change closure criterion (HCLOSEXMD) of 1E-04 feet for inner iterations and 1E-05 feet for outer iterations, 2000 maximum outer iterations and 200 maximum inner iterations.

5.2 Model Calibration

The following sections describe the approach taken to calibrate the model and the results of the model calibration.

5.2.1 Approach

The groundwater flow model was first calibrated through a trial-and-error approach by adjusting hydraulic conductivity and recharge rates until the model reasonably matched field measurements. Model calibration then continued with parameter estimation techniques in PEST software (Doherty, 2010), used with pilot points within Groundwater Vistas.

Most data relied upon for model calibration were measured water levels provided by KPRG for the site wells and reported water levels in regional wells downloaded from the ISGS ILWATER database. Groundwater elevations measured in wells and piezometers are located throughout the model domain, with most being concentrated near the ash ponds. The period of measured water levels from the site wells since 2011 were averaged, having removed outliers determined from the interquartile range, and used as model calibration targets (Table 4). The data from the site wells were considered reliable and were given a target weight of 1. The regional wells typically had one reported water level from when the well was drilled. These water level measurements are much older and were considered much less reliable for model calibration, and therefore were given a target weight of 0.1. These regional wells were included to provide coverage away from the site, but only in a general sense.

In addition to calibrating to measured water levels in the wells, qualitative considerations of model calibration included:

- General groundwater flow directions, and patterns in the hydraulic gradient including a less steep hydraulic gradient beneath the ash ponds and a wide, eastward bend to the water level contours east of the ash ponds,
- General consistency in the modeled hydraulic conductivity and the field-measured hydraulic conductivity,
- General consistency in the modeled water budget with the conceptual water budget, and
- Limiting or eliminating flooding above the surface of the model.

The measure of model calibration, other than the qualitative considerations, was to minimize the calibration residual, measured as the difference between measured and modeled groundwater elevations in wells. A negative residual indicates that the modeled groundwater elevation is higher than the measured elevation, and a positive residual indicates that the modeled groundwater elevation is lower. The statistical measures of average residual, sum of squared residuals, and root mean square (RMS) error were used to objectively evaluate the calibration.

The RMS error was calculated as:

$$\mathrm{RMS} = \left[\frac{1}{n}\sum_{i=1}^{n}(h_o - h_s)^2\right]^{0.5}$$

where $h_o - h_s$ is the target residual and n is the number of observed groundwater elevation values. The RMS error is typically scaled against the range in observed groundwater elevations in the model area. A scaled RMS error of less than 10% is the standard calibration criteria that is generally considered acceptable throughout the industry (Anderson, 2015).

Initially, the lithologic intervals in borehole locations were intersected with the model grid and zones of hydraulic conductivity ("K zones") were drawn around these lithologic groups (i.e., grouped together areas of sand, areas of sand and gravel, etc). Hydraulic conductivity was defined for these K zones based on literature values and professional judgement for initial model calibration. After the basic model calibration was completed by varying the values of hydraulic conductivity and recharge, the model calibration was refined using pilot points and PEST software. The manual calibration suggested a relatively higher zone of hydraulic conductivity from west to east across the site, and lower hydraulic conductivity to the north and south. Pilot points were defined throughout model layers 1 through 5 to estimate the horizontal and vertical hydraulic conductivity values. The initial value of horizontal hydraulic conductivity was 180 ft/d, consistent with the revised estimates of hydraulic conductivity (Table 3), and initially was allowed to vary up to one-half order of magnitude, a range deemed reasonable to account for the accuracy of field-measured hydraulic conductivity. The horizontal to vertical ratio of hydraulic conductivity (the vertical anisotropy (Kh:Kv)) was initially assumed equal to 1, and could be varied up to 1000 (i.e. Kh = 1000Kv).

5.2.2 Model Calibration Results

The calibrated distribution of hydraulic conductivity in the model is shown for each model layer on Figures 11a through 11c. The calibrated model calculated groundwater level contours are shown on Figure 12. The spatial distribution of the calibration residuals is shown on Figure 13 and a scatter plot of the residuals are shown on Figure 14. The calibrated model water budget is provided in Table 5, the model calibration residuals are provided in Table 6, and the calibrated model statistics are provided in Table 7. Recharge from precipitation was simulated at approximately 1 in/yr (2.2E-04 ft/d), consistent with the conceptual model and equal to approximately 3 percent of MAP (Section 4.5.1)

5.2.2.1 Calibrated Hydraulic Conductivity

The model calibrated distribution of hydraulic conductivity ranges from 1 to 500 ft/d in model layers 1 through 5. Use of PEST software for the model calibration resulted in a krigged distribution of hydraulic conductivity rather than zones of hydraulic conductivity. A krigged surface is more applicable for the unconsolidated sediments above the carbonates because the bounds of the hydraulic conductivity zones were based on available borehole logs which include old drillers logs, thereby making the definition of zones uncertain. During the PEST calibration the lower bound of the pilot points was lowered to 1 ft/d to achieve a better calibration. The carbonate layer was modeled with hydraulic conductivity values ranging from 1 to 2 ft/d to represent moderately permeable bedrock.

The resulting distribution of horizontal hydraulic conductivity in the unconsolidated sediments has the highest values (greater than 300 ft/d) beneath the area of the ponds, in the northwestern portion of the model and in the southeastern portion of the model. The resulting vertical hydraulic conductivity values (Kv) are approximately one-half of the horizontal values (Kh), representing a vertical anisotropy ratio of 2:1 Kh:Kv, appropriate for sands, gravelly sands, and silty sands. The carbonate bedrock was not simulated with vertical anisotropy (i.e. Kh:Kv=1).

The calibrated values of hydraulic conductivity at wells MW-01, -03, and -05 were compared to the field data for these wells (Table 3). The modeled values of hydraulic conductivity for these three wells are consistent with the higher estimates of hydraulic conductivity from Patrick Engineering (Patrick Engineering, 2011), however, each well location is in an area of steeper gradient (change) in hydraulic conductivity, with significantly different values in the adjacent model cells. Averaging the calibrated model's values of horizontal hydraulic conductivity in the model cells immediately adjacent to the model cell containing the well yields average horizontal hydraulic conductivities of:

- MW-01: 108.1 ft/d,
- MW-03: 167.5 ft/d, and
- MW-05: 234.1 ft/d.

These values are consistent within one-half order of magnitude with the new estimates of hydraulic conductivity for these wells (Table 3) and show the spatial variability in modeled values of hydraulic conductivity.

The West and East Ponds were simulated with a value of hydraulic conductivity of 1E-04 ft/d, a low value to represent the liner and that allows for numerical stability and is six orders of magnitude lower than the surrounding materials.

5.2.2.2 Calibrated Water Budget

The model calibrated water budget is provided in Table 5. Groundwater flow in from the western model boundary is the largest inflow component of the modeled water budget and equals 391 af/yr (46,648 cfd), a bit higher than, but still consistent with, the conceptual water budget estimate of 307 af/yr. Calibrated recharge from precipitation equals 45 af/yr (5,353 cfd), consistent with the conceptual water budget estimate of 49 af/yr. The total, modeled inflows to groundwater is 436 af/yr (52,001 cfd).

Outflows from the groundwater model discharge to Lake Michigan. Discharges to the GHB representing the inlet on the north side of the site and the small channel to the south were added to this category. Outflows to Lake Michigan balance the inflows at 436 af/yr (51,995 cfd). This is somewhat lower than the conceptual water budget estimate of 503 af/yr but represents the balanced water budget with spatially varying hydraulic conductivity.

5.2.2.3 Statistics and Residuals

The weighted calibration residuals and modeled water level for each well are provided in Table 6. Calibration residuals for the site wells range from -0.46 feet in well MW-08 upgradient of the ash ponds to 0.87 feet in well MW-01 downgradient of the ash pond, meaning that the calibration error in the hydraulic gradient across the ash pond is just over one foot. The average residual considering all calibration targets, with weighted residuals for the regional wells, is -0.045 feet, and is -0.01 feet for the site wells (Table 7). The RMS error for all weighted calibration targets is 0.39 feet, or 2.2 percent of the change in hydraulic head across the model domain. The RMS error for the site wells is 0.34 feet, or 9.7 percent of the change in hydraulic head across the site. These results are below the recommended threshold of 10 percent for the scaled RMS error (Anderson, 2015).

The sum of squared residuals (phi) for the weighted calibration targets from the manual calibration was 173 ft^2, representing the starting point for the PEST calibration. The final, calibrated phi was 3.6 ft^2, representing a significant improvement of the calibration by the PEST software (Table 7).

The modeled water level contours and water level elevation in each calibration target (well) is shown on Figure 12. The modeled water level contours match the overall eastward groundwater flow direction shown in the groundwater flow maps presented as part of the Application for Initial Operating Permit (KPRG, 2021) as well as the gentler hydraulic gradient beneath the ash ponds. The calibration residual for each calibration target (monitoring well) are shown on Figure 13. Generally, the modeled water level is low on the downgradient southeast side of the ash pond, and high on the southwest end of the ash pond, although the magnitudes of the residuals are low. The overall model calibration to measured groundwater levels in site wells is very close, within approximately one-half foot everywhere except MW-01, which has a residual of 0.87 feet.

A scatter plot of the calibration residuals is provided for both all wells and site wells in Figure 14. In a perfect model calibration, each point would fall on a 1:1 line. Ideally deviations from the line should be balanced between high and low representing a lack of bias in the model calibration toward over- or under-prediction of the groundwater system. The calibration residuals for all wells are generally close to the 1:1 line and are very close for the site wells. The model calibration to the site wells is relatively balanced.

These results demonstrate that the model reasonably matches the overall groundwater elevations across the model domain, and the water balance reasonably represents the conceptual model of groundwater flow. The calibrated model is appropriate to use for predictive simulations.

5.3 Model Sensitivity

A sensitivity analysis was conducted as part of the model calibration. Calibrating the numerical model was an exercise of fine-tuning the heterogeneity and distribution of the horizontal and vertical hydraulic conductivity values and the recharge to match measured water levels in the wells. During the PEST and manual trial-and-error calibration model runs, the model was the most sensitive to the values of hydraulic conductivity. The model calibration was particularly sensitive to the hydraulic conductivity values near the ash ponds, and to the north of the ash ponds, which is expected based on the placement of calibration targets and the inlet to Lake Michigan north of the site. The model calibration was also sensitive to the hydraulic conductivity of the underlying bedrock unit, and a moderately permeable value of hydraulic conductivity improved the model calibration to the site wells. The bedrock unit is not expected to be an important part of the flow system of any potential releases of constituents from the ash ponds, given the high permeability of the unconsolidated sediments beneath the ponds and the dominant, horizontal flow direction toward the regional boundary of Lake Michigan.

The model calibration is sensitive to the recharge rate, but to a lesser extent than it is to hydraulic conductivity. Two sensitivity model runs were conducted specifically to test the calibrated model's sensitivity to the simulated recharge rates:

- Recharge sensitivity run #1: the background recharge was increased from 3 percent of MAP to 9 percent of MAP. In this model, the modeled water level in all calibration targets became over estimated (too high) and the scaled RMS error increased from 9.7 percent to 18.5 percent.
- Recharge sensitivity run #2: the ash ponds were simulated with a recharge rate 20 times higher than the calibrated model's background recharge rate to test if the model would calibrate better with leakage from the ash ponds. In this model, the modeled water levels in all calibration targets became over estimated (too high) and the scaled RMS error increased from 9.7 percent to 14.5 percent.

The recharge sensitivity model runs show that the model calibration with the calibrated distribution of hydraulic conductivity is not improved with an increase in recharge.

6.0 PREDICTIVE MODEL SIMULATIONS

Four predictive model runs were conducted of various closure alternatives for the ash ponds. Transport modeling was performed using the software MT3D-USGS, a widely used and accepted version of the MT3D software designed to be compatible with MODFLOW-NWT.

The calibrated, steady state groundwater flow model was used as the basis for a 100-year transport simulation of a surrogate constituent from the ash ponds. As described earlier, water quality data do not indicate that the ash ponds are a contributing source of mass to groundwater. Therefore, in order to provide a platform upon which to evaluate potential closure alternatives, a hypothetical release from the ponds was established. The hypothetical release assumes that the ash ponds are full of ash and water and that the liners are fully compromised or non-existent. An initial distribution of a hypothetical surrogate mass was applied to the model grid as the initial concentrations in the scenarios. This initial distribution was determined from a 100-year transport simulation of the hypothetical surrogate mass, simulated with a relative concentration of “1” within the ash ponds. The hypothetical source concentrations at the ash ponds travelled through the steady state, calibrated flow model, by advection and dispersion to create an equilibrated distribution of concentrations that were the starting point for the predictive scenarios.

The source concentrations of the surrogate constituent were applied to both the West and East Ponds in model layer 1, representing the approximate bottom elevations of the ponds. A dispersity value of 1 foot was assumed in all directions. A uniform value of specific yield of 20 percent was assumed along with an effective porosity of 35 percent.

The resulting distribution of the hypothetical surrogate constituent at 100 years is shown on Figure 15. Groundwater beneath the Ash Ponds has a concentration of “1” (100 percent), decreasing to approximately 70 to 90 percent by Lake Michigan. Hypothetical monitoring points were placed between the ash ponds and Lake Michigan to show the modeled changing concentrations over time. Concentrations from this hypothetical situation are highest downgradient of monitoring wells MW-01 and MW-02 and are highest in the upper model layers representing the shallower materials. Hypothetical concentrations stabilize at all locations within approximately 10 to 30 years in the shallow deposits.

6.1 Post-Closure Scenarios

Four post-closure scenarios were simulated:

1. Closure by removal: In this model scenario, the source of mass at the ash ponds was removed, along with the liners. Background recharge was assigned to the pond footprints. The groundwater flow model was run in steady state and the transport model was simulated for 100 years.
2. Closure by removal: In this model scenario the source of mass at the ash ponds was removed, along with the liner beneath the East Pond. Background recharge was assigned to the footprint of the East Pond. It was assumed that the West Pond would continue to have a liner with a low vertical permeability

(approximately 1E-13 centimeters per second (cm/s)). The low vertical permeability was not simulated directly but rather the recharge assigned to the West Pond was reduced five orders of magnitude from the background recharge assigned elsewhere in the model. The groundwater flow model was run in steady state and the transport model was simulated for 100 years.

3. Closure by capping: In this model scenario the source of mass was assumed to remain in the ash ponds but was hydraulically isolated from the water table by dewatering of the ash and placement of a cap over the West and East Ponds with the presence of the existing liners. This was simulated by removing the source from the model and assigning recharge at a rate five orders of magnitude lower than the background recharge assigned elsewhere in the model. The groundwater flow model was run in steady state and the transport model was simulated for 100 years.
4. Closure by removal (West Pond), Closure by capping (East Pond): In this model scenario the source of mass at the West Pond was removed and it was assumed that the liner would remain. Recharge was assigned to the West Pond at a rate five orders of magnitude lower than the background recharge to account for the liner. It was assumed that the remaining source in the East Pond would be hydraulically isolated from the water table through dewatering of the ash and placement of a cap, which was simulated by removing the source and assigning a low recharge rate set to five orders of magnitude lower than the background recharge rate assigned elsewhere in the model. The groundwater flow model was run in steady state and the transport model was simulated for 100 years.

6.2 Results

Scenario 1. Closure by removal.

The results of Scenario 1 are shown on Figures 16 through 18. The results of this model scenario indicate that if the mass source is removed from the Ash Ponds, even without maintaining a liner, that concentrations in groundwater beneath the site will be significantly reduced within the first five years (to relative concentrations below approximately 20 percent). The hypothetically introduced impacts should be flushed through the system immediately east of the ponds within 10 to 30 years, depending on the exact location, from pond closure activities. Within 25 years, relative concentrations of less than approximately 50 percent of the hypothetical release will only remain in the small area northeast of the ash ponds, and within 100 years, this area will be reduced to below 1 percent. The model indicates that the hypothetically introduced source has moved completely through the flow system in the area directly east of the ash ponds within about 30 years.

Scenario 2. Closure by removal.

The results of Scenario 2 are shown on Figures 19 through 21. The results of this model scenario are very similar to Scenario 1, as expected because the application of the scenario details to the model only results in a difference of the recharge rate through the West Pond. The movement of the mass from the ash ponds follows the same general direction toward Lake Michigan.

Scenario 3. Closure by capping.

The results of Scenario 3 are shown on Figures 22 through 24. The results of this model scenario are very similar to Scenarios 1 and 2. Hydraulically isolating the remaining source mass from the water table was accomplished in the model by removing the source boundary condition (dewatering the ash and including a liner and cap), therefore, in practice, Scenario 3 is very similar to Scenarios 1 and 2. The movement of the mass from the ash ponds follows the same general direction toward Lake Michigan.

Scenario 4. Closure by removal (West Pond) and Closure by capping (East Pond).

The results of Scenario 4 are shown on Figures 25 through 27. The results of this model scenario are very similar to Scenarios 1 through 3, because this scenario simulates a combination of the components of Scenarios 1 through 3. Hydraulically isolating the remaining source mass in the East Pond from the water table (dewatering the ash, including a liner and placement of a cap) was accomplished in the model by removing the source boundary condition, therefore, in practice, Scenario 4 is very similar to Scenarios 1 through 3. The movement of the mass from the ash ponds follows the same general direction toward Lake Michigan.

7.0 CONCLUSIONS

A numerical groundwater flow model was created for the vicinity of the East and West Ash Ponds at the Waukegan Station. The model was calibrated to current water levels in site wells to replicate the groundwater flow patterns beneath the site. Groundwater flow paths from the ash ponds are to the east toward Lake Michigan. Since existing groundwater monitoring data indicates that the ponds are not leaking, to accomplish the modeling requirements of part 845.220(d)(3), a hypothetical source of groundwater impacts was introduced beneath the two ponds. The source assumed that both ponds were full of ash and water with fully compromised liners (essentially no liner). A surrogate constituent was simulated at the ash ponds and allowed to leach downward to the groundwater system. The surrogate mass travelled with the groundwater flow paths toward Lake Michigan. This hypothetical distribution of mass served as the initial concentrations to predictive scenarios of pond closure alternatives. The site data in upgradient and downgradient monitoring wells do not suggest that the ash ponds are the source of the elevated constituents that have been measured in the groundwater and in fact there are no exceedances of the proposed GWPSs for this site and nearly all CCR parameters measured in monitoring wells immediately downgradient of the ash ponds are below the Part 845.600(a) groundwater quality standards which are based on the Part 620 Class I drinking water standards. The predictive modeling begins with a hypothetical case in which the ponds have been freely discharging contaminants to groundwater. The predictive scenarios then illustrate the relative reduction in the mass concentrations in groundwater as a result of the various closure alternatives being evaluated.

Four predictive scenarios were modeled to evaluate the relative effects of removing the hypothetical source, hydraulically isolating the source by dewatering of the ash and the inclusion of both a liner and cap, or a combination of both. The results of the four predictive scenarios are similar, as expected because the closure conditions are similar in that hydrogeologically the source is essentially removed either through direct removal of ash or isolation of the ash from the underlying groundwater system though dewatering and inclusion of a liner and cap. In all scenarios, the initial distribution of the hypothetical dissolved mass in groundwater was quickly reduced, and directly east of the ponds the hypothetically introduced mass completely flushed through the system within 20 to 35 years.

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Signature Page

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TABLES

Table 1: Precipitation Data near Waukegan Station

Month	Average Monthly Precipitation (inches)[1,2]
January	1.66
February	1.20
March	2.35
April	3.94
May	3.61
June	3.77
July	3.78
August	3.30
September	3.62
October	2.93
November	2.55
December	2.00
Average Annual Precipitation[1]	32.6

Notes:

[1]Data were averaged for the periods of complete records available for stations: Waukegan 2.2 E IL, Waukegan IL, and Waukegan No.2

[2]Periods of complete records were determined as months with 5 or less missing days and years without months with more than 5 missing days

Table 2: Compiled Borehole Lithology

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft bgs	ft bgs		
120974156100	0	5	gray sand loam w/gravel fill	loam
120974156100	5	7	mucky black sandy loam w/fibers	loam
120974156100	7	9	medium dense fine grained brown sandy loam	loam
120974156100	9	11	very dense medium grained brown sand	sand
120974156100	11	14	very dense fine to medium grained gray sandy loam	loam
120974156100	14	16.5	medium dense fine grained gray sandy loam	loam
120974156100	16.5	25.5	very dense fine to medium grained gray sand	sand
120974156100	25.5	26	very dense gray silty loam	loam
120974156700	0	3.5	black cinders fill	fill
120974156700	3.5	4.5	brown gravel fill w/broken concrete	fill
120974156700	4.5	7	very loose brown cinders fill	fill
120974156700	7	9.5	very loose brown peat	peat
120974156700	9.5	12	loose fine grained brown sand loam	loam
120974156700	12	17	very dense fine grained gray sand	sand
120974156700	17	19.5	dense fine grained gray sand	sand
120974156700	19.5	24.5	very dense fine grained gray sand	sand
120974156700	24.5	26.5	hard pebbly gray silt loam till	loam
120974156800	0	6.5	very loose cinders fill	fill
120974156800	6.5	9.5	very loose sandy fill	fill
120974156800	9.5	11.5	loose medium grained brown sand loam	loam
120974156800	11.5	14	medium dense fine grained gray gravel	sand
120974156800	14	16.5	dense fine to medium grained brown sand	sand
120974156800	16.5	19.5	medium dense fine grained brown sand	sand
120974156800	19.5	21.5	loose fine grained brown sand	sand
120974156800	21.5	24	very dense fine to medium grained brown sand	sand
120974156800	24	26	very dense gray silt	silt and clay
120974156500	0	9.5	very loose black cinders fill	fill
120974156500	9.5	12	very soft brown peat	peat
120974156500	12	14.5	medium dense fine grained gray sand	sand
120974156500	14.5	19.5	very dense fine to medium grained gray sand	sand
120974156500	19.5	22	dense fine to medium grained brown sand	sand
120974156500	22	26.5	very dense fine to medium grained brown sand	sand
120974156600	0	6.5	very loose black cinders fill	fill
120974156600	6.5	9	very loose brown sand loam	loam
120974156600	9	11.5	loose brown sand loam	loam
120974156600	11.5	14	medium dense medium grained brown sand	sand
120974156600	14	16.5	dense medium grained brown sand	sand
120974156600	16.5	19	very dense medium grained brown sand	sand
120974156600	19	21.5	medium dense medium grained brown sand	sand
120974156600	21.5	24	hard pebbly gray silty clay loam till	loam
120974156600	24	26	hard gray silt loam	loam
120974157200	0	1.5	cinder & fly ash fill	fill
120974157200	1.5	4.5	loose red cinders fill	fill
120974157200	4.5	7.5	loose brown & black cinder fill	fill
120974157200	7.5	12.5	medium dense brown sandy loam	loam
120974157200	12.5	22.5	dense brown sand	sand
120974157200	22.5	23.5	dense gray silt loam	loam
120974157300	0	7	very loose cinders fill	fill
120974157300	7	9.5	medium dense brown sand	sand
120974157300	9.5	12	loose brown sand	sand
120974157300	12	14.5	dense brown sand	sand
120974157300	14.5	17	medium dense brown sand	sand
120974157300	17	19.5	very dense brown sand	sand
120974157300	19.5	26.5	very dense gray silt	silt and clay
120974156900	0	1	black cinders fill	fill
120974156900	1	6	very soft black peat	peat
120974156900	6	9.5	loose fine grained gray sand loam	loam
120974156900	9.5	12	medium dense fine grained gray sand loam	loam
120974156900	12	14.5	very dense fine to medium grained gray sand	sand
120974156900	14.5	17.5	dense fine to medium grained gray sand	sand
120974156900	17.5	19.5	hard pebbly gray silty clay	silt and clay

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft bgs	ft bgs		
120974156900	19.5	26.5	hard gray silt loam	loam
120974157000	0	7.5	loose black cinders & fly ash fill	fill
120974157000	7.5	10	very loose brown cinder fill	fill
120974157000	10	12.5	loose black organic sandy loam mixed with cinders	loam
120974157000	12.5	17.5	medium dense brown sandy loam with some cinders inter mixed	loam
120974157000	17.5	22.5	dense brown sand	sand
120974157000	22.5	25	very dense brown sand	sand
120974157000	25	27.5	very dense gray silt loam	loam
120974157000	27.5	30	hard gray silt loam	loam
120974157000	30	32	very dense gray silt loam	loam
120970172800	0	30	sand	sand
120970172800	30	55	hardpan	hardpan
120970172800	55	105	clay, blue	clay
120970172800	105	108	sand	sand
120970172800	108	108	rock at	bedrock
120970172900	0	34	sand	sand
120970172900	34	55	hardpan	hardpan
120970172900	55	98	clay, blue	clay
120970172900	98	112	sand & gravel	sand and gravel
120970172900	112	127	rock	bedrock
120974157100	0	7.5	black cinder fill	fill
120974157100	7.5	9.5	very soft black & brown muck w/sand seams	clay
120974157100	9.5	17.5	medium dense brown sand	sand
120974157100	17.5	20	dense brown sand	sand
120974157100	20	24	medium dense brown sand	sand
120974157100	24	27	very dense gray silt loam	loam
120974156400	0	3.5	black cindery fill	fill
120974156400	3.5	7	medium dense brown sandy loam topsoil	topsoil
120974156400	7	14	medium dense fine grained brown sandy loam	loam
120974156400	14	20	dense fine to medium grained brown sand	sand
120974156400	20	25	very dense fine grained brown sand	sand
120974156400	25	32	hard gray silty loam	loam
120974120400	112	840	limestone	carbonates
120973561700	0	12	light brown, fine/medium sand	sand
120973561700	12	15	gray, fine/medium sand w/fine gravel	sand
120973561800	0	5	black fine/medium sand	sand
120973561800	5	13	brown fine/medium sand	sand
120974802700	0	2	Silty sand, trace clay and organic matter, dark gray, moist, loose	sand
120974802700	2	6	Fine to medium sand, trace gravel - brown, wet, medium dense	sand
120974802700	6	13	Fine to medium sand, trace gravel - brown to brown-gray - wet - dense to very dense	sand
120974802800	0	4	Fill	fill
120974802800	4	10	Fine to medium sand, wet, medium	sand
120974802800	10	17	Fine to medium sand, trace gravel, very dense	sand
120973562100	0	23	gray fine/medium sand	sand
120973562100	23	40	gray very fine sand & silt	sand
120974645500	0.5	1	sand, dark gray	sand
120974645500	1	6	silty clay, gray, tough	silt and clay
120974645500	6	11	silt, trace gravel & clay, gray, hard(estimated),moist to wet	silt and clay
120974645500	11	38	silty & sandy clay, trace gravel, with horizontal seams of sand & light gray silt	clay, sand
120974645500	38	41	silty, very fine sand, gray, hard(estimated),moist	silt and clay
120973561900	0	4	black fine/medium sand w/debris fill mat	fill
120973561900	4	14	brown fine/medium sand	sand
120973562000	0	14	fine/med grayish sand w/trace of gravel	sand
120970264200	0	4.5	black cinders fill	fill
120970264200	4.5	6	soft black peat	peat
120970264200	6	12	medium dense fine to medium grained gray sand loam	loam
120970264200	12	14.5	dense medium grained gray sand	sand
120970264200	14.5	17	very dense medium grained brown sand	sand
120970264200	17	19.5	medium dense medium grained brown sand	sand
120970264200	19.5	22	very dense medium grained brown sand	sand
120970264200	22	26.5	hard gray silt loam	loam
120975335000	0	1	Miscellaneous fill	fill
120975335000	1	38	Gray silty clay till, horizontal seams of silt and fine sand tough to hard	silt and clay
120975335000	38	41	Gray, silty, very fine sand	sand

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft bgs	ft bgs		
120974646200	0.5	18	fine to medium sand, trace gravel,& silt, brown & slightly gray, dense to very dense, moist to wet	sand
120974646200	18	42	silty clay, trace to some sand, trace gravel, with pockets of light gray silt, hard	silt and clay
120970173400	0	112	lake sand	sand
120970173400	112	303	lime hard	carbonates
120970173400	303	320	red rock	carbonates
120970173400	320	365	lime sandy, water here	carbonates
120970173400	365	550	shale blue	shale
120975335100	0	8	Gray fine, sand, fill trace clay	fill
120975335100	8	16	Gray, fine sand, trace clay	sand
120975335100	16	21	Gray brown, fine sand, trace silt and gravel, medium dense	sand
120974801200	0	14	Fill	fill
120974750300	0	9.5	black-brown fine to coarse sand w/fine gravel	sand and gravel
120974799000	0	5	fill	fill
120974799000	7	11	sand	sand
120974799000	11	13	sand and gravel	sand and gravel
120974799000	13	17	sand	sand
120974799000	17	23	sand and gravel	sand and gravel
120974799100	10	25	sand	sand
120974799900	0	0.5	Silty clayey topsoil, trace roots and sand	topsoil
120974799900	0.5	2	Fine to med. sand, trace to some gravel, silt, clay	sand
120974799900	2	6	Fine to medium sand, trace silt, organic material	sand
120974799900	6	9.5	Fine to med. sand, trace silt, gravel	sand and gravel
120974799900	9.5	18	Fine to medium sand trace silt	sand
120974799900	18	26.5	Fine sand, trace silt	sand
120974800000	0	1	topsoil	topsoil
120974800000	1	9.5	Fine sand, trace silt, and gravel	sand
120974800000	9.5	18.5	sand and gravel	sand and gravel
120974800000	18.5	26.5	sand, silt, gravel	dirty sand and gravel
120974799500	0	3.5	topsoil	topsoil
120974799500	3.5	8.5	sand and silt	sand
120974799500	8.5	18	sand and gravel	sand
120974799500	18	26.5	sand and silt	sand
120974799600	0	0.5	topsoil	topsoil
120974799600	0.5	18	sand and gravel	sand and gravel
120974799600	18	26.5	sand and silt	sand
120974800300	0	0.5	topsoil	topsoil
120974800300	2	3.5	sand and organic materials	sand
120974800300	3.5	9.5	sand	sand
120974800300	9.5	18.5	sand and gravel	sand and gravel
120974800300	18.5	26.5	sand and silt	sand
120974800400	0	1	topsoil	topsoil
120974800400	1	2	sand	sand
120974800400	2	26.5	sand and gravel	sand and gravel
120974800100	0	0.5	topsoil	topsoil
120974800100	0.5	3	cinder and clay	fill
120974800100	3	18.5	sand and gravel	sand and gravel
120974800100	18.5	27	sand and silt	sand
120974753700	0	9	sludge, brick, concrete (6.5-9 moist)	fill
120974753700	9	13	wood	fill
120974753700	13	15.5	sand, fine, black, waterbearing	sand
120974754200	0	14	sludge	fill
120974754200	14	20	sludge, moist w/wet lense like areas	fill
120974754200	20	22.8	gravel fine to medium, fill	sand and gravel
120974754200	22.8	23	shingles	sand and gravel
120974754200	23	29	shingles, gravel, sludge	sand and gravel
120974754200	29	30.5	sand, fine, black, waterbearing	sand
120970173700	0	166	drift	sand
120970173700	166	174	rock	bedrock
120970173500	0	95	drift rock at 95'	sand
120970173500	95	95	drift rock at 95'	sand
120970173200	0	95	drift rock at 95'	sand
120970173200	95	95	drift rock at 95'	sand
120970173300	0	100	drift	sand

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft bgs	ft bgs		
120970173300	100	101	rock	carbonates
120974805200	0.5	13.5	fill	fill
120974805200	13.5	16.5	peat	peat
120974805200	16.5	18.5	sand and clay	clay, sand
120974805200	18.5	25.5	sand and silt	sand
120974805200	25.5	27	silt, clay, and sand - wet	clay, sand
120974799800	0	1	topsoil	topsoil
120974799800	1	24	sand and gravel	sand and gravel
120974799800	24	41.5	sand and silt	sand
120974751900	0	29	sand	sand
120974751900	29	40	sand and clay	clay, sand
120974758100	0	11	sand and gravel	sand and gravel
120974758100	11	31.5	sand and gravel - Saturated	sand and gravel
120974758100	31.5	34	silt and gravel	dirty sand and gravel
120974758100	34	36	clay, gravel, and silt	clay, sand, gravel
120974755700	0	8	gray, fine sand, fill trace clay	sand
120974755700	8	16	gray, fine sand, trace clay	sand
120974755700	16	21	Gray brown, fine sand, trace silt and gravel, medium dense	sand
120974755800	0	1	topsoil	topsoil
120974755800	1	31	sand and gravel	sand and gravel
120974755800	31	43	clay and gravel	clay, sand, gravel
120974759000	0	3.5	fill	fill
120974759000	3.5	23	sand and gravel	sand and gravel
120974759000	23	38.5	sand and silt	sand
120974759000	38.5	40	silt and clay	silt and clay
120974758800	0	23	sand	sand
120974758800	23	39.5	sand and silt	sand
120974759500	0	4	fill	fill
120974759500	4	39.5	sand and gravel	sand and gravel
120974759500	39.5	40.2	silt and clay	silt and clay
120974759200	0	3	fill	fill
120974759200	3	15	sand and gravel	sand and gravel
120974753500	0	16.5	sludge	sand
120974753500	16.5	19	sand, fine, shingle sand, moist	sand
120974753500	19	26.5	sludge, moist	sand
120974753500	26.8	28	sludge w/2" layer of shingle sand	sand
120974753500	28	31.5	sludge	sand
120974753500	31.5	34	sludge, marl, sand, layered	sand
120974753500	34	35.5	sand & gravel layers, black	sand and gravel
120974753600	0	2.5	road gravel, cinders	fill
120974753600	2.5	5	sand fine to medium, black, waterbearing	sand
120974753600	5	9	sand fine to medium, tan, waterbearing	sand
120974753600	9	14	sand fine to medium & gravel fine to medium, waterbearing	sand
120974753600	14	37	sand fine to medium, waterbearing	sand
120974753600	37	39.5	sand fine to very fine, silty, waterbearing	sand
120974753600	39.5	40	clay, occasional stone, gray	clay
120974755000	0	0.5	asphalt	fill
120974755000	0.5	3	fill-tan/brown silty sand w/some gravel	fill
120974755000	3	5	fill-gray silty clay w/gravel	fill
120974755000	5	15	gray fine silty sand w/trace gravel	sand
120974753400	0	9	sludge, fiber	sand
120974753400	9	26.5	sludge, fiber, moist	sand
120974753400	26.5	30.5	sand, black tar like w/some stones & service board	sand
120974750500	0	1.5	cinder fill material	fill
120974750500	1.5	10	light gray-green fine to medium sand	sand
120974758000	0	2.5	silt and clay	silt and clay
120974758000	2.5	6	sand	sand
120974758000	6	15	sand and gravel	sand and gravel
120970173000	0	30	sand	sand
120970173000	30	55	hardpan	hardpan
120970173000	55	102	clay, blue	clay
120970173000	102	115	sand & gravel	sand and gravel
120970173000	115	132	rock	carbonates
120970173100	0	50	sand	sand

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft bgs	ft bgs		
120970173100	50	60	hardpan	hardpan
120970173100	60	97	clay, blue	clay
120970173100	97	115	sand & gravel	sand and gravel
120970173100	115	132	rock	carbonates
MW-01	0	13.5	FILL: Brown fine sand, fine gravel, black, cinders, ash	fill
MW-01	13.5	16	FILL: Light Brown fine and medium sand, dry	fill
MW-01	16	18	FILL: Occasional black coal, cinders	fill
MW-01	18	20	FILL: Brown fine sand, occasional black cinders	fill
MW-01	20	25	SM: Light brown fine sand, trace medium sand, medium dense, moist	sand
MW-01	25	29	SM: Trace fine gravel	sand and gravel
MW-01	29	32	SM: Fine Sand, trace coarse to medium sand, medium dense, saturated	sand
MW-02	0	11	FILL: Black coal cinders, ash, fine sand, fine gravel, gray silt	fill
MW-02	11	18.5	SM: Light brown fine sand, gray fine sand	sand
MW-02	18.5	21.5	SM: Light brown fine sand, trace medium sand, well graded	sand
MW-02	21.5	24.5	SM: Medium dense, dry	sand
MW-02	24.5	30	Trace fine gravel and coarse sand	sand and gravel
MW-03	0	7	FILL: Brown silty sand, fine gravel, black coal cinders, ash	fill
MW-03	7	15	FILL: Gray silt, cinders, ash, sand	fill
MW-03	15	16	FILL: Light brown fine sand	fill
MW-03	16	18.5	FILL: Black coarse coal cinders	fill
MW-03	18.5	20	SM: Light Brown fine sand	sand
MW-03	20	24	SM: Light brown fine sand, trace medium sand, well graded, medium dense	sand
MW-03	24	30	SM: Trace fine gravel	sand and gravel
MW-04	0	9	FILL: Dark brown silt, coarse gravel, black coal cinders, dry	fill
MW-04	9	13	FILL: Wood, gray silt, cinders, dry	fill
MW-04	13	15	FILL: Some medium sand	fill
MW-04	15	18.5	FILL: Cinders mixed with brown fine sand	fill
MW-04	18.5	29.58	SM: Light brown fine sand, well graded, medium dense	sand
MW-04	29	30	SM: Trace fine gravel, trace coarse sand	sand and gravel
MW-05	0	0.5	FILL: Dark brown silty clay topsoil	fill
MW-05	0.5	7	FILL: Brown fine to medium sand, with black coal cinders	fill
MW-05	7	9	FILL: Loose	fill
MW-05	9	11	FILL: Brick	fill
MW-05	11	14	FILL: Black coal cinders	fill
MW-05	14	16	FILL: Dark gray silt	fill
MW-05	16	17	FILL: Gray medium sand, black coal cinders	fill
MW-05	17	21	SM: Gray fine sand, trace medium to coarse sand, well graded, loose to medium dense, saturated	sand
MW-05	21	26	GP: Gray fine gravel, coarse sand, poorly graded, medium dense, saturated	sand and gravel
MW-05	26	31.92	SM: Gray fine sand, trace medium sand, trace fine gravel, well graded, medium dense	sand
MW-06	0	2	FILL: Dark brown silty clay, slightly moist	fill
MW-06	2	3.5	FILL: Brown to dark brown fine silty sand, moist	fill
MW-06	3.5	5	Black SILTY SAND, organics, slightly moist	sand
MW-06	5	20	Brown medium to fine grained SILTY SAND. Wet at 7 feet. Some coarse sand	sand
MW-07	0	5	FILL: Brown to dark brown clay, black medium grained sand with some reddish and gray layers, some silty layers, slightly moist	fill
MW-07	5	9.5	FILL: Tan fine to medium grained sand with thin black layers	fill
MW-07	9.5	10.5	FILL: Gray silt with thin banding light to dark, slightly moist	fill
MW-07	10.5	14	Black CLAYEY SILT with organics, soft, wet	silt and clay
MW-07	14	25	Brown fine to medium grained SAND with traces of silt, slightly moist. Wet at 17.5 feet. Some coarse gravel	sand
MW-08	0	1	Topsoil	topsoil
MW-08	1	3	FILL: Gray SILT with traces fine sand, very moist	fill
MW-08	3	4	FILL: Brown SILT with black sandy SLAG layered	fill
MW-08	4	5	FILL: Greenish gray SILTY SAND - thin slag layer	fill
MW-08	5	7	Black SILT and CLAY, wet	silt and clay
MW-08	7	8	PEAT	peat
MW-08	8	14	Gray SILTY SAND, fine to coarse grained, wet	sand
MW-08	14	18	Brown SILTY SAND, fine to medium grained	sand
MW-09	0	0.5	FILL: Black Clay/Silt/Fine grained Sand mix, moist	fill
MW-09	0.5	4	FILL: Gray Silt, dry	fill
MW-09	4	6	FILL: Begin dark gray	fill
MW-09	6	9.5	FILL: Black slag	fill

Well Name/Identifier	From[1]	To[1]	Description	Lithology Group
	ft bgs	ft bgs		
MW-09	9.5	10.5	Peat, black silty clay with organics, wet	clay
MW-09	10.5	13	light gray silty sand, fine to medium grained with trace coarse grained, organics	sand
MW-09	13	18	brown silty sand, fine to medium grained with trace coarse grained	sand
MW-16	0	0.5	FILL: Dark brown clayey top soil, dry	fill
MW-16	0.5	1	FILL: Brown Sand/Silt/gravel mix, dry	fill
MW-16	1	2.5	FILL: Brown Silty Sand, slightly moist	fill
MW-16	2.5	9	FILL: Brown and dark gray silt, and fine sand, some cinders, slightly moist	fill
MW-16	9	11	FILL: Orange brown SILTY SAND, medium grained, slightly moist	fill
MW-16	11	16	FILL: Dark Brown to Black SAND, fine to medium, cinders, trace silt, slightly moist	fill
MW-16	16	17	FILL: Tan SILTY SAND, with gray SILT layers, slightly moist	fill
MW-16	17	18	FILL: Gray SILT, some black, very moist	fill
MW-16	18	24	FILL: Black SAND, fine to medium, cinders, slightly moist	fill
MW-16	24	30	Brown SILTY SAND, fine to medium, moist	sand

Notes:

[1]Depth intervals in feet below ground surface

Table 3: Hydraulic Conductivity Data for Site Wells

Well Name	Screened Depth	Screened Geology	Test Name	2011 Hydraulic Conductivity Estimate		2021 Hydraulic Conductivity Estimate	
	ft bgs			ft/s	ft/d	ft/s	ft/d
MW-1	22-32	Sandy Gravel	D1	3.73E-03	320	1.73E-03	150
			U2	4.41E-03	380	1.96E-03	170
MW-3	20-30	Sandy Gravel	D2	4.35E-03	380	1.90E-03	160
			U3	3.67E-03	320	1.62E-03	140
MW-5	18.5-28.5	Sandy Gravel	U3	4.14E-03	360	1.85E-03	160
			D3	3.95E-03	340	1.76E-03	150

Notes:
ft bgs = feet below ground surface
ft/d = feet per day
ft/s = feet per second

Table 4: Groundwater Elevation Data

	Site Wells														
	MW-01	MW-02	MW-03	MW-04	MW-05	MW-06	MW-07	MW-08	MW-09	MW-10	MW-11	MW-12	MW-14	MW-15	MW-16
Groundwater Elevation:															
Minimum (ft)	579.42	579.27	579.45	579.34	580.65	580.89	579.57	582.96	583.17	583.83	583.69	583.68	584.17	581.32	579.08
Maximum (ft)	584.19	584.27	584.30	584.29	584.63	584.56	584.35	584.05	584.62	584.86	585.18	584.61	586.04	583.19	584.19
1st Quartile (ft)	581.32	581.23	581.22	581.19	582.22	582.71	580.60	582.98	583.74	583.85	584.49	583.70	584.67	581.48	579.92
3rd Quartile (ft)	582.81	582.84	582.90	582.82	583.47	583.82	583.02	584.04	584.42	584.83	584.98	584.60	585.66	583.18	583.59
IQR (ft)	1.49	1.61	1.68	1.63	1.25	1.11	2.42	1.06	0.68	0.99	0.50	0.89	0.99	1.70	3.67
Lower Bound (ft)	579.09	578.82	578.69	578.75	580.35	581.04	576.96	581.40	582.72	582.36	583.74	582.36	583.19	578.93	574.40
Upper Bound (ft)	585.05	585.26	585.43	585.26	585.34	585.48	586.66	585.63	585.44	586.31	585.72	585.93	587.15	585.72	589.10
Average (ft)[1]	582.11	582.09	582.10	582.03	582.85	583.23	581.86	583.52	584.05	584.33	584.73	584.15	585.13	582.40	581.61

	Regional Wells[2]							
	4754200	4759500	4803300	3561700	3562100	3562000	3561900	3561800
Groundwater Elevation:								
Water Level (ft)	584	567	574	576	579	579	579	580
Measurement Date	9/13/84	10/28/88	12/28/72	12/1/89	11/30/89	11/30/89	11/30/89	11/30/89

Notes:

ft = feet

IQR = Interquartile range

[1]The calculated average water level was used as the calibration head target in the numerical groundwater flow model

[2]The regional well identification numbers begin with "12097"

The water levels for the site wells span the period 2011 through 2020. The regional wells had one water level reported with the well drilling log.

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Table 5: Calibrated Water Budget

Component	Conceptual Flux	Modeled Flux	
	af/yr	af/yr	cfd
INFLOWS			
Recharge	49	45	5,353
Eastern flow	307	391	46,648
Total Inflows		436	52,001
OUTFLOWS			
Discharge to Lake Michigan	503	436	51,995
Total outflows		436	51,995

Notes:

af/yr = acre-feet per year

cfd = cubic feet per day

Table 6: Calibration Residuals

Well	Easting	Northing	Target Value[1]	Weight	Modeled Water Level	Residual[2]
	NAD83, State Plane, IL East, ft		ft		ft	ft
MW-01	1125118.24	2080965.37	582.11	1	581.24	0.87
MW-02	1124929.8	2080733.97	582.09	1	582.41	-0.32
MW-03	1124846.31	2080479.24	582.10	1	581.66	0.44
MW-04	1124772.02	2080263.94	582.03	1	581.51	0.52
MW-05	1123826.78	2080582.58	582.85	1	583.27	-0.42
MW-06	1123386.48	2080372.77	583.23	1	583.39	-0.16
MW-07	1123881.57	2080048.8	581.86	1	581.81	0.05
MW-08	1123374.93	2080860.59	583.52	1	583.98	-0.46
MW-09	1123625.91	2081124.03	584.05	1	583.84	0.21
MW-10	1122891.19	2081300.18	584.33	1	584.71	-0.37
MW-11	1122742.19	2081932.65	584.73	1	585.07	-0.34
MW-12	1123291.63	2081281.2	584.15	1	584.25	-0.10
MW-14	1122699.62	2081299.02	585.13	1	584.91	0.22
MW-15	1123442.11	2080124.02	582.40	1	582.67	-0.27
MW-16	1124340.91	2080096.96	581.61	1	581.61	-0.002
120973561700	1126655.61	2084076.3	576.00	0.1	577.77	-0.18
120973561800	1126679.83	2084091.03	580.00	0.1	577.64	0.24
120973561900	1126679.83	2084091.03	579.00	0.1	577.64	0.14
120973562000	1126677.75	2083424.45	579.00	0.1	576.83	0.22
120973562100	1126642.78	2083356.45	579.00	0.1	576.88	0.21
120974754200	1124668.54	2084203.28	584.00	0.1	583.92	0.01
120974759500	1126939.83	2084076.61	567.00	0.1	575.88	-0.89
120974803300	1123719.07	2078968.83	574.00	0.1	580.50	-0.65

Notes:

ft = feet

[1]The target value for site-specific wells is the long-term average of measured water levels, discounting outliers, and for regional wells is the reported water level in well logs

[2]The residual for the regional (non-site) wells represents the weighted value

Table 7: Calibration Statistics

Parameter	All Wells[1]	Site Wells
Average Residual (ft)	-0.045	-0.009
Minimum Residual (ft)	-0.888	-0.464
Maximum Residual (ft)	0.873	0.873
Sum of Squared Residuals (ft^2)	3.6	1.7
RMS Error (ft)	0.39	0.34
%RMS[2]	2.2%	9.7%

Notes:

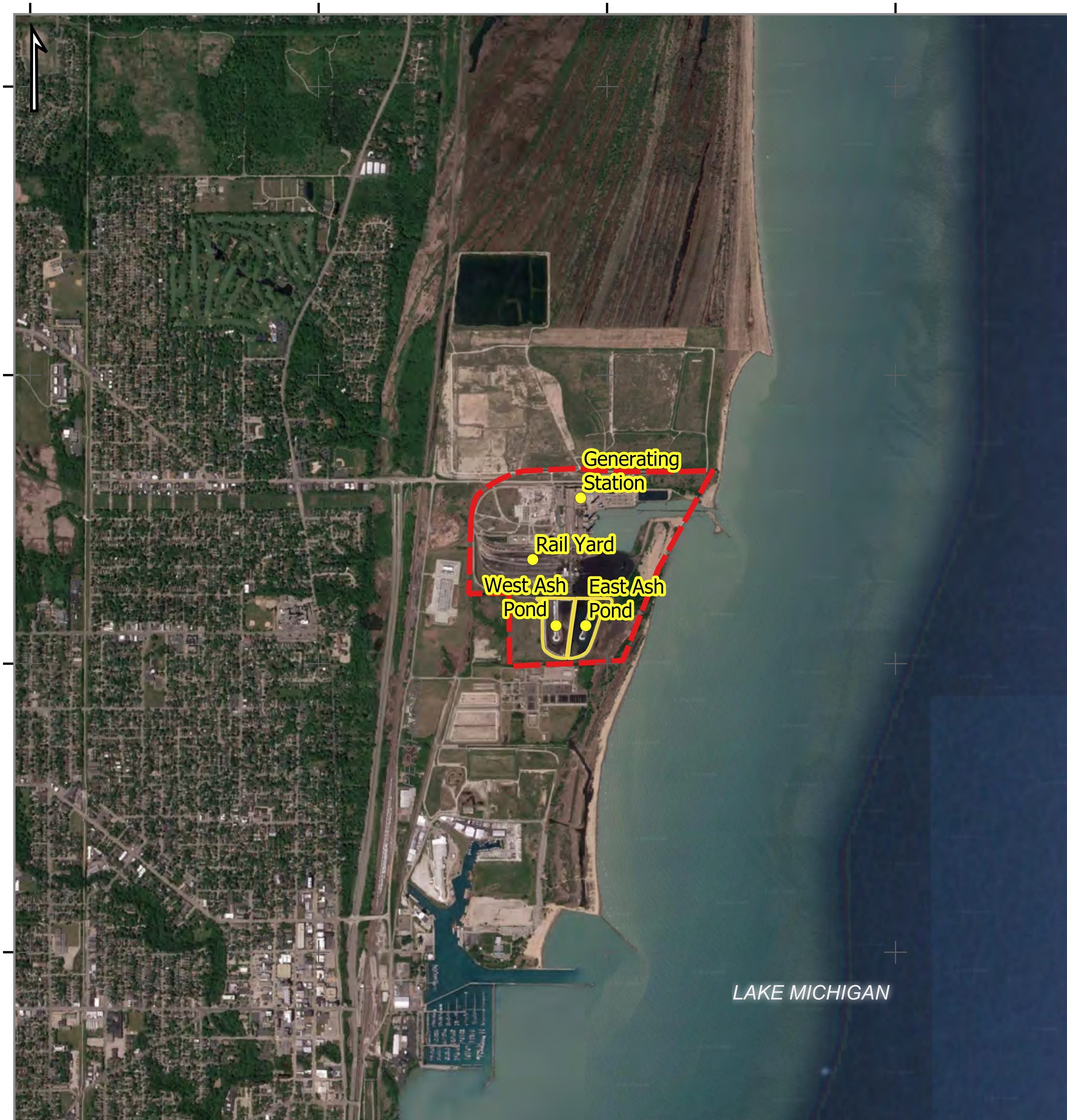
ft = feet, ft^2 = square feet

RMS = root mean square

[1]Regional (non-site specific) wells were given a weight of 0.1

[2]Calculated by dividing the RMS error by the range in measured values

FIGURES



LEGEND

APPROXIMATE SITE BOUNDARY

0 0.5 mi

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure1_LocationMap.qgz

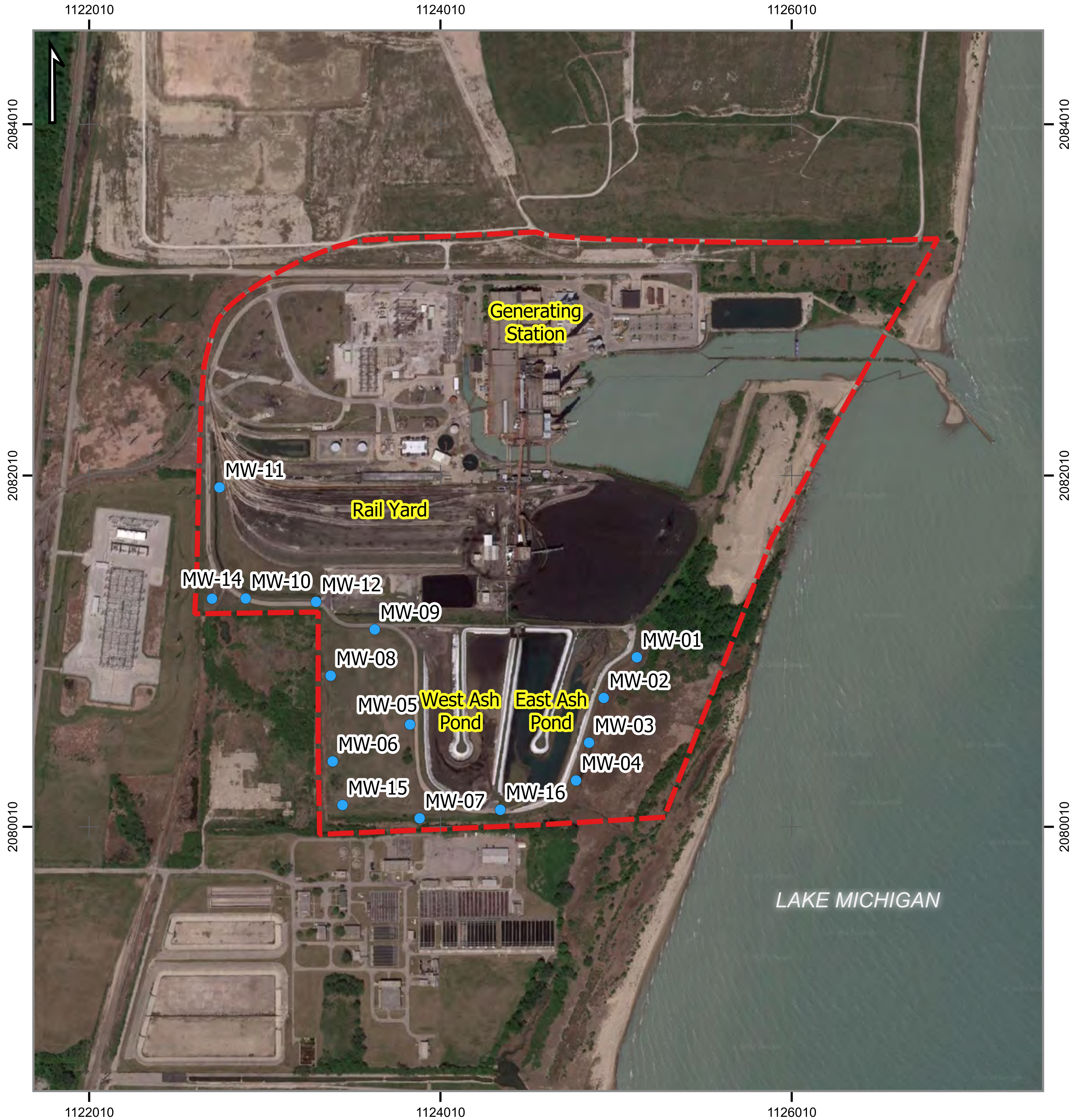
BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**LOCATION MAP**

SCALE AT ANSI A			
1:30,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022

BAS PROJECT No.	FIGURE:
21141101	1



LEGEND

SITE MONITORING WELL

APPROXIMATE SITE BOUNDARY

0 500 1,000 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure2_SiteWells.qgz

BAS GROUNDWATER CONSULTING KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**SITE WELLS**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:9,400	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE:	2

LEGEND

NOAA CLIMATE STATION

APPROXIMATE SITE BOUNDARY

0 2,000 4,000 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure3_ClimateStations.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**CLIMATE STATIONS**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
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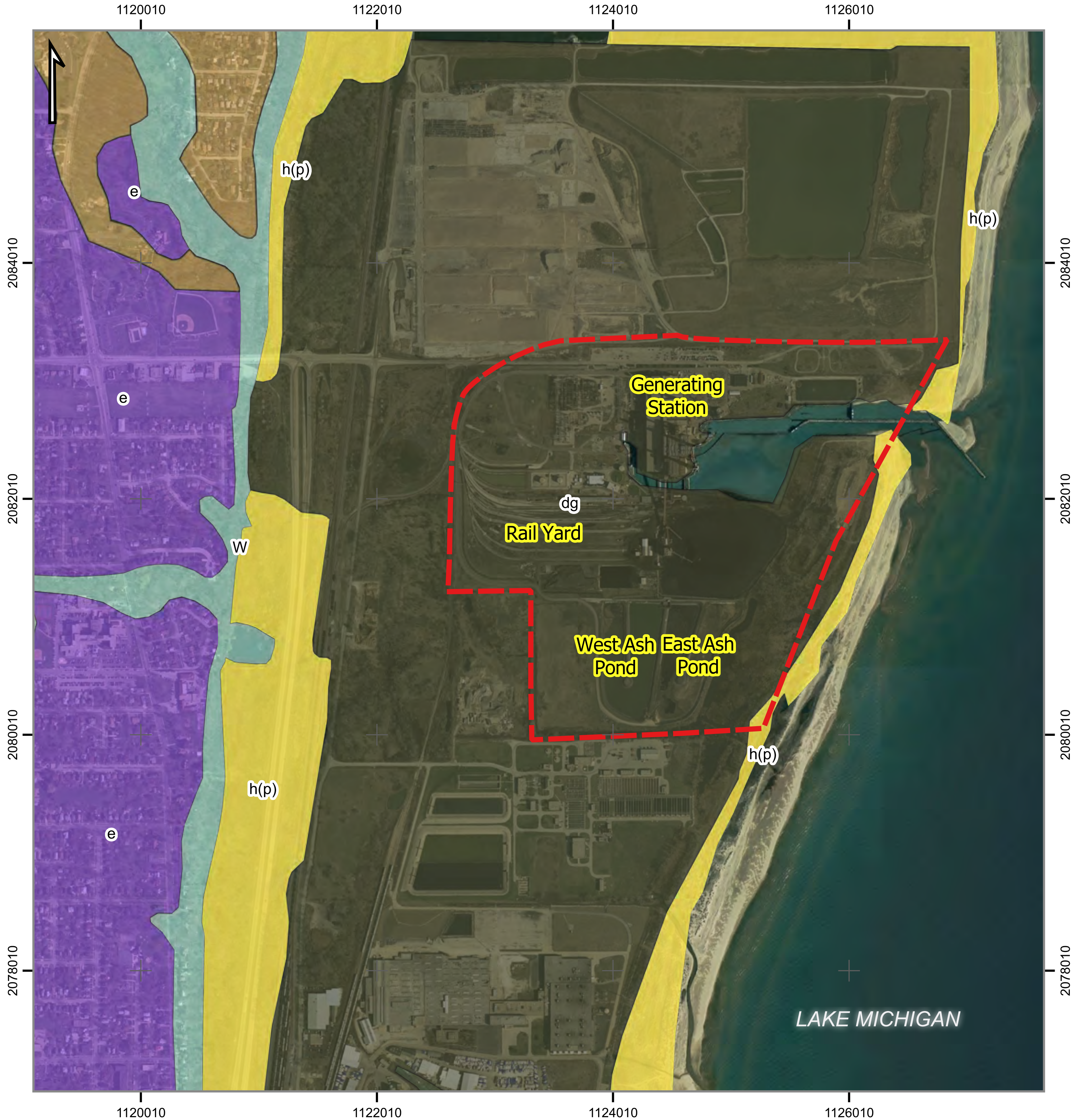
BAS PROJECT No. 21141101		FIGURE: **3**	



LEGEND

APPROXIMATE SITE BOUNDARY

SURFACE GEOLOGY

DISTURBED GROUND

HENRY FORMATION (PARKLAND FACIES)

EQUALITY FORMATION

HENRY FORMATION (MACKINAW FACIES)

WADSWORTH FORMATION

0 700 1,400 ft

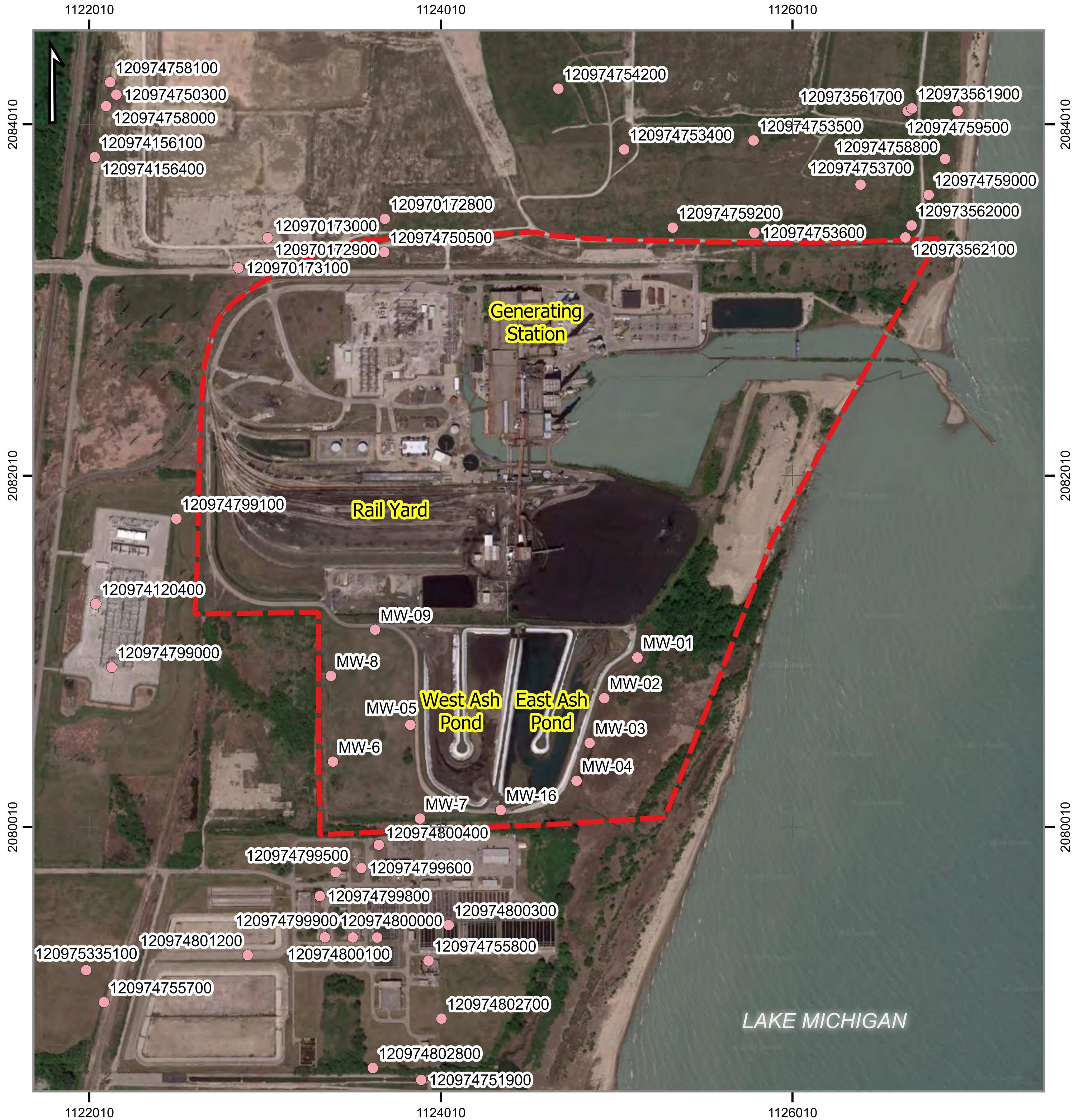
FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure4_Geology.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**SURFACE GEOLOGY**		
SCALE AT ANSI A 1:14,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: **4**	



LEGEND

- WELLS WITH BOREHOLE LITHOLOGY DATA
- APPROXIMATE SITE BOUNDARY

0 500 1,000 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure5_WellsWBoreholes.qgz

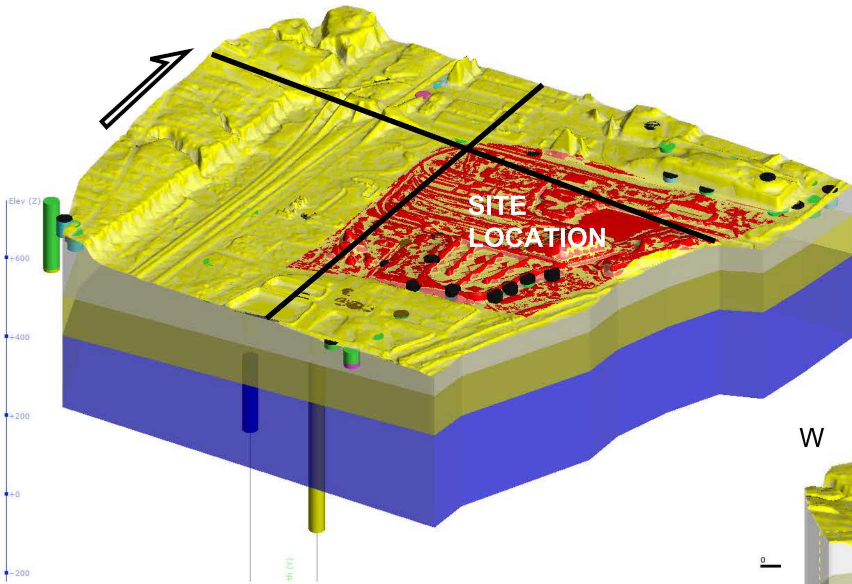
BAS GROUNDWATER CONSULTING

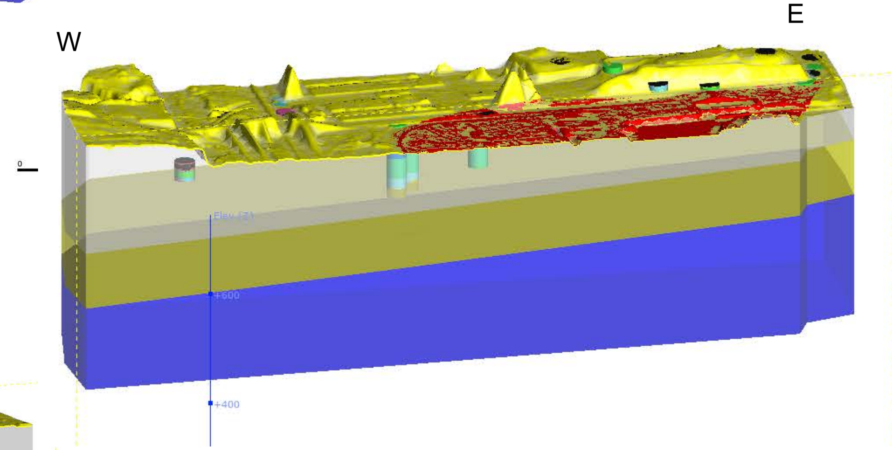
KPRG

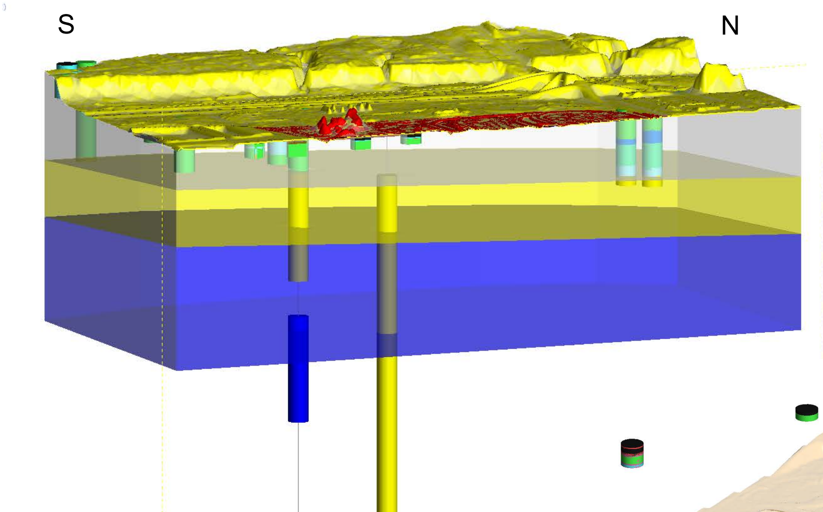
CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**WELLS WITH BOREHOLE LITHOLOGY DATA**

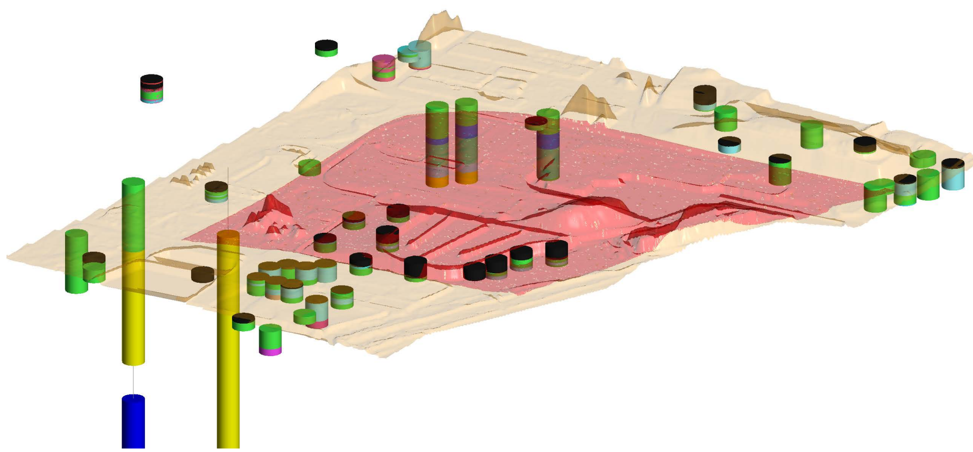
SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:9,400	CHECKED	BAS	01/27/2022

BAS PROJECT No.	FIGURE:
21141101	5









LEGEND

LEAPFROG_GEOLOGY

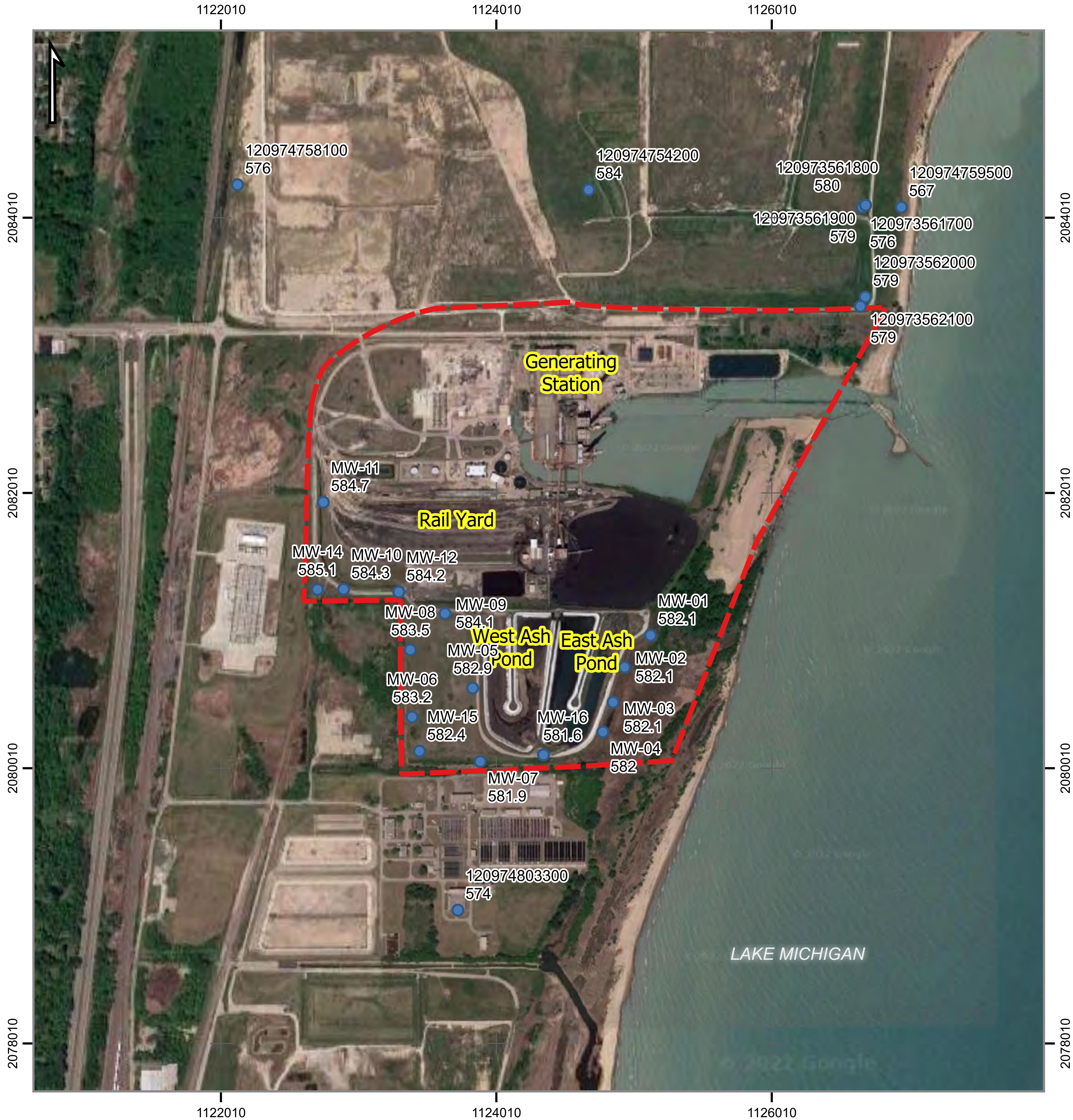
- topsoil
- fill
- loam
- clay
- clay, sand
- clay, sand, gravel
- dirty sand and gravel
- hardpan
- peat
- sand and gravel
- silt and clay
- sand
- carbonates
- shale

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure6_LeapfrogGeology.qgz

BAS GROUNDWATER CONSULTING   KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**BOREHOLE LITHOLOGY DATA**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: **6**	



LEGEND

WELL WITH WATER LEVEL ELEVATION (FT, AMSL)

APPROXIMATE SITE BOUNDARY

0 600 1,200 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure7_WellsWWaterLevelData.qgz

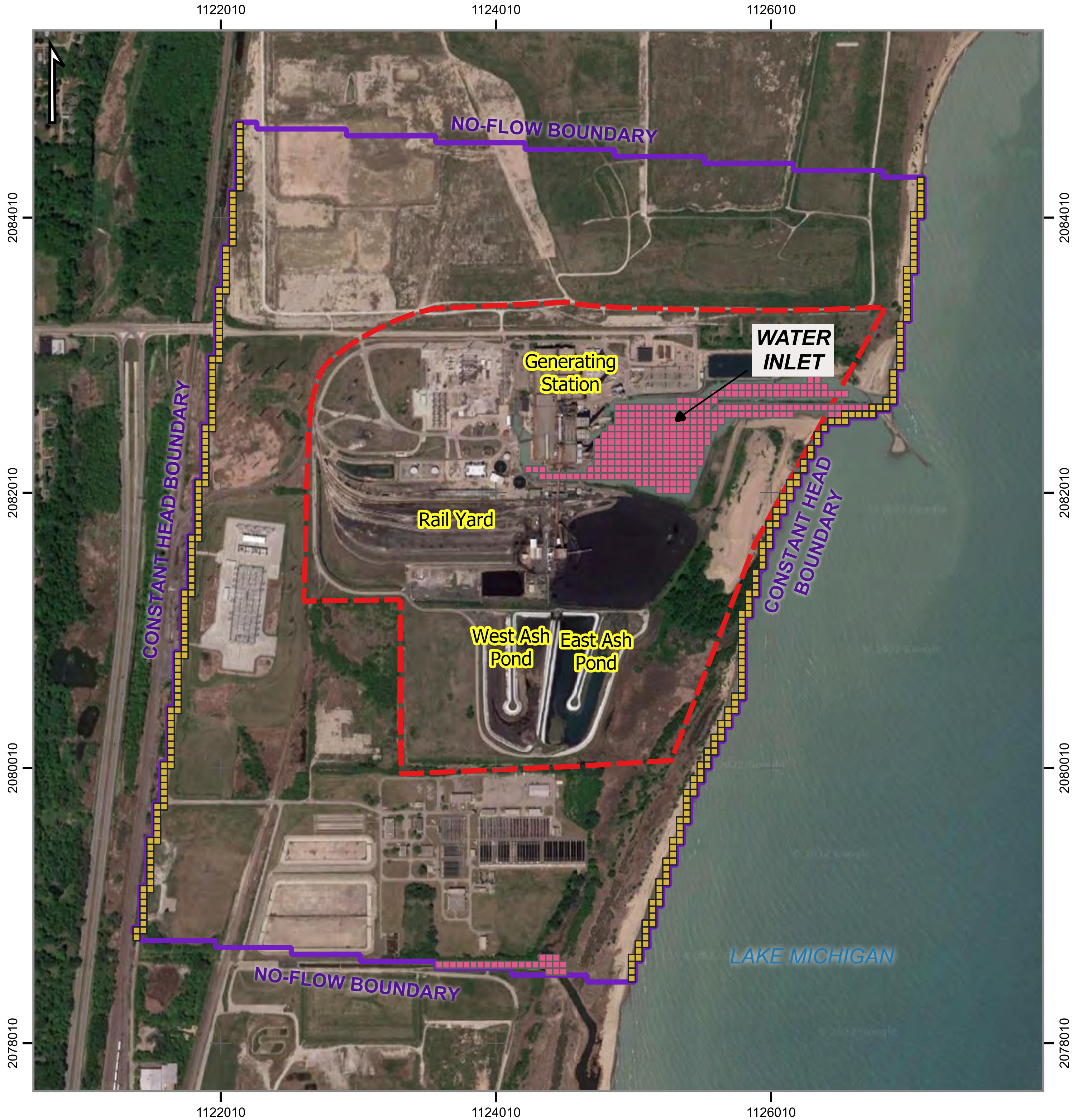
BAS GROUNDWATER CONSULTING

K P R G

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**WELLS WITH WATER LEVEL DATA**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:12,000	CHECKED	BAS	01/27/2022

BAS PROJECT No.	FIGURE:
21141101	7



LEGEND

- MODEL BOUNDARY
- GENERAL HEAD BOUNDARY
- CONSTANT HEAD BOUNDARY
- APPROXIMATE SITE BOUNDARY

0 600 1,200 ft

FEET

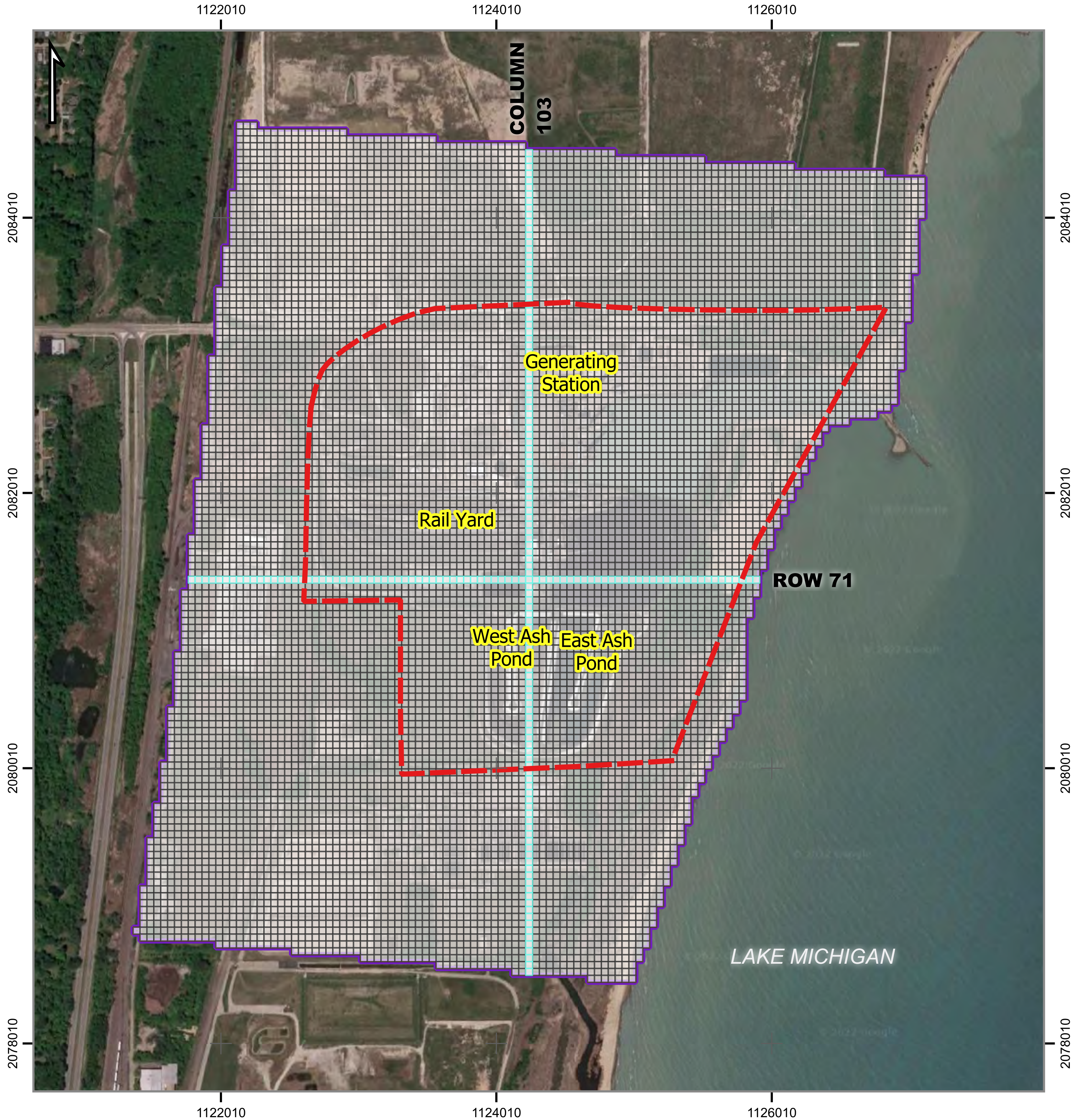
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure8_ModelBoundary.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL BOUNDARY CONDITIONS**

SCALE AT ANSI A 1:12,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE:	8



LEGEND

- MODEL BOUNDARY
- MODEL GRID
- APPROXIMATE SITE BOUNDARY

HIGHLIGHTED SECTIONS SHOWN ON FIGURE 10

0 600 1,200 ft

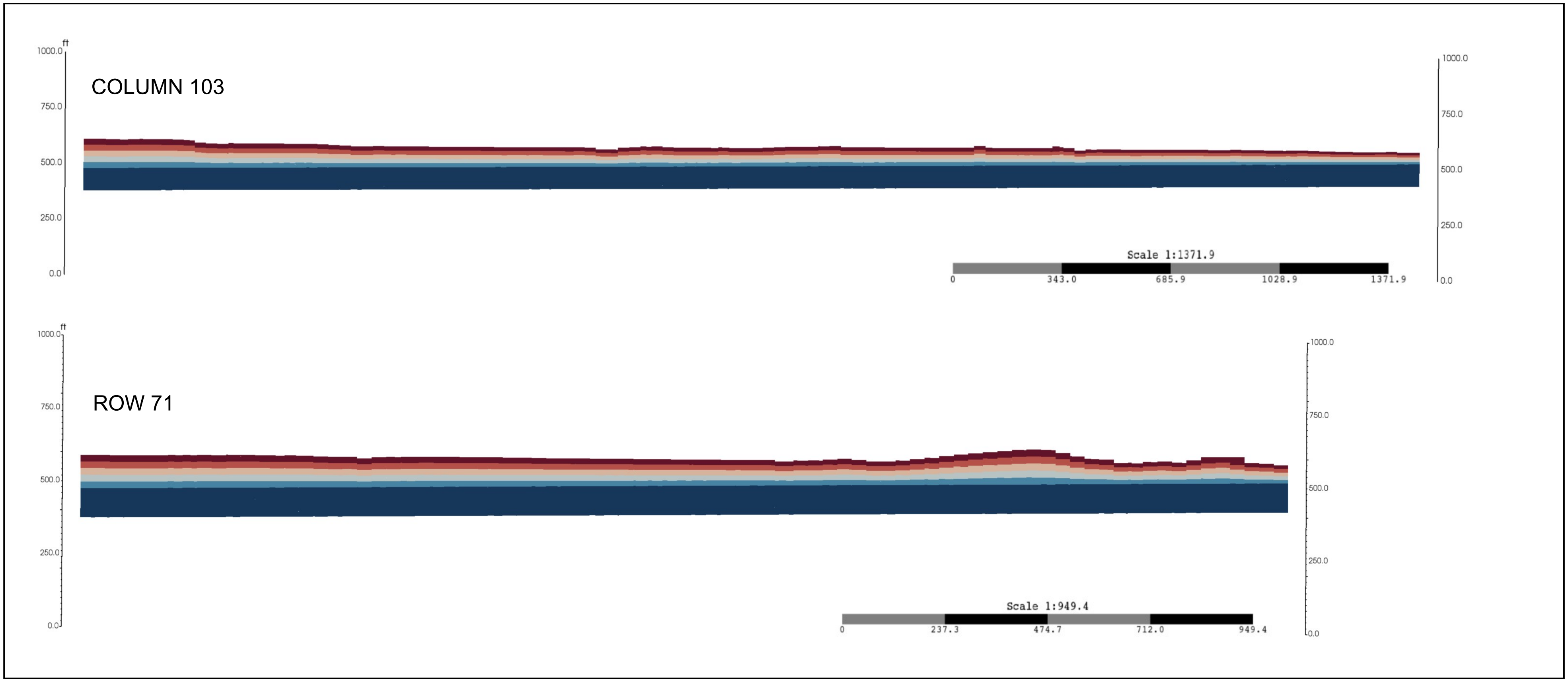
FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure9_ModelGrid.qgz

BAS GROUNDWATER CONSULTING

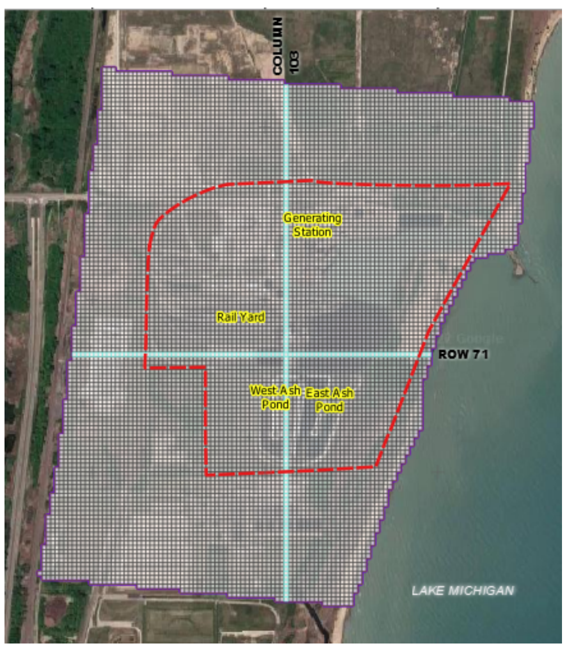
KPRG

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**MODEL GRID**		
SCALE AT ANSI A 1:12,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: 9		



LEGEND

- LAYER 1
- LAYER 2
- LAYER 3
- LAYER 4
- LAYER 5
- LAYER 6

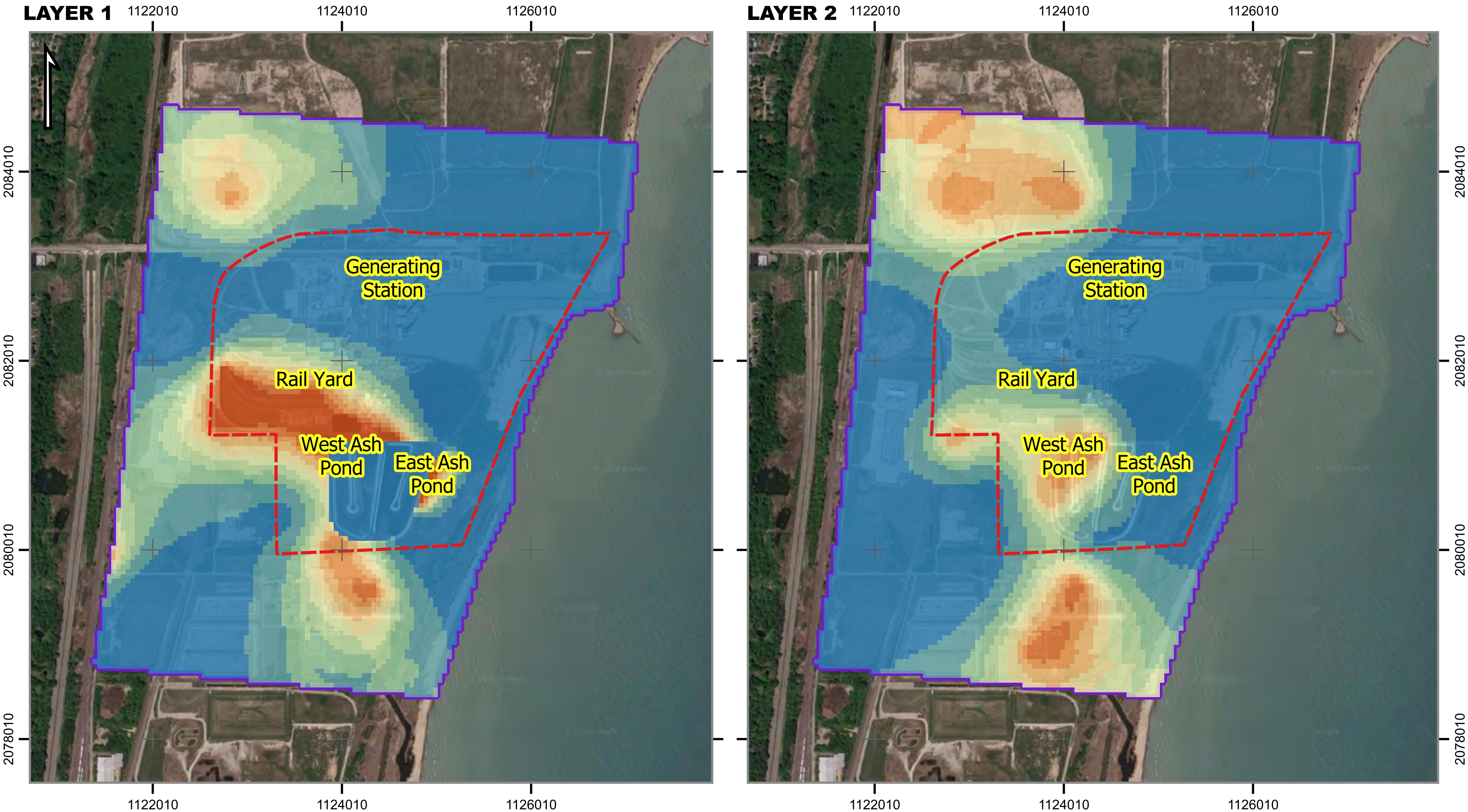


Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure10_ModelLayering.qgz

BAS GROUNDWATER CONSULTING KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL LAYERING**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: **10**	



LEGEND

MODEL BOUNDARY

APPROXIMATE SITE BOUNDARY

CALIBRATED HYDRAULIC CONDUCTIVITY VALUES, FT/D

0 - 19	89 - 131	331 - 397
19 - 52	131 - 182	397 - 461
52 - 89	182 - 252	461 - 500
	252 - 331	

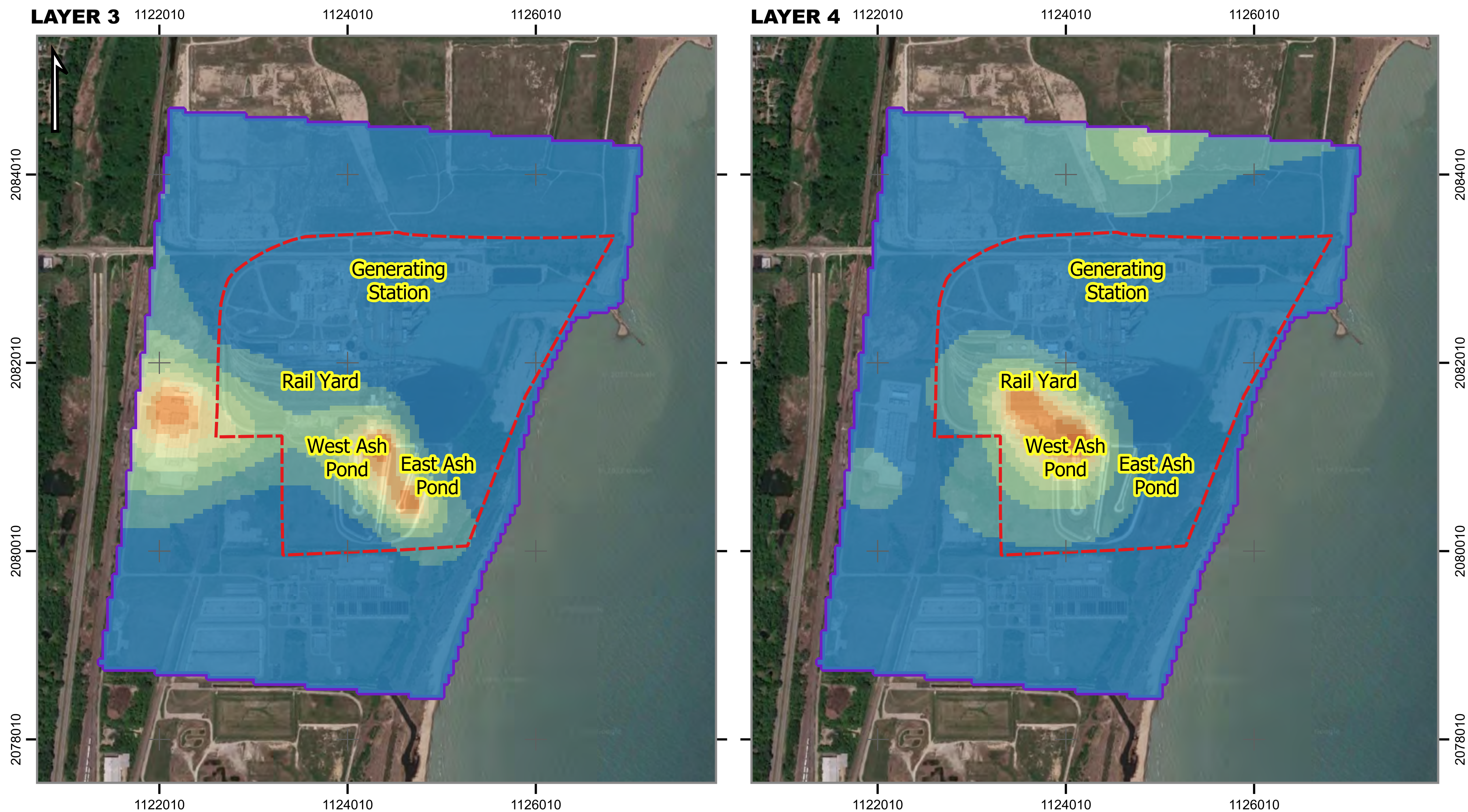
BAS GROUNDWATER CONSULTING   KPRG

0 900 1,800 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure11a_CalibratedKsLayers1_2.qgz

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**CALIBRATED HYDRAULIC CONDUCTIVITY DISTRIBUTION IN MODEL LAYERS 1 & 2**		
SCALE AT ANSI A 1:18,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: **11a**		



LEGEND

MODEL BOUNDARY

APPROXIMATE SITE BOUNDARY

CALIBRATED HYDRAULIC CONDUCTIVITY VALUES, FT/D

1 - 15	40 - 75	218 - 290
15 - 40	75 - 114	290 - 368
	114 - 161	368 - 448
	161 - 218	448 - 500

BAS GROUNDWATER CONSULTING

K P R G

0 900 1,800 ft

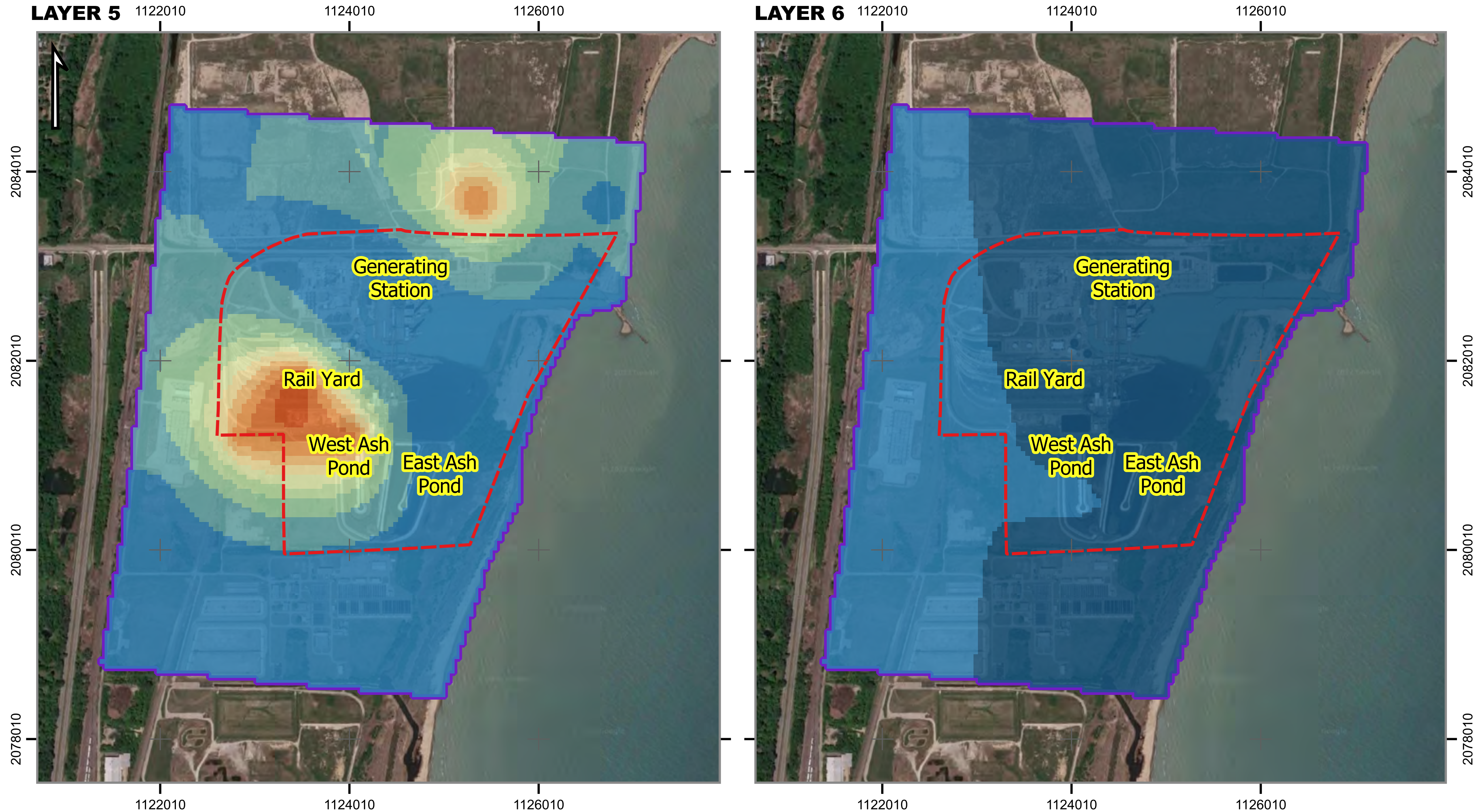
FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure11b_CalibratedKsLayers3_4.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**CALIBRATED HYDRAULIC CONDUCTIVITY DISTRIBUTION IN MODEL LAYERS 3 & 4**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:18,000	CHECKED	BAS	01/27/2022

BAS PROJECT No.	FIGURE:
21141101	**11b**



LEGEND

MODEL BOUNDARY

APPROXIMATE SITE BOUNDARY

CALIBRATED HYDRAULIC CONDUCTIVITY VALUES, FT/D

- 0.0 - 1
- 1 - 15
- 15 - 40
- 40 - 75
- 75 - 114
- 114 - 161
- 161 - 218
- 218 - 290
- 290 - 368
- 368 - 448
- 448 - 500

BAS GROUNDWATER CONSULTING

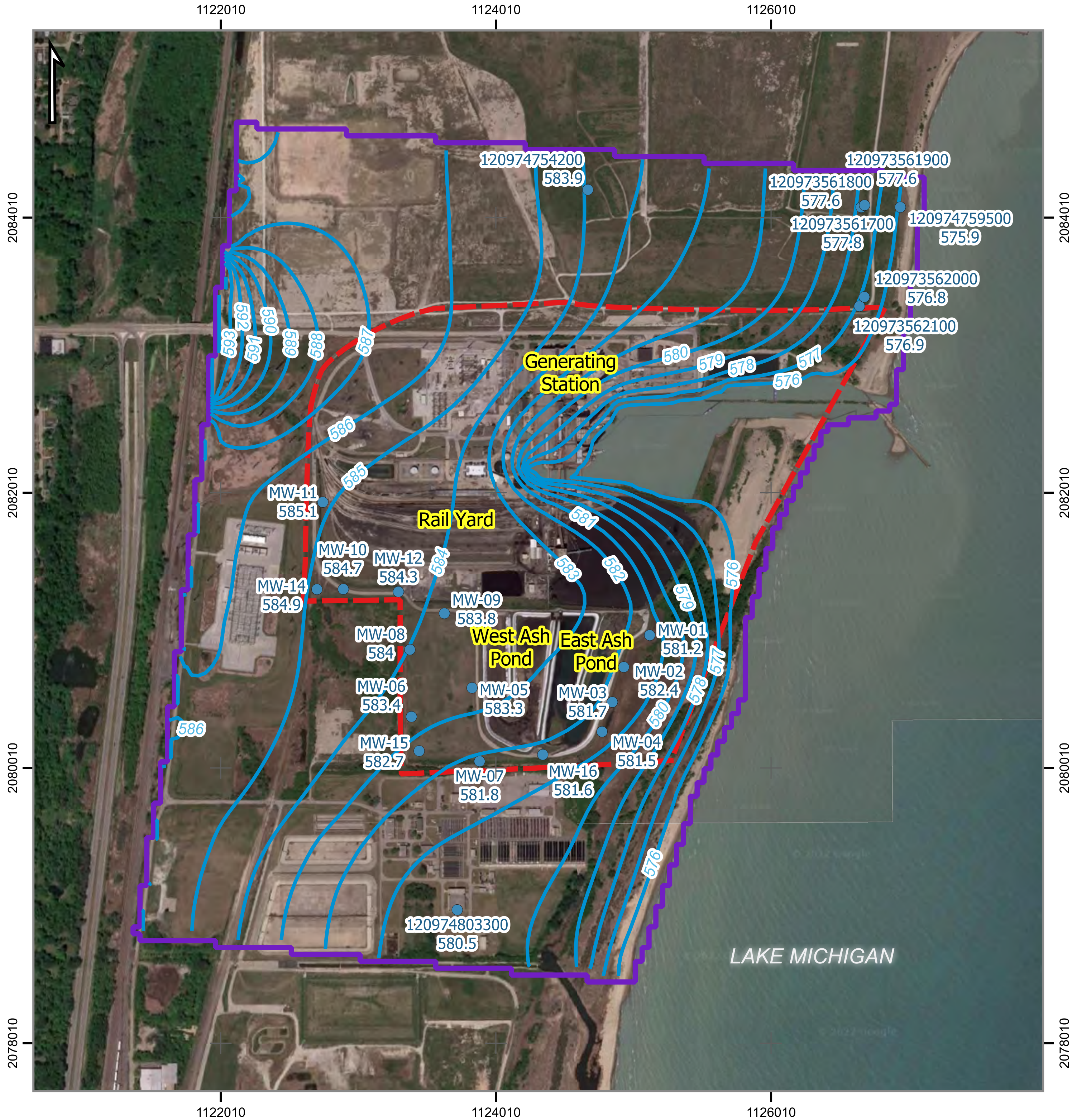
K P R G

0 900 1,800 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure11c_CalibratedKsLayers5_6.qgz

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**CALIBRATED HYDRAULIC CONDUCTIVITY DISTRIBUTION IN MODEL LAYERS 5 & 6**		
SCALE AT ANSI A 1:18,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. *21141101*		FIGURE: **11c**	



LEGEND

- MODELED WATER LEVEL ELEVATION (FT, AMSL)
- MODELED WATER LEVEL ELEVATION CONTOUR (FT, AMSL)
- APPROXIMATE SITE BOUNDARY

0 600 1,200 ft

FEET

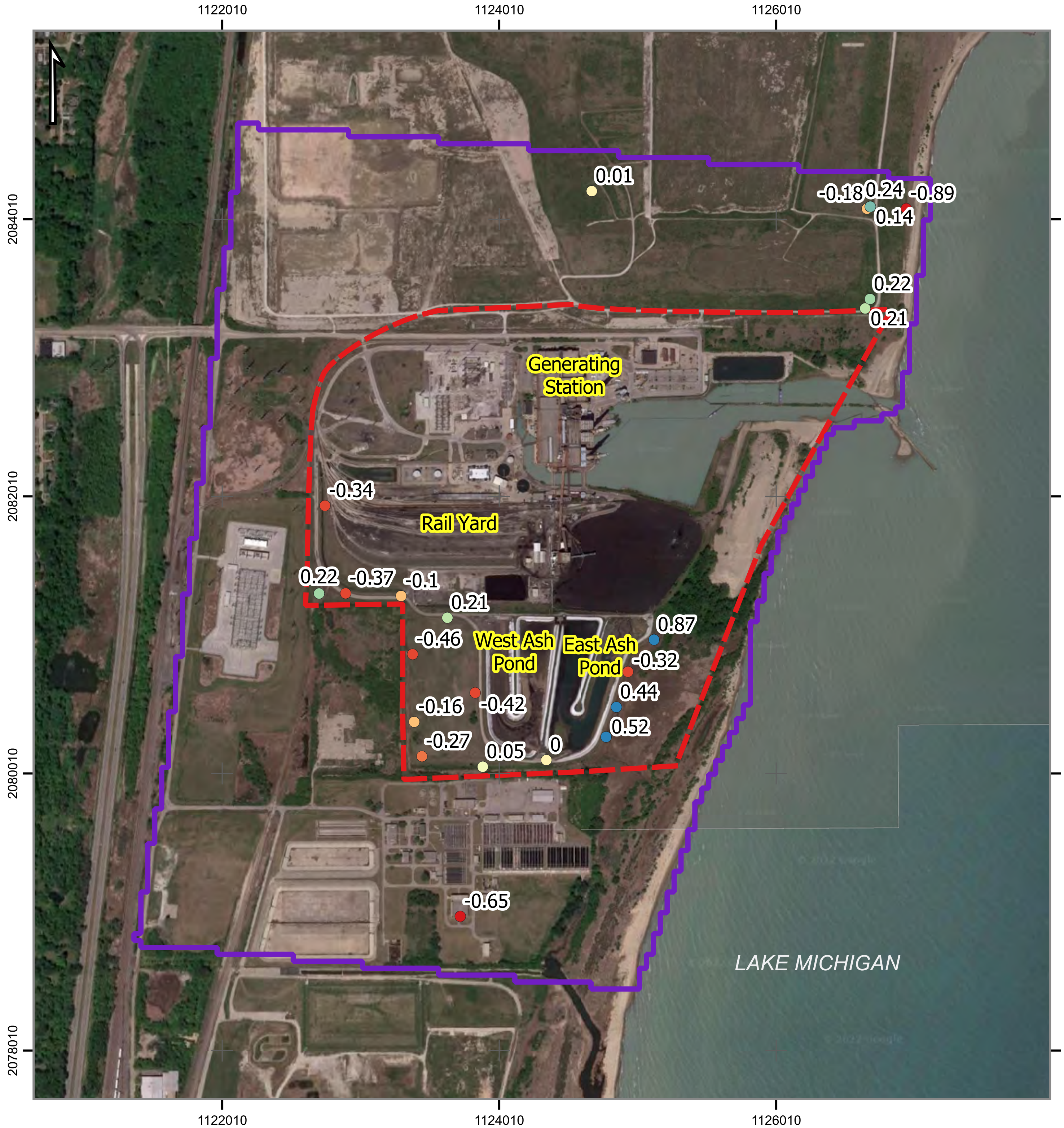
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure12_CalibratedWLs.qgz

BAS GROUNDWATER CONSULTING

KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**CALIBRATED WATER LEVEL ELEVATIONS**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:12,000	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: 12		



LEGEND

RESIDUAL (FT.)

APPROXIMATE SITE BOUNDARY

RESIDUALS (FT.)

- -1.0 to -0.5
- -0.5 to -0.3
- -0.3 to -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to 0.0
- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.4
- 0.4 to 0.9

THE RESIDUAL FOR THE REGIONAL (NON-SITE) WELLS REPRESENTS THE WEIGHTED VALUE

0 600 1,200 ft

FEET

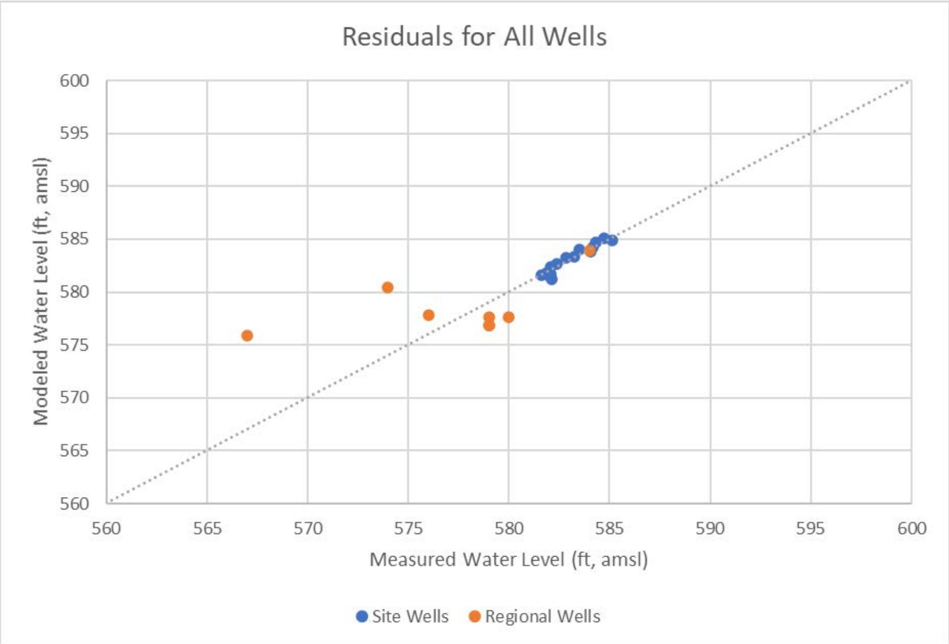
Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure13_CalibratedResiduals.qgz

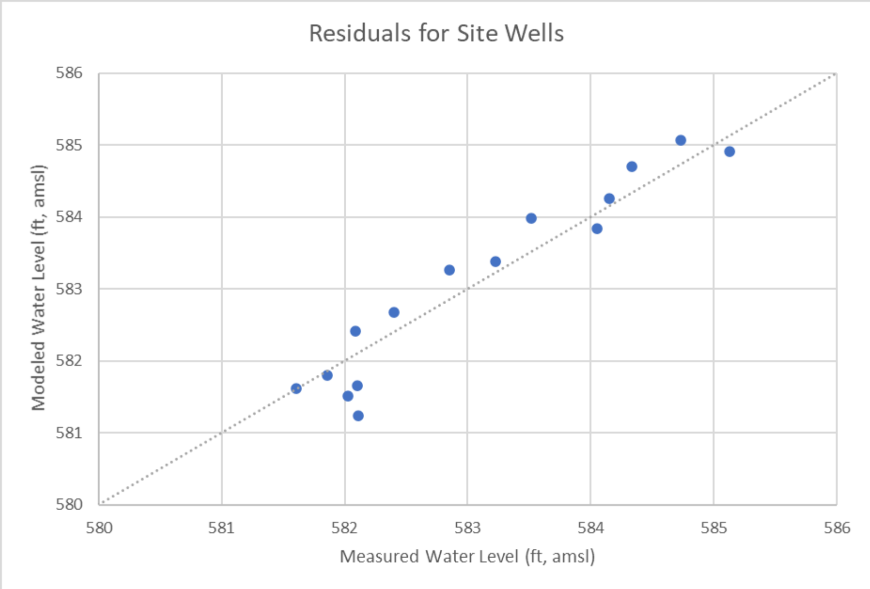
BAS GROUNDWATER CONSULTING KPRG

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**CALIBRATED WATER LEVEL RESIDUALS**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:12,000	CHECKED	BAS	01/27/2022

BAS PROJECT No.	FIGURE:
21141101	**13**





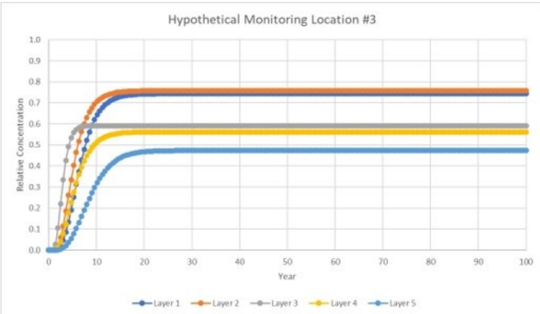
BAS GROUNDWATER CONSULTING

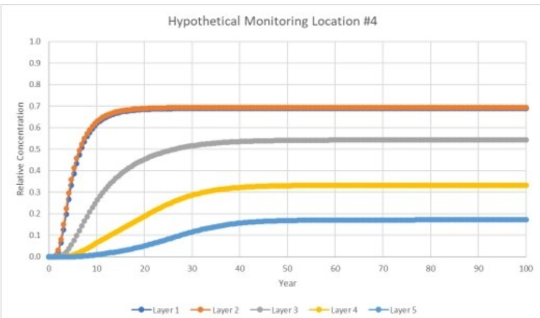
KPRG

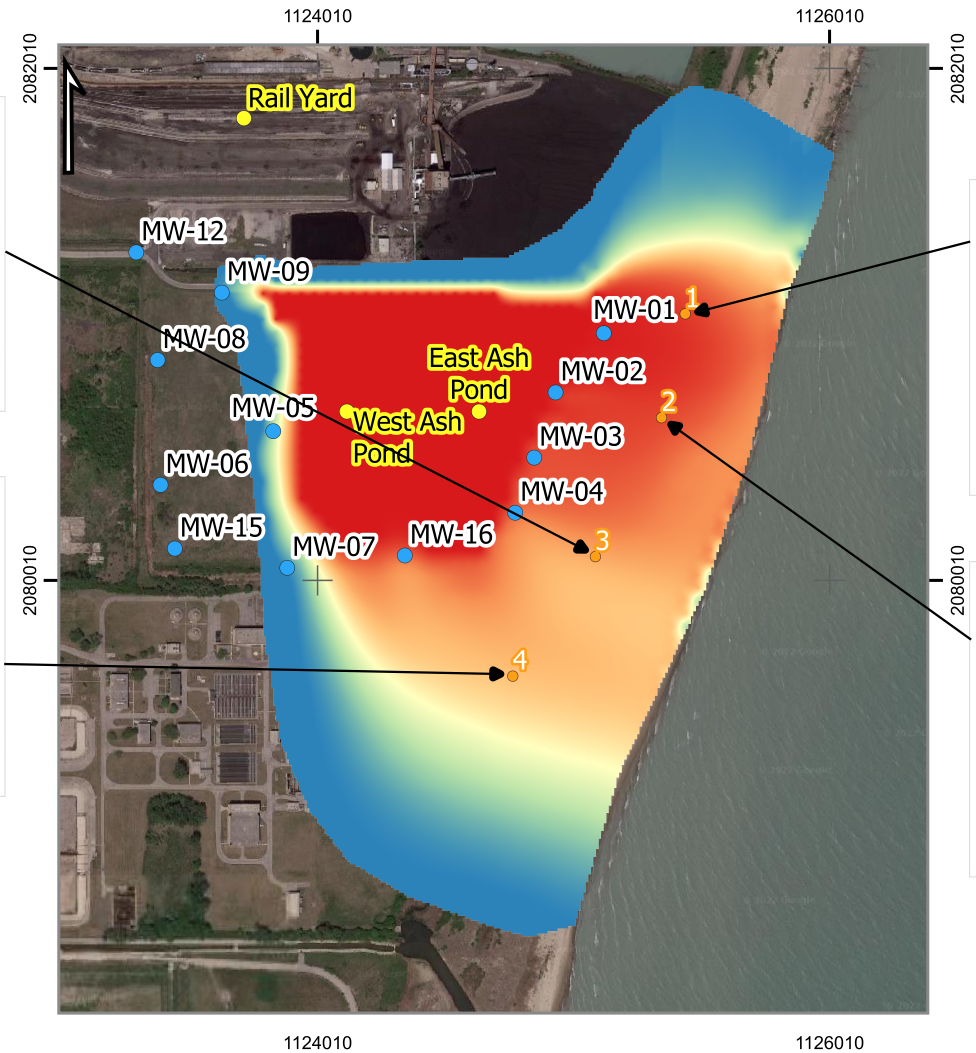
SCALE AT ANSI A	DRAWN	DZF	01/27/2021
	CHECKED	BAS	01/27/2021
BAS PROJECT No. 21141101		FIGURE: 14	

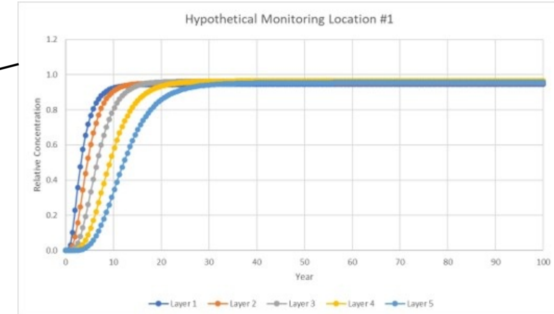
CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**CALIBRATION SCATTER PLOT**

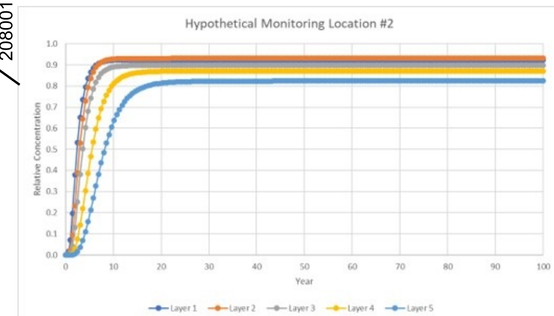
Project File: Figure14_CalibrationScatterPlot.qgz











STARTING CONDITIONS: DEFINED A SURROGATE SOURCE OF "1" BENEATH ASH PONDS, FORWARD RUN FOR 100 YEARS WITH ADVECTION AND DISPERSION

LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01	0.6
0.1	0.7
0.2	0.8
0.3	0.9
0.4	1
0.5	

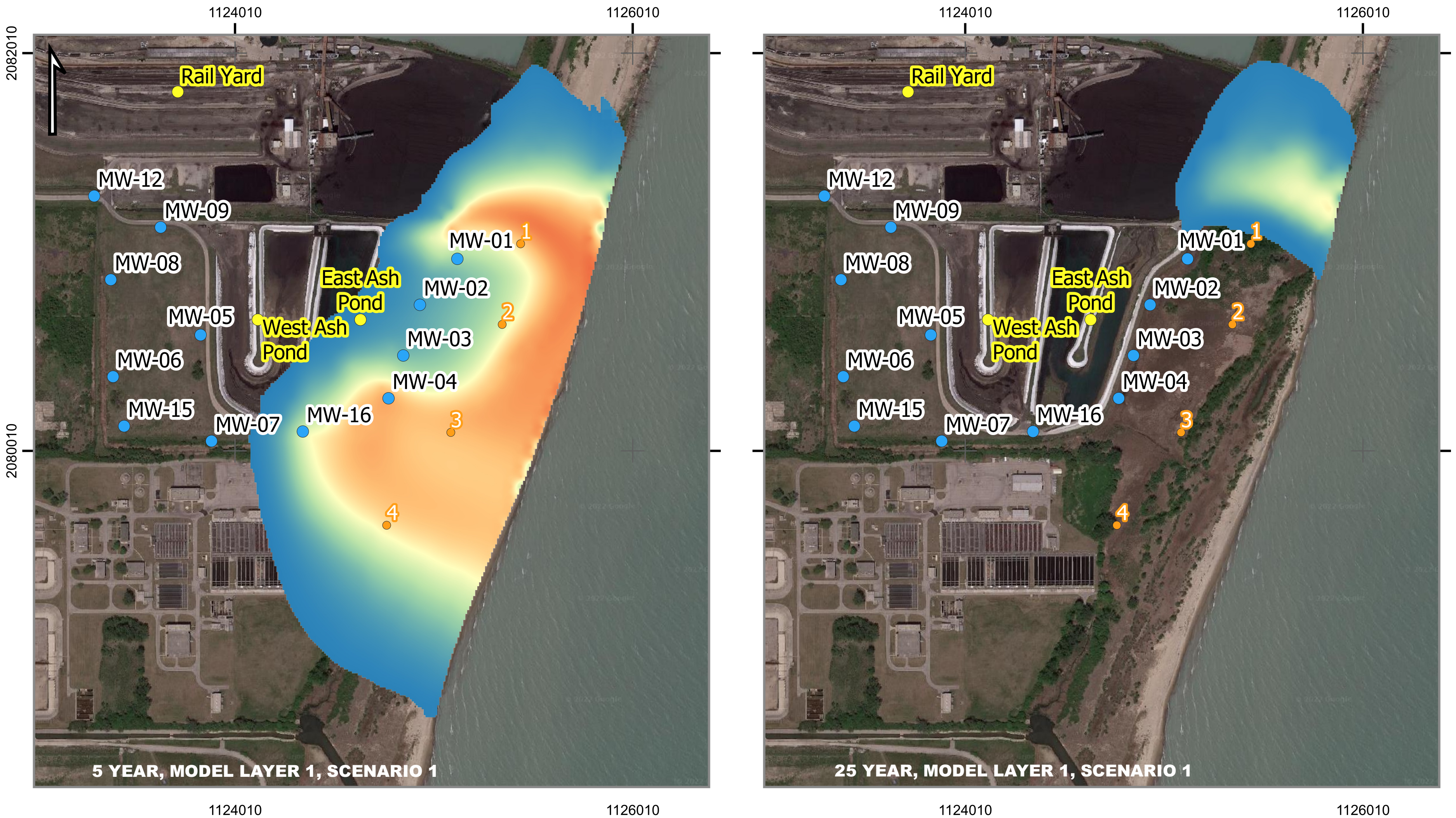
BAS GROUNDWATER CONSULTING   K P R G

0 400 800 ft

FEET

Coordinate System:
Project File: Figure15_StartingPositions.qgz

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	MODEL SCENARIOS STARTING CONDITIONS		
SCALE AT ANSI A: 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No.: 21141101		FIGURE: 15	



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01	0.6
0.1	0.7
0.2	0.8
0.3	0.9
0.4	1
0.5	

BAS GROUNDWATER CONSULTING

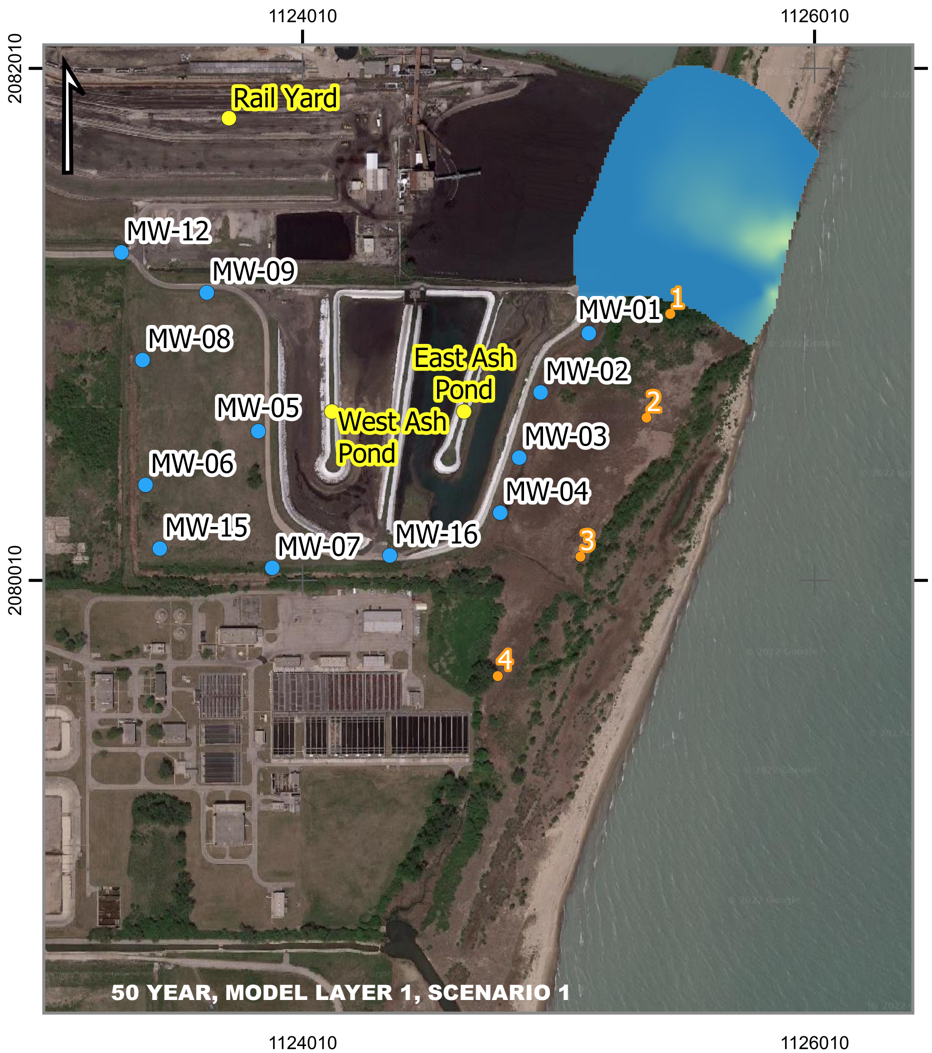
K P R G

0 400 800 ft

FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure16_5yearAnd25YearDistributions.qgz

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**MODEL SCENARIO 1: 5-YEAR AND 25-YEAR PLUME DISTRIBUTIONS**		
SCALE AT ANSI A 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: **16**	



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

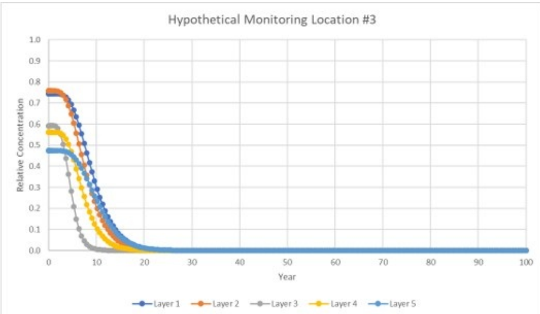
BAS GROUNDWATER CONSULTING

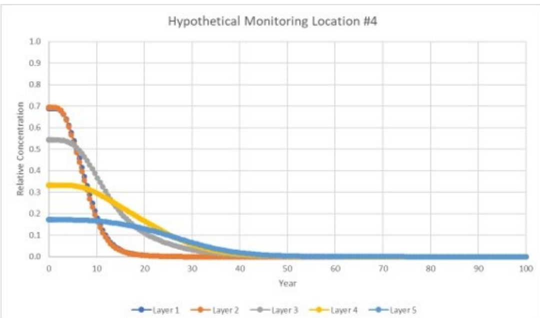
KPRG

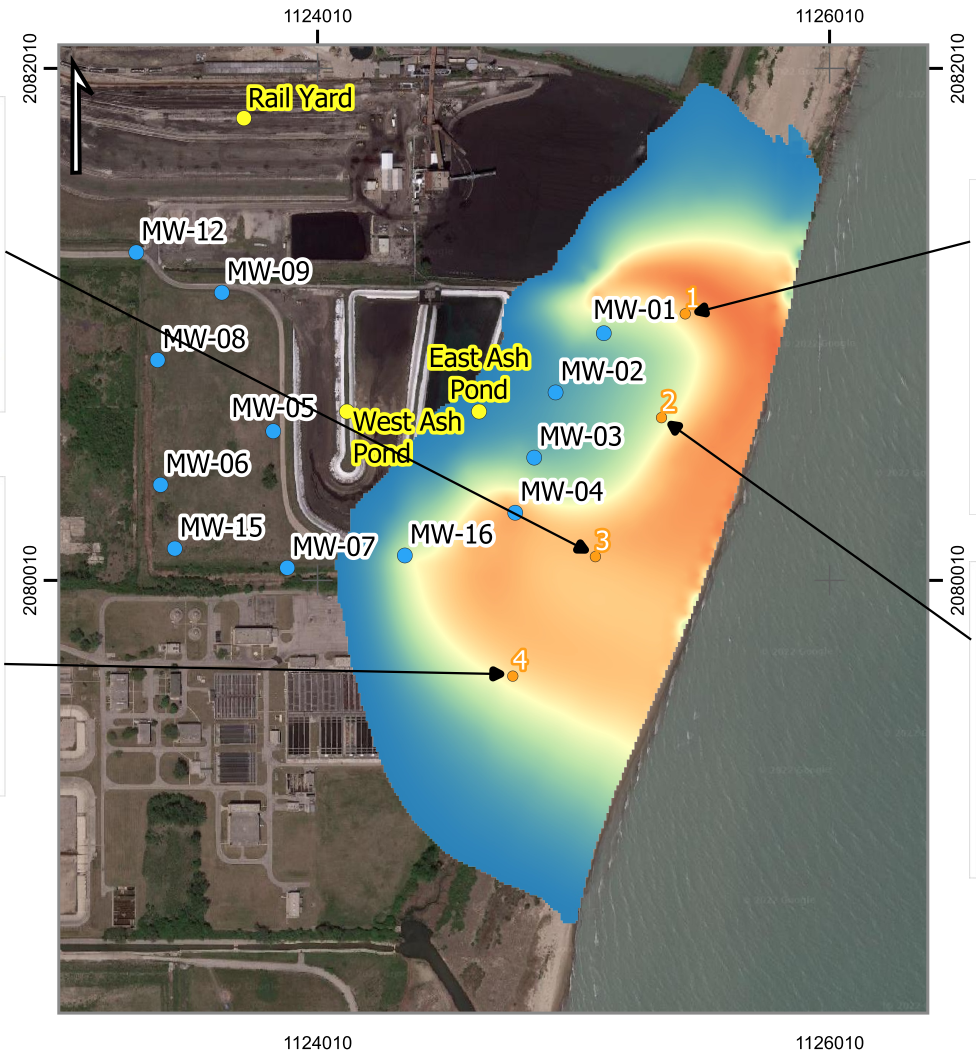
0 400 800 ft
FEET

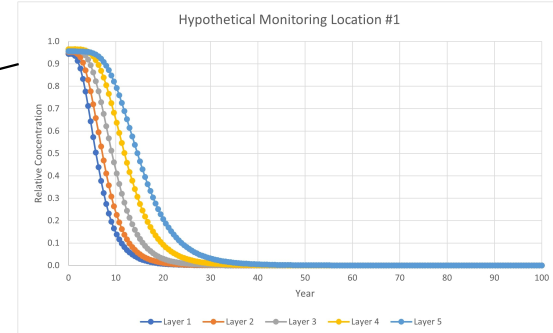
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure17_50yearAnd100YearDistributions.qgz

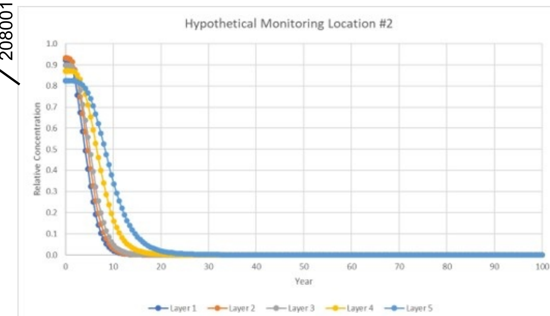
CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	MODEL SCENARIO 1: 50-YEAR AND 100-YEAR PLUME DISTRIBUTIONS		
SCALE AT ANSI A 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: 17		











STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1, AT 5 YEARS

0.01	0.6
0.1	0.7
0.2	0.8
0.3	0.9
0.4	1
0.5	

0 400 800 ft

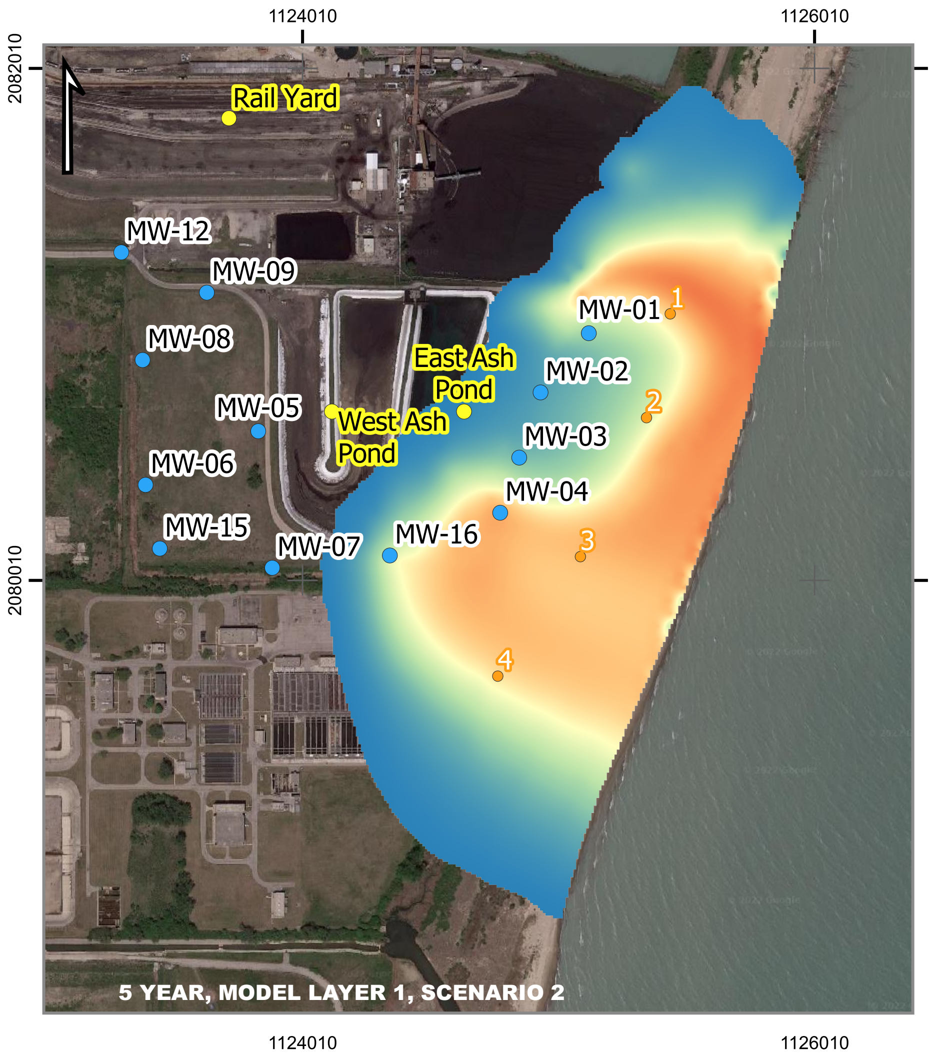
FEET

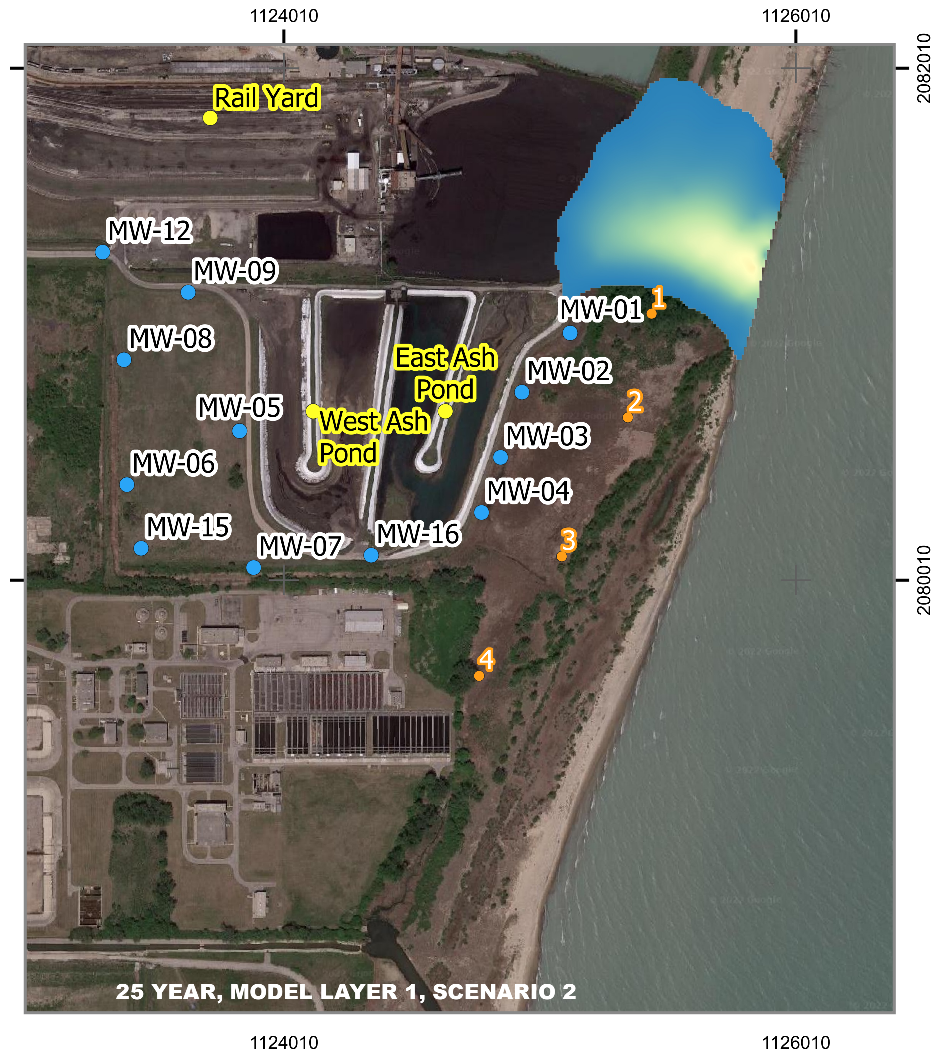
Coordinate System:

Project File: Figure18_Scenario1StartingPositions.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL SCENARIO 1: DECAY OF CONCENTRATIONS THROUGH TIME**

SCALE AT ANSI A 1:9,000	*DRAWN*	*DZF*	01/27/2022
	CHECKED	*BAS*	01/27/2022
BAS PROJECT No. *21141101*		*FIGURE:* **18**	





LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1

0 400 800 ft

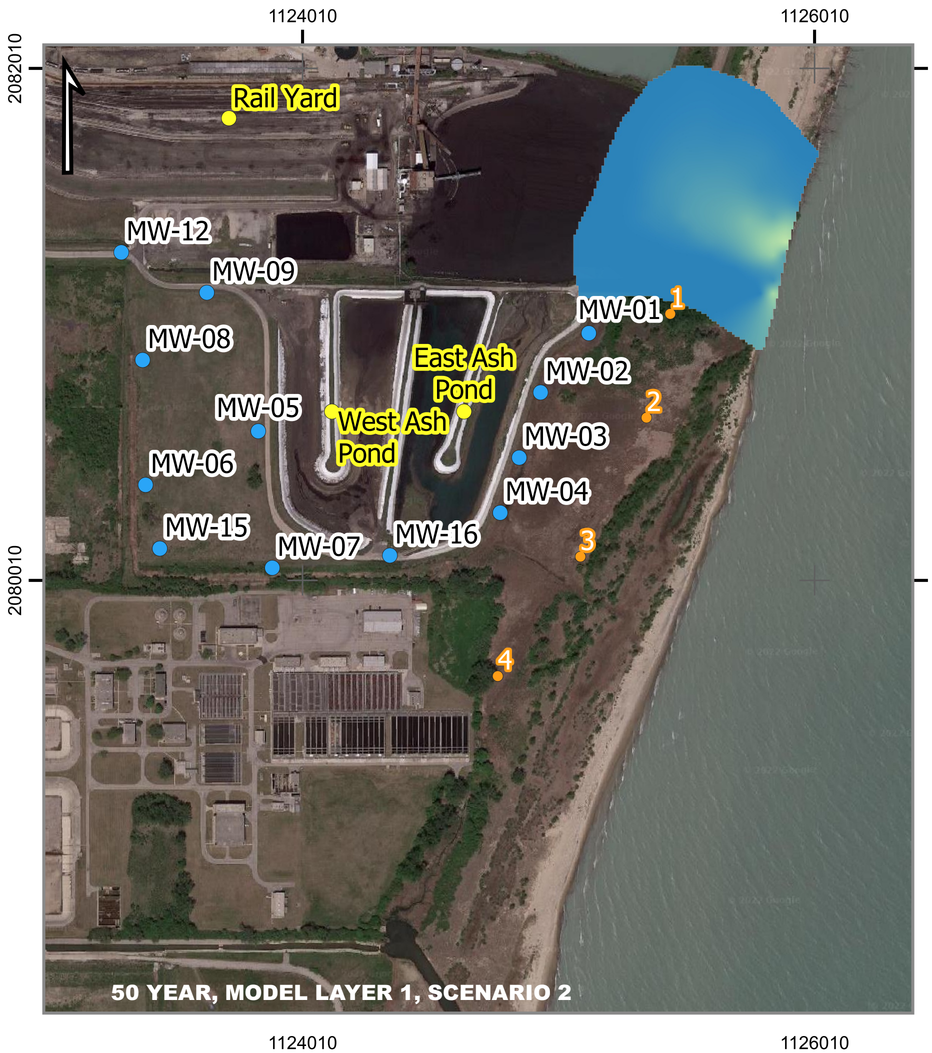
FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet

Project File: Figure19_5yearAnd25YearDistributions.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	MODEL SCENARIO 2: 5-YEAR AND 25-YEAR PLUME DISTRIBUTIONS

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:9,000	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: 19	



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01	0.6
0.1	0.7
0.2	0.8
0.3	0.9
0.4	1
0.5	

BAS GROUNDWATER CONSULTING

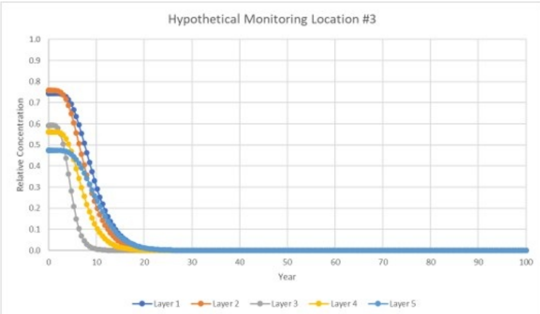
KPRG

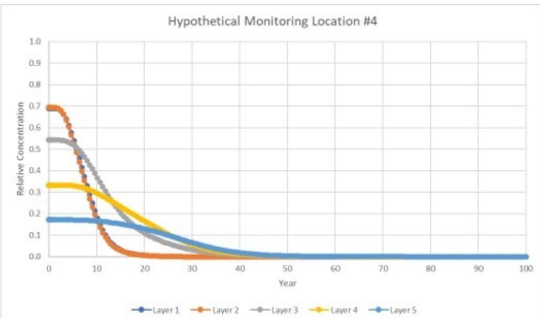
0 400 800 ft

FEET

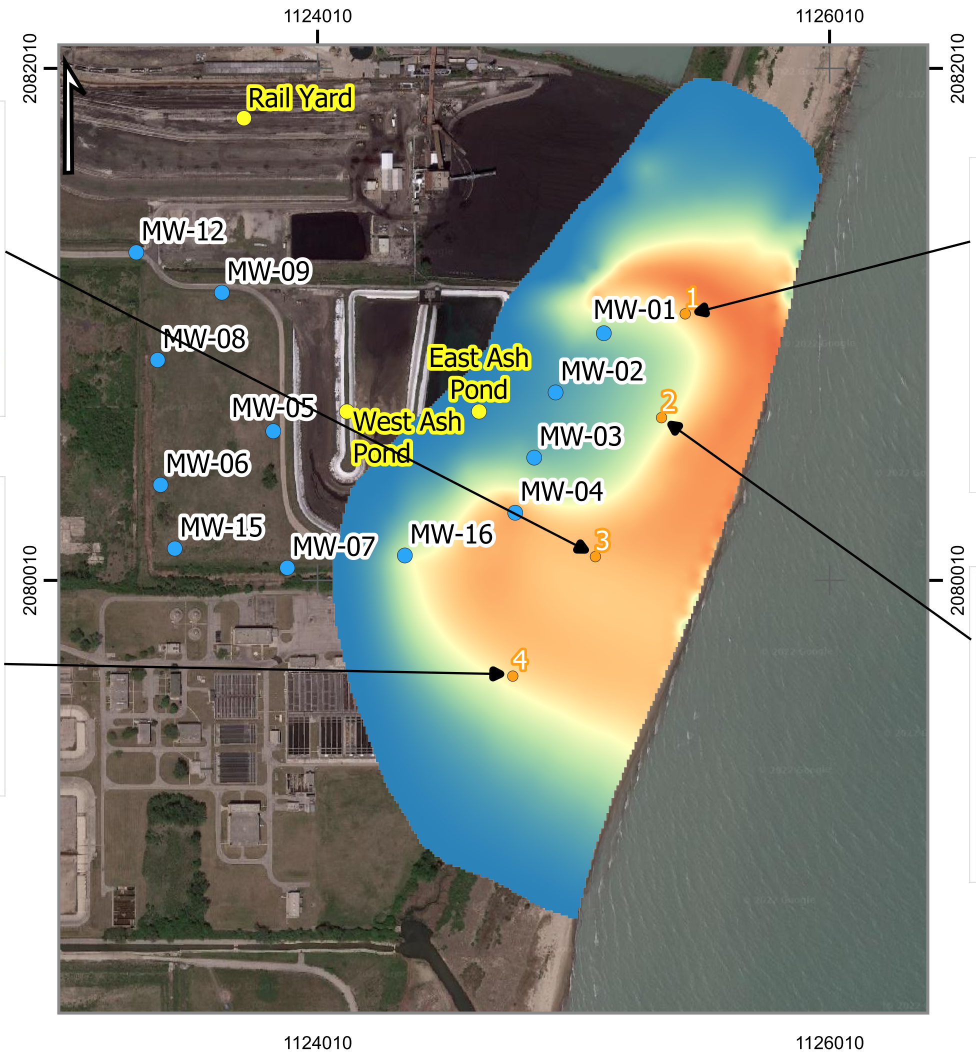
Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure20_50yearAnd100YearDistributions.qgz

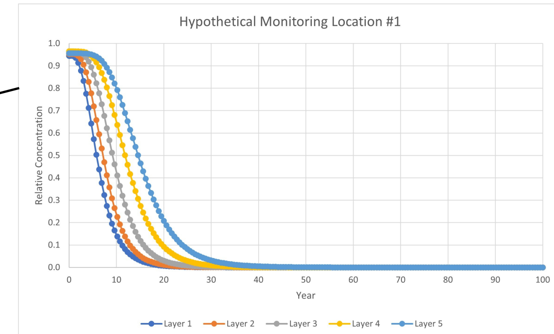
CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**MODEL SCENARIO 2: 50-YEAR AND 100-YEAR PLUME DISTRIBUTIONS**		
SCALE AT ANSI A 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: **20**		

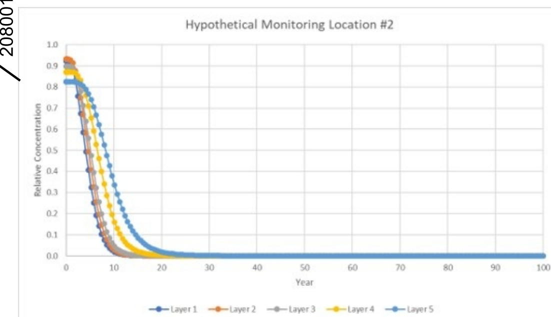




STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS







LEGEND

- PROPERTY BOUNDARY
- MODEL BOUNDARY
- HYPOTHETICAL MONITORING WELL LOCATION
- SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1, AT 5 YEARS

- 0.01
- 0.1
- 0.2
- 0.3
- 0.4
- 0.5
- 0.6
- 0.7
- 0.8
- 0.9
- 1

BAS GROUNDWATER CONSULTING

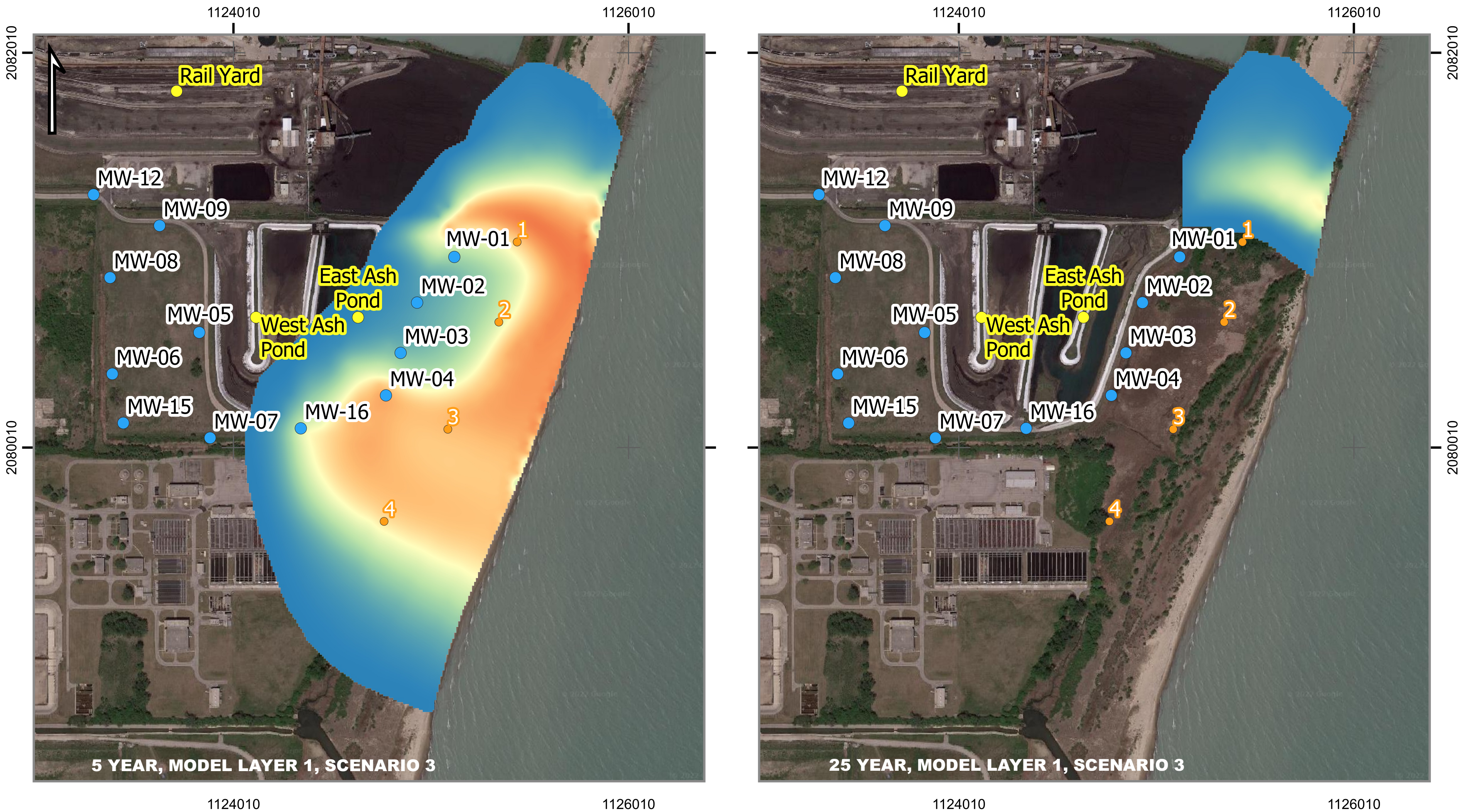
KPRG

0 400 800 ft
FEET

Coordinate System:
Project File: Figure21_Scenario2StartingPositions.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL SCENARIO 2: DECAY OF CONCENTRATIONS THROUGH TIME**

SCALE AT ANSI A	DRAWN DZF 01/27/2022
1:9,000	CHECKED BAS 01/27/2022
BAS PROJECT No. 21141101	FIGURE: **21**



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01	0.6
0.1	0.7
0.2	0.8
0.3	0.9
0.4	1
0.5	

BAS GROUNDWATER CONSULTING

K P R G

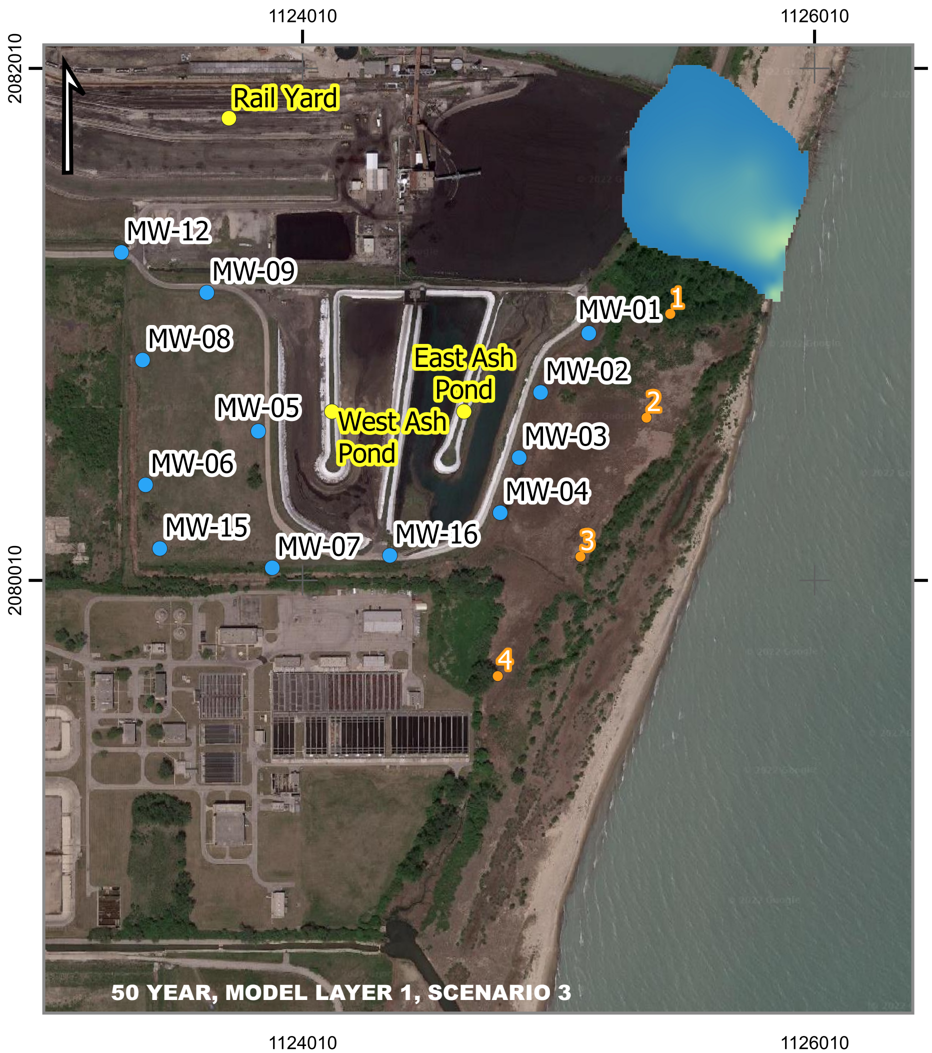
0 400 800 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure22_5yearAnd25YearDistributions.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL SCENARIO 3: 5-YEAR AND 25-YEAR PLUME DISTRIBUTIONS**

SCALE AT ANSI A: 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: **22**	



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

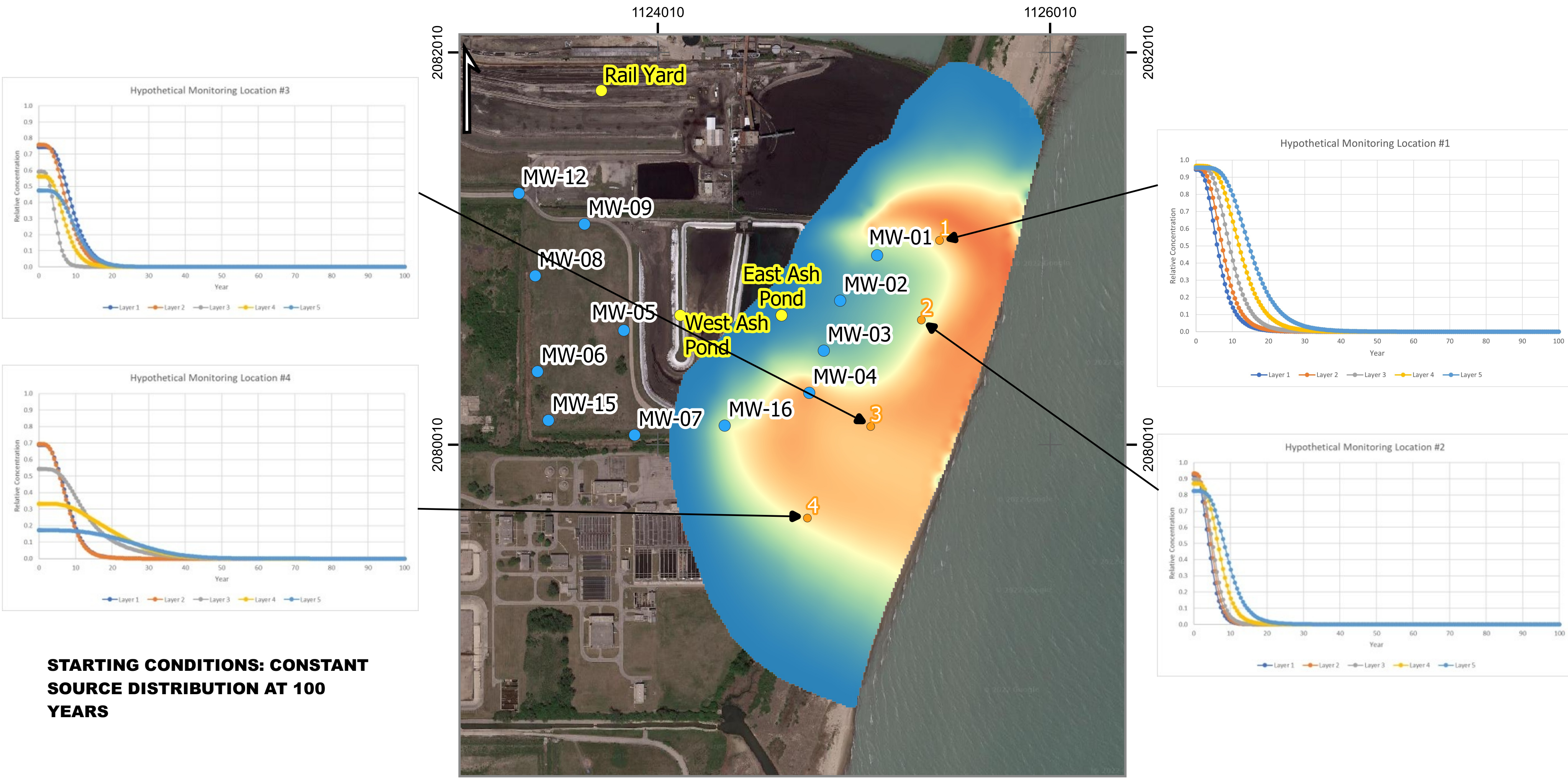
BAS GROUNDWATER CONSULTING

KPRG

0 400 800 ft
FEET

Coordinate System:
NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure23_50yearAnd100YearDistributions.qgz

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	**MODEL SCENARIO 3: 50-YEAR AND 100-YEAR PLUME DISTRIBUTIONS**		
SCALE AT ANSI A 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: **23**		



STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS

LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1, AT 5 YEARS

0.01
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

BAS GROUNDWATER CONSULTING

K P R G

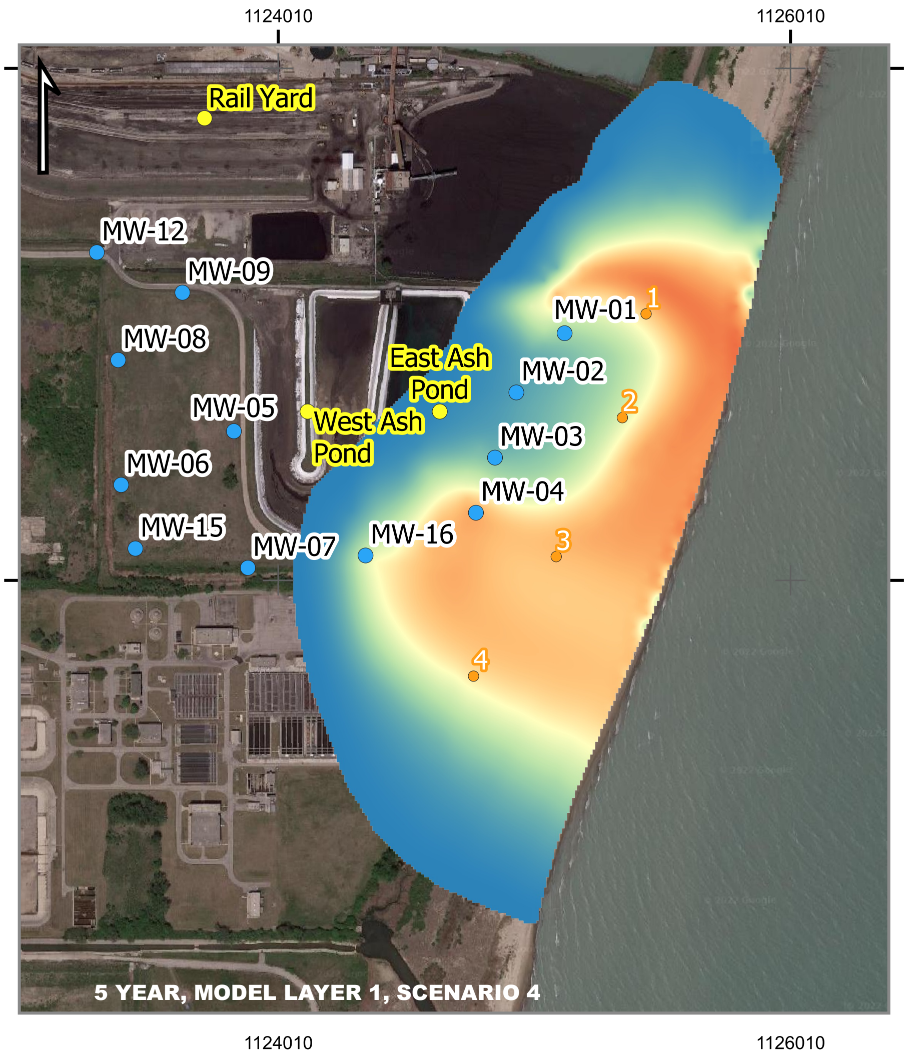
0 400 800 ft

FEET

Coordinate System:
Project File: Figure24_Scenario3StartingPositions.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL SCENARIO 3. DECAY OF CONCENTRATIONS THROUGH TIME**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:9,000	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101		FIGURE: **24**	



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

BAS GROUNDWATER CONSULTING

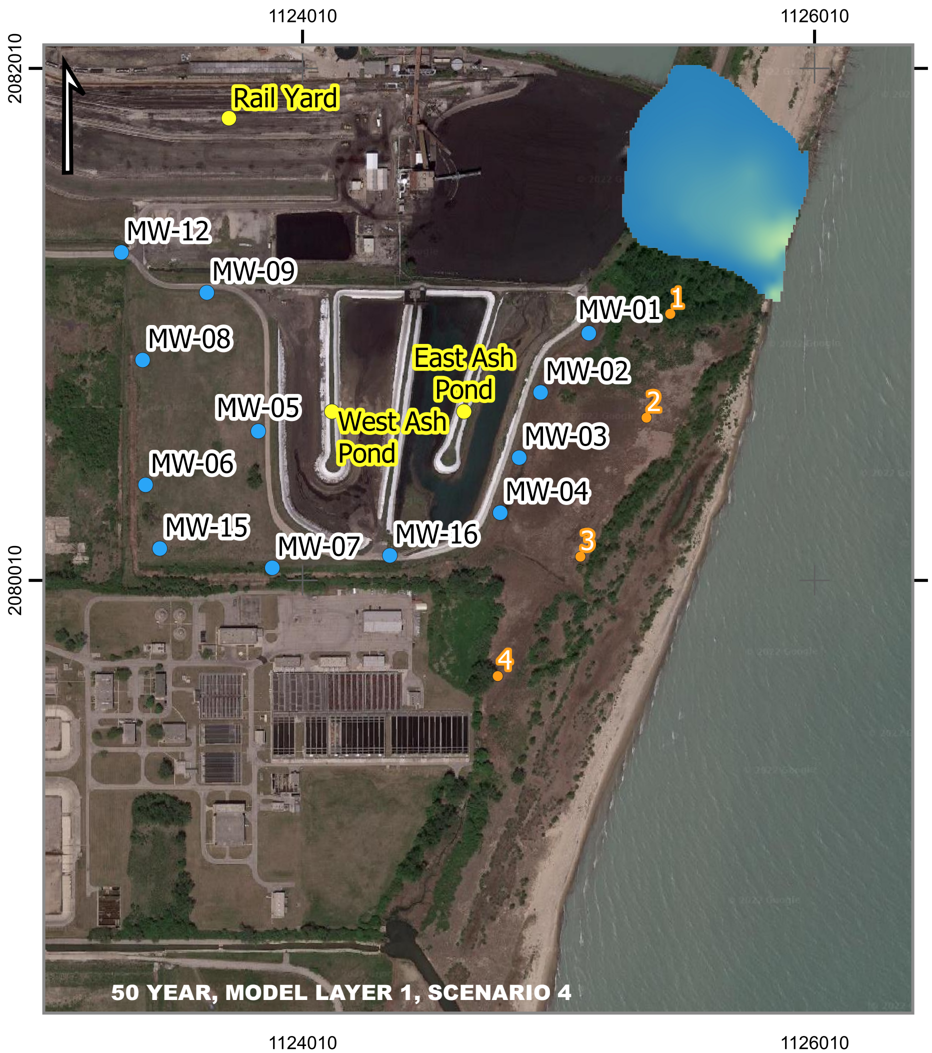
K P R G

0 400 800 ft

FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure25_5yearAnd25YearDistributions.qgz

CLIENT	MIDWEST GENERATION, LLC		
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL		
TITLE	MODEL SCENARIO 4: 5-YEAR AND 25-YEAR PLUME DISTRIBUTIONS		
SCALE AT ANSI A 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: 25		



LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1

0.01
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

BAS GROUNDWATER CONSULTING

KPRG

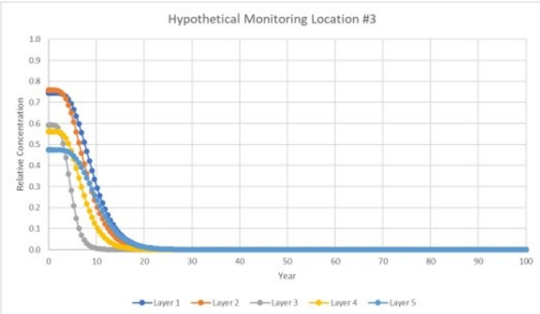
0 400 800 ft

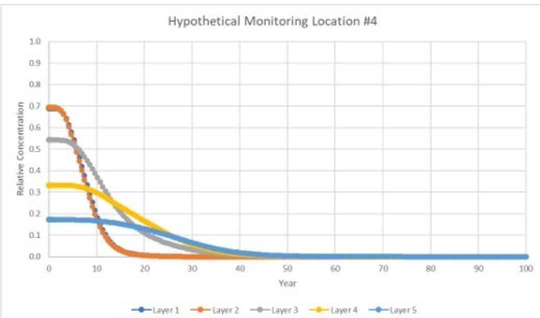
FEET

Coordinate System: NAD_1983_StatePlane_Illinois_East_FIPS_1201_Feet
Project File: Figure26_50yearAnd100YearDistributions.qgz

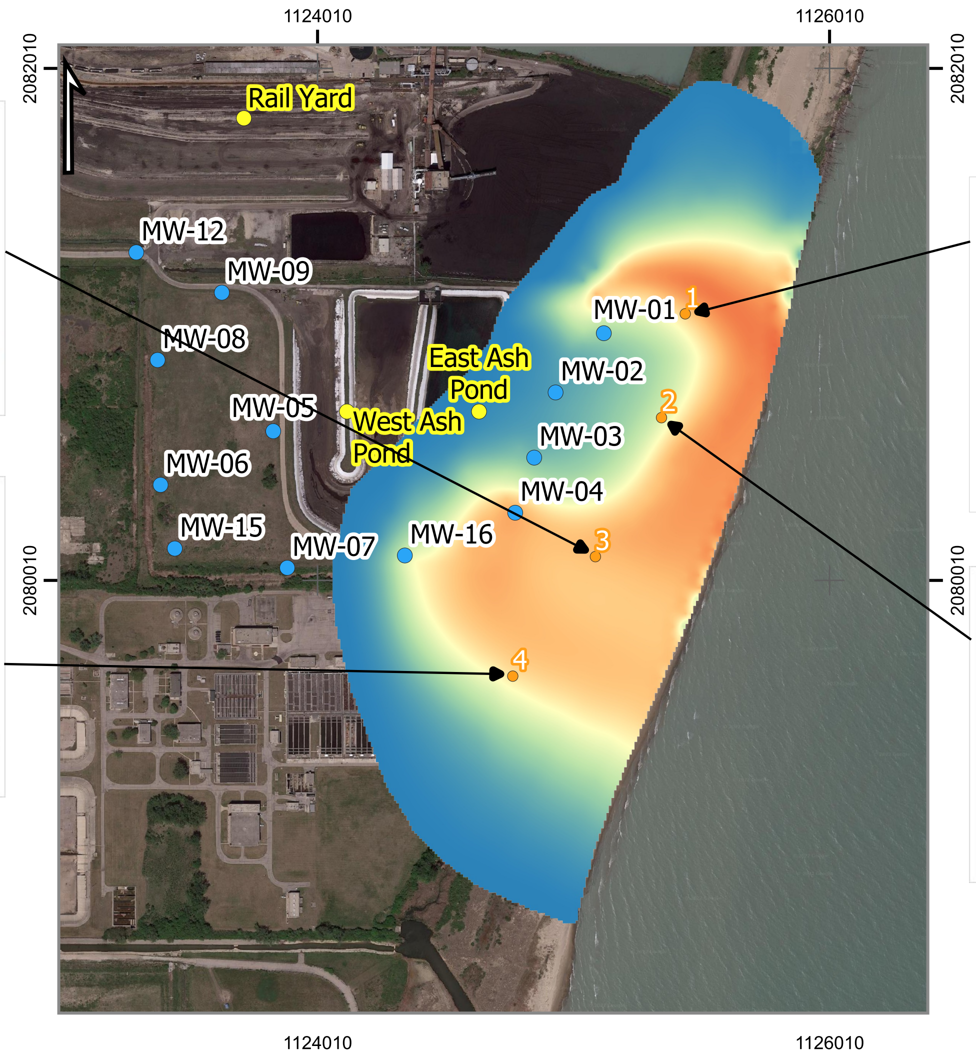
CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL SCENARIO 4: 50-YEAR AND 100-YEAR PLUME DISTRIBUTIONS**

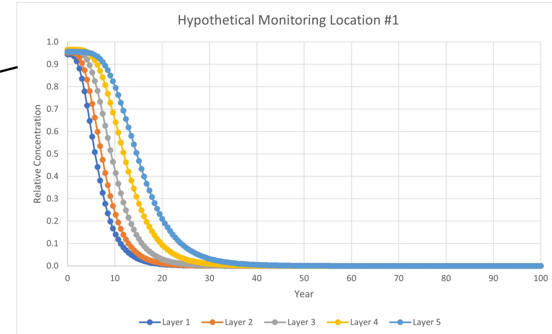
SCALE AT ANSI A 1:9,000	DRAWN	DZF	01/27/2022
	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: **26**		

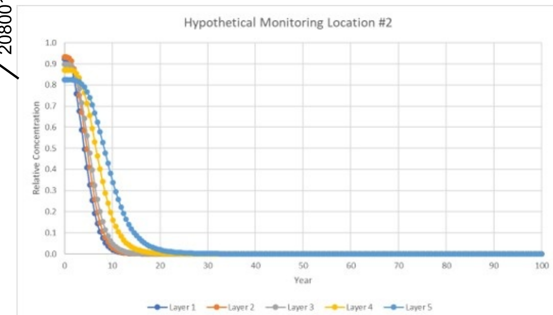




STARTING CONDITIONS: CONSTANT SOURCE DISTRIBUTION AT 100 YEARS







LEGEND

PROPERTY BOUNDARY

MODEL BOUNDARY

HYPOTHETICAL MONITORING WELL LOCATION

SITE WELL

RELATIVE CONCENTRATIONS IN MODEL LAYER 1, AT 5 YEARS

0.01	0.6
0.1	0.7
0.2	0.8
0.3	0.9
0.4	1
0.5	

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K P R G

0 400 800 ft

FEET

Coordinate System:
Project File: Figure27_Scenario4StartingPositions.qgz

CLIENT	MIDWEST GENERATION, LLC
SITE	WAUKEGAN 401 E GREENWOOD AVE, WAUKEGAN, IL
TITLE	**MODEL SCENARIO 4. DECAY OF CONCENTRATIONS THROUGH TIME**

SCALE AT ANSI A	DRAWN	DZF	01/27/2022
1:9,000	CHECKED	BAS	01/27/2022
BAS PROJECT No. 21141101	FIGURE: **27**		

BAS GROUNDWATER CONSULTING

basgroundwater.com

ATTACHMENT 9
GROUNDWATER MONITORING INFORMATION

Attachment 9-1 – Local Well Stratigraphy Information

Attachment 9-1.
Local Well Stratigraphy Information. Midwest Generation, LLC, Waukegan Generating Station, Waukegan, IL.

ID	Well_Count	Well_ID	From	To	Description
1	1	120974156100	0	5	gray sand loam w/gravel fill
2		120974156100	5	7	mucky black sandy loam w/fibers
3		120974156100	7	9	medium dense fine grained brown sandy loam
4		120974156100	9	11	very dense medium grained brown sand
5		120974156100	11	14	very dense fine to medium grained gray sandy loam
6		120974156100	14	16.5	medium dense fine grained gray sandy loam
7		120974156100	16.5	25.5	very dense fine to medium grained gray sand
8		120974156100	25.5	26	very dense gray silty loam
9	2	120974156700	0	3.5	black cinders fill
10		120974156700	3.5	4.5	brown gravel fill w/broken concrete
11		120974156700	4.5	7	very loose brown cinders fill
12		120974156700	7	9.5	very loose brown peat
13		120974156700	9.5	12	loose fine grained brown sand loam
14		120974156700	12	17	very dense fine grained gray sand
15		120974156700	17	19.5	dense fine grained gray sand
16		120974156700	19.5	24.5	very dense fine grained gray sand
17		120974156700	24.5	26.5	hard pebbly gray silt loam till
18	3	120974156800	0	6.5	very loose cinders fill
19		120974156800	6.5	9.5	very loose sandy fill
20		120974156800	9.5	11.5	loose medium grained brown sand loam
21		120974156800	11.5	14	medium dense fine grained gray gravel
22		120974156800	14	16.5	dense fine to medium grained brown sand
23		120974156800	16.5	19.5	medium dense fine grained brown sand
24		120974156800	19.5	21.5	loose fine grained brown sand
25		120974156800	21.5	24	very dense fine to medium grained brown sand
26		120974156800	24	26	very dense gray silt
27	4	120974156500	0	9.5	very loose black cinders fill
28		120974156500	9.5	12	very soft brown peat
29		120974156500	12	14.5	medium dense fine grained gray sand
30		120974156500	14.5	19.5	very dense fine to medium grained gray sand
31		120974156500	19.5	22	dense fine to medium grained brown sand
32		120974156500	22	26.5	very dense fine to medium grained brown sand
33	5	120974156600	0	6.5	very loose black cinders fill
34		120974156600	6.5	9	very loose brown sand loam
35		120974156600	9	11.5	loose brown sand loam
36		120974156600	11.5	14	medium dense medium grained brown sand
37		120974156600	14	16.5	dense medium grained brown sand
38		120974156600	16.5	19	very dense medium grained brown sand
39		120974156600	19	21.5	medium dense medium grained brown sand
40		120974156600	21.5	24	hard pebbly gray silty clay loam till
41		120974156600	24	26	hard gray silt loam
42	6	120974157200	0	1.5	cinder & fly ash fill
43		120974157200	1.5	4.5	loose red cinders fill
44		120974157200	4.5	7.5	loose brown & black cinder fill
45		120974157200	7.5	12.5	medium dense brown sandy loam
46		120974157200	12.5	22.5	dense brown sand
47		120974157200	22.5	23.5	dense gray silt loam
48	7	120974157300	0	7	very loose cinders fill
49		120974157300	7	9.5	medium dense brown sand
50		120974157300	9.5	12	loose brown sand
51		120974157300	12	14.5	dense brown sand
52		120974157300	14.5	17	medium dense brown sand
53		120974157300	17	19.5	very dense brown sand
54		120974157300	19.5	26.5	very dense gray silt
55	8	120974156900	0	1	black cinders fill
56		120974156900	1	6	very soft black peat
57		120974156900	6	9.5	loose fine grained gray sand loam
58		120974156900	9.5	12	medium dense fine grained gray sand loam
59		120974156900	12	14.5	very dense fine to medium grained gray sand
60		120974156900	14.5	17.5	dense fine to medium grained gray sand
61		120974156900	17.5	19.5	hard pebbly gray silty clay
62		120974156900	19.5	26.5	hard gray silt loam
63	9	120974157000	0	7.5	loose black cinders & flyash fill
64		120974157000	7.5	10	very loose brown cinder fill
65		120974157000	10	12.5	loose black organic sandy loam mixed with cinders
66		120974157000	12.5	17.5	medium dense brown sandy loam with some cinders inter mixed
67		120974157000	17.5	22.5	dense brown sand
68		120974157000	22.5	25	very dense brown sand
69		120974157000	25	27.5	very dense gray silt loam
70		120974157000	27.5	30	hard gray silt loam
71		120974157000	30	32	very dense gray silt loam

72	10	120970172800	0	30	sand
73		120970172800	30	55	hardpan
74		120970172800	55	105	clay, blue
75		120970172800	105	108	sand
76		120970172800	108	108	rock at
77	11	120970172900	0	34	sand
78		120970172900	34	55	hardpan
79		120970172900	55	98	clay, blue
80		120970172900	98	112	sand & gravel
81		120970172900	112	127	rock
82	12	120974157100	0	7.5	black cinder fill
83		120974157100	7.5	9.5	very soft black & brown muck w/sand seams
84		120974157100	9.5	17.5	medium dense brown sand
85		120974157100	17.5	20	dense brown sand
86		120974157100	20	24	medium dense brown sand
87		120974157100	24	27	very dense gray silt loam
88	13	120974156400	0	3.5	black cindery fill
89		120974156400	3.5	7	medium dense brown sandy loam topsoil
90		120974156400	7	14	medium dense fine grained brown sandy loam
91		120974156400	14	20	dense fine to medium grained brown sand
92		120974156400	20	25	very dense fine grained brown sand
93		120974156400	25	32	hard gray silty loam
94	14	120974120400	0	112	no record
95		120974120400	112	840	limestone
96		120974120400	840	1150	St. Peter
97		120974120400	1150	1540	Dresback
98		120974120400	1540	1540	Mt. Simon
99	15	120973561700	0	12	light brown, fine/medium sand
100		120973561700	12	15	gray, fine/medium sand w/fine gravel
101	16	120973561800	0	5	black fine/medium sand
102		120973561800	5	13	brown fine/medium sand
103	17	120974802700	0	2	Silty sand, trace clay and organic matter, dark gray, moist, loose
104		120974802700	2	6	Fine to medium sand, trace gravel - brown, wet, medium dense
105		120974802700	6	13	Fine to medium sand, trace gravel - brown to brown-gray - wet - dense to very dense
106	18	120974802800	0	4	Fill
107		120974802800	4	10	Fine to medium sand, wet, medium
108		120974802800	10	17	Fine to medium sand, trace gravel, very dense
109	19	120973562100	0	23	gray fine/medium sand
110		120973562100	23	40	gray very fine sand & silt
111	20	120974645500	0	0.5	4" asphalt
112		120974645500	0.5	1	sand,dark gray
113		120974645500	1	6	silty clay,gray,tough
114		120974645500	6	11	silt,trace gravel & clay,gray,hard(estimated),moist to wet
115		120974645500	11	38	silty & sandy clay,trace gravel,with horizontal seams of sand & light gray silt
116		120974645500	38	41	silty,very fine sand,gray,hard(estimated),moist
117	21	120973561900	0	4	black fine/medium sand w/debris fill mat
118		120973561900	4	14	brown fine/medium sand
119	22	120973562000	0	14	fn/med grayish sand w/trace of gvl
120	23	120970264200	0	4.5	black cinders fill
121		120970264200	4.5	6	soft black peat
122		120970264200	6	12	medium dense fine to medium grained gray sand loam
123		120970264200	12	14.5	dense medium grained gray sand
124		120970264200	14.5	17	very dense medium grained brown sand
125		120970264200	17	19.5	medium dense medium grained brown sand
126		120970264200	19.5	22	very dense medium grained brown sand
127		120970264200	22	26.5	hard gray silt loam
128	24	120975335000	0	1	Miscellaneous fill
129		120975335000	1	38	Gray silty clay till, horizontal seams of silt and fine sand tough to hard
130		120975335000	38	41	Gray, silty, very fine sand
131	25	120974646200	0	0.5	1" asphalt, 5" concrete
132		120974646200	0.5	18	fine to medium sand,trace gravel,& silt,brown & slightly gray,dense to very dense,moist to wet
133		120974646200	18	42	silty clay,trace to some sand,trace gravel,with pockets of light gray silt, hard

134	26	120970173400	0	112	lake sand
135		120970173400	112	303	lime hard
136		120970173400	303	320	red rock
137		120970173400	320	365	lime sandy, water here
138		120970173400	365	550	shale blue
139		120970173400	550	600	lime hard
140		120970173400	600	650	lime brn, sndy, water here-hole 1/2 full
141		120970173400	650	700	lime brown, fairly hard
142		120970173400	700	750	lime gray, hard
143		120970173400	750	800	lime gray, very hard
144		120970173400	800	840	lime grayish-blue, hard
145		120970173400	840	900	sand coarse, water here
146		120970173400	900	950	sand wht f, more water-hole nearly full
147		120970173400	950	1000	sand f, water bearing, well running over
148		120970173400	1000	1010	red rock
149		120970173400	1010	1040	lime, sandy, brown, hard
150		120970173400	1040	1050	red rock
151		120970173400	1050	1100	lime, sandy, gray
152		120970173400	1100	1105	shale green
153		120970173400	1105	1150	lime, sandy, firm
154		120970173400	1150	1255	sand white
155		120970173400	1255	1270	lime, brown, sandy, firm, water here
156		120970173400	1270	1275	slate green
157		120970173400	1275	1345	12 1/2" hole; lime, gray, very hard
158	27	120975335100	0	8	Gray fine, sand, fill trace clay
159		120975335100	8	16	Gray, fine sand, trace clay
160		120975335100	16	21	Gray brown, fine sand, trace silt and gravel, medium dense
161	28	120974801200	0	14	Fill
162	29	120974750300	0	9.5	black-brown fine to coarse sand w/fine gravel
163	30	120974799000	0	5	fill
164		120974799000	7	11	sand
165		120974799000	11	13	sand and gravel
166		120974799000	13	17	sand
167		120974799000	17	23	sand and gravel
168	31	120974799100	10	25	sand
169	32	120974799900	0	0.5	Silty clayey topsoil, trace roots and sand
170		120974799900	0.5	2	Fine to med. sand, trace to some gravel, silt, clay
171		120974799900	2	6	Fine to medium sand, trace silt, organic material
172		120974799900	6	9.5	Fine to med. sand, trace silt, gravel
173		120974799900	9.5	18	Fine to medium sand trace silt
174		120974799900	18	26.5	Fine sand, trace silt
175	33	120974800000	0	1	topsoil
176		120974800000	1	9.5	Fine sand, trace silt, and gravel
177		120974800000	9.5	18.5	sand and gravel
178		120974800000	18.5	26.5	sand, silt, gravel
179	34	120974799500	0	3.5	topsoil
180		120974799500	3.5	8.5	sand and silt
181		120974799500	8.5	18	sand and gravel
182		120974799500	18	26.5	sand and silt
183	35	120974799600	0	0.5	topsoil
184		120974799600	0.5	18	sand and gravel
185		120974799600	18	26.5	sand and silt
186	36	120974800300	0	0.5	topsoil
187		120974800300	2	3.5	sand and organic materials
188		120974800300	3.5	9.5	sand
189		120974800300	9.5	18.5	sand and gravel
190		120974800300	18.5	26.5	sand and silt
191	37	120974800400	0	1	topsoil
192		120974800400	1	2	sand
193		120974800400	2	26.5	sand and gravel
194	38	120974800100	0	0.5	topsoil
195		120974800100	0.5	3	cinder and clay
196		120974800100	3	18.5	sand and gravel
197		120974800100	18.5	27	sand and silt
198	39	120974753700	0	9	sludge, brick, concrete (6.5-9 moist)
199		120974753700	9	13	wood
200		120974753700	13	15.5	sand, fine, black, waterbearing
201	40	120974754200	0	14	sludge
202		120974754200	14	20	sludge, moist w/wet lense like areas
203		120974754200	20	22.8	gravel fine to medium, fill
204		120974754200	22.8	23	shingles
205		120974754200	23	29	shingles, gravel, sludge
206		120974754200	29	30.5	sand, fine, black, waterbearing

207	41	120970173700	0	166	drift
208		120970173700	166	174	rock
209	42	120970173500	0	95	drift rock at 95'
210		120970173500	95	95	drift rock at 95'
211	43	120970173200	0	95	drift rock at 95'
212		120970173200	95	95	drift rock at 95'
213	44	120970173300	0	100	drift
214		120970173300	100	101	rock
215	45	120974805200	0.5	13.5	fill
216		120974805200	13.5	16.5	peat
217		120974805200	16.5	18.5	sand and clay
218		120974805200	18.5	25.5	sand and silt
219		120974805200	25.5	27	silt, clay, and sand - wet
220	46	120974799800	0	1	topsoil
221		120974799800	1	24	sand and gravel
222		120974799800	24	41.5	sand and silt
223	47	120974751900	0	29	sand
224		120974751900	29	40	sand and clay
225	48	120974758100	0	11	sand and gravel
226		120974758100	11	31.5	sand and gravel - Saturated
227		120974758100	31.5	34	silt and gravel
228		120974758100	34	36	clay, gravel, and silt
229	49	120974755700	0	8	gray, fine sand, fill trace clay
230		120974755700	8	16	gray, fine sand, trace clay
231		120974755700	16	21	Gray brown, fine sand, trace silt and gravel, medium dense
232	50	120974755800	0	1	topsoil
233		120974755800	1	31	sand and gravel
234		120974755800	31	43	clay and gravel
235	51	120974759000	0	3.5	fill
236		120974759000	3.5	23	sand and gravel
237		120974759000	23	38.5	sand and silt
238		120974759000	38.5	40	silt and clay
239	52	120974758800	0	23	sand
240		120974758800	23	39.5	sand and silt
241	53	120974759500	0	4	fill
242		120974759500	4	39.5	sand and gravel
243		120974759500	39.5	40.2	silt and clay
244	54	120974759200	0	3	fill
245		120974759200	3	15	sand and gravel
246	55	120974753500	0	16.5	sludge
247		120974753500	16.5	19	sand, fine, shingle sand, moist
248		120974753500	19	26.5	sludge, moist
249		120974753500	26.8	28	sludge w/2" layer of shingle sand
250		120974753500	28	31.5	sludge
251		120974753500	31.5	34	sludge, marl, sand, layered
252		120974753500	34	35.5	sand & gravel layers, black
253	56	120974753600	0	2.5	road gravel, cinders
254		120974753600	2.5	5	sand fine to medium, black, waterbearing
255		120974753600	5	9	sand fine to medium, tan, waterbearing
256		120974753600	9	14	sand fine to medium & gravel fine to medium, waterbearing
257		120974753600	14	37	sand fine to medium, waterbearing
258		120974753600	37	39.5	sand fine to very fine, silty, waterbearing
259		120974753600	39.5	40	clay, occasional stone, gray
260	57	120974755000	0	0.5	asphalt
261		120974755000	0.5	3	fill-tan/brown silty sand w/some gravel
262		120974755000	3	5	fill-gray silty clay w/gravel
263		120974755000	5	15	gray fine silty sand w/trace gravel
264	58	120974753400	0	9	sludge, fiber
265		120974753400	9	26.5	sludge, fiber, moist
266		120974753400	26.5	30.5	sand, black tar like w/some stones & service board
267	59	120974750500	0	1.5	cinder fill material
268		120974750500	1.5	10	light gray-green fine to medium sand
269	60	120974758000	0	2.5	silt and clay
270		120974758000	2.5	6	sand
271		120974758000	6	15	sand and gravel
272	61	120970173000	0	30	sand
273		120970173000	30	55	hardpan
274		120970173000	55	102	clay, blue
275		120970173000	102	115	sand & gravel
276		120970173000	115	132	rock

277	62	120970173100	0	50	sand
278		120970173100	50	60	hardpan
279		120970173100	60	97	clay, blue
280		120970173100	97	115	sand & gravel
281		120970173100	115	132	rock
282	63	MW-01	0	13.5	FILL: Brown fine sand, fine gravel, black, cinders, ash
283		MW-01	13.5	16	FILL: Light Brown fine and medium sand, dry
284		MW-01	16	18	FILL: Occasional black coal, cinders
285		MW-01	18	20	FILL: Brown fine sand, occasional black cinders
286		MW-01	20	25	SM: Light brown fine sand, trace medium sand, medium dense, moist
287		MW-01	25	29	SM: Trace fine gravel
288		MW-01	29	32	SM: Fine Sand, trace coarse to medium sand, medium dense, saturated
289	64	MW-02	0	11	FILL: Black coal cinders, ash, fine sand, fine gravel, gray silt
290		MW-02	11	18.5	SM: Light brown fine sand, gray fine sand
291		MW-02	18.5	21.5	SM: Light brown fine sand, trace medium sand, well graded
292		MW-02	21.5	24.5	SM: Medium dense, dry
293		MW-02	24.5	30	Trace fine gravel and coarse sand
294	65	MW-03	0	7	FILL: Brown silty sand, fine gravel, black coal cinders, ash
295		MW-03	7	15	FILL: Gray silt, cinders, ash, sand
296		MW-03	15	16	FILL: Light brown fine sand
297		MW-03	16	18.5	FILL: Black coarse coal cinders
298		MW-03	18.5	20	SM: Light Brown fine sand
299		MW-03	20	24	SM: Light brown fine sand, trace medium sand, well graded, medium dense
300		MW-03	24	30	SM: Trace fine gravel
301	66	MW-04	0	9	FILL: Dark brown silt, coarse gravel, black coal cinders, dry
302		MW-04	9	13	FILL: Wood, gray silt, cinders, dry
303		MW-04	13	15	FILL: Some medium sand
304		MW-04	15	18.5	FILL: Cinders mixed with brown fine sand
305		MW-04	18.5	29.58	SM: Light brown fine sand, well graded, medium dense
306		MW-04	29	30	SM: Trace fine gravel, trace coarse sand
307	67	MW-05	0	0.5	FILL: Dark brown silty clay topsoil
308		MW-05	0.5	7	FILL: Brown fine to medium sand, with black coal cinders
309		MW-05	7	9	FILL: Loose
310		MW-05	9	11	FILL: Brick
311		MW-05	11	14	FILL: Black coal cinders
312		MW-05	14	16	FILL: Dark gray silt
313		MW-05	16	17	FILL: Gray medium sand, black coal cinders
314		MW-05	17	21	SM: Gray fine sand, trace medium to coarse sand, wel graded, loose to medium dense, saturated
315		MW-05	21	26	GP: Gray fine gravel, coarse sand, poorly graded, medium dense, saturated
316		MW-05	26	31.92	SM: Gray fine sand, trace medium sand, trace fine gravel, well graded, medium dense
317	68	MW-09	0	0.5	FILL: Black Clay/Silt/Fine grained Sand mix, moist
318		MW-09	0.5	4	FILL: Gray Silt, dry
319		MW-09	4	6	FILL: Begin dark gray
320		MW-09	6	9.5	FILL: Black slag
321		MW-09	9.5	10.5	Peat, black silty clay with organics, wet
322		MW-09	10.5	13	light gray silty sand, fine to medium grained with trace coarse grained, organics
323		MW-09	13	18	brown silty sand, fine to medium grained with trace coarse grained
324	69	MW-16	0	0.5	FILL: Dark brown clayey top soil, dry
325		MW-16	0.5	1	FILL: Brown Sand/Silt/gravel mix, dry
326		MW-16	1	2.5	FILL: Brown Silty Sand, slighly moist
327		MW-16	2.5	9	FILL: Brown and dark gray silt, and fine sand, some cinders, slightly moist
328		MW-16	9	11	FILL: Orange brown SILTY SAND, medium grained, slightyly moist
329		MW-16	11	16	FILL: Dark Brown to Black SAND, fine to medium, cinders, trace silt, slightly moist
330		MW-16	16	17	FILL: Tan SILTY SAND, with gray SILT layers, slightly moist
331		MW-16	17	18	FILL: Gray SILT, some black, very moist
332		MW-16	18	24	FILL: Black SAND, fine to medium, cinders, slightly moist
333		MW-16	24	30	Brown SILTY SAND, fine to medium, moist

Attachment 9-2 – Boring Logs

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-1-Wa** SHEET **1** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.5**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL 10 20 30 40 50 LL / Unconfined Compressive Strength (TSF) 1 2 3 4 5	NOTES & TEST RESULTS
23.5	0.0		Brown fine sand, fine gravel, black cinders, ash FILL				
				SS-1 1.0-2.5 16"R	3 5 7		qu=NT
							Bentonite seal 2.0'-20.0'. Stickup protective cover installed.
			Dry	SS-2 3.5-5.0 18"R	6 10 13		qu=NT
				SS-3 6.0-7.5 14"R	6 11 16		qu=NT
			Dry	SS-4 8.5-10.0 12"R	4 9 10		qu=NT
				SS-5 11.0-12.5 16"R	2 3 3		qu=NT
10.0	13.5		Light brown fine and medium sand, dry FILL	SS-6 13.5-15.0 18"R	2 4 3		qu=NT
			Occasional black coal, cinders	SS-7 16.0-17.5 18"R	3 4 4		qu=NT
			Brown fine sand, occasional black cinders	SS-8 18.5-20.0 18"R	6 7 9		qu=NT
3.5	20.0						

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/13/10** ENDED **10/13/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
∇ **23.5**
∇
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-1-Wa** SHEET **2** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.5**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ 10 20 ○ 30 40 △ 50 LL / Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
3.5	20.0		Light brown fine sand, trace medium sand, medium dense, moist SM				Sand pack 20.0'-32.0'
				SS-9 21.0-22.5 18"R	5 8 10		qu=NT
							Set screen (slot 0.010") 22.0'-32.0'
0.0	23.5		∇ Saturated	SS-10 23.5-25.0 18"R	6 9 10		qu=NT
			Trace fine gravel				
				SS-11 26.0-27.5 18"R	5 6 12		qu=NT
			Fine sand, trace coarse to medium sand, medium dense, saturated	SS-12 28.5-30.0 18"R	6 9 13		qu=NT
-8.5	32.0		End of Boring at 32.0'				

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/13/10** ENDED **10/13/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
∇ 23.5
∇
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-2-Wa** SHEET **1** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.0**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✱ (1 2 3 4 5)	NOTES & TEST RESULTS
23.0	0.0		Black coal cinders, ash, fine sand, fine gravel, gray silt FILL				
				SS-1 1.0-2.5 14"R	4 10 15		qu=NT
							Bentonite seal 2.0'-19.0'. Stickup protective cover installed.
			Dry	SS-2 3.5-5.0 14"R	8 10 23		qu=NT
				SS-3 6.0-7.5 14"R	12 11 16		qu=NT
			Dry	SS-4 8.5-10.0 18"R	7 12 14		qu=NT
12.0	11.0		Light brown fine sand, gray fine sand	SS-5 11.0-12.5 18"R	12 13 13		qu=NT
				SS-6 13.5-15.0 18"R	1 3 6		qu=NT
				SS-7 16.0-17.5 18"R	8 10 10		qu=NT
			Dry				
4.5	18.5		Light brown fine sand, trace medium sand, well graded SM	SS-8 18.5-20.0 18"R	9 12 14		qu=NT Sand pack 19.0'-30.0'

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/13/10** ENDED **10/13/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
∇ 21.5
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-2-Wa** SHEET **2** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.0**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
3.0	20.0						Set screen (slot 0.010") 20.0'-30.0'
1.5	21.5		∇ Saturated	SS-9 21.0-22.5 18"R	6 10 11		qu=NT
			Medium dense, dry				
			Trace fine gravel and coarse sand	SS-10 23.5-25.0 18"R	3 7 12		qu=NT
				SS-11 26.0-27.5 18"R	4 7 13		qu=NT
				SS-12 28.5-30.0 18"R	2 8 12		qu=NT
-7.0	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/13/10** ENDED **10/13/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
∇ **21.5**
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-3-Wa** SHEET **1** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.2**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL 10 20 30 40 50 LL / Unconfined Compressive Strength (TSF) 1 2 3 4 5	NOTES & TEST RESULTS
23.2	0.0		Brown silty sand, fine gravel, black coal cinders, ash FILL				
				SS-1 1.0-2.5 16"R	7 13 16		qu=NT
							Bentonite seal 2.0'-19.0'. Stickup protective cover installed.
			Dry	SS-2 3.5-5.0 18"R	9 16 18		qu=NT
			Gray silt, cinders, ash, sand	SS-3 6.0-7.5 14"R	15 20 26/4.5"		qu=NT
				SS-4 8.5-10.0 18"R	9 16 18		qu=NT
				SS-5 11.0-12.5 18"R	6 10 12		qu=NT
				SS-6 13.5-15.0 18"R	3 4 9		qu=NT
			Light brown fine sand				
			Black coarse coal cinders	SS-7 16.0-17.5 18"R	7 7 9		qu=NT
4.7	18.5		Light brown fine sand SM	SS-8 18.5-20.0 18"R	6 7 12		Sand pack 19.0'-20.0'
3.2	20.0						

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/13/10** ENDED **10/13/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
▽ **21.0**
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-3-Wa** SHEET **2** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.2**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
3.2	20.0		Light brown fine sand, trace medium sand, well graded, medium dense				Set screen (slot 0.010") 20.0'-30.0'
2.2	21.0		▽ SM Saturated	SS-9 21.0-22.5 18"R	4 6 10		qu=NT
			Trace fine gravel	SS-10 23.5-25.0 18"R	4 6 10		qu=NT
				SS-11 26.0-27.5 18"R	6 7 16		qu=NT
				SS-12 28.5-30.0 18"R	6 12 14		qu=NT
-6.8	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/13/10** ENDED **10/13/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
▽ **21.0**
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER	**B-MW-4-Wa**	SHEET	**1** OF **2**
CLIENT	**Midwest Generation**		
PROJECT & NO.	**21053.070**		
LOCATION	**Waukegan**		

LOGGED BY **MPG**

GROUND ELEVATION **23.6**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
23.6	0.0		Dark brown silt, coarse gravel, black coal cinders, dry FILL				
				SS-1 1.0-2.5 18"R	6 13 19		qu=NT
							Bentonite seal 2.0'-19.0'. Stickup protective cover installed.
				SS-2 3.5-5.0 17"R	8 24 21		qu=NT
				SS-3 6.0-7.5 6"R	13 31/4"		qu=NT
			Wood, gray silt, cinders, dry	SS-4 8.5-10.0 18"R	14 26 26		qu=NT
			Some medium sand	SS-5 11.0-12.5 18"R	11 14 13		qu=NT
			Cinders mixed with brown fine sand	SS-6 13.5-15.0 18"R	5 8 8		qu=NT
				SS-7 16.0-17.5 18"R	7 10 12		qu=NT
5.1	18.5		Light brown fine sand, well graded, medium dense SM	SS-8 18.5-20.0 18"R	7 11 13		qu=NT Sand pack 19.0'-30.0'

DRILLING CONTRACTOR	**Groff Testing**
DRILLING METHOD	**4.25" I.D. HSA**
DRILLING EQUIPMENT	**CME 550 ATV**
DRILLING STARTED **10/12/10**	ENDED **10/12/10**

REMARKS

Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)

▽ 23.0

▼

▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-4-Wa** SHEET **2** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **23.6**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content (PL □ ○ △ LL, 10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
3.6	20.0						Set screen (slot 0.010") 20.0'-30.0'
			Moist	SS-9 21.0-22.5 18"R	4 6 6		qu=NT
0.6	23.0		∇ Saturated				
				SS-10 23.5-25.0 18"R	4 4 8		qu=NT
				SS-11 26.0-27.5 18"R	8 8 10		qu=NT
			Trace fine gravel, trace coarse sand	SS-12 28.5-30.0 18"R	7 8 12		qu=NT
-6.4	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/12/10** ENDED **10/12/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
∇ 23.0
∇
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-5-Wa** SHEET **1** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **21.5**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ 10 20 ○ 30 40 △ LL 50 / Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
21.5	0.0		Dark brown silty clay topsoil				
21.0	0.5		FILL				
			Black coal cinders, medium sand FILL	SS-1 1.0-2.5 14"R	6 10 10		qu=NT
							Bentonite seal 2.0'-18.0'. Stickup protective cover installed.
			Dry	SS-2 3.5-5.0 14"R	4 6 5		qu=NT
				SS-3 6.0-7.5 16"R	2 6 8		qu=NT
			Brown fine to medium sand, with black coal cinders				
			Loose	SS-4 8.5-10.0 18"R	2 2 2		qu=NT
			Brick	SS-5 11.0-12.5 18"R	1 2 1		qu=NT
			Moist				
			Black coal cinders	SS-6 13.5-15.0 17"R	1 2 1		qu=NT
			Dark gray silt	SS-7 16.0-17.5 18"R	4 2 2		qu=NT
4.5	17.0		Gray medium sand, black coal cinders				
			Gray fine sand, trace medium to coarse sand, well graded, loose to medium dense, saturated SM				Sand pack 18.0'-30.0'
				SS-8 18.5-20.0	4 4 5		Set screen (slot 0.010") 18.5'-28.5'

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/12/10** ENDED **10/12/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
▽ **21.0**
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **B-MW-5-Wa** SHEET **2** OF **2**
CLIENT **Midwest Generation**
PROJECT & NO. **21053.070**
LOCATION **Waukegan**

LOGGED BY **MPG**
GROUND ELEVATION **21.5**

ELEVATION	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL / Water Content / LL (10 20 30 40 50); Unconfined Compressive Strength (TSF) (1 2 3 4 5)	NOTES & TEST RESULTS
1.5	20.0						
0.5	21.0	▽					
			Gray fine gravel, coarse sand, poorly graded, medium dense, saturated GP	SS-9 21.0-22.5 16"R	5 7 8		qu=NT
				SS-10 23.5-25.0 18"R	6 9 8		qu=NT
-4.5	26.0						
			Gray fine sand, trace medium sand, trace fine gravel, well graded, medium dense SM	SS-11 26.0-27.5 16"R	6 8 13		qu=NT
				SS-12 28.5-30.0 18"R	7 10 13		qu=NT
-8.5	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 550 ATV**
DRILLING STARTED **10/12/10** ENDED **10/12/10**

REMARKS
Installed 2" diameter PVC monitoring well.

WATER LEVEL (ft.)
▽ **21.0**
▼
▼

KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

GEOLOGIC LOG OF MW-6

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

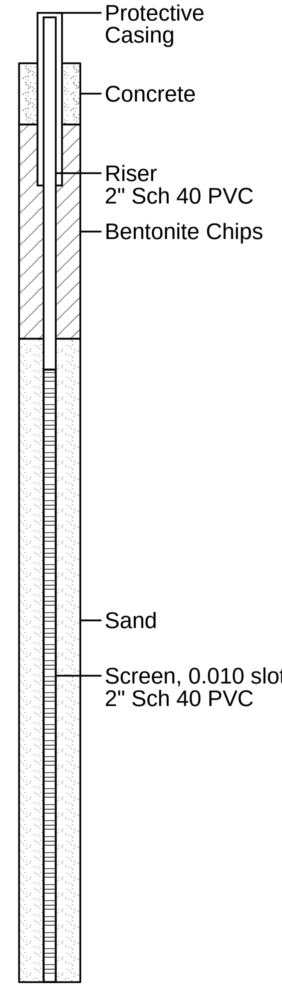
Project No. 18311.31

Date Started	: 11/19/2012
Date Well Set	: 11/19/2012
Rock Coring Tools	: Not cored
Drilling Tools	: 4.25 ID HSA
Drill Rig	: Geoprobe
Driller Name/Co	: T. Brown/Cabeno

Total Boring Depth	: 20 feet
Well Bottom Depth	: 15 feet
Surface Elev.	: 586.75 feet above MSL
TOC Elev.	: 589.73 feet above MSL
Groundwater Elev.	: 580.89 feet above MSL
Riser Material	: 2" Sch 40 PVC
Screen Material	: 2" Sch 40 PVC, 0.010 slot
Coordinate N	: 42 22' 36.90" N
Coordinate E	: 087 49' 6.7" W
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 586.75	DESCRIPTION	% PID	% Recovery
0		FILL: Dark brown silty clay, slightly moist	0	
	585		0	
2		FILL: Brown to dark brown fine SILTY SAND, moist	0	
	583		0	
4		Black SILTY CLAY, organics, slightly moist	0	80
	581	Brown medium to fine grained SILTY SAND	0	
6		- Wet	0	
8	579			
	577		0	80
10				
12	575		0	
	573		0	100
14				
	571	- Some coarse sand	0	
16				
	569		0	80
18				
	567		0	
20		End of Geoprobe boring at 20', end HSA boring at 15'		
22	565			

Well Diagram: MW-6



KPRG
ENVIRONMENTAL CONSULTATION & REMEDIATION
KPRG and Associates, Inc.

GEOLOGIC LOG OF MW-7

(Page 1 of 1)

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

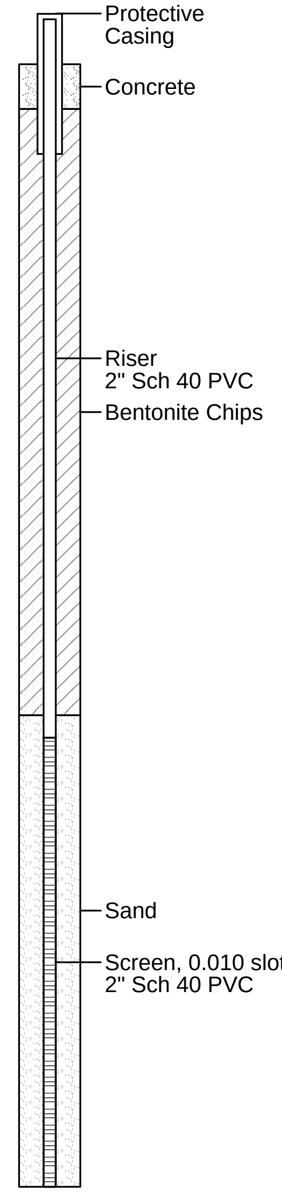
Project No. 18311.31

Date Started	: 11/19/2012
Date Well Set	: 11/19/2012
Rock Coring Tools	: Not cored
Drilling Tools	: 4.25 ID HSA
Drill Rig	: Geoprobe
Driller Name/Co	: T. Brown/Cabeno

Total Boring Depth	: 25 feet
Well Bottom Depth	: 25 feet
Surface Elev.	: 595.87 feet above MSL
TOC Elev.	: 598.29 feet above MSL
Groundwater Elev.	: 579.57 feet above MSL
Riser Material	: 2" Sch 40 PVC
Screen Material	: 2" Sch 40 PVC, 0.010 slot
Coordinate N	: 42 22' 34.00" N
Coordinate E	: 087 48' 59.70" W
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 595.87	DESCRIPTION	PID	% Recovery
0		FILL: Brown to dark brown clay approximately 3" thick	0	
		FILL: Black medium grained sand with some reddish and gray layers, some silty layers, slightly moist	0	
2	594		0	
			0	
4	592		0	80
		FILL: Tan fine to medium grained sand with thin black layers	0	
6	590		0	
8	588		0	80
10	586	FILL: Gray silt with thin banding light to dark, slightly moist		
		Black CLAYEY SILT with organics, soft, wet	0	
12	584		0	100
14	582	Brown fine to medium grained SAND with traces of silt, slightly moist	0	
16	580	- Some gravel	0	80
18	578	- Wet	0	
20	576	- Some coarse gravel	0	
22	574	- Some coarse gravel	0	
24	572			
26	570	End of boring at 25'		
28	568			
30	566			

Well Diagram: MW-7



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Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 20013

GEOLOGIC LOG OF MW-8

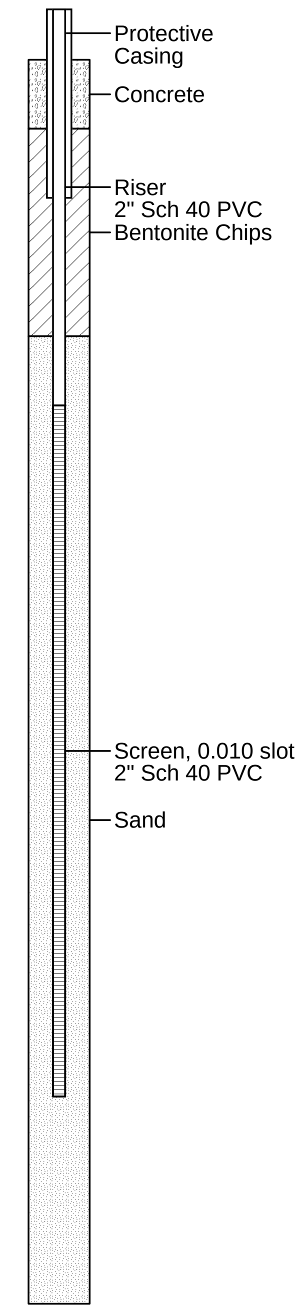
(Page 1 of 1)

Date Started	: 04/29/2014
Date Well Set	: 04/29/2014
Rock Coring Tools	: Not cored
Drilling Tools	: 4.25 ID HSA
Drill Rig	: Geoprobe
Driller Name/Co	: J. Martin/TSC

Total Boring Depth	: 18 feet
Well Bottom Depth	: 15 feet
Surface Elev.	: 588.42 feet above MSL
TOC Elev.	: 590.99 feet above MSL
Groundwater Elev.	: feet above MSL
Riser Material	: 2" Sch 40 PVC
Screen Material	: 2" Sch 40 PVC, 0.010 slot
Coordinate N	: 2080826 N
Coordinate E	: 1123351 E
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 588.42	DESCRIPTION	PID	% Recovery
0		Grass, Black clayey TOP SOIL		
1		FILL: Gray SILT with traces fine sand, very moist		100
2	586			
3		FILL: Brown SILT with black sandy SLAG layered		100
4	584	FILL: Greenish gray SILTY SAND - thin slag layer		
5		Black SILT and CLAY, wet		100
6	582			
7				100
7.5		6" PEAT		
8	580	Gray SILTY SAND, fine to coarse grained, wet		
9				50
10	578			
11				50
12	576			
13				50
14	574	Brown SILTY SAND, fine to medium grained		
15				50
16	572			
17				50
18	570	End of Boring at 18'		

Well Diagram: MW-8



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GEOLOGIC LOG OF MW-9

(Page 1 of 1)

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 20013

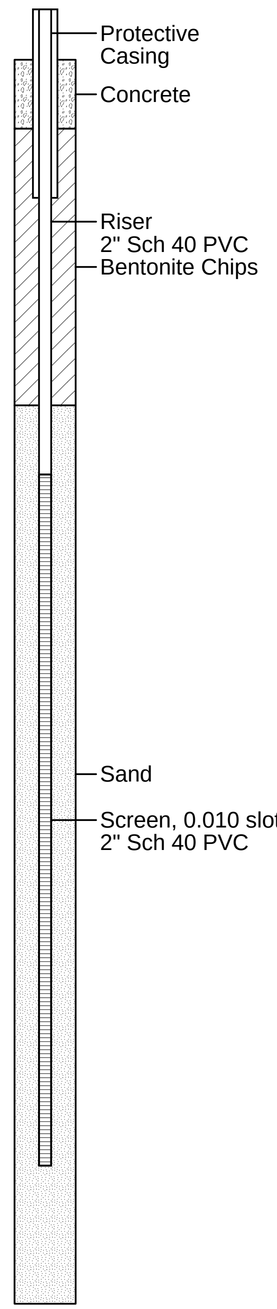
Date Started	: 04/29/2014
Date Well Set	: 04/29/2014
Rock Coring Tools	: Not cored
Drilling Tools	: 4.25 ID HSA
Drill Rig	: Geoprobe
Driller Name/Co	: J. Martin/TSC

Total Boring Depth	: 18 feet
Well Bottom Depth	: 16 feet
Surface Elev.	: 591.58 feet above MSL
TOC Elev.	: 594.09 feet above MSL
Groundwater Elev.	: feet above MSL
Riser Material	: 2" Sch 40 PVC
Screen Material	: 2" Sch 40 PVC, 0.010 slot
Coordinate N	: 2081118 N
Coordinate E	: 1123540 E
Logged By	: P. Allenstein

Depth in Feet: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18
Surf. Elev. 591.58: 590, 588, 586, 584, 582, 580, 578, 576, 574

DESCRIPTION	PID	% Recovery
FILL: Black CLAY/SILT/fine grained SAND mix, moist		
FILL: Gray SILT, dry		100
		75
- Begin dark gray		
		75
FILL: Black SLAG		100
		100
PEAT, black SILTY CLAY with organics, wet		
Light gray SILTY SAND, fine to medium grained with trace coarse grained, organics		100
Brown SILTY SAND, fine to medium grained with trace coarse grained		
End of Boring at 18'		

Well Diagram: MW-9



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GEOLOGIC LOG OF GP MW-10

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 18721

Date	: 09/02/2021
Drill Rig	: Geoprobe 7822 DT
Driller	: Cabeno Environmental
Total Boring Depth	: 15 feet
Logged By	: M. Dolan

Depth in Feet	DESCRIPTION	% Recovery	REMARKS
0–2	FILL: Gray fine grained SAND, trace gravel, dry	50	
2–4	FILL: Black SLAG, medium to coarse grained, slightly moist		
4–5.5	FILL: Black/gray SILTY SAND, wet		
5.5–15	Tan/gray medium to coarse grained SILTY SAND, trace gravel, wet	65	
		100	
15	End of boring at 15'		

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GEOLOGIC LOG OF GP MW-11

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 18721

Date	: 09/02/2021
Drill Rig	: Geoprobe 7822 DT
Driller	: Cabeno Environmental
Total Boring Depth	: 15 feet
Logged By	: M. Dolan

Depth in Feet	DESCRIPTION	% Recovery	REMARKS
0	FILL: Dark brown/gray SILTY CLAY, top soil, slightly moist		
0.5	FILL: Gray fine grained SILTY SAND, slightly moist		
1.5	FILL: Black SLAG, medium to coarse grained, slightly moist	50	
3	- wet		
6	Gray fine to medium grained SILTY SAND, trace gravel, wet	70	
		40	
15	End of boring at 15'		

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GEOLOGIC LOG OF GP MW-12

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 18721

Date	: 09/02/2021
Drill Rig	: Geoprobe 7822 DT
Driller	: Cabeno Environmental
Total Boring Depth	: 15 feet
Logged By	: M. Dolan

Depth in Feet	DESCRIPTION	% Recovery	REMARKS
0	FILL: Dark brown SILTY CLAY top soil, dry		
0.5	FILL: Light brown/tan coarse SAND and GRAVEL, dry		
2	FILL: Black SLAG, medium to coarse grained, slightly moist	50	
4	- wet		
6	Peat, gray SILT, trace sand and organics, wet		
7	Tan/gray medium to coarse grained SILTY SAND, trace gravel, wet	70	
12.5		50	
15	End of boring at 15'		

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GEOLOGIC LOG OF GP MW-14

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 18721

Date	: 09/02/2021
Drill Rig	: Geoprobe 7822 DT
Driller	: Cabeno Environmental
Total Boring Depth	: 15 feet
Logged By	: M. Dolan

Depth in Feet	DESCRIPTION	% Recovery	REMARKS
0–0.5	FILL: Dark brown/gray SILTY CLAY, top soil, slightly moist	50	
0.5–3	Tan/light brown fine to medium grained SAND, trace gravel, slightly moist		
3–5	PEAT, red-brown SILT, trace sand and organics, wet		
5–15	Tan/gray fine to medium grained SILTY SAND, trace gravel, wet	75	
		95	
15	End of boring at 15'		

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

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GEOLOGIC LOG OF GP MW-15

Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

Project No. 18721

Date	: 09/02/2021
Drill Rig	: Geoprobe 7822 DT
Driller	: Cabeno Environmental
Total Boring Depth	: 15 feet
Logged By	: M. Dolan

Depth in Feet	DESCRIPTION	% Recovery	REMARKS
0–4	FILL: Gray/Dark Gray SILT, trace coarse sand, slightly moist	70	
4–8.5	Tan SILTY SAND, fine to medium grained, trace gravel, slightly moist - wet (6)	50	
8.5–15	Tan SAND and GRAVEL, coarse grained, wet	95	
15	End of Boring at 15'		

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

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GEOLOGIC LOG OF MW-16

(Page 1 of 1)

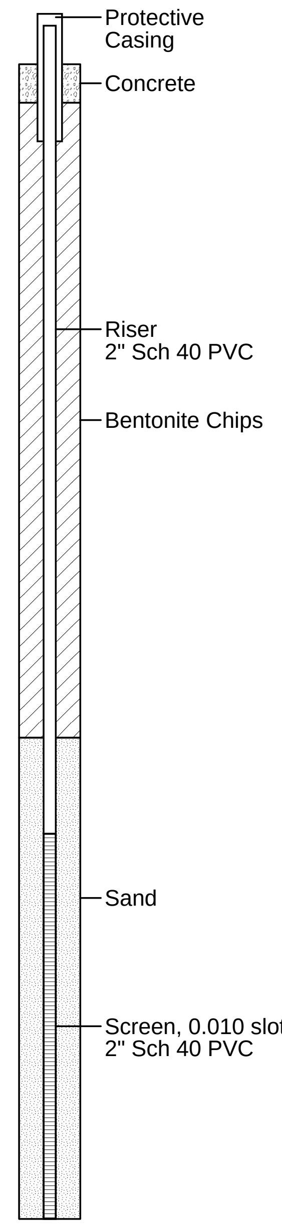
Midwest Generation, LLC
Waukegan Station
Waukegan, Illinois

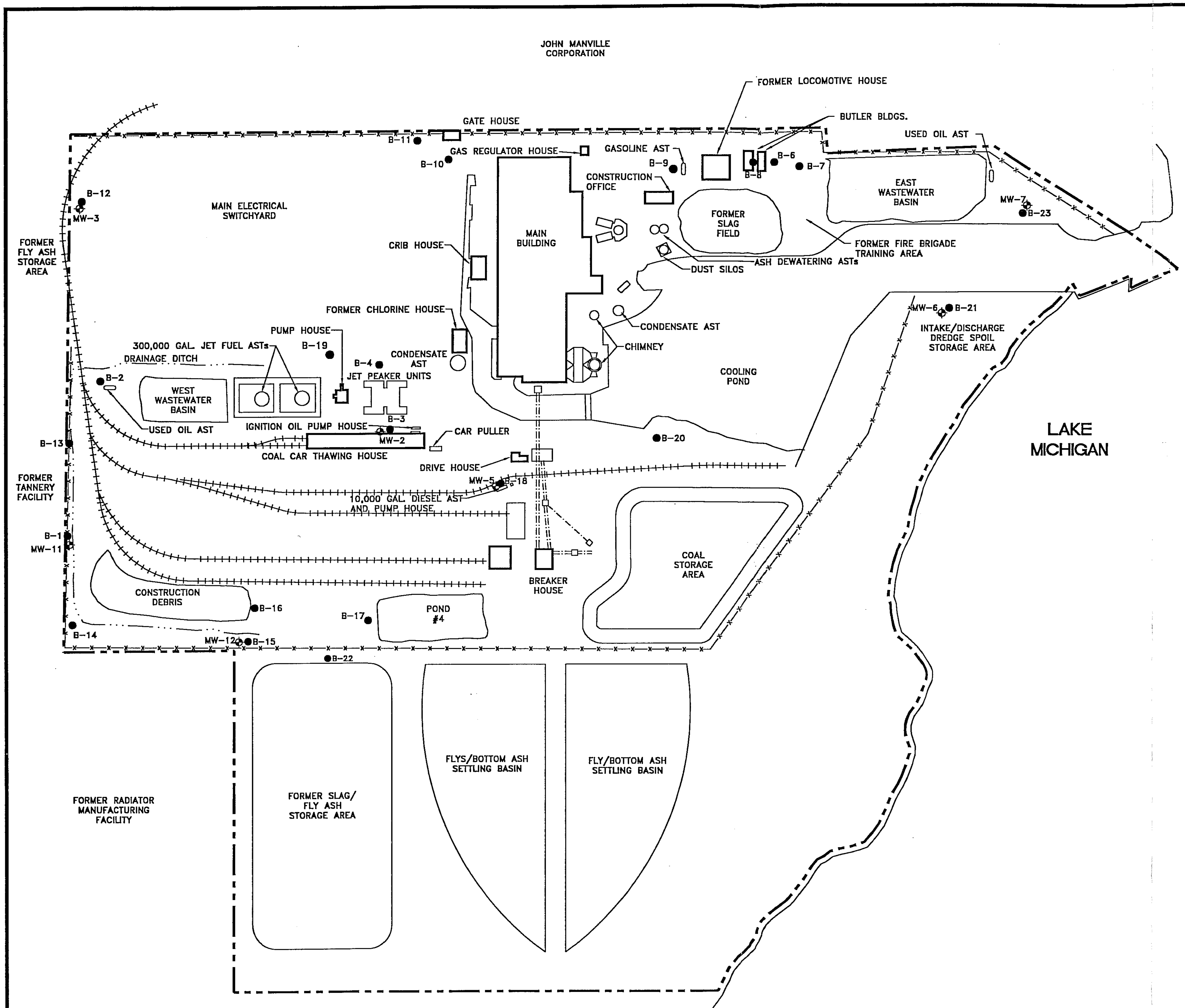
Date Started	: 10/20/2015
Date Well Set	: 10/20/2015
Rock Coring Tools	: Not cored
Drilling Tools	: 4.25 ID HSA
Drill Rig	: Geoprobe
Driller Name/Co	: N. Vissman / Cabeno

Total Boring Depth	: 35 feet
Well Bottom Depth	: 30.4 feet
Surface Elev.	: 604.52 feet above MSL
TOC Elev.	: 607.41 feet above MSL
Groundwater Elev.	: feet above MSL
Riser Material	: 2" Sch 40 PVC
Screen Material	: 2" Sch 40 PVC, 0.010 slot
Coordinate N	: 2080069.664
Coordinate E	: 1124344.912
Logged By	: P. Allenstein

Depth in Feet	Surf. Elev. 604.52	DESCRIPTION	PID	% Recovery
0	604	FILL: Dark Brown Clayey Top Soil, dry.		
		FILL: Brown SAND/SILT/GRAVEL mix, dry.		
2	602	FILL: Brown SILTY SAND, slightly moist.		75
		FILL: Brown and Dark Gray SILT, and FINE SAND, some cinders, slightly moist.		
4	600			
6	598			
8	596			100
		FILL: Orange Brown SILTY SAND, medium grained, slightly moist.		
10	594			
		FILL: Dark Brown to Black SAND, fine to medium, cinders, trace silt, slightly moist.		
12	592			100
14	590			
16	588	FILL: Tan SILTY SAND, with Gray SILT layers, slightly moist.		
		FILL: Gray SILT, some black, very moist.		75
18	586	FILL: Black SAND, fine to medium, cinders, slightly moist.		
20	584			
22	582			10
24	580	Brown SILTY SAND, fine to medium, moist.		
26	578			
28	576			10
30	574	End of Boring at 30'		
32	572			
34				

Well Diagram: MW-16





LEGEND:

PROPERTY BOUNDARY

RAILROAD LINE

FENCE

CONVEYOR LINE

MW-2 MONITORING WELL

B-1 SOIL BORING

Note:
• All dimensions and locations are approximate.

Source:
• ENSR field observations.

Dwg No: WAUKEGANSB

WAUKEGAN GENERATING STATION
10 GREENLAND AVENUE
WAUKEGAN, ILLINOIS

COMMONWEALTH EDISON COMPANY

November 1998 File No: 1801-023-610

SOIL BORING/ MONITORING WELL SITE PLAN

FIGURE 5

N

NOT TO SCALE

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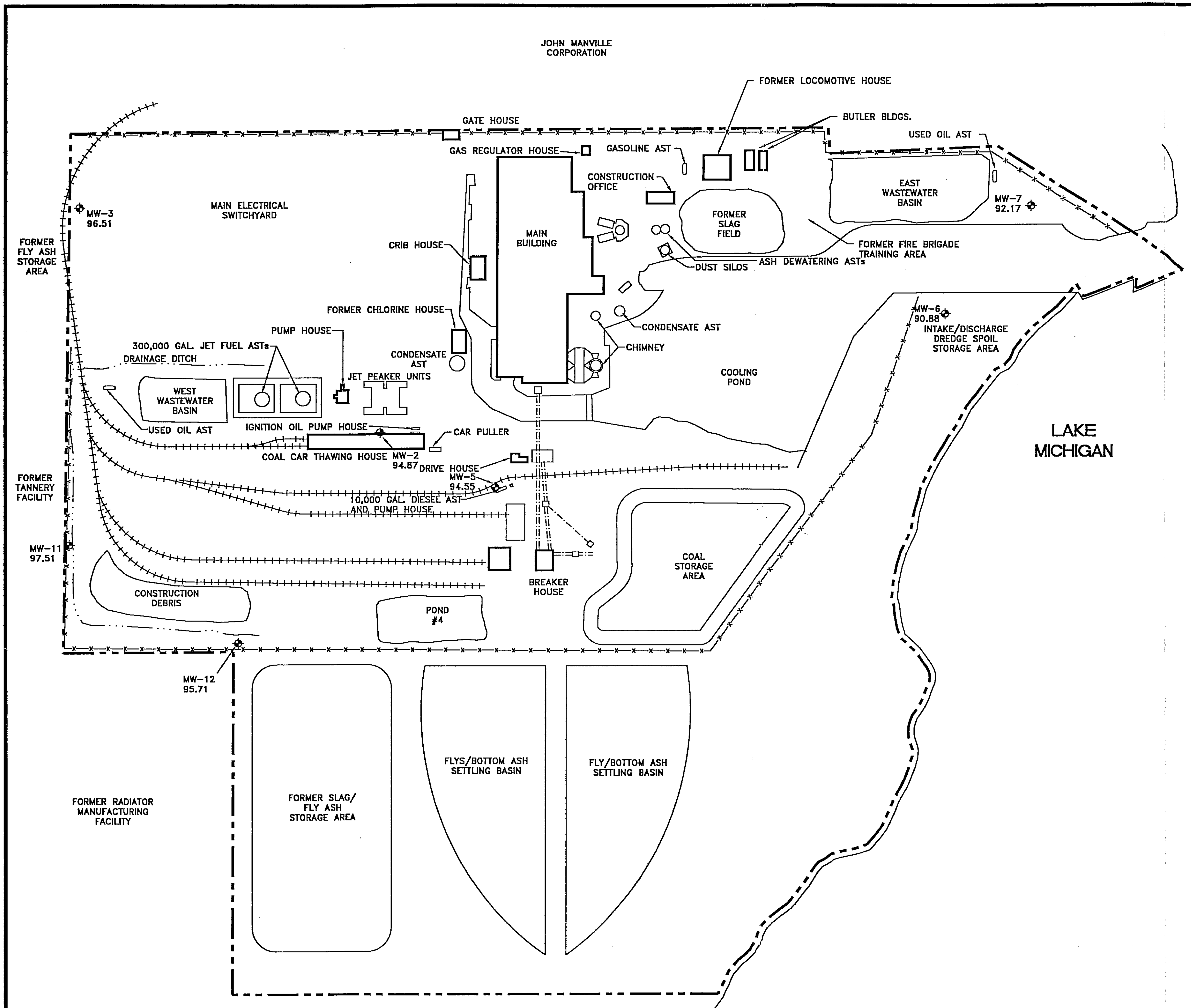

LEGEND:

- PROPERTY BOUNDARY
- RAILROAD LINE
- FENCE
- CONVEYOR LINE
- MW-2 94.87 — MONITORING WELL WITH GROUND WATER ELEVATION IN FEET.

Note:
- All dimensions and locations are approximate.

Source:
- ENSR field observations.

Dwg No: WAUKEGANGW1

WAUKEGAN GENERATING STATION
10 GREENLAND AVENUE
WAUKEGAN, ILLINOIS

COMMONWEALTH EDISON COMPANY

November 1998 File No: 1801-023-610

GROUNDWATER ELEVATION MAP

FIGURE 6

NOT TO SCALE

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APPENDIX A

Boring Logs and Monitoring Well Construction Diagrams

Phase II Environmental Site Assessment
Commonwealth Edison Company
December 7, 1998

Waukegan Generating Station
10 Greenwood Avenue
Waukegan, Illinois

ENSR®

Log of Borehole B-1

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0		Ground Surface					
0–4		2' Light brown, medium grain, sand 2' Coal	1	GP	100	< 1	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Log of Borehole B-2

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0		Ground Surface					
0–4		Light brown sand with gravel	1	GP	80	11.5	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: 0–15 ft; 0–4 m

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-3

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		Dark brown-black, sand, saturated	1	GP	100	18.7	0 - 4 PNA/BETX/pH/PCBs/ RCRA Metals
4–8			2	SS	100	15.6	
8		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/27/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-4

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0 – 4		1.5' Gravel 6" Clay and silt, wet with gravel 2' Orange black coal with sand	1	GP	100	4.2	0 - 4 PNA/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Log of Borehole B-6

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		.5' Gravel .5' Coal 3' Light brown sand, medium grained, wet	1	GP	100	9.5	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Log of Borehole B-7

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

Depth (ft)	Symbol	Description / Classification	Sample Number	Sample Type	Recovery(%)	PID Reading	Lab Analysis
0		Ground Surface					
0–4		1' Coal 2.5' Light brown, sand, medium grained, wet .5' Gray sand, medium grained, wet	1	GP	100	5.8	0 - 4 PNAs/BETX/pH/PCBs RCRA Metals
4		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-8

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		Coal to 2' 2' Light brown, sand, moist to wet, with fines	1	GP	100	9.7	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-9

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0		Ground Surface					
0 - 4		Coal to 3' 1' Light brown, sand, wet	1	GP	100	10.8	0 - 4 PNAS/BETX/PCBs RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: Geoprobe

Drill Date: 10/29/98

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Log of Borehole B-10

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4	▨	Coal to 2' 6" Brown sandy clay 1' Light brown sand, fine to medium grained	1	GP	80	9.0	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4–8	▨	Light brown sand, fine grained, wet with 1" gravel seam at 7'	2	SS	75	9.6	
8		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Log of Borehole B-11

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	Lab Analysis
0 / 0		Ground Surface					
0–4		6" Gravel 2.5' Coal slag with sand	1	GP	100	8.5	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Log of Borehole B-12

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–8		Borehole not logged.	1	GP	100	12.3	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
8		End of Borehole					

Depth scale: ft 0–15; m 0–4.

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/28/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-13

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		Coal with fine gravel bottom 1.5' wet	1	GP	60	1.4	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-14

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		3' Wet coal Sand and gravel saturated	1	GP	100	1.4	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: 0–15 ft; 0–4 m

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Log of Borehole B-15

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0		Ground Surface					
0 - 4		2' Coal 2' Light brown, medium grain, sand, wet	1	GP	100	< 1	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-16

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	Lab Analysis
0 / 0		Ground Surface					
0 - 2		Coal/Slag	1	GP	50	2.3	0 - 2 PNAs/BETX/pH/PCBs/ RCRA Metals
2		End of Borehole					

Depth scale: ft 0–15; m 0–4.

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-17

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		1' Coal 1' Light brown-black, medium grain, sand 2' Coal	1	GP	100	5.4	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/29/98**

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Log of Borehole B-18

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4		Brown-black sand, with odor saturated	1	GP	100	123	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/27/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-19

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0		Ground Surface					
0 - 4		1' Loose sand and coal 1' Rusty orange caol consolidated Coal, moist to wet	1	GP	75	19.3	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-20

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 ft / 0 m		Ground Surface					
0–4 ft	▒	Black coal consolidated .5' Sand and gravel seam at 2.5' Same with silt, wet at 3.5'	1	GP	100	19.4	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4–6 ft	▒	Black coal, consolidated, moist	2	GP	50	16.0	
6 ft		End of Borehole					

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-21

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–4	⁙	Sand, medium grained, dry to moist, loose 1' Sand, medium grained, wet	1	GP	80	16.4	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4–6	⁙	Light brown-gray, sand, medium grained, wet	2	GP	20	20.3	
6		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: Geoprobe

Drill Date: 10/26/98

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Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Log of Borehole B-22

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				Lab Analysis
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	
0 / 0		Ground Surface					
0–1.5		Coal and gray coal ash	1	GP	30	< 1	0 - 2 PNAs/BETX/pH/PCBs/ RCRA Metals
		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/26/98**

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Log of Borehole B-23

Project No:1801-023-610

Project: Phase II Investigation

Client: Commonwealth Edison

Location: Waukegan Power Station

Geologist: BB

SUBSURFACE PROFILE			SAMPLE				
Depth (ft / m)	Symbol	Description / Classification	Number	Type	Recovery(%)	PID Reading	Lab Analysis
0		Ground Surface					
0–4		Light brown sand, loose, with gravel 2' Same, wet	1	GP	100	12.4	0 - 4 PNAs/BETX/pH/PCBs/ RCRA Metals
4		End of Borehole					

Depth scale: ft 0–15; m 0–4

Drilled By:Fox Drilling

Drill Method: **Geoprobe**

Drill Date: **10/27/98**

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Sheet: 1 of 1

Attachment 9-3 – Historical CCA Groundwater Data

Attachment 9-3. CCA Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

Sample: MW-01	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012		9/28/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	0.0052	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0056	0.0030	ND
Arsenic	0.010	0.0010	0.054	0.0010	0.040	0.0010	0.17	0.0010	0.077	0.0010	0.057	0.0010	0.078	0.0010	0.070	0.0010	0.070
Barium	2.0	0.0025	0.023	0.0025	0.022	0.0025	0.020	0.0025	0.038	0.0025	0.051	0.0025	0.034	0.0025	0.028	0.0025	0.013
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0050	ND
Boron	2.0	0.050	2.6	0.050	2.0	0.50	2.6	0.050	2.5	0.050	2.8	0.50	2.5	0.50	2.0	0.25	1.9
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND ^
Chloride	200.0	2.0	39	2.0	48	2.0	52	2.0	41	2.0	32	2.0	47	2.0	46	2.0	47
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	0.020	0.010	0.013	0.010	ND	0.010	ND	0.010	0.012	0.010	0.019
Fluoride	4.0	0.10	0.45	0.10	0.59	0.10	0.71	0.10	0.33	0.10	0.46	0.10	0.46	0.10	0.39	0.10	0.34
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	ND	0.0025	0.0027	0.0025	0.0086	0.0025	0.020	0.0025	0.011	0.0025	0.0052 ^	0.0025	ND	0.0025	ND
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	ND	0.10	0.52	0.10	0.30	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	ND	0.10	0.52	0.10	0.32	0.10	ND	0.10	ND	0.10	ND ^
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.021	0.020	0.10	0.020	0.023	0.020	ND
Perchlorate	0.0049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Selenium	0.05	0.0025	0.031	0.0025	0.030	0.0025	0.016	0.0025	0.039	0.0025	0.032	0.0025	0.037	0.0025	0.013	0.0025	0.0093
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	50	350	50	230	50	260	50	280	100	330	100	390	50	300	50	240
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	460	10	470	10	460	10	570	10	750	10	630	10	630	10	450
Vanadium	0.049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
BETX	11.705	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
pH	6.5 - 9.0	NA	10.41	NA	9.92	NA	9.97	NA	8.78	NA	8.62	NA	9.54	NA	9.75	NA	10.78
Temperature	NA	NA	17.38	NA	14.81	NA	15.98	NA	15.82	NA	14.18	NA	15.88	NA	18.27	NA	15.45
Conductivity	NA	NA	0.698	NA	0.74	NA	0.74	NA	0.67	NA	0.79	NA	0.77	NA	0.72	NA	0.58
Dissolved Oxygen	NA	NA	NM	NA	0.33	NA	0.24	NA	0.1	NA	0.3	NA	0.16	NA	0.41	NA	0.06
ORP	NA	NA	NM	NA	-52.8	NA	-126.2	NA	-313	NA	-274	NA	-173	NA	-198	NA	-179

Sample: MW-01	Date	12/19/2012		3/7/2013		6/7/2013		7/25/2013		11/4/2013		3/10/2014		5/16/2014		8/21/2014	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.091	0.0010	0.098	0.0010	0.036	0.0010	0.055	0.0010	0.046	0.0010	0.031	0.0010	0.036	0.0010	0.019
Barium	2.0	0.0025	0.013	0.0025	0.033	0.0025	0.052	0.0025	0.040	0.0025	0.065	0.0025	0.031	0.0025	0.025	0.0025	0.032
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	2.0	0.050	1.9	0.50	2.2	0.50	2.2	0.50	2.3	0.25	3.1	0.25	1.9	0.050	2.0	0.25	2.0
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	200.0	2.0	48	2.0	45	2.0	34	2.0	42	2.0	28	2.0	33	2.0	31	10	79
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	0.0022	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.013	0.010	0.029	0.010	ND
Fluoride	4.0	0.10	0.41 ^	0.10	0.50	0.10	0.41	0.10	0.45	0.10	0.28	0.10	0.27	0.10	0.46	0.10	0.76
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	ND	0.0025	0.0047	0.0025	0.011	0.0025	0.011	0.0025	0.021	0.0025	0.0073	0.0025	ND	0.0025	0.026
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	1.0	0.10	0.10	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	1.1	0.10	0.10	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrite	NA	0.020	0.055	0.020	ND	0.020	0.058	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.024
Perchlorate	0.0049	0.004	ND	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.05	0.0025	ND	0.0025	0.056	0.0025	0.043	0.0025	0.031	0.0025	0.013	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	50	200	50	250	100	260	100	300	50	260	50	130	50	170	50	130
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	460	10	510	10	660	10	580	10	580	10	290	10	300	10	460
Vanadium	0.049	0.0050	0.026	0.0050	0.018	0.0050	0.056	0.0050	0.042	0.0050	0.0067	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	11.705	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	6.5 - 9.0	NA	10.47	NA	9.85	NA	8.37	NA	8.81	NA	8.42	NA	8.99	NA	8.88	NA	7.92
Temperature	NA	NA	14.17	NA	12.8	NA	12.94	NA	14.93	NA	13.41	NA	13.79	NA	9.41	NA	16.04
Conductivity	NA	NA	0.53	NA	0.6	NA	0.655	NA	0.65	NA	0.51	NA	0.41	NA	0.36	NA	0.638
Dissolved Oxygen	NA	NA	0.45	NA	0.36	NA	0.39	NA	0.28	NA	0.55	NA	1.21	NA	1.46	NA	0.43
ORP	NA	NA	-205	NA	-98.2	NA	-109.4	NA	-133.6	NA	-213.3	NA	-98.4	NA	42.7	NA	22.7

Sample: MW-01	Date	11/6/2014		2/17/2015		4/21/2015		8/12/2015		11/2/2015		3/1/2016		5/4/2016		8/23/2016		12/5/2016	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND ^	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.21	0.0010	0.050	0.0010	0.056	0.0010	0.034	0.0010	0.073	0.0010	0.12	0.0010	0.11	0.0010	0.12	0.0010	0.15
Barium	2.0	0.0025	0.0094	0.0025	0.018	0.0025	0.020	0.0025	0.019	0.0025	0.020	0.0025	0.029	0.0025	0.016	0.0025	0.015	0.0025	0.014
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^
Boron	2.0	0.50	2.2	0.25	1.7	0.050	1.5	0.25	1.2	0.50	1.7	0.50	1.9	0.25	2.1	0.50	2.1	0.050	1.9
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	200.0	2.0	70	2.0	54	2.0	52	2.0	64	2.0	69	2.0	62	2.0	59	2.0	62	2.0	65
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	0.0024	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND ^
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	0.013	0.010	0.010	0.010	0.012	0.010	0.029	0.010	0.030	0.010	0.015
Fluoride	4.0	0.10	0.56	0.10	0.21	0.10	0.18	0.10	0.42	0.10	0.43	0.10	0.29	0.10	0.29	0.10	0.26	0.10	0.34
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND^	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	0.0054	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	0.24	0.10	ND	0.10	ND	0.10	ND	0.10	0.17	0.10	ND	0.10	0.12	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	0.41	0.10	0.26	0.10	ND	0.10	ND	0.10	0.17	0.10	ND ^	0.10	0.12	0.10	ND
Nitrogen/Nitrite	NA	0.020	0.078	0.020	0.17	0.040	0.23	0.020	0.10	0.020	0.036	0.020	ND	0.020	0.026	0.020	ND	0.020	0.056
Perchlorate	0.0049	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.05	0.0025	0.035	0.0025	0.0095	0.0025	0.0081	0.0025	0.017	0.0025	0.0099	0.0025	0.0090	0.0025	0.013	0.0025	0.014	0.0025	0.0073
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	50	270	50	200	50	250	50	260	50	320	50	260	50	210	50	230	50	200
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	450	10	560	10	500	10	600	10	560	10	570	10	460	10	550	10	570
Vanadium	0.049	0.0050	0.49	0.0050	0.12	0.0050	0.091	0.0050	0.092	0.0050	0.10	0.0050	0.071	0.0050	0.071	0.0050	0.095	0.0050	0.091
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	11.705	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.001	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	6.5 - 9.0	NA	10.54	NA	12.01	NA	11.69	NA	11.83	NA	10.93	NA	11.13	NA	11.09	NA	10.49	NA	10.46
Temperature	NA	NA	11.91	NA	7.73	NA	8.44	NA	17.78	NA	17.17	NA	8.43	NA	11.96	NA	19.68	NA	10.73
Conductivity	NA	NA	0.616	NA	0.63	NA	0.617	NA	0.918	NA	1.054	NA	0.58	NA	0.67	NA	0.88	NA	0.71
Dissolved Oxygen	NA	NA	1.75	NA	1.06	NA	3.31	NA	2.04	NA	0.45	NA	1.05	NA	0.67	NA	1.53	NA	1.27
ORP	NA	NA	-37.2	NA	-74.9	NA	-73.2	NA	-44.5	NA	88.7	NA	-177.8	NA	-202.1	NA	-218.6	NA	-150.4

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature °C degrees Celcius
Conductivity ms/cm^{c} millisiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

Attachment 9-3. CCA Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

Sample: MW-02	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012		9/28/2012		12/19/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	0.015	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.025	0.0010	0.016	0.0010	0.012	0.0010	0.0087	0.0010	0.0094	0.0010	0.0094	0.0010	0.011	0.0010	0.011	0.0010	0.0089
Barium	2.0	0.0025	0.0091	0.0025	0.014	0.0025	0.024	0.0025	0.020	0.0025	0.023	0.0025	0.017	0.0025	0.016	0.0025	0.019	0.0025	0.016
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0050	ND	0.0010	ND
Boron	2.0	0.050	2.2	0.050	2.2	0.50	2.0	0.050	1.7	0.050	1.9	0.50	2.0	0.50	2.6	0.25	2.1	0.050	1.9
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND ^	0.00050	ND
Chloride	200.0	2.0	42	2.0	45	2.0	46	2.0	45	2.0	50	2.0	53	2.0	48	2.0	55	2.0	54
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	0.014	0.010	0.019	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	4.0	0.10	0.35	0.10	0.53	0.10	0.80	0.10	0.56	0.10	0.67	0.10	0.88	0.10	1.1	0.10	1.1	0.10	1.3 ^
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^	0.10	ND
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	0.0034	0.0025	0.018	0.0025	0.032	0.0025	0.038	0.0025	0.035	0.0025	0.028 ^	0.0025	0.031	0.0025	0.025	0.0025	0.023
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0025	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	0.23	0.10	0.12	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	0.23	0.10	0.12	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^	0.10	ND
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.004	ND
Selenium	0.05	0.0025	0.026	0.0025	0.0085	0.0025	0.028	0.0025	0.022	0.0025	0.0086	0.0025	0.0046	0.0025	ND	0.0025	0.0027	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	50	230	50	160	50	150	50	200	50	180	50	200	50	210	50	270	50	210
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	410	10	400	10	410	10	460	10	490	10	400	10	520	10	540	10	500
Vanadium	0.049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.0050	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.0005	ND
BETX	11.705	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.0025	ND
pH	6.5 - 9.0	NA	9.98	NA	9.31	NA	8.65	NA	7.82	NA	7.77	NA	7.82	NA	7.90	NA	8.24	NA	7.94
Temperature	NA	NA	15.3	NA	13.42	NA	14.58	NA	14.46	NA	13.5	NA	14.79	NA	16.22	NA	14.24	NA	13.01
Conductivity	NA	NA	0.61	NA	0.62	NA	0.69	NA	0.56	NA	0.55	NA	0.55	NA	0.63	NA	0.66	NA	0.54
Dissolved Oxygen	NA	NA	NM	NA	0.29	NA	0.22	NA	0.14	NA	0.24	NA	0.12	NA	0.17	NA	0.07	NA	0.33
ORP	NA	NA	NM	NA	28.4	NA	93	NA	-206	NA	-119	NA	-76	NA	-87	NA	-116	NA	-43

Sample: MW-02	3/7/2013		6/7/2013		7/25/2013		11/4/2013		3/10/2014		5/15/2014		8/21/2014		11/6/2014		2/17/2015	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND ^	0.0030	ND
Arsenic	0.0010	0.012	0.0010	0.0090	0.0010	0.0087	0.0010	0.0091	0.0010	0.0085	0.0010	0.0062	0.0010	0.0081	0.0010	0.0095	0.0010	0.0089
Barium	0.0025	0.020	0.0025	0.021	0.0025	0.026	0.0025	0.028	0.0025	0.046	0.0025	0.086	0.0025	0.029	0.0025	0.029	0.0025	0.024
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.50	2.2	0.50	1.9	0.50	2.1	0.25	2.2	0.25	2.8	0.25	2.6	0.25	3.0	0.50	3.0	0.25	3.2
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	50	2.0	52	2.0	47	2.0	55	2.0	51	2.0	57	2.0	47	2.0	48	2.0	29
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	1.2	0.10	1.3	0.10	0.93	0.10	0.60	0.10	0.60	0.10	0.70	0.10	0.76	0.10	0.61	0.10	0.99
Iron	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.16	0.10	ND	0.10	ND	0.10	ND
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.039	0.0025	0.051	0.0025	0.069	0.0025	0.034	0.0025	0.085	0.0025	0.16	0.0025	0.050	0.0025	0.041	0.0025	0.043
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0030
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	0.0084	0.0025	ND	0.0025	0.015	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.0060	0.0025	0.0045	0.0025	ND
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	230	50	220	50	260	100	290	50	370	100	280	50	210	50	350	50	150
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	520	10	550	10	530	10	770	10	670	10	710	10	550	10	510	10	440
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.00077	0.0025	0.00077
pH	NA	8.95	NA	7.63	NA	7.61	NA	7.97	NA	8.38	NA	7.65	NA	8.13	NA	8.61	NA	8.79
Temperature	NA	12.2	NA	12.99	NA	14.79	NA	13.16	NA	12.72	NA	11.00	NA	15.15	NA	11.87	NA	8.01
Conductivity	NA	0.62	NA	0.550	NA	0.59	NA	0.62	NA	0.72	NA	0.79	NA	0.684	NA	0.647	NA	0.43
Dissolved Oxygen	NA	0.18	NA	0.32	NA	0.42	NA	0.60	NA	0.81	NA	0.79	NA	0.32	NA	0.47	NA	0.89
ORP	NA	-66.4	NA	-124.3	NA	-90.4	NA	-129.8	NA	-121.9	NA	-18.2	NA	-58.2	NA	-145.3	NA	-162.8

Sample: MW-02	4/21/2015		8/12/2015		11/2/2015		3/1/2016		5/4/2016		8/23/2016		12/5/2016	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.0089	0.0010	0.042	0.0010	0.015	0.0010	0.010	0.0010	0.0071	0.0010	0.0088	0.0010	0.015
Barium	0.0025	0.027	0.0025	0.012	0.0025	0.013	0.0025	0.020	0.0025	0.019	0.0025	0.016	0.0025	0.014
Beryllium	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.25	2.9	0.25	2.5	0.50	2.5	0.50	3.6	0.25	3.3	0.50	3.0	0.25	3.0
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	45	2.0	43	2.0	49	2.0	46	2.0	51	2.0	57	2.0	51
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND
Cyanide	0.010	0.025	0.010	ND	0.010	0.011	0.010	0.020	0.010	0.017	0.010	0.023	0.010	0.017
Fluoride	0.10	1.1	0.10	1.1	0.10	0.79	0.10	1.3	0.10	1.6	0.10	1.3	0.10	0.98 F1
Iron	0.10	ND	0.10	ND	0.10	ND^	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.068	0.0025	0.028	0.0025	0.035	0.0025	0.038	0.0025	0.040	0.0025	0.021	0.0025	0.023
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	0.0085	0.0025	0.0044	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.0033
Silver	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	190	50	230	50	230	50	220	50	160	50	220	50	160
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	430	10	490	10	380	10	500	10	430	10	490	10	470
Vanadium	0.0050	ND	0.0050	0.0096	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.00050	ND	0.00050	ND	0.00050	0.00061	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	0.0006	0.0025	0.00251	0.0025	ND	0.0025	0.0019	0.0025	ND	0.0025	ND
pH	NA	7.95	NA	10.13	NA	8.27	NA	8.57	NA	8.19	NA	7.52	NA	8.62
Temperature	NA	9.19	NA	18.47	NA	16.44	NA	6.48	NA	11.43	NA	20.96	NA	8.79
Conductivity	NA	0.511	NA	0.638	NA	0.629	NA	0.44	NA	0.53	NA	0.69	NA	0.44
Dissolved Oxygen	NA	3.09	NA	0.73	NA	0.56	NA	0.95	NA	0.87	NA	2.54	NA	2.20
ORP	NA	-128.5	NA	-88.7	NA	52.9	NA	-101.2	NA	-128.2	NA	-119.5	NA	-29.6

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature	°C	degrees Celcius
Conductivity	ms/cm^{c}	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

Attachment 9-3. CCA Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

Sample: MW-03	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	0.0051	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.0043	0.0010	0.0041	0.0010	0.0049	0.0010	0.0077	0.0010	0.0049	0.0010	0.0071	0.0010	0.0030
Barium	2.0	0.0025	0.0057	0.0025	0.0086	0.0025	0.018	0.0025	0.0044	0.0025	0.0058	0.0025	0.0049	0.0025	0.0067
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	2.0	0.050	1.7	0.050	2.2	0.50	2.3	0.050	1.6	0.050	1.6	0.50	1.5	0.25	1.3
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	200.0	2.0	53	2.0	49	2.0	53	2.0	49	2.0	51	2.0	52	2.0	41
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	0.030	0.010	ND	0.010	ND	0.010	ND
Fluoride	4.0	0.10	0.27	0.10	0.47	0.10	0.39	0.10	0.24	0.10	0.67	0.10	0.64	0.10	0.76
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	ND	0.0025	0.0059	0.0025	0.0044	0.0025	ND	0.0025	0.0054	0.0025	0.0036 ^	0.0025	0.0070
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	0.29	0.10	ND	0.10	ND	0.10	ND	0.10	0.17
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	0.29	0.10	ND	0.10	ND	0.10	ND	0.10	0.17
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Selenium	0.05	0.0025	0.0094	0.0025	0.016	0.0025	0.030	0.0025	0.012	0.0025	0.011	0.0025	0.0064	0.0025	0.017
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	20	120	25	130	25	130	25	97	25	110	50	140	50	150
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	280	10	350	10	340	10	300	10	380	10	340	10	420
Vanadium	0.049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
BETX	11.705	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
pH	6.5 - 9.0	NA	9.21	NA	8.58	NA	8.64	NA	9.20	NA	8.61	NA	8.89	NA	7.58
Temperature	NA	NA	17.98	NA	14.27	NA	15.5	NA	14.32	NA	13.62	NA	14.89	NA	16.32
Conductivity	NA	NA	0.455	NA	0.55	NA	0.59	NA	0.34	NA	0.41	NA	0.44	NA	0.53
Dissolved Oxygen	NA	NA	NM	NA	0.53	NA	0.16	NA	0.06	NA	0.17	NA	0.13	NA	0.47
ORP	NA	NA	NM	NA	87	NA	163.2	NA	-199	NA	-52	NA	-47	NA	78

Sample: MW-03	9/28/2012		12/19/2012		3/7/2013		6/7/2013		7/25/2013		11/4/2013		3/10/2014		5/15/2014		8/21/2014	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.0044	0.0010	0.0031	0.0010	0.0018	0.0010	0.0014	0.0010	0.0025	0.0010	0.0050	0.0010	0.0013	0.0010	0.0020	0.0010	0.0041
Barium	0.0025	0.010	0.0025	0.011	0.0025	0.015	0.0025	0.039	0.0025	0.017	0.0025	0.015	0.0025	0.012	0.0025	0.0061	0.0025	0.012
Beryllium	0.0050	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.25	1.4	0.050	1.9	0.50	2.0	0.50	2.5	0.50	1.8	0.25	1.9	0.25	1.1	0.050	1.2	0.25	2.3
Cadmium	0.00050	ND ^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	47	2.0	49	2.0	45	2.0	39	2.0	43	2.0	25	2.0	37	2.0	37	10	89
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.96	0.10	1.1 ^	0.10	0.99	0.10	0.48	0.10	0.83	0.10	0.63	0.10	0.74	0.10	0.57	0.10	0.55
Iron	0.10	ND ^	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.0034	0.0025	0.0034	0.0025	0.015	0.0025	0.0062	0.0025	0.0031	0.0025	0.0082	0.0025	0.0069	0.0025	0.0028	0.0025	0.0083
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	0.42	0.10	ND	0.10	ND	0.10	13	0.10	ND	0.10	ND	0.10	0.11	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	0.50	0.10	ND	0.10	ND	0.50	13	0.10	ND	0.10	ND	0.10	0.11	0.10	0.15	0.10	ND
Nitrogen/Nitrite	0.020	0.076	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.072	0.020	ND
Perchlorate	NR	NR	0.004	ND	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	0.0072	0.0025	ND	0.0025	0.011	0.0025	0.067	0.0025	0.0085	0.0025	0.0045	0.0025	0.0028	0.0025	ND	0.0025	ND
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	260	50	240	50	240	100	290	100	240	50	140	50	170	25	100	50	110
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	480	10	520	10	470	10	860	10	530	10	380	10	340	10	210	10	470
Vanadium	NR	NR	0.0050	ND	0.0050	ND	0.0050	0.0055	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	NR	NR	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	NR	NR	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	NA	9.14	NA	8.22	NA	8.55	NA	7.13	NA	7.46	NA	7.26	NA	7.38	NA	8.47	NA	7.82
Temperature	NA	13.83	NA	13.02	NA	12.6	NA	12.87	NA	13.95	NA	15.35	NA	11.89	NA	8.47	NA	18.83
Conductivity	NA	0.58	NA	0.55	NA	0.61	NA	0.860	NA	0.580	NA	0.40	NA	0.37	NA	0.27	NA	0.600
Dissolved Oxygen	NA	0.07	NA	0.27	NA	0.4	NA	0.59	NA	0.31	NA	0.54	NA	0.78	NA	0.40	NA	1.05
ORP	NA	2	NA	17	NA	40.8	NA	-84.1	NA	0.80	NA	-128.2	NA	-78.5	NA	90.5	NA	4.2

Sample: MW-03	11/6/2014		2/17/2015		4/21/2015		8/12/2015		11/2/2015		3/1/2016		5/4/2016		8/24/2016		12/5/2016	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND ^	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.0029	0.0010	0.0031	0.0010	0.0039	0.0010	0.0039	0.0010	0.0090	0.0010	0.0062	0.0010	0.0021	0.0010	0.0081	0.0010	0.0056
Barium	0.0025	0.013	0.0025	0.013	0.0025	0.0082	0.0025	0.012	0.0025	0.011	0.0025	0.016	0.0025	0.0097	0.0025	0.0055	0.0025	0.014
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.50	2.3	0.25	1.6	0.050	1.2	0.25	1.6	0.50	2.0	0.50	2.7	0.25	2.4	0.50	1.8	0.25	2.7
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	64	2.0	72	2.0	64	2.0	72	10	88	2.0	73	2.0	71	2.0	67	2.0	68
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	0.014	0.010	ND	0.010	ND	0.010	ND	0.010	0.034	0.010	0.015	0.010	ND	0.010	ND
Fluoride	0.10	0.65	0.10	0.67	0.10	0.60	0.10	0.50	0.10	0.49	0.10	0.36	0.10	0.59	0.10	0.22	0.10	0.38
Iron	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND^	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.00050	0.0015	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.0035	0.0025	0.0032	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.015	0.0025	0.0070	0.0025	ND	0.0025	0.011
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.22	0.10	0.16	0.10	ND	0.10	0.17
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.22	0.10	0.16	0.10	ND	0.10	0.17
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.0035	0.0025	0.013	0.0025	0.0039	0.0025	0.0044	0.0025	ND	0.0025	0.0033
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	240	50	110	50	200	50	200	50	260	50	240	50	160	50	180	50	150
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	400	10	430	10	420	10	480	10	490	10	580	10	470	10	430	10	530
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.016	0.0050	0.014	0.0050	0.013	0.0050	0.018
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00073	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.00056	0.0025	0.00293	0.0025	ND	0.0025	0.0020	0.0025	ND	0.0025	ND
pH	NA	6.95	NA	7.12	NA	6.67	NA	9.22	NA	9.26	NA	7.33	NA	7.25	NA	9.13	NA	7.62
Temperature	NA	13.28	NA	8.19	NA	9.94	NA	16.64	NA	18.38	NA	4.33	NA	11.40	NA	19.01	NA	9.64
Conductivity	NA	0.513	NA	0.46	NA	0.497	NA	0.628	NA	0.803	NA	0.48	NA	0.59	NA	0.57	NA	0.43
Dissolved Oxygen	NA	1.43	NA	1.02	NA	3.32	NA	0.93	NA	0.41	NA	1.84	NA	1.06	NA	1.17	NA	1.17
ORP	NA	13.2	NA	64.6	NA	43.0	NA	-52.0	NA	-7.0	NA	-7.7	NA	-72.7	NA	-163.3	NA	-7.4

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature	°C	degrees Celcius
Conductivity	ms/cm^c	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

Attachment 9-3. CCA Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

Sample: MW-04	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012		9/28/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.0060	0.0010	0.0077	0.0010	0.0059	0.0010	0.0058	0.0010	0.0065	0.0010	0.0068	0.0010	0.0091	0.0010	0.0079
Barium	2.0	0.0025	0.026	0.0025	0.025	0.0025	0.034	0.0025	0.039	0.0025	0.036	0.0025	0.038	0.0025	0.025	0.0025	0.024
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0050	ND
Boron	2.0	0.050	2.0	0.050	2.1	0.50	2.0	0.050	1.8	0.050	2.1	0.50	2.2	0.50	2.5	0.25	2.2
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND ^
Chloride	200.0	2.0	39	2.0	47	2.0	45	2.0	59	2.0	60	2.0	71	2.0	53	2.0	55
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	4.0	0.10	0.60	0.10	0.84	0.10	0.97	0.10	0.67	0.10	0.82	0.10	0.73	0.10	0.82	0.10	0.85
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	0.058	0.0025	0.035	0.0025	0.028	0.0025	0.36	0.0025	0.025	0.0025	0.038 ^	0.0025	0.041	0.0025	0.028
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	0.18	0.10	0.14	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	0.18	0.10	0.14	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Selenium	0.05	0.0025	0.0039	0.0025	ND	0.0025	0.022	0.0025	0.025	0.0025	0.015	0.0025	0.0091	0.0025	ND	0.0025	0.0061
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	50	250	50	170	50	160	25	160	50	160	50	280	50	250	50	210
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	430	10	400	10	380	10	470	10	480	10	490	10	540	10	440
Vanadium	0.049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
BETX	11.705	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
pH	6.5 - 9.0	NA	7.80	NA	8.54	NA	7.69	NA	7.42	NA	7.35	NA	7.25	NA	7.51	NA	8.63
Temperature	NA	NA	16.00	NA	13.14	NA	14.07	NA	13.38	NA	12.35	NA	13.78	NA	15.78	NA	13.28
Conductivity	NA	NA	0.637	NA	0.62	NA	0.6	NA	0.56	NA	0.52	NA	0.58	NA	0.61	NA	0.53
Dissolved Oxygen	NA	NA	NM	NA	0.3	NA	0.31	NA	0.23	NA	0.45	NA	0.33	NA	0.25	NA	0.49
ORP	NA	NA	NM	NA	-10.6	NA	115.3	NA	-85	NA	38	NA	43	NA	17	NA	-123

Sample: MW-04	12/19/2012		3/7/2013		6/6/2013		7/25/2013		11/4/2013		3/11/2014		5/16/2014		8/21/2014	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.0080	0.0010	0.0081	0.0010	0.0032	0.0010	0.0044	0.0010	0.0055	0.0010	0.0062	0.0010	0.0061	0.0010	0.0064
Barium	0.0025	0.031	0.0025	0.031	0.0025	0.049	0.0025	0.049	0.0025	0.047	0.0025	0.071	0.0025	0.053	0.0025	0.029
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.50	2.5	0.50	2.4	0.50	2.3	0.50	2.5	0.25	2.8	0.25	3.0	0.25	2.7	0.25	1.5
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	55	2.0	50	2.0	51	2.0	42	2.0	46	2.0	41	2.0	34	2.0	33
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.72 ^	0.10	0.73	0.10	0.67	0.10	0.60	0.10	0.48	0.10	0.28	0.10	0.27	0.10	0.26
Iron	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.031	0.0025	0.034	0.0025	0.016	0.0025	0.024	0.0025	0.036	0.0025	0.074	0.0025	0.052	0.0025	0.046
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	0.31	0.10	ND	0.10	0.21	0.10	0.12	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	0.31	0.10	ND	0.10	0.21	0.10	0.12	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.004	ND	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	0.0043	0.0025	0.028	0.0025	0.050	0.0025	0.011	0.0025	0.0034	0.0025	ND	0.0025	ND
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	220	50	230	50	260	100	300	50	270	100	360	50	140	25	130
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	510	10	460	10	660	10	610	10	630	10	680	10	470	10	370
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	NA	8.41	NA	8.93	NA	7.25	NA	7.18	NA	7.35	NA	7.99	NA	7.76	NA	7.74
Temperature	NA	13.11	NA	11.9	NA	12.91	NA	14.1	NA	13.17	NA	10.93	NA	10.27	NA	16.85
Conductivity	NA	0.57	NA	0.56	NA	0.666	NA	0.70	NA	0.59	NA	0.65	NA	0.59	NA	0.43
Dissolved Oxygen	NA	0.07	NA	0.14	NA	0.37	NA	0.35	NA	0.37	NA	1.28	NA	0.52	NA	0.43
ORP	NA	-151	NA	-54.3	NA	-55.9	NA	13.7	NA	-166.2	NA	-99.2	NA	13.8	NA	-48.2

Sample: MW-04	11/6/2014		2/17/2015		4/21/2015		8/12/2015		11/3/2015		3/1/2016		5/4/2016		8/24/2016		12/5/2016	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.0080	0.0010	0.0080	0.0010	0.0075	0.0010	0.0072	0.0010	0.0069	0.0010	0.0065	0.0010	0.0067	0.0010	0.010	0.0010	0.010
Barium	0.0025	0.024	0.0025	0.031	0.0025	0.033	0.0025	0.034	0.0025	0.035	0.0025	0.033	0.0025	0.018	0.0025	0.018	0.0025	0.11
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.50	1.6	0.25	2.0	0.25	1.8	0.25	1.6	0.50	1.5	0.50	1.9	0.25	1.6	0.50	1.7	0.25	2.9
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	36	2.0	53	2.0	70	2.0	65	2.0	63	2.0	51	2.0	49	2.0	58	2.0	56
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.23	0.10	0.26	0.10	0.28	0.10	0.41	0.10	0.44	0.10	0.56	0.10	0.59	0.10	0.52	0.10	0.21
Iron	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND^	0.10	ND	0.10	ND	0.10	ND	0.10	0.15
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.035	0.0025	0.058	0.0025	0.056	0.0025	0.060	0.0025	0.061	0.0025	0.053	0.0025	0.021	0.0025	0.033	0.0025	0.14
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.023
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	200	50	140	50	130	50	210	50	240	50	180	50	150	20	130	100	340
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	280	10	440	10	400	10	480	10	390	10	450	10	330	10	330	10	990
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.00083	0.0025	ND	0.0025	0.0015	0.0025	ND	0.0025	ND
pH	NA	7.53	NA	7.99	NA	7.18	NA	8.38	NA	6.68	NA	7.17	NA	6.92	NA	7.01	NA	7.40
Temperature	NA	10.41	NA	4.49	NA	11.22	NA	19.57	NA	14.98	NA	5.27	NA	9.49	NA	17.84	NA	9.93
Conductivity	NA	0.374	NA	0.39	NA	0.457	NA	0.676	NA	0.68	NA	0.40	NA	0.48	NA	0.49	NA	0.89
Dissolved Oxygen	NA	4.55	NA	1.02	NA	3.77	NA	0.66	NA	1.40	NA	0.99	NA	1.62	NA	2.78	NA	2.34
ORP	NA	-56.8	NA	-74.7	NA	-73.4	NA	-62.6	NA	33.4	NA	-52.8	NA	-103.0	NA	-113.3	NA	4.6

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature °C degrees Celcius
Conductivity ms/cm[c] millisiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

Attachment 9-3. CCA Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

Sample: MW-05	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012		9/28/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.0076	0.0010	0.0082	0.0010	0.0013	0.0010	ND	0.0010	0.010	0.0010	0.010	0.0010	0.0098	0.0010	0.012
Barium	2.0	0.0025	0.060	0.0025	0.066	0.0025	0.057	0.0025	0.041	0.0025	0.073	0.0025	0.063	0.0025	0.051	0.0025	0.067
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0050	ND
Boron	2.0	5.0	28	5.0	33	2.5	12	5.0	30	1.0	37	5.0	44	5.0	47	5.0	41
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND ^
Chloride	200.0	10	100	10	120	50	540	50	220	10	110	2.0	50	2.0	50	10	170
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0021
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	4.0	0.10	0.29	0.10	0.34	0.10	0.24	0.10	0.18	0.10	0.29	0.10	0.29	0.10	0.31	0.10	0.32
Iron	5.0	0.10	3.5	0.10	2.8	0.10	0.95	0.10	0.42	0.10	5.6	0.10	6.6	0.10	5.9	0.10	5.1 ^
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	0.71	0.0025	0.60	0.0025	0.28	0.0025	0.030	0.0025	0.99	0.0025	0.76 ^	0.0025	0.75	0.0025	0.57
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	0.0026	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	0.27	0.10	0.20	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	0.27	0.10	0.20	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Selenium	0.05	0.0025	0.0028	0.0025	ND	0.0025	0.0094	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	200	920	250	780	250	1100	250	810	250	1100	250	980	250	800	250	710
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	1500	10	1800	10	3300	10	2300	10	2300	10	2000	10	2000	10	1900
Vanadium	0.049	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
BETX	11.705	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
pH	6.5 - 9.0	NA	7.21	NA	7.56	NA	6.72	NA	6.87	NA	7.15	NA	7.45	NA	6.97	NA	7.32
Temperature	NA	NA	15.23	NA	12.13	NA	13.41	NA	13.37	NA	11.63	NA	14.23	NA	15.74	NA	13.17
Conductivity	NA	NA	1.801	NA	2.16	NA	4.34	NA	2.26	NA	1.87	NA	0.52	NA	1.68	NA	1.76
Dissolved Oxygen	NA	NA	NM	NA	0.45	NA	0.49	NA	0.04	NA	0.35	NA	0.16	NA	0.12	NA	0.13
ORP	NA	NA	NM	NA	-72.1	NA	81.8	NA	-40	NA	-84	NA	-39	NA	-76	NA	-108

Sample: MW-05	Date	12/19/2012		3/7/2013		6/6/2013		7/25/2013		11/5/2013		3/11/2014		5/16/2014		8/21/2014	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.011	0.0010	0.012	0.0010	ND	0.0010	0.0013	0.0010	0.0086	0.0010	0.0097	0.0010	0.0090	0.0010	0.0019
Barium	2.0	0.0025	0.070	0.0025	0.060	0.0025	0.045	0.0025	0.037	0.0025	0.054	0.0025	0.051	0.0025	0.036	0.0025	0.031
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	2.0	5.0	27	5.0	33	5.0	12	5.0	29	1.0	32	2.5	31	5.0	36	5.0	35
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	200.0	10	220	2.0	68	50	600	10	210	2.0	49	2.0	45	2.0	47	2.0	47
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	4.0	0.10	0.36 ^	0.10	0.36	0.10	0.21	0.10	0.32	0.10	0.32	0.10	0.29	0.10	0.31	0.10	0.31
Iron	5.0	0.10	3.9	0.10	4.0	0.10	0.41	0.10	1.1	0.10	4.6	0.10	5.5	0.10	5.5	0.10	4.0
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	0.48	0.0025	0.51	0.0025	0.17	0.0025	0.44	0.0025	0.54	0.0025	0.62	0.0025	0.49	0.0025	0.65
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	0.0026	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	0.45	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	0.45	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	0.033	0.020	ND	0.020	ND	0.020	ND	0.020	0.047
Perchlorate	0.0049	0.004	ND	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.05	0.0025	ND	0.0025	ND	0.0025	0.0037	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	250	550	250	650	250	1200	250	890	250	870	250	640	100	630	130	640
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	1800	10	1600	17	3500	10	2000	10	1600	10	1400	10	1500	10	1600
Vanadium	0.049	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	11.705	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	6.5 - 9.0	NA	7.36	NA	7.33	NA	6.61	NA	6.74	NA	7.20	NA	7.64	NA	7.07	NA	7.06
Temperature	NA	NA	12.46	NA	12.5	NA	13.12	NA	15.7	NA	13.34	NA	10.19	NA	10.13	NA	19.08
Conductivity	NA	NA	1.74	NA	1.48	NA	3.118	NA	2.18	NA	1.24	NA	0.86	NA	1.33	NA	1.509
Dissolved Oxygen	NA	NA	0.1	NA	0.22	NA	0.63	NA	0.50	NA	0.47	NA	1.45	NA	0.59	NA	4.09
ORP	NA	NA	-101	NA	-129.7	NA	18.4	NA	22.3	NA	-107.0	NA	-94.3	NA	-28.2	NA	-80

Sample: MW-05	Date	11/5/2014		2/17/2015		4/20/2015		8/13/2015		11/3/2015		3/2/2016		5/2/2016		8/24/2016		12/7/2016	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND ^	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.010	0.0010	0.0097	0.0010	0.010	0.0010	0.017 ^	0.0010	ND	0.0010	ND	0.0010	0.0023	0.0010	ND ^	0.0010	0.0075	0.0010	0.013
Barium	2.0	0.0025	0.046	0.0025	0.046	0.0025	0.068	0.0025	0.041	0.0025	0.039	0.0025	0.036	0.0025	0.036	0.0025	0.074	0.0025	0.071
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	2.0	5.0	36	5.0	32	2.5	24	2.5	11	5.0	12	5.0	14	5.0	23	2.5	43	5.0	49
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	200.0	2.0	42	2.0	41	10	270	50	720	10	370	10	300	10	140	10	150	2.0	68
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND
Cyanide	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	4.0	0.10	0.29	0.10	0.26	0.10	0.23	0.10	0.19	0.10	0.20	0.10	0.19	0.10	0.22	0.10	0.28	0.10	0.29
Iron	5.0	0.10	8.6	0.10	7.2	0.10	6.9	0.10	0.28	0.10	0.58	0.10	2.3	0.10	1.8	0.10	13	0.10	8.9
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.15	0.0025	0.62	0.0025	0.46	0.0025	0.63	0.0025	0.18	0.0025	0.20	0.0025	0.17	0.0025	0.32	0.0025	0.65	0.0025	0.53
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.1	0.0020	0.0020	0.0020	ND	0.0020	0.0037	0.0020	0.0026	0.0020	ND	0.0020	0.0046	0.0020	0.0045	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	10.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	NA	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^	0.10	ND	0.10	ND
Nitrogen/Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0049	0.0040	ND	0.0040	ND	0.0040	ND ^	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.05	0.0025	ND	0.0025	ND	0.0025	0.0030 ^	0.0025	0.024	0.0025	0.014	0.0025	0.0054	0.0050	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	400.0	200	840	250	660	250	700	250	1200	200	910	500	1200	250	1000	250	1100	250	610
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	1,200	10	1500	10	1700	13	2200	17	3500	13	2700	10	2800	10	2400	10	2200	10	2000
Vanadium	0.049	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00079	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	11.705	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.00259	0.0025	ND	0.0025	0.00054	0.0025	ND	0.0025	ND
pH	6.5 - 9.0	NA	7.30	NA	7.46	NA	6.73	NA	7.03	NA	6.18	NA	6.71	NA	6.73	NA	6.80	NA	6.82
Temperature	NA	NA	11.27	NA	7.51	NA	10.27	NA	19.55	NA	14.09	NA	7.82	NA	13.27	NA	20.78	NA	7.90
Conductivity	NA	NA	1.316	NA	1.28	NA	2.095	NA	3.582	NA	3.073	NA	2.52	NA	2.38	NA	2.17	NA	1.41
Dissolved Oxygen	NA	NA	1.61	NA	1.97	NA	2.75	NA	1.11	NA	1.42	NA	2.24	NA	1.66	NA	2.05	NA	1.15
ORP	NA	NA	-53	NA	-100.6	NA	-58.6	NA	-34.2	NA	46.2	NA	12.1	NA	-20.6	NA	-72.7	NA	-59.3

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature	°C	degrees Celcius
Conductivity	ms/cm^c	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

Sample: MW-06	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012		9/28/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Arsenic	0.010	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Barium	2.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Beryllium	0.004	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	2.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cadmium	0.005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chloride	200.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chromium	0.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cobalt	1.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Copper	0.65	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cyanide	0.2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fluoride	4.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Iron	5.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Lead	0.0075	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Manganese	0.15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mercury	0.002	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nickel	0.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen/Nitrate	10.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen/Nitrate, Nitrite	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen/Nitrite	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Perchlorate	0.0049	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Selenium	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Silver	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sulfate	400.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thallium	0.002	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total Dissolved Solids	1,200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Vanadium	0.049	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zinc	5.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Benzene	0.005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BETX	11.705	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
pH	6.5 - 9.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Temperature	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Conductivity	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dissolved Oxygen	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ORP	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Sample: MW-06	12/19/2012		3/7/2013		6/6/2013		7/25/2013		11/5/2013		3/10/2014		5/15/2014		8/21/2014		11/5/2014	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND ^
Arsenic	0.0010	0.0029	0.0010	0.0019	0.0010	0.0065	0.0010	0.0096	0.0010	0.0034	0.0010	0.0017	0.0010	0.0043	0.0010	0.0083	0.0010	0.0045
Barium	0.0025	0.11	0.0025	0.088	0.0025	0.077	0.0025	0.092	0.0025	0.13	0.0025	0.012	0.0025	0.061	0.0025	0.089	0.0025	0.10
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.25	1.1	0.50	2.8	0.50	6.7	2.5	4.3	0.25	2.4	0.25	2.0	0.25	2.2	0.25	2.9	0.50	3.7
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	10	110	2.0	61	2.0	48	2.0	69	10	85	2.0	8.0	10	84	10	98	10	97
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	0.0015	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0025	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.43 ^	0.10	0.27	0.10	0.30	0.10	0.34	0.10	0.30	0.10	0.17	0.10	0.22	0.10	0.35	0.10	0.29
Iron	0.10	2.6	0.10	2.0	0.10	6.2	0.10	16	0.10	4.1	0.10	0.19	0.10	3.0	0.10	9.2	0.10	6.7
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.21	0.0025	0.36	0.0025	0.75	0.0025	0.72	0.0025	0.44	0.0025	0.0073	0.0025	0.17	0.0025	0.38	0.0025	0.44
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	0.0039	0.0020	0.0029	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	1.1	0.10	ND	0.10	ND	0.10	0.54	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	1.1	0.10	ND	0.10	ND	0.10	0.54	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.004	ND	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.014	0.0025	ND	0.0025	0.0033	0.0025	0.0034
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	160	100	380	100	390	100	360	100	350	25	93	50	170	50	120	50	240
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	940	10	1100	10	1100	10	1100	10	1200	10	190	10	870	10	950	10	890
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	NA	7.52	NA	7.42	NA	6.83	NA	6.88	NA	7.24	NA	7.94	NA	7.18	NA	7.11	NA	7.33
Temperature	NA	11.32	NA	7.1	NA	9.68	NA	12.92	NA	13.14	NA	5.14	NA	8.91	NA	17.83	NA	12.69
Conductivity	NA	1.05	NA	1.01	NA	0.911	NA	1.18	NA	1.10	NA	0.21	NA	0.9	NA	1.179	NA	1.092
Dissolved Oxygen	NA	0.07	NA	0.33	NA	0.4	NA	0.28	NA	0.22	NA	7.07	NA	0.51	NA	0.97	NA	1.37
ORP	NA	-128	NA	-99.4	NA	-72.7	NA	-109.7	NA	-126.3	NA	-9.90	NA	-36.7	NA	-116.9	NA	-94.1

Sample: MW-06	2/18/2015		4/20/2015		8/12/2015		11/3/2015		2/29/2016		5/3/2016		8/25/2016		12/6/2016	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.0030	0.0010	0.0027	0.0010	0.0037	0.0010	0.0039	0.0010	0.0016	0.0020	0.0023	0.0010	0.0022	0.0010	0.0012
Barium	0.0025	0.063	0.0025	0.066	0.0025	0.084	0.0025	0.096	0.0025	0.093	0.0025	0.074	0.0025	0.11	0.0025	0.089
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	0.50	3.5	0.050	1.4	0.25	2.0	0.50	1.9	0.50	2.8	5.0	10	0.50	1.6	0.50	5.8
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	10	81	10	100	10	110	10	120	10	100	10	77	10	140	10	100
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0023	0.0020	ND ^	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.23	0.10	0.32	0.10	0.36	0.10	0.36	0.10	0.34	0.10	0.33	0.10	0.35	0.10	0.29
Iron	0.10	7.6	0.10	0.62	0.10	4.2	0.10	5.2	0.10	5.9	0.10	5.8	0.10	5.2	0.10	4.8
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.38	0.0025	0.19	0.0025	0.24	0.0025	0.26	0.0025	0.26	0.0025	0.26	0.0025	0.28	0.0025	0.39
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0050	ND	0.0025	ND	0.0025	ND
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	50	190	50	160	50	170	50	180	50	250	50	300	50	180	100	250
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	900	10	850	10	1100	10	870	10	960	10	1000	10	1000	10	1100
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00068	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	0.00078	0.0025	ND	0.0025	ND	0.0025	0.00398	0.0025	ND	0.0025	0.00071	0.0025	ND	0.0025	ND
pH	NA	7.45	NA	6.76	NA	7.69	NA	6.81	NA	7.24	NA	7.22	NA	6.90	NA	6.79
Temperature	NA	4.41	NA	7.68	NA	19.07	NA	13.96	NA	8.01	NA	12.41	NA	18.68	NA	8.54
Conductivity	NA	0.85	NA	0.905	NA	1.246	NA	1.294	NA	0.96	NA	1.13	NA	1.34	NA	1.03
Dissolved Oxygen	NA	3.00	NA	4.67	NA	2.11	NA	0.96	NA	1.44	NA	2.12	NA	2.00	NA	1.45
ORP	NA	-104.5	NA	-45.6	NA	-130.8	NA	-55.1	NA	-90.1	NA	-107.3	NA	-86.0	NA	-82.7

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature	°C	degrees Celcius
Conductivity	ms/cm[c]	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

Sample: MW-07	Date	10/25/2010		3/24/2011		6/13/2011		9/13/2011		12/6/2011		3/14/2012		6/18/2012		9/28/2012	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Arsenic	0.010	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Barium	2.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Beryllium	0.004	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron	2.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cadmium	0.005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chloride	200.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chromium	0.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cobalt	1.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Copper	0.65	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cyanide	0.2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fluoride	4.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Iron	5.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Lead	0.0075	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Manganese	0.15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mercury	0.002	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nickel	0.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen/Nitrate	10.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen/Nitrate, Nitrite	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen/Nitrite	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Perchlorate	0.0049	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Selenium	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Silver	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sulfate	400.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thallium	0.002	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total Dissolved Solids	1,200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Vanadium	0.049	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zinc	5.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Benzene	0.005	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BETX	11.705	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
pH	6.5 - 9.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Temperature	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Conductivity	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dissolved Oxygen	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ORP	NA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Sample: MW-07	12/19/2012		3/7/2013		6/6/2013		7/25/2013		11/4/2013		3/10/2014		5/15/2014		8/21/2014		11/5/2014	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND ^
Arsenic	0.0010	0.0099	0.0010	0.012	0.0010	0.010	0.0010	0.011	0.0010	0.012	0.0010	0.0096	0.0010	0.0098	0.0010	0.011	0.0010	0.0095
Barium	0.0025	0.080	0.0025	0.082	0.0025	0.082	0.0025	0.083	0.0025	0.082	0.0025	0.073	0.0025	0.089	0.0025	0.072	0.0025	0.062
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	5.0	43	5.0	49	5.0	42	5.0	44	1.0	45	2.5	39	5.0	27	5.0	40	5.0	41
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	60	2.0	54	2.0	44	2.0	33	2.0	53	2.0	34	2.0	35	2.0	36	2.0	48
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.48	0.10	0.50	0.10	0.46	0.10	0.46	0.10	0.44	0.10	0.39	0.10	0.30	0.10	0.47	0.10	0.45
Iron	0.10	12	0.10	12	0.10	13	0.10	13	0.10	13	0.10	11	0.10	12	0.10	11	0.10	9.4
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.46	0.0025	0.49	0.0025	0.48	0.0025	0.46	0.0025	0.46	0.0025	0.46	0.0025	0.60	0.0025	0.40	0.0025	0.34
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	0.11	0.10	ND	0.10	ND	0.10	ND	0.10	0.11	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	0.11	0.10	ND	0.10	ND	0.10	ND	0.10	0.11	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Perchlorate	0.004	ND	0.004	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.0025	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	250	630	250	710	250	650	250	860	250	770	250	540	100	330	130	690	200	880
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	1800	10	1800	10	1800	10	1800	10	1800	10	1600	10	1300	10	1600	10	1500
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.0005	ND	0.0005	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	NA	7.27	NA	8.24	NA	7.09	NA	7.10	NA	7.18	NA	7.67	NA	6.89	NA	7.25	NA	7.46
Temperature	NA	12.99	NA	1.5	NA	12.46	NA	13.99	NA	12.92	NA	12.33	NA	9.89	NA	18.25	NA	13.37
Conductivity	NA	1.54	NA	1.17	NA	1.385	NA	1.52	NA	1.01	NA	0.98	NA	1.26	NA	1.607	NA	1.394
Dissolved Oxygen	NA	0.05	NA	0.33	NA	0.80	NA	0.28	NA	0.54	NA	1.19	NA	0.62	NA	1.18	NA	2.35
ORP	NA	-129	NA	-111.6	NA	-151.7	NA	-125.8	NA	-127.7	NA	-116.8	NA	-16.9	NA	-143.6	NA	-112.5

Sample: MW-07	2/17/2015		4/20/2015		8/12/2015		11/3/2015		2/29/2016		5/2/2016		8/24/2016		12/7/2016	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND
Arsenic	0.0010	0.011	0.0010	0.014	0.0010	0.010	0.0010	0.011	0.0010	0.0079	0.0020	0.0078	0.0010	0.0074	0.0010	0.0088
Barium	0.0025	0.069	0.0025	0.071	0.0025	0.065	0.0025	0.063	0.0025	0.053	0.0025	0.066	0.0025	0.081	0.0025	0.087
Beryllium	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Boron	5.0	37	2.5	37	5.0	32	5.0	26	5.0	22	5.0	24	2.5	26	5.0	33
Cadmium	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Chloride	2.0	48	2.0	46	2.0	64	10	85	2.0	59	2.0	54	2.0	49	2.0	36
Chromium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Cobalt	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND
Copper	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND
Cyanide	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND
Fluoride	0.10	0.38	0.10	0.34	0.10	0.47	0.10	0.45	0.10	0.57	0.10	0.37	0.10	0.38	0.10	0.32
Iron	0.10	12	0.10	14	0.10	11	0.10	11	0.10	8.3	0.10	14	0.10	11	0.10	16
Lead	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Manganese	0.0025	0.45	0.0025	0.62	0.0025	0.43	0.0025	0.40	0.0025	0.30	0.0025	0.48	0.0025	0.52	0.0025	0.55
Mercury	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND
Nickel	0.0020	ND	0.0020	0.0021	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0022	0.0020	ND	0.0020	ND
Nitrogen/Nitrate	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND
Nitrogen/Nitrate, Nitrite	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND ^	0.10	ND	0.10	ND
Nitrogen/Nitrite	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	ND	0.020	ND
Perchlorate	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND	0.0040	ND
Selenium	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0050	ND	0.0025	ND	0.0025	ND
Silver	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND^	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
Sulfate	250	710	130	470	200	760	200	770	100	580	130	610	100	620	250	510
Thallium	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND
Total Dissolved Solids	10	1600	10	1400	10	1700	10	1500	10	1300	10	1500	10	1500	10	1800
Vanadium	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND
Zinc	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND
Benzene	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND
BETX	0.0025	0.0012	0.0025	ND	0.0025	ND	0.0025	0.0015	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
pH	NA	7.56	NA	6.59	NA	7.38	NA	6.80	NA	7.31	NA	7.02	NA	6.99	NA	6.83
Temperature	NA	5.67	NA	10.80	NA	16.66	NA	15.05	NA	11.51	NA	12.08	NA	20.24	NA	7.26
Conductivity	NA	1.20	NA	1.34	NA	1.62	NA	1.65	NA	1.17	NA	1.45	NA	1.63	NA	1.26
Dissolved Oxygen	NA	1.31	NA	3.14	NA	0.87	NA	0.53	NA	0.90	NA	1.07	NA	2.46	NA	1.34
ORP	NA	-137.2	NA	-73.9	NA	-135.5	NA	-69.4	NA	-97.4	NA	-118.4	NA	-94.4	NA	-92.4

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater.
All values are in mg/L (ppm) unless otherwise noted.

DL - Detection limit
NA - Not Applicable
ND - Not Detected
NM - Not Measured

NR - Not Required
NS - Not Sampled
^ - Denotes instrument related QC exceeds the control limits

Temperature °C degrees Celcius
Conductivity ms/cm[c] millisiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

MW-01	Date	2/21/2017		5/15/2017		9/14/2017		11/27/2017		2/7/2018		5/29/2018	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030
Arsenic	0.010	0.0010	0.14	0.0010	0.11	0.0010	0.039	0.0010	0.048	0.0010	0.12	0.0010	0.17
Barium	2.0	0.0025	0.015	0.0025	0.016	0.0025	0.033	0.0025	0.053	0.0025	0.021	0.0025	0.022
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010
Boron	2.0	0.25	2.1	0.25	2.3	0.25	2.9	0.25	2.5	0.50	2.2	0.50	2.3
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050
Chloride	200.0	2.0	61	2.0	58	2.0	49	2.0	45	2.0	53	2.0	53
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020
Cyanide, Total	0.2	0.010	0.014	0.010	0.018	0.010	ND	0.010	ND	0.010	ND	0.010	0.010
Fluoride	4.0	0.10	0.30	0.10	0.29	0.10	0.24	0.10	0.17	0.10	0.27	0.10	0.31
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00079
Manganese	0.15	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.0072	0.0025	ND	0.0025	0.0025
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.00020
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020
Nitrogen, Nitrate	10.0	0.10	ND	0.10	0.11	0.10	0.29	0.10	2.2	0.10	ND	0.10	0.10
Nitrogen, Nitrate Nitrite	NA	0.10	ND	0.10	0.19	0.10	0.48	0.20	2.9	0.10	0.12	0.10	0.22
Nitrogen, Nitrite	NA	0.020	0.038	0.020	0.078	0.020	0.19	0.20	0.72	0.020	0.035	0.020	0.15
Radium 226	20	0.119	ND	0.0943	0.114	0.0567	0.109	0.0628	ND	0.0636	0.0858	0.126	0.17
Radium 228	20	0.518	ND *	0.474	ND	0.398	ND	0.396	0.619	0.381	ND	0.546	ND
Selenium	0.05	0.0025	0.0025	0.0025	0.0055	0.0025	0.0099	0.0025	0.021	0.0025	0.0059	0.0025	0.0064
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050
Sulfate	400.0	50	260	50	330	100	410	50	280	50	350	50	360
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND	0.0020	0.0020
Total Dissolved Solids	1,200	10	550	10	600	10	750	10	800	10	580	10	570
Vanadium	0.049	0.0050	0.077	0.0050	0.088	0.0050	0.077	0.0050	0.038	0.0050	0.062	0.0050	0.049
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020
pH	6.5 - 9.0	NA	11.30	NA	10.69	NA	10.45	NA	7.85	NA	11.13	NA	8.44
Temperature	NA	NA	14.8	NA	15.1	NA	14.9	NA	12.9	NA	12.1	NA	14.2
Conductivity	NA	NA	0.81	NA	0.71	NA	0.96	NA	0.82	NA	0.69	NA	0.65
Dissolved Oxygen	NA	NA	1.98	NA	2.73	NA	0.22	NA	3.97	NA	0.74	NA	5.32
ORP	NA	NA	65.2	NA	-22.1	NA	-1.1	NA	-9.0	NA	-171.8	NA	-23.9

MW-01	Date	8/20/2018		11/5/2018		2/11/2019		5/14/2019		8/14/2019		11/19/2019	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	0.0030	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.010	0.0010	0.012	0.001	0.075	0.001	0.094	0.001	0.063	0.001	0.052	0.001	0.069
Barium	2.0	0.0025	0.11	0.0025	0.029	0.0025	0.024	0.0025	0.029	0.0025	0.027	0.0025	0.02
Beryllium	0.004	0.0010	0.0010	0.001	ND ^	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	2.0	0.50	3.6	0.25	2.1	0.25	2.2	0.05	2.1	0.25	2.4	0.5	2.4
Cadmium	0.005	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	200.0	2.0	30	2	40	2	53	2	46	2	47	2	35
Chromium	0.1	0.0050	0.0050	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	1.0	0.0010	0.0010	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.65	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.2	0.010	0.010	0.01	ND F2	0.01	ND	0.01	ND	0.01	ND	0.01	ND
Fluoride	4.0	0.10	0.10	0.10	0.26	0.1	0.22	0.1	0.18	0.1	0.19	0.1	0.25
Iron	5.0	0.10	0.10	0.10	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Lead	0.0075	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.15	0.0025	0.035	0.0025	ND	0.0025	ND	0.0025	0.005	0.0025	0.0056	0.0025	0.0025
Mercury	0.002	0.00020	0.00020	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.1	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	10.0	0.10	0.67	0.10	0.22	0.1	ND	0.1	0.17	0.1	ND	0.1	0.1
Nitrogen, Nitrate Nitrite	NA	0.10	0.67	0.10	0.22	0.1	ND	0.1	0.17	0.1	ND	0.1	0.1
Nitrogen, Nitrite	NA	0.020	0.020	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND ^
Radium 226	20	0.0793	0.388	0.259	ND	0.228	ND	0.109	ND	0.241	ND	0.112	ND
Radium 228	20	0.373	ND	0.539	ND	0.395	ND	0.426	ND	0.609	ND	0.581	ND
Selenium	0.05	0.0025	0.0063	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	400.0	130	420	50	270	50	320	20	260	20	250	500	ND
Thallium	0.002	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	1,200	10	1200	10	540	10	540	10	580	10	560	10	520
Vanadium	0.049	0.0050	0.0055	0.005	0.023	0.005	0.02	0.005	0.013	0.005	0.015	0.005	0.032
Zinc	5.0	0.020	0.020	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
pH	6.5 - 9.0	NA	6.94	NA	8.70	NA	9.98	NA	9.85	NA	9.11	NA	10.58
Temperature	NA	NA	18.4	NA	12.34	NA	12.90	NA	12.20	NA	133.00	NA	12.82
Conductivity	NA	NA	0.96	NA	0.543	NA	0.775	NA	0.670	NA	0.900	NA	0.763
Dissolved Oxygen	NA	NA	5.34	NA	2.84	NA	0.75	NA	0.71	NA	0.29	NA	0.55
ORP	NA	NA	154.0	NA	-61.7	NA	-151.5	NA	17.8	NA	81.2	NA	-93.7

MW-01	Date	3/2/2020		4/21/2020		8/17/2020		11/17/2020		3/1/2021		5/5/2021	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.010	0.001	0.042	0.001	0.043	0.001	0.022	0.001	0.022	0.001	0.026	0.001	0.024
Barium	2.0	0.0025	0.033	0.0025	0.041	0.0025	0.046	0.0025	0.068	0.0025	0.05	0.0025	0.04
Beryllium	0.004	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	2.0	0.5	2.4	0.05	2.7	0.25	2.5	0.5	3.2	0.5	3.7	0.5	3.2
Cadmium	0.005	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.005	ND	0.0005	ND
Chloride	200.0	2	28	2	25	2	48	10	92	10	110	6	70
Chromium	0.1	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	1.0	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.65	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.2	0.01	ND F1	0.01	ND	0.005	ND	0.005	ND	0.005	0.0059	0.005	ND
Fluoride	4.0	0.1	0.17	0.1	0.22	0.1	0.27	0.1	0.15	0.1	0.16	0.1	0.2
Iron	5.0	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Lead	0.0075	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.15	0.0025	0.0093	0.0025	0.003	0.0025	0.011	0.0025	0.023	0.0025	0.0095	0.0025	0.0076
Mercury	0.002	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.1	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	10.0	0.1	0.11	0.1	0.17	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrate Nitrite	NA	0.1	0.17	0.1	0.17	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrite	NA	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	20	0.127	ND	0.0912	ND	0.0768	0.115	0.528	ND	0.102	ND	0.149	ND
Radium 228	20	0.395	ND	0.452	ND	0.393	ND	0.557	ND	0.565	ND	0.342	0.407
Selenium	0.05	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	400.0	500	ND	500	ND	25	210	25	240	25	210	25	190
Thallium	0.002	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	1,200	10	610	10	450	30	470	30	650	10	560	10	460
Vanadium	0.049	0.005	0.0097	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Zinc	5.0	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
pH	6.5 - 9.0	NA	8.83	NA	9.40	NA	8.48	NA	7.97	NA	8.92	NA	9.00
Temperature	NA	NA	12.60	NA	12.50	NA	13.40	NA	13.60	NA	13.40	NA	13.50
Conductivity	NA	NA	0.306	NA	0.633	NA	0.738	NA	1.090	NA	1.151	NA	0.706
Dissolved Oxygen	NA	NA	0.74	NA	0.46	NA	0.37	NA	1.78	NA	-1.85	NA	1.40
ORP	NA	NA	126.8	NA	25.0	NA	75.6	NA	6.3	NA	56.6	NA	69.1

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature	°C	degrees Celsius
Conductivity	ms/cm^c	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

Attachment 9-3. Permit Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

MW-02	Date	2/21/2017		5/15/2017		9/14/2017		11/27/2017		2/7/2018		5/29/2018		8/20/2018		11/5/2018	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030	0.0030	0.0030	0.003	ND
Arsenic	0.010	0.0010	0.026	0.0010	0.016	0.0010	0.011	0.0010	0.012	0.0010	0.014	0.0010	0.0054	0.0010	0.0070	0.001	0.0091
Barium	2.0	0.0025	0.010	0.0025	0.027	0.0025	0.035	0.0025	0.024	0.0025	0.024	0.0025	0.038	0.0025	0.034	0.0025	0.016
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.0010	0.0010	0.001	ND ^
Boron	2.0	0.25	2.9	0.50	3.4	0.50	4.0	0.50	3.6	0.50	3.7	0.50	4.6	0.50	3.6	0.25	2.9
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND
Chloride	200.0	2.0	51	2.0	50	2.0	54	2.0	57	2.0	53	2.0	41	2.0	50	2	54
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.0010	0.0010	0.001	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0021	0.0020	0.0020	0.0020	0.0020	0.002	ND
Cyanide, Total	0.2	0.010	0.019	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.010	0.010	0.010	0.01	ND
Fluoride	4.0	0.10	0.78	0.10	0.38	0.10	0.44	0.10	0.58	0.10	0.38	0.10	0.39	0.10	0.48	0.10	0.69
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.24	0.10	0.10	0.10	0.10	0.10	ND
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND
Manganese	0.15	0.0025	0.017	0.0025	0.019	0.0025	0.029	0.0025	0.020	0.0025	0.018	0.0025	0.032	0.0025	0.031	0.0025	0.018
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.00020	0.00020	0.00020	0.0002	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND
Nitrogen, Nitrate	10.0	0.10	ND	0.10	0.67	0.10	0.26	0.10	ND	0.10	ND	0.10	1.3	0.10	0.37	0.10	ND
Nitrogen, Nitrate Nitrite	NA	0.10	ND	0.10	0.73	0.10	0.26	0.10	ND	0.10	ND	0.10	1.3	0.10	0.37	0.10	ND
Nitrogen, Nitrite	NA	0.020	ND	0.020	0.057	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND
Radium 226	20	0.144	ND	0.108	ND	0.0616	0.102	0.0578	0.169	0.0679	0.0887	0.0907	0.178	0.0805	0.326	0.199	ND
Radium 228	20	0.406	ND *	0.518	ND	0.361	0.492	0.395	0.924	0.36	ND	0.433	ND	0.354	ND	0.383	ND
Selenium	0.05	0.0025	ND	0.0025	0.022	0.0025	0.0054	0.0025	ND	0.0025	ND	0.0025	0.0086	0.0025	0.0067	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND
Sulfate	400.0	50	210	50	350	100	330	50	200	50	290	100	420	100	230	50	170
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND
Total Dissolved Solids	1,200	10	380	10	630	10	730	10	620	10	580	10	930	10	730	10	500
Vanadium	0.049	0.0050	0.0066	0.0050	0.0091	0.0050	0.0075	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0070	0.005	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND
pH	6.5 - 9.0	NA	8.75	NA	8.33	NA	8.19	NA	7.34	NA	12.34	NA	6.85	NA	7.22	NA	8.06
Temperature	NA	NA	12.8	NA	18.3	NA	14.5	NA	12.4	NA	12.3	NA	14.1	NA	17.2	NA	12.41
Conductivity	NA	NA	0.50	NA	0.68	NA	0.85	NA	0.62	NA	0.63	NA	0.88	NA	0.76	NA	0.539
Dissolved Oxygen	NA	NA	2.19	NA	5.13	NA	0.19	NA	4.22	NA	0.68	NA	6.78	NA	3.08	NA	3.76
ORP	NA	NA	67.4	NA	-49.2	NA	35.2	NA	-42.3	NA	-337.5	NA	20.4	NA	96.1	NA	-23.8

MW-02	2/11/2019		5/14/2019		8/14/2019		11/19/2019		3/2/2020		4/21/2020		8/17/2020		11/17/2020		3/1/2021		5/5/2021	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.001	0.0091	0.001	0.0087	0.001	0.0085	0.001	0.0073	0.001	0.0079	0.001	0.008	0.001	0.0087	0.001	0.0066	0.001	0.013	0.001	0.0083
Barium	0.0025	0.038	0.0025	0.012	0.0025	0.027	0.0025	0.05	0.0025	0.028	0.0025	0.032	0.0025	0.021	0.0025	0.028	0.0025	0.032	0.0025	0.03
Beryllium	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	0.5	3.8	0.05	2.4	0.25	3.1	1	4.9	1	3.1	0.05	3.3	0.25	2.8	0.5	3.8	0.5	4.6	1	4.6
Cadmium	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	2	51	2	52	2	41	2	43	2	49	2	50	2	50	2	23	2	34	2	38
Chromium	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.005	ND	0.005	ND	0.005	0.0054	0.005	ND
Fluoride	0.1	0.86	0.1	0.97	0.1	0.84	0.1	0.67	0.1	1	0.1	1	0.1	0.94	0.1	0.78	0.1	0.84	0.1	0.72
Iron	0.1	0.22	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	0.19	0.1	ND	0.1	0.36	0.1	ND
Lead	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.0025	0.052	0.0025	0.015	0.0025	0.062	0.0025	0.069	0.0025	0.045	0.0025	0.037	0.0025	0.034	0.0025	0.048	0.0025	0.042	0.0025	0.042
Mercury	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	0.1	0.46	0.1	ND	0.1	ND	0.1	1.2	0.1	ND	0.1	0.1	0.1	0.2	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrate Nitrite	0.1	0.46	0.1	ND	0.1	ND	0.1	1.2	0.1	0.14	0.1	0.1	0.1	0.2	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrite	0.02	ND	0.02	ND	0.02	ND	0.02	ND ^	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	0.257	ND	0.123	ND	0.212	ND	0.0921	0.172	0.109	ND	0.105	ND	0.0806	ND	0.54	ND	0.0997	ND	0.15	ND
Radium 228	0.424	0.5	0.443	0.493	0.623	ND	0.483	ND	0.394	ND	0.424	ND	0.372	ND	0.532	ND	0.586	0.586	0.463	ND
Selenium	0.0025	0.0048	0.0025	ND	0.0025	0.003	0.0025	0.0074	0.0025	ND	0.0025	0.0028	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	50	350	20	150	20	200	500	ND	500	ND	500	ND	25	230	100	300	25	190	25	200
Thallium	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	10	720	10	460	10	530	10	850	10	580	10	600	30	550	30	610	10	450	10	410
Vanadium	0.005	0.0059	0.005	ND	0.005	0.0055	0.005	0.008	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Zinc	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
pH	NA	7.46	NA	8.30	NA	7.96	NA	7.37	NA	7.57	NA	8.02	NA	7.89	NA	7.67	NA	8.54	NA	8.39
Temperature	NA	11.40	NA	12.00	NA	13.40	NA	12.79	NA	12.20	NA	12.10	NA	13.60	NA	13.10	NA	12.10	NA	12.50
Conductivity	NA	0.969	NA	0.611	NA	0.900	NA	1.235	NA	0.311	NA	0.305	NA	0.830	NA	0.990	NA	0.861	NA	0.690
Dissolved Oxygen	NA	0.30	NA	0.19	NA	0.27	NA	8.12	NA	0.21	NA	0.31	NA	1.72	NA	2.25	NA	-0.04	NA	1.10
ORP	NA	-17.2	NA	31.4	NA	110.4	NA	-45.2	NA	-8.9	NA	-87.6	NA	-0.6	NA	-45.7	NA	-80.3	NA	11.9

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature °C degrees Celsius
Conductivity ms/cm[c] millisiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

Attachment 9-3. Permit Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

MW-03	Date	2/21/2017		5/16/2017		9/14/2017		11/28/2017		2/8/2018		5/29/2018		8/20/2018		11/5/2018	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030	0.003	ND
Arsenic	0.010	0.0010	0.016	0.0010	0.0036	0.0010	0.0026	0.0010	0.0021	0.0010	0.0065	0.0010	0.0065	0.0010	0.0040	0.001	0.012
Barium	2.0	0.0025	0.0064	0.0025	0.028	0.0025	0.027	0.0025	0.016	0.0025	0.012	0.0025	0.012	0.0025	0.0098	0.0025	0.0086
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	ND ^	0.0010	0.0010	0.001	ND ^
Boron	2.0	0.25	2.1	0.25	3.5	0.50	3.6	0.25	2.1	0.25	2.4	0.25	2.4	0.25	2.7	0.25	2.6
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.0005	ND
Chloride	200.0	2.0	67	2.0	60	2.0	58	2.0	68	2.0	60	2.0	60	2.0	54	2	48
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.005	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.001	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0041	0.0020	0.0041	0.0020	0.0020	0.002	ND
Cyanide, Total	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.010	0.01	ND
Fluoride	4.0	0.10	0.36	0.10	0.27	0.10	0.26	0.10	0.54	0.10	0.41	0.10	0.41	0.10	0.53	0.10	0.5
Iron	5.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10	0.10	ND
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.0005	ND
Manganese	0.15	0.0025	0.0025	0.0025	0.010	0.0025	0.026	0.0025	0.0092	0.0025	0.0048	0.0025	0.0048	0.0025	0.0076	0.0025	0.0067
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.00022	0.00020	ND	0.00020	ND	0.00020	0.00020	0.0002	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.002	ND
Nitrogen, Nitrate	10.0	0.10	0.10	0.10	0.72	0.10	0.56	0.10	0.19	0.10	0.12	0.10	0.12	0.10	0.20	0.10	0.13
Nitrogen, Nitrate Nitrite	NA	0.10	0.10	0.10	0.72	0.10	0.56	0.10	0.19	0.10	0.12	0.10	0.12	0.10	0.20	0.10	0.13
Nitrogen, Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.02	ND
Radium 226	20	0.122	ND	0.110	0.159	0.0681	0.203	0.0649	ND	0.123	ND	0.105	ND	0.113	0.17	0.18	ND
Radium 228	20	0.389	ND *	0.402	ND	0.366	ND	0.34	0.682	0.468	ND	0.386	ND	0.365	0.408	0.379	ND
Selenium	0.05	0.0025	ND	0.0025	0.0088	0.0025	0.0085	0.0025	ND	0.0025	0.0042	0.0025	0.0042	0.0025	0.0025	0.0025	0.003
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.0005	ND
Sulfate	400.0	50	170	50	280	50	290	25	110	50	190	50	190	50	210	50	220
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.002	ND
Total Dissolved Solids	1,200	10	440	10	690	10	650	10	460	10	500	10	500	10	450	10	490
Vanadium	0.049	0.0050	0.028	0.0050	0.013	0.0050	0.0092	0.0050	0.011	0.0050	0.034	0.0050	0.034	0.0050	0.017	0.005	0.021
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.02	ND
pH	6.5 - 9.0	NA	7.56	NA	7.90	NA	7.53	NA	6.96	NA	7.74	NA	6.84	NA	7.52	NA	8.99
Temperature	NA	NA	11.4	NA	14.5	NA	14.7	NA	13.2	NA	11.6	NA	16.96	NA	17.11	NA	11.47
Conductivity	NA	NA	0.53	NA	0.78	NA	0.78	NA	0.52	NA	0.521	NA	0.59	NA	0.529	NA	0.395
Dissolved Oxygen	NA	NA	1.64	NA	5.46	NA	0.32	NA	2.80	NA	0.35	NA	4.18	NA	2.08	NA	8.53
ORP	NA	NA	83.5	NA	-30.5	NA	81.3	NA	-62.4	NA	313.7	NA	11.7	NA	72.9	NA	-101.3

MW-03	2/11/2019		5/14/2019		8/14/2019		11/19/2019		3/2/2020		4/21/2020		8/17/2020		11/17/2020		3/1/2021		5/5/2021	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.001	0.01	0.001	0.0056	0.001	0.052	0.001	0.0066	0.001	0.0053	0.001	0.0066	0.001	0.0041	0.001	0.0071	0.001	0.0073	0.001	0.007
Barium	0.0025	0.026	0.0025	0.023	0.0025	0.0096	0.0025	0.033	0.0025	0.031	0.0025	0.033	0.0025	0.046	0.0025	0.033	0.0025	0.042	0.0025	0.038
Beryllium	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	0.25	3.6	0.05	3.4	0.25	3	1	4.3	1	3.7	1	4.3	0.25	2.9	0.5	3.7	0.5	4.8	0.5	5.8
Cadmium	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	2	28	2	16	2	13	2	17	2	21	2	17	2	45	2	54	2	45	2	45
Chromium	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.005	ND	0.005	ND	0.005	0.0057	0.005	ND
Fluoride	0.1	0.59	0.1	0.55	0.1	0.6	0.1	0.28	0.1	0.29	0.1	0.28	0.1	0.22	0.1	0.26	0.1	0.2	0.1	0.21
Iron	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Lead	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.0025	0.04	0.0025	0.031	0.0025	0.018	0.0025	0.065	0.0025	0.055	0.0025	0.065	0.0025	0.1	0.0025	0.072	0.0025	0.09	0.0025	0.096
Mercury	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	0.1	0.4	0.1	0.5	0.1	0.14	0.1	0.51	0.1	0.11	0.1	0.51	0.1	0.31	0.1	0.14	0.1	0.3	0.1	0.19
Nitrogen, Nitrate Nitrite	0.1	0.4	0.1	0.5	0.1	0.14	0.1	0.51	0.1	0.15	0.1	0.51	0.1	0.31	0.1	0.14	0.1	0.3	0.1	0.19
Nitrogen, Nitrite	0.02	ND	0.02	ND	0.02	ND	0.02	ND ^	0.02	ND	0.02	ND ^	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	0.255	ND	0.100	ND	0.189	ND	0.117	0.178	0.127	ND	0.114	0.166	0.0848	0.228	0.531	ND	0.11	ND	0.131	0.201
Radium 228	0.424	ND	0.439	ND	0.540	ND	0.472	ND	0.46	ND	0.462	ND	0.355	0.426	0.484	0.51	0.717	ND	0.381	0.503
Selenium	0.0025	0.012	0.0025	0.0067	0.0025	0.0049	0.0025	0.013	0.0025	ND	0.0025	0.013	0.0025	0.011	0.0025	0.0033	0.0025	0.01	0.0025	0.0078
Silver	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	100	290	40	280	20	220	500	ND	500	ND	500	ND	100	290	50	250	100	290	25	220
Thallium	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	10	690	10	700	10	480	10	720	10	760	10	720	30	870	30	640	10	700	10	560
Vanadium	0.005	0.011	0.005	0.0086	0.005	0.035	0.005	0.012	0.005	0.0085	0.005	0.012	0.005	0.0077	0.005	0.0051	0.005	0.0076	0.005	0.0058
Zinc	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	0.11	0.02	ND	0.02	ND	0.02	ND
pH	NA	7.31	NA	7.21	NA	9.22	NA	7.47	NA	7.02	NA	6.87	NA	6.9	NA	7.05	NA	7.19	NA	7.18
Temperature	NA	10.9	NA	12.9	NA	13.3	NA	12.75	NA	12.9	NA	13	NA	12.5	NA	13.7	NA	14.2	NA	13.8
Conductivity	NA	1.003	NA	0.92	NA	0.77	NA	1.061	NA	0.329	NA	0.85	NA	1.314	NA	1.09	NA	1.496	NA	0.967
Dissolved Oxygen	NA	0.27	NA	0.33	NA	0.3	NA	0.51	NA	0.25	NA	0.32	NA	0.28	NA	2.21	NA	0.59	NA	0.56
ORP	NA	-112.3	NA	84.7	NA	-8.1	NA	-52.9	NA	40.6	NA	20.1	NA	88.5	NA	19.6	NA	86.3	NA	134.2

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature	°C	degrees Celsius
Conductivity	ms/cm^c	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

MW-04	Date	2/22/2017		5/16/2017		9/14/2017		11/28/2017		2/8/2018		5/30/2018		8/20/2018		11/6/2018		2/11/2019		5/14/2019		8/14/2019		11/19/2019		3/2/2020		4/21/2020		8/17/2020		11/18/2020		3/1/2020		5/5/2021	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030	0.0030	0.0030	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.010	0.0010	0.018	0.0010	0.0058	0.0010	0.0027	0.0010	0.0048	0.0010	0.049	0.0010	0.0050	0.0010	0.0023	0.001	0.003	0.001	0.011	0.001	0.0028	0.001	0.0034	0.001	0.004	0.001	0.0045	0.001	0.0051	0.001	0.004	0.001	0.0054	0.001	0.016	0.001	0.0089
Barium	2.0	0.0025	0.092	0.0025	0.075	0.0025	0.084	0.0025	0.059	0.0025	0.085	0.0025	0.052	0.0025	0.071	0.0025	0.071	0.0025	0.061	0.0025	0.039	0.0025	0.046	0.0025	0.048	0.0025	0.044	0.0025	0.043	0.0025	0.039	0.0025	0.042	0.0025	0.036	0.0025	0.032
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	0.0010	0.0010	0.0010	0.001	ND ^	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	2.0	0.25	2.4	0.25	2.6	0.50	4.0	0.50	2.9	0.25	2.3	0.50	3.0	0.25	2.8	0.25	2.4	0.25	2.9	0.05	2.6	0.25	2.8	0.5	3.1	0.5	3.2	0.05	2.7	0.5	3.7	0.5	3.2	0.5	3.3	0.5	3.2
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	200.0	2.0	41	2.0	34	2.0	46	2.0	35	2.0	34	2.0	21	2.0	20	2	56	2	62	2	60	2	56	2	43	2	38	2	34	2	21	2	19	2	17	2	17
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0012	0.0010	0.0058	0.0010	0.0010	0.0010	0.0010	0.001	ND	0.001	0.0013	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	0.0013	0.001	0.0011
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	0.0037	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	0.0025	0.002	ND	0.002	ND	0.002	ND	0.002	0.0043	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.010	0.010	0.010	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.005	ND	0.005	ND	0.005	0.0055	0.005	ND
Fluoride	4.0	0.10	0.14	0.10	0.26	0.10	0.27	0.10	0.25	0.10	0.18	0.10	0.38	0.10	0.25	0.10	0.4	0.1	0.48	0.1	0.62	0.1	0.82	0.1	0.79	0.1	0.88	0.1	0.91	0.1	1.1	0.1	0.99	0.1	0.89	0.1	0.92
Iron	5.0	0.10	0.56	0.10	0.13	0.10	0.32	0.10	0.18	0.10	2.8	0.10	0.22	0.10	0.10	0.10	ND	0.1	0.49	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	0.42	0.1	0.2
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.15	0.0025	0.14	0.0025	0.032	0.0025	0.037	0.0025	0.26	0.0025	0.58	0.0025	0.049	0.0025	0.065	0.0025	0.086	0.0025	0.41	0.0025	0.049	0.0025	0.091	0.0025	0.1	0.0025	0.11	0.0025	0.13	0.0025	0.1	0.0025	0.16	0.0025	0.2	0.0025	0.18
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.00024	0.00020	ND	0.00020	0.00020	0.00020	0.00020	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND F1	0.0002	ND	0.0002	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	10.0	0.10	ND	0.10	0.58	0.10	0.69	0.10	ND	0.10	ND	0.10	0.28	0.10	0.80	0.10	0.37	0.1	0.25	0.1	0.29	0.1	0.34	0.1	0.22	0.1	0.49	0.1	0.14	0.1	0.3	0.1	0.15	0.1	0.14	0.1	0.23
Nitrogen, Nitrate Nitrite	NA	0.10	ND	0.10	0.58	0.10	0.69	0.10	ND	0.10	ND	0.10	0.28	0.10	0.80	0.10	0.37	0.1	0.25	0.1	0.29	0.1	0.34	0.1	0.22	0.1	0.49	0.1	0.14	0.1	0.3	0.1	0.15	0.1	0.14	0.1	0.23
Nitrogen, Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND ^	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	20	0.125	0.376	0.0831	0.198	0.0881	0.214	0.0985	0.155	0.0826	0.253	0.125	0.129	0.0977	0.354	0.182	ND	0.212	ND	0.0979	ND	0.176	ND	0.118	ND	0.114	ND	0.136	0.217	0.0815	0.114	0.469	ND	0.122	0.19	0.147	ND
Radium 228	20	0.395	0.624 *	0.336	0.521	0.410	0.568	0.352	0.694	0.385	0.497	0.445	ND	0.381	ND	0.337	ND	0.375	0.715	0.352	0.425	0.534	ND	0.452	ND	0.409	ND	0.572	ND	0.32	ND	0.631	0.631	0.51	ND	0.401	ND
Selenium	0.05	0.0025	0.0043	0.0025	0.021	0.0025	0.026	0.0025	0.0028	0.0025	ND	0.0025	0.0091	0.0025	0.020	0.0025	0.011	0.0025	0.0063	0.0025	0.0043	0.0025	0.008	0.0025	0.004	0.0025	0.0045	0.0025	0.0034	0.0025	0.0061	0.0025	0.0027	0.0025	ND	0.0025	0.0042
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	400.0	100	350	100	350	100	500	25	120	50	180	50	230	50	200	100	420	50	290	20	200	20	260	500	ND	500	ND	500	ND	100	290	50	250	25	230	25	190
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND ^	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	1,200	10	850	10	950	10	1200	10	570	10	660	10	730	10	680	10	820	10	790	10	750	10	710	10	730	10	740	10	700	30	710	30	680	10	590	10	510
Vanadium	0.049	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0051	0.0050	0.0050	0.0050	0.0050	0.005	ND	0.005	0.0066	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	0.0055	0.005	ND	0.005	ND	0.005	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
pH	6.5 - 9.0	NA	7.44	NA	7.94	NA	7.04	NA	7.04	NA	7.48	NA	6.57	NA	7.25	NA	6.83	NA	8.05	NA	7.30	NA	7.37	NA	7.27	NA	7.09	NA	7.18	NA	7.06	NA	7.17	NA	7.66	NA	7.46
Temperature	NA	NA	11.9	NA	13.4	NA	14.4	NA	13.3	NA	10.9	NA	13.2	NA	18.7	NA	10.60	NA	11.40	NA	11.90	NA	13.00	NA	12.83	NA	12.00	NA	11.90	NA	13.20	NA	13.70	NA	11.50	NA	10.70
Conductivity	NA	NA	0.92	NA	0.89	NA	1.17	NA	0.83	NA	0.71	NA	0.72	NA	0.77	NA	0.823	NA	1.122	NA	1.010	NA	1.110	NA	1.039	NA	0.339	NA	0.297	NA	1.131	NA	1.120	NA	1.100	NA	0.792
Dissolved Oxygen	NA	NA	2.82	NA	3.89	NA	1.05	NA	1.25	NA	0.34	NA	5.18	NA	6.38	NA	8.74	NA	0.39	NA	0.55	NA	0.35	NA	0.54	NA	0.22	NA	0.30	NA	2.02	NA	2.34	NA	0.54	NA	0.20
ORP	NA	NA	99.9	NA	-15.8	NA	95.2	NA	-55.3	NA	2.1	NA	9.7	NA	92.0	NA	69.1	NA	23.5	NA	85.1	NA	16.6	NA	-63.2	NA	-14.7	NA	-28.5	NA	54.3	NA	-15.8	NA	-45.6	NA	81.8

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature	°C	degrees Celsius
Conductivity	ms/cm^c	millisiemens/centimeters
Dissolved Oxygen	mg/L	milligrams/liter
Oxygen Reduction Potential (ORP)	mV	millivolts

Attachment 9-3. Permit Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

MW-05	Date	2/22/2017		5/15/2017		9/11/2017		11/30/2017		2/7/2018		5/31/2018		8/21/2018		11/7/2018	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030	0.0030	0.0030	0.003	ND
Arsenic	0.010	0.0010	0.040	0.0010	0.0053	0.0010	0.076	0.0010	0.034	0.0010	0.017	0.0010	0.0086	0.0010	0.015	0.001	0.019
Barium	2.0	0.0025	0.061	0.0025	0.036	0.0025	0.046	0.0025	0.066	0.0025	0.067	0.0025	0.042	0.0025	0.028	0.0025	0.027
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.0010	0.0010	0.001	ND ^
Boron	2.0	5.0	42	0.50	7.7	5.0	44	5.0	47	5.0	41	1.0	10	5.0	41	5	43
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND
Chloride	200.0	10	82	2.0	73	2.0	71 F1	10	81	2.0	73	2.0	37	2.0	57	2	51 ^
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0011	0.0010	0.0014	0.001	0.001
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0021	0.0020	0.0020	0.002	ND
Cyanide, Total	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.010	0.010	0.010	0.01	ND
Fluoride	4.0	0.10	0.21	0.10	0.15	0.10	0.25	0.10	0.27	0.10	0.26	0.10	0.22	0.10	0.23	0.10	0.27
Iron	5.0	0.10	15	0.10	1.9	0.10	35	0.10	19	0.10	14	0.10	2.1	0.10	11	0.10	9.1
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND
Manganese	0.15	0.0025	0.54	0.0025	0.12	0.0025	0.62	0.0025	0.63	0.0025	0.58	0.0025	0.20	0.0025	0.51	0.0025	0.43
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.00020	0.00020	0.00020	0.0002	ND
Nickel	0.1	0.0020	ND	0.0020	0.0038	0.0020	0.0033	0.0020	ND	0.0020	ND	0.0020	0.0053	0.0020	0.0039	0.002	0.0043
Nitrogen, Nitrate	10.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10	0.10	0.10	0.10	ND
Nitrogen, Nitrate Nitrite	NA	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10	0.10	0.10	0.10	ND
Nitrogen, Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND
Radium 226	20	0.110	0.331	0.110	ND	0.0778	0.170	0.0771	0.284	0.0699	0.359	0.109	0.141	0.115	0.545	0.194	ND
Radium 228	20	0.443	0.805	0.531	0.703	0.474	ND	0.332	1.29	0.338	1.33	0.386	0.986	0.544	ND	0.411	ND
Selenium	0.05	0.0025	ND	0.0025	0.0041	0.0025	0.0071	0.0025	ND	0.0025	ND	0.0025	0.0032	0.0025	0.0025	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND
Sulfate	400.0	250	700	500	1100	250	750	100	790	250	700	250	960	250	680	250	580
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND
Total Dissolved Solids	1,200	10	1700	10	2600	10	2000	10	1900	10	1900	10	2500	10	2100	10	1900
Vanadium	0.049	0.0050	ND	0.0050	ND	0.0050	0.020	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND
pH	6.5 - 9.0	NA	7.46	NA	7.78	NA	6.89	NA	7.02	NA	7.08	NA	6.95	NA	7.13	NA	6.93
Temperature	NA	NA	14.8	NA	13.9	NA	14.6	NA	11.2	NA	11.0	NA	19.0	NA	16.9	NA	9.24
Conductivity	NA	NA	1.63	NA	2.20	NA	1.79	NA	1.48	NA	1.55	NA	2.12	NA	1.55	NA	1.485
Dissolved Oxygen	NA	NA	1.46	NA	5.90	NA	0.58	NA	1.44	NA	0.23	NA	4.29	NA	1.87	NA	4.11
ORP	NA	NA	-29.1	NA	-20.7	NA	-68.1	NA	58.5	NA	52.2	NA	-10.9	NA	-15.4	NA	-15.8

MW-05	2/12/2019		5/14/2018		8/13/2019		11/20/2019		3/3/2020		4/22/2020		8/17/2020		11/19/2020		3/1/2021		5/7/2021	
Parameter	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.001	0.018	0.001	0.014	0.001	0.14	0.001	0.0071	0.001	0.007	0.001	0.0028	0.001	0.017	0.001	0.034	0.001	0.04	0.001	0.021
Barium	0.0025	0.027	0.0025	0.026	0.0025	0.061	0.0025	0.033	0.0025	0.031	0.0025	0.031	0.0025	0.04	0.0025	0.06	0.0025	0.054	0.0025	0.049
Beryllium	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND ^	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	5	47	1	11	0.5	4.9	1	5.4	1	17 B	1	5.4	5	31	5	29	5	33	5	33
Cadmium	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	2	60	2	37	2	28	2	20	2	18	2	12	2	21	2	32	2	31	2	20
Chromium	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.002	ND	0.002	ND	0.002	0.0036	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.005	ND	0.005	ND	0.005	0.0065	0.005	ND
Fluoride	0.1	0.35	0.1	0.19	0.1	0.13	0.1	0.18	0.1	0.19	0.1	0.18	0.1	0.25	0.1	0.28	0.1	0.29	0.1	0.28
Iron	0.1	9.8	0.1	3.4	0.1	64	0.1	2.3	0.1	4.7	0.1	0.87	0.1	17	0.1	19	0.1	14	0.1	12
Lead	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.0025	0.44	0.0025	0.13	0.0025	0.06	0.0025	0.086	0.0025	0.25	0.0025	0.083	0.0025	0.65	0.0025	0.64	0.0025	0.54	0.0025	0.65
Mercury	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.002	0.003	0.002	0.0069	0.002	0.0046	0.002	0.007	0.002	0.0041	0.002	0.003	0.002	0.0023	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrate Nitrite	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrite	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	0.273	ND	0.102	ND	0.219	ND	0.131	ND	0.153	ND	0.108	ND	0.109	0.137	0.362	0.431	0.102	0.337	0.235	ND
Radium 228	0.385	ND	0.339	ND	0.554	ND	0.441	ND	0.447	ND	0.536	ND	0.414	ND	0.459	0.739	0.63	1.31	0.602	1.32
Selenium	0.0025	ND	0.0025	0.0027	0.0025	ND	0.0025	0.004	0.0025	0.0049	0.0025	0.0046	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND ^	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	250	890	40	1000	40	790	500	830	1300	ND	1000	ND	100	930	100	930	100	880	100	850
Thallium	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	10	1800	10	2600	10	2100	10	2100	10	2100	10	1900	150	2000	150	2100	10	1800	10	1700
Vanadium	0.005	ND	0.005	ND	0.005	0.06	0.005	ND	0.005	ND	0.005	ND	0.005	0.0072	0.005	0.0051	0.005	ND	0.005	ND
Zinc	0.02	ND	0.02	ND	0.02	ND	0.02	0.02	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
pH	NA	7.00	NA	6.72	NA	6.75	NA	7.44	NA	6.75	NA	6.63	NA	6.58	NA	6.94	NA	7.02	NA	7.00
Temperature	NA	12.20	NA	12.30	NA	20.40	NA	12.50	NA	11.70	NA	11.90	NA	12.80	NA	12.70	NA	11.70	NA	12.00
Conductivity	NA	1.873	NA	2.520	NA	2.660	NA	2.388	NA	0.431	NA	0.370	NA	2.401	NA	2.446	NA	2.744	NA	1.996
Dissolved Oxygen	NA	0.21	NA	0.29	NA	1.50	NA	1.46	NA	0.25	NA	0.30	NA	6.00	NA	1.90	NA	0.32	NA	0.13
ORP	NA	-93.5	NA	-41.5	NA	146.9	NA	-17.1	NA	-74.1	NA	-11.3	NA	151.0	NA	-110.5	NA	-97.2	NA	-100.6

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature °C degrees Celsius
Conductivity ms/cm[c] millisiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

Attachment 9-3. Permit Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

MW-06	Date	2/22/2017		5/15/2017		9/11/2017		11/28/2017		2/8/2018		5/30/2018		8/21/2018		11/7/2018		2/12/2019		5/16/2019		8/13/2019		11/20/2019		3/3/2020		4/22/2020		8/18/2020		11/19/2020		3/2/2021		5/7/2021	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030	0.0030	0.0039	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.010	0.0010	0.0087	0.0010	0.0055	0.0010	0.0047	0.0010	0.0069	0.0010	0.0026	0.0010	0.0036	0.0010	0.0027	0.001	0.0043	0.001	0.014	0.001	0.0055	0.001	0.0037	0.001	0.0037	0.001	0.0023	0.001	0.0015	0.001	0.0028	0.001	0.0026	0.001	0.0028	0.001	0.0018
Barium	2.0	0.0025	0.073	0.0025	0.086	0.0025	0.11	0.0025	0.070	0.0025	0.075	0.0025	0.087	0.0025	0.092	0.0025	0.17	0.0025	0.25	0.0025	0.094	0.0025	0.2	0.0025	0.2	0.0025	0.16	0.0025	0.12	0.0025	0.12	0.0025	0.11	0.0025	0.082	0.0025	0.07
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND ^	0.0010	0.0010	0.0010	0.0010	0.001	ND ^	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND ^	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	2.0	1.0	8.9	0.25	1.8	0.25	3.2	1.0	6.6	0.25	2.0	0.050	0.98	0.50	0.50	0.25	1.5	0.25	1.3	5	26	0.5	3.8	1	4.6	1	2.0	0.25	2.0	0.25	1.2	0.5	2.1	2.5	4.0	0.25	1.6
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	200.0	2.0	44	10	100	10	120	10	85	10	86	2.0	89	2.0	62	10	130 ^	10	160	2	38	10	180	10	190	10	200	10	140	10	100	2	64	2	49	10	56
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.0010	0.0010	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.65	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0027	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND	0.002	0.0059	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.010	0.010	0.010	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Fluoride	4.0	0.10	0.21	0.10	0.34	0.10	0.30	0.10	0.31	0.10	0.29	0.10	0.34	0.10	0.26	0.10	0.4	0.1	0.3	0.1	0.23	0.1	0.25	0.1	0.31	0.1	0.31	0.1	0.36	0.1	0.4	0.1	0.37	0.1	0.33	0.1	0.34
Iron	5.0	0.10	12	0.10	7.7	0.10	9.2	0.10	5.6	0.10	5.3	0.10	4.3	0.10	3.1	0.10	7.6	0.1	16	0.1	6.8	0.1	9.9	0.1	12	0.1	9.5	0.1	3.8	0.1	6	0.1	8.3	0.1	4.9	0.1	3.4
Lead	0.0075	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.15	0.0025	0.47	0.0025	0.20	0.0025	0.36	0.0025	0.25	0.0025	0.25	0.0025	0.14	0.0025	0.10	0.0025	0.21	0.0025	0.28	0.0025	0.24	0.0025	0.34	0.0025	0.29	0.0025	0.26	0.0025	0.17	0.0025	0.14	0.0025	0.36	0.0025	0.19	0.0025	0.2
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.00020	0.00020	0.00020	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	10.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10	0.10	0.19	0.10	0.10	0.10	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	0.11	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrate Nitrite	NA	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10 F1 F2	0.10	0.19	0.10	0.10	0.10	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	0.11	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	20	0.146	0.255	0.116	0.227	0.0850	0.385	0.0656	0.283	0.0749	0.416	0.105	ND	0.0917	0.0495	0.209	0.294	0.222	0.85	0.0948	0.438	0.221	0.518	0.104	0.54	0.109	0.545	0.116	0.272	0.145	0.374	ND	0.478	0.1	0.312	0.132	0.217
Radium 228	20	0.475	ND	0.413	0.651	0.381	0.566	0.435	ND	0.383	ND	0.415	0.436	0.342	ND	0.397	ND	0.395	1.27	0.408	1.18	0.660	1.16	0.419	0.734	0.443	1.37	0.698	1.1	0.534	1.48	ND	0.606	0.47	ND *	0.46	0.552
Selenium	0.05	0.0025	0.0037	0.0025	ND	0.0025	ND	0.0025	0.0037	0.0025	ND	0.0025	0.0025	0.0025	0.029	0.0025	ND	0.0025	0.0031	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.03	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	400.0	100	290	50	130	50	190	25	100	20	150	20	89	50	170	50	110	100	290	40	390	40	310	500	ND	500	ND	130	ND	25	58	50	350	25	190	25	99
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	1,200	10	930	10	730	10	940	10	810	10	690	10	620	10	860	10	840	10	1200	10	1300	10	1300	10	1400	10	1300	10	880	30	590	60	1300	10	660	10	530
Vanadium	0.049	0.0050	0.0077	0.0050	0.0054	0.0050	ND	0.0050	0.0093	0.0050	ND	0.0050	0.0050	0.0050	0.0073	0.005	ND	0.005	0.012	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Zinc	5.0	0.020	ND	0.020	ND	0.020	0.021	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
pH	6.5 - 9.0	NA	7.35	NA	8.26	NA	7.08	NA	7.06	NA	7.52	NA	6.80	NA	7.24	NA	7.00	NA	7.17	NA	7.22	NA	7.72	NA	7.98	NA	7.09	NA	7.11	NA	6.98	NA	6.86	NA	7.16	NA	7.21
Temperature	NA	NA	11.4	NA	15.2	NA	13.8	NA	11.9	NA	7.5	NA	16.2	NA	19.4	NA	8.03	NA	9.20	NA	11.00	NA	12.50	NA	11.84	NA	8.40	NA	7.90	NA	13.00	NA	12.30	NA	7.30	NA	8.40
Conductivity	NA	NA	1.00	NA	0.87	NA	1.13	NA	0.92	NA	0.74	NA	0.85	NA	0.80	NA	1.060	NA	1.765	NA	1.310	NA	1.910	NA	2.163	NA	0.464	NA	0.327	NA	1.243	NA	1.866	NA	1.269	NA	1.010
Dissolved Oxygen	NA	NA	1.66	NA	8.11	NA	0.33	NA	4.29	NA	0.94	NA	7.10	NA	2.70	NA	3.12	NA	0.19	NA	0.17	NA	0.29	NA	0.49	NA	0.21	NA	0.21	NA	0.12	NA	2.07	NA	0.44	NA	2.07
ORP	NA	NA	7.9	NA	-116.2	NA	-113.6	NA	-45.8	NA	-81.3	NA	0.9	NA	24.6	NA	-55.8	NA	-89.9	NA	-168.6	NA	-130.6	NA	-115.0	NA	-137.3	NA	-118.5	NA	-117.2	NA	-89.6	NA	-53.9	NA	-66.4

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature °C degrees Celsius
Conductivity ms/cm^c millisiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

Attachment 9-3. Permit Groundwater Analytical Results - Midwest Generation LLC, Waukegan Station, Waukegan, IL

MW-07	Date	2/22/2017		5/16/2017		9/11/2017		11/28/2017		2/6/2018		5/30/2018		8/21/2018		11/7/2018		2/12/2019	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	ND	0.0030	0.0030	0.0030	0.0030	0.003	ND	0.003	ND
Arsenic	0.010	0.0010	0.010	0.0010	0.0095	0.0010	0.011	0.0010	0.0084	0.0010	0.0088	0.0010	0.0075	0.0010	0.0075	0.001	0.0088	0.001	0.012
Barium	2.0	0.0025	0.096	0.0025	0.087	0.0025	0.085	0.0025	0.076	0.0025	0.077	0.0025	0.085	0.0025	0.076	0.0025	0.085	0.0025	0.11
Beryllium	0.004	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.0010	0.0010	0.001	ND ^	0.001	ND
Boron	2.0	5.0	49	1.0	50	5.0	50	5.0	38	5.0	35	5.0	41	5.0	44	5	50	5	35
Cadmium	0.005	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND
Chloride	200.0	2.0	65	2.0	49	2.0	46	2.0	56	2.0	53	2.0	41	2.0	52	2	55 ^	2	56
Chromium	0.1	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND	0.005	0.008
Cobalt	1.0	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	ND	0.0010	0.0010	0.0010	0.0010	0.001	ND	0.001	0.0024
Copper	0.65	0.0020	0.0021	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	0.01
Cyanide, Total	0.2	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	ND	0.010	0.010	0.010	0.010	0.01	ND	0.01	ND
Fluoride	4.0	0.10	0.25	0.10	0.31	0.10	0.32	0.10	0.36	0.10	0.33	0.10	0.29	0.10	0.29	0.10	0.31	0.1	0.25
Iron	5.0	0.10	18	0.10	19	0.10	16	0.10	13	0.10	14	0.10	16	0.10	16	0.10	19	0.1	22
Lead	0.0075	0.00050	0.0010	0.00050	0.00072	0.00050	ND	0.00050	ND	0.00050	0.00052	0.00050	0.00050	0.00050	0.00050	0.0005	0.00053	0.0005	0.0062
Manganese	0.15	0.0025	0.62	0.0025	0.69	0.0025	0.61	0.0025	0.48	0.0025	0.44	0.0025	0.62	0.0025	0.54	0.0025	0.63	0.0025	0.58
Mercury	0.002	0.00020	ND	0.00020	ND	0.00020	ND	0.00020	0.0017	0.00020	ND	0.00020	0.00020	0.00020	0.00020	0.0002	ND	0.0002	ND
Nickel	0.1	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	0.0068
Nitrogen, Nitrate	10.0	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10	0.10	0.10	0.10	ND	0.1	ND
Nitrogen, Nitrate Nitrite	NA	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	ND	0.10	0.10	0.10	0.10	0.10	ND	0.1	ND
Nitrogen, Nitrite	NA	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND	0.02	ND
Radium 226	20	0.127	0.738	0.112	0.548	0.0720	0.544	0.0687	0.468	0.0741	0.556	0.118	0.539	0.0881	0.732	0.193	0.919	0.288	0.779
Radium 228	20	0.454	1.38	0.360	0.875	0.351	1.53	0.325	1.94	0.362	1.44	0.428	1.32	0.335	1.18	0.377	1.39	0.393	1.65
Selenium	0.05	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	0.0025	0.0025	0.0025	0.0025	ND	0.0025	ND
Silver	0.05	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	ND	0.00050	0.00050	0.00050	0.00050	0.0005	ND	0.0005	ND
Sulfate	400.0	250	880	250	690	250	660	100	580	250	620	250	620	250	630	250	560	250	1000
Thallium	0.002	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	ND	0.0020	0.0020	0.0020	0.0020	0.002	ND	0.002	ND
Total Dissolved Solids	1,200	10	1900	10	1800	10	1800	10	1700	10	1700	10	1800	10	1900	10	1900	10	1700
Vanadium	0.049	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	ND	0.0050	0.0050	0.0050	0.0050	0.005	ND	0.005	0.01
Zinc	5.0	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	ND	0.020	0.020	0.020	0.020	0.02	ND	0.02	0.033
pH	6.5 - 9.0	NA	7.48	NA	7.97	NA	7.15	NA	7.31	NA	7.35	NA	6.65	NA	7.29	NA	6.50	NA	7.03
Temperature	NA	NA	12.6	NA	15.1	NA	13.1	NA	12.9	NA	10.6	NA	15.2	NA	18.0	NA	9.07	NA	10.20
Conductivity	NA	NA	1.57	NA	1.52	NA	1.54	NA	1.43	NA	1.41	NA	1.52	NA	1.49	NA	1.486	NA	1.999
Dissolved Oxygen	NA	NA	1.71	NA	2.83	NA	0.46	NA	2.89	NA	6.68	NA	4.23	NA	3.22	NA	2.24	NA	0.24
ORP	NA	NA	-26.8	NA	-93.2	NA	-126.2	NA	-57.6	NA	204.7	NA	-70.3	NA	-60.3	NA	-46.2	NA	-108.3

MW-07	Date	5/16/2019		8/13/2019		11/20/2019		3/3/2020		4/22/2020		8/18/2020		11/19/2020		3/1/2021		5/7/2021	
Parameter	Standards	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result	DL	Result
Antimony	0.006	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND	0.003	ND
Arsenic	0.010	0.001	0.015	0.001	0.021	0.001	0.0097	0.001	0.0093	0.001	0.0082	0.001	0.0085	0.001	0.008	0.001	0.0087	0.001	0.0086
Barium	2.0	0.0025	0.092	0.0025	0.08	0.0025	0.062	0.0025	0.058	0.0025	0.058	0.0025	0.061	0.0025	0.066	0.0025	0.082	0.0025	0.075
Beryllium	0.004	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND ^	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Boron	2.0	5	23	5	36	5	21	5	23	5	20	5	21	5	27	5	39	5	48
Cadmium	0.005	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Chloride	200.0	10	83	10	79	2	42	2	70	2	52	2	26	2	49	2	20	4	17
Chromium	0.1	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Cobalt	1.0	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND	0.001	ND
Copper	0.65	0.002	0.0046	0.002	0.0032	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Cyanide, Total	0.2	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.01	ND	0.005	ND	0.005	ND	0.005	0.0056	0.005	ND
Fluoride	4.0	0.1	0.25	0.1	0.27	0.1	0.27	0.1	0.29	0.1	0.3	0.1	0.27	0.1	0.33	0.1	0.29	0.1	0.28
Iron	5.0	0.1	21	0.1	23	0.1	20	0.1	15	0.1	19	0.1	22	0.1	19	0.1	27	0.1	27
Lead	0.0075	0.0005	0.00064	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Manganese	0.15	0.0025	0.61	0.0025	0.55	0.0025	0.54	0.0025	0.38	0.0025	0.56	0.0025	0.6	0.0025	0.5	0.0025	0.73	0.0025	0.67
Mercury	0.002	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND	0.0002	ND
Nickel	0.1	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Nitrogen, Nitrate	10.0	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrate Nitrite	NA	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
Nitrogen, Nitrite	NA	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND
Radium 226	20	0.0926	0.494	0.181	0.550	0.134	0.355	0.141	0.441	0.103	0.378	0.116	0.641	0.557	ND	0.11	0.584	0.19	0.429
Radium 228	20	0.44	1.21	0.606	1.34	0.514	0.735	0.451	1.24	0.463	1.13	0.491	1.02	0.679	ND	0.515	1.5	0.571	1.89
Selenium	0.05	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND	0.0025	ND
Silver	0.05	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND	0.0005	ND
Sulfate	400.0	40	530	40	680	1000	ND	500	530	500	ND	100	510	100	710	100	960	250	1000
Thallium	0.002	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND	0.002	ND
Total Dissolved Solids	1,200	10	1700	10	1700	10	1300	10	1500	10	1300	150	1100	150	1800	10	1900	10	2000
Vanadium	0.049	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND	0.005	ND
Zinc	5.0	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.02	0.032	0.02	ND
pH	6.5 - 9.0	NA	7.02	NA	7.09	NA	7.84	NA	7.11	NA	6.96	NA	6.80	NA	7.01	NA	6.96	NA	6.98
Temperature	NA	NA	11.50	NA	12.20	NA	12.74	NA	11.90	NA	11.40	NA	12.00	NA	13.60	NA	11.50	NA	11.60
Conductivity	NA	NA	1.870	NA	2.230	NA	1.845	NA	0.421	NA	0.351	NA	1.982	NA	2.156	NA	2.868	NA	2.239
Dissolved Oxygen	NA	NA	0.21	NA	0.31	NA	0.49	NA	0.02	NA	0.22	NA	0.17	NA	2.10	NA	0.30	NA	0.15
ORP	NA	NA	-158.8	NA	-145.0	NA	-116.1	NA	-155.3	NA	-156.6	NA	-118.6	NA	-129.8	NA	-104.1	NA	-110.0

Notes: Standards obtained from IAC, Title 35, Chapter I, Part 620, Subpart D, Section 620.410 - Groundwater Quality Standards for Class I: Potable Resource Groundwater
All values are in mg/L (ppm) unless otherwise noted.

B- Compound also detected in blank
DL - Detection limit
NA - Not Applicable
ND - Not Detected

* - LCS or LCSD is outside acceptable limits.
^ - Instrument related QC outside limits.
F1 - MS and/or MSD Recovery outside of limits.

Temperature °C degrees Celsius
Conductivity ms/cm^c milliesiemens/centimeters
Dissolved Oxygen mg/L milligrams/liter
Oxygen Reduction Potential (ORP) mV millivolts

Attachment 9-4 – IL PE Stamp

CERTIFICATION
35 Ill. Adm. Code 845.630

In accordance with Section 35 Ill. Adm. Code 845.630(g), I hereby certify based on review of the information contained within the Initial Operating Permit Application for Waukegan Station dated October 29, 2021, the groundwater monitoring system has been designed and constructed to satisfy the requirements of 35 Ill. Adm. Code 845.630. For this site the minimum number of wells required is deemed sufficient based on the following: 1) The number of wells, placement and screened intervals are based on a hydrogeologic assessment performed for the site; 2) hydrogeologic considerations included aquifer characteristics affecting flow velocity and physical transport processes; 3) available historical groundwater flow data indicate consistent flow conditions over time; and 4) Illinois Environmental Protection Agency (IEPA) approved the overall hydrogeologic assessment as part of a larger study.

Certified by: [illegible]

Date: 10/29/21

JOSHUA D. DAVENPORT
062-061945
LICENSED
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Joshua Davenport, P.E.
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Attachment 9-5 – CCR Compliance Statistical Approach

KPRG

ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

ILLINOIS STATE CCR RULE COMPLIANCE STATISTICAL APPROACH FOR GROUNDWATER DATA EVALUATION

Midwest Generation, LLC
Waukegan Generating Station
401 E. Greenwood Ave.
Waukegan, Illinois

PREPARED BY: KPRG and Associates, Inc.
14665 West Lisbon Road, Suite 1A
Brookfield, WI 53005

August 23, 2021

TABLE OF CONTENTS

SECTION/DESCRIPTION **PAGE**

1.0 INTRODUCTION

On April 21, 2021, the Illinois Pollution Control Board (IPCB) and Illinois Environmental Protection Agency (Illinois EPA) enacted a final rule regulating coal combustion residuals (CCR) as part of Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (State CCR Rule). The State CCR Rule specifically requires that the owner or operator of a CCR unit must develop an Operating Permit that will specify a sampling and analysis program that includes procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain of custody (COC) control, and quality assurance and quality control. As a result, each regulated facility must develop a program that meets the State CCR Rule. At the Waukegan facility, the East and West Ash Ponds require monitoring under the State CCR Rule. The monitoring well network around this pond consists of eight monitoring wells. Wells MW-9, MW-11 and MW-14 are upgradient monitoring locations and wells MW-01 through MW-04 and MW-16 are downgradient monitoring locations (see Figure 1).

Section 845.640(f) of the State CCR Rule requires the development of the statistical approach that will be used for assessing the data and determining whether a statistically significant increase over background concentrations in groundwater has occurred at identified downgradient monitoring points. Potential statistical methods that can be applied to the data are listed in Section 845.640(f) and performance standards are provided in 845.640(g).

This narrative of the statistical approach that will be used for the Waukegan facility's groundwater monitoring data is intended to fulfill certification requirements under Section 845.640(f)(2). The professional engineer's certification of this statistical approach is provided in Section 4.0 of this document.

2.0 STATISTICAL METHOD SELECTION and BACKGROUND DATA EVALUATION

Section 845.640(f)(1) identifies five statistical data evaluation methods that can be used for assessing site groundwater data. Relative to the subject site, the prediction interval procedure identified in 845.640(f)(1)(C) will be used. This approach is robust and conforms to varying data distributions and facilitates various non-detect frequencies. U.S. EPA identifies this method as preferred over establishment of tolerance intervals (Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009 [Unified Guidance]).

Total recoverable metals groundwater data has been collected for this site since 2015 as part of Federal CCR Rule requirements. Under the Federal CCR Rule, the initial eight rounds of quarterly data generated were used to develop a representative background concentration with which to develop applicable prediction limits for subsequent statistical downgradient monitoring well data comparisons. Since additional data has been generated since the initial eight rounds of groundwater monitoring under the Federal CCR Rule, the full, currently available data set through the second quarter 2021 will be evaluated for potential use in developing a representative background dataset. If appending this additional data to the original eight rounds of background sampling is determined to be not statistically appropriate, then the background calculations will be reverted to using the initial eight rounds of background data for subsequent calculations. The established, representative background concentration for the upgradient well locations will be used to develop prediction limits for the regulated unit for each constituent listed in Section 845.600(a) and (b) as provided in Table 1.

Statistical evaluations will be performed with the assistance of the Sanitas™ software package.

2.1 Outlier Testing

The background dataset will be first checked for potential outliers for each constituent. Potential causes of outliers can be, but are not limited to:

- Changes in sampling technique;
- Changes in analytical methods;
- Data transcription errors;
- Unnatural localized event such as a spill; or
- Natural but extreme variations in constituent concentration.

The Unified Guidance does not recommend removing an outlier from the data set unless it can be shown that the outlier is not caused by extreme natural variation. If the outlier can be traced to other than natural causes, the data set will be adjusted appropriately.

2.2 Spatial Variability

If more than one background well is being used for the monitored unit, an evaluation of spatial variability will be performed to determine whether the mean concentration of a constituent varies statistically between the background points. This is generally accomplished by performing an Analysis of Variance (ANOVA). If statistically significant spatial variation is determined to be present, the background points will not be combined between the wells. If the spatial variability is determined to be natural, an intrawell data evaluation approach may be considered for both upgradient and downgradient wells.

2.3 Temporal Variability

Temporal variability in groundwater data from a specific monitoring point occurs when a consistent fluctuation of constituent concentrations occurs over time. The most common example is seasonal variation. If such a variation is noted in the data, the dataset should be corrected to account for the trend; however, any such corrections must be applied judiciously and would be completed in accordance with the Unified Guidance recommended procedures.

2.4 Trend Testing

As discussed above, it is intended to expand the initial background dataset collected under the Federal CCR Rule which consisted of eight rounds of quarterly sampling, with any additional data collected for a specific well since that time to facilitate a larger background data set upon which to develop subsequent interwell, and if necessary intrawell, prediction limits. The expanded background dataset for each upgradient well, for each constituent listed in Table 1, will undergo trend analysis to determine if there may be a potential statistically significant trend in the data. Linear regression will be the primary trend analysis tool, however, other methods such Sen's Slope Estimator may also be used. If a statistically significant trend is identified in the larger combined background dataset, the new data cannot be added to the initial background dataset, and only the original eight rounds of data can be used for that well in background development and associated subsequent calculations.

2.5 Test of Normality

The main underlying assumption in parametric data evaluations, such as establishing prediction limits, is that the underlying data distribution is normal. A quick approximation can be made by calculating the Coefficient of Variance (CV) which is the quotient of the standard deviation divided by the sample mean. In general, if this quotient is greater than 1, the underlying data distribution is probably not normal. The new Unified Guidance is more conservative and suggests that if this quotient is greater than 0.5, the dataset may not be normal and a more robust distribution evaluation should be performed. Therefore, for any CV value greater than 0.5 for a specific dataset, normality will be evaluated using the Shapiro-Wilk Test with an alpha (α) value of 0.05 (or 95%).

If the dataset does not pass this initial test, the data will undergo a log transformation and the test will be repeated for the natural log values of the dataset. If it is determined that this dataset is log-normal, statistical evaluations will be completed on those values and the result converted back to the standard value. If the underlying distribution is also determined not to be log-normal, the Unified Guidance provides for a number of other data transformations that can be performed to evaluate whether those underlying distributions may be normal at which point the entire dataset would be transformed for subsequent calculations.

If a normal underlying distribution can not be determined, non-parametric statistical evaluations will need to be considered which do not rely on a specific underlying distribution.

2.6 Non-Detects

It is not uncommon in environmental datasets to have parameters being detected at low concentrations during one sampling event and being not detected in other sampling events. Having a consistent approach to the handling of non-detect values is an important part of the statistical evaluation process. The handling of non-detect values will be accomplished as follows:

- 100 Percent Non-Detects – Assumed that the constituent is not present and no statistical evaluations will be performed. The upper prediction limit will be set at the Reporting Limit (RL) established by the analytical laboratory.

- 50 Percent or Greater Non-Detects – A non-parametric evaluation will be performed where the confidence interval will be constructed using the highest detected concentration as the upper prediction limit.

- 15 to 50 Percent Non-Detects – Aitchison's Adjustment will be used with subsequent parametric or non-parametric evaluations, as appropriate, based on underlying distributions.

- 0 to 15 Percent Non-Detects - The non-detect values will be replaced with RL/2 and the dataset will be evaluated for distribution normality with subsequent parametric or non-parametric evaluations, as appropriate, based on underlying distributions.

2.7 Prediction Limit Calculation for Normally Distributed Data

For datasets where the distribution or underlying transformed distribution is normal, a parametric statistical approach will be used for establishing the prediction limit at the required 95% statistical confidence. In accordance with Unified Guidance, the following equation will be used:

$$95\%\ Prediction\ Limit\ = \bar{x} + t_{1-0.05/m,n-1} s \sqrt{1 + \frac{1}{n}}$$

Where:

$\bar{x}$ = the sample mean of the detected or adjusted results
S = sample standard deviation of the detected or adjusted results
$t_{1-0.05\,/m,n-1}$ = the students t-coefficient for degrees of freedom (n-1) and confidence level (1-0.05/m)
n = the number of samples
m = the number of future samples

The number of future sampling events (*m*) will be set at 2 which will account for one sampling event and a confirmation resampling. This will assist in limiting the potential number of false positives. An acceptable site-wide false positive (SWFP) rate of 10% or less is acceptable under the Unified Guidance.

2.8 Prediction Limit Calculation for Non-Normally Distributed Data

If the dataset distribution or underlying distribution is determined not to be normal, a non-parametric approach will need to be used for the establishment of the prediction limit. The non-parametric evaluation will use the highest detected concentration as the upper prediction limit for the specific constituent.

3.0 GROUNDWATER MONITORING

The State CCR Rule does not distinguish between detection monitoring or assessment monitoring as was defined under the Federal CCR Rule. To meet the requirements set forth in Section 845.650(b), a minimum of eight rounds of groundwater data need to be collected for establishing background. As noted above, if more than eight rounds of data are available, then the larger dataset will be evaluated to determine whether the background dataset can be expanded to provide a more robust statistical assessment. At that point, statistical evaluation of the background dataset will be performed to establish the upper prediction limits for each Section 845.600(a) and (b) constituent. It is noted that in the case of pH, a lower prediction limit will also be established since this parameter has an established upper and lower value range for compliance.

Site specific Groundwater Protection Standards (GWPSs) will be developed in accordance with Section 845.600(a)(2) as follows:

- If the constituent has an established State standard listed in Section 845.600(a)(1) and the standard is greater than the calculated background upper prediction limit, then the standard will serve as the GWPS. If the background upper prediction limit is greater than the standard, the upper prediction limit will serve as the GWPS.

- If the constituent does not have an established standard (i.e., calcium and turbidity) then the calculated upper prediction limit will serve as the GWPS.

Once the proposed GWPSs are determined and approved by Illinois EPA, subsequent downgradient well concentrations will be compared against the upper prediction limit (and lower prediction limit in the case of pH), and the GWPSs. If an exceedance of the GWPS is identified during a quarterly sampling event, an immediate resampling of the specific well(s) will be completed for those specific parameters. If the exceedance is confirmed by the resampling, the Illinois EPA will be notified of the exceedance(s) and the notification will be placed in the facilities operating record in accordance with 845.800(d)(16). It is noted that there are some constituents that historically may have had no detections (i.e., 100% non-detects). In this case, in accordance with the Unified Guidance, if there is a detection of such a constituent, then the Double Quantification Rule will be applied. Under this rule, a confirmed exceedance is registered if any well-constituent pair in the 100% non-detect group exhibits quantified measurements (i.e., at or above the Reporting Limit in two consecutive sample and resample events.

If an exceedance of the GWPS is recorded and reported to Illinois EPA, an Alternate Source Demonstration (ASD) may be completed within 60-days of the confirmed exceedance in accordance with Section 845.650(e) and submitted to the Illinois EPA as well as placing the ASD on the facility’s publically accessible CCR website. Illinois EPA will review and approve or disapprove the ASD.

If it is decided not to complete an ASD or if Illinois EPA does not concur with and approve the ASD, a characterization of the nature and extent of the potential release must be completed in accordance with Section 845.650(d)(1) as well as meeting the requirements of Sections 845.660, 845.670 and 845.680.

4.0 CERTIFICATION

In accordance with Section 845.640(f)(2) of the State CCR Rule, I hereby certify based on a review of the information contained within this Illinois State CCR Rule Compliance Statistical Approach for Groundwater Data Evaluation dated August 23, 2021, the statistical procedures developed and selected for evaluation of groundwater data associated with the Midwest Generation Waukegan Station CCR Units are adequate and appropriate for evaluating the groundwater data.

Certified by: ______________________

Date: 8/23/21

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FIGURE

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CCR MONITORING WELL SITE MAP

WAUKEGAN STATION
WAUKEGAN, ILLINOIS

Scale: 1" = 550'	Date: January 2, 2018
KPRG Project No. 12313.2	FIGURE 1

W:\projects\midwest generation\attorney-client privilege\gw evaluations\waukegan map.dwg

TABLE

Table 1. Section 845.600 Groundwater Monitoring Parameter List

Parameter	Section 845.600 Standards
Antimony	0.006
Arsenic	0.01
Barium	2
Beryllium	0.004
Boron	2.0
Cadmium	0.005
Chloride	200
Chromium	0.1
Cobalt	0.006
Combined Radium 226 + 228 (pCi/L)	5.0
Fluoride	4.0
Lead	0.0075
Lithium	0.04
Mercury	0.002
Molybdenum	0.10
pH (standard units)	6.5-9.0
Selenium	0.05
Sulfate	400
Thallium	0.002
Total Dissolved Solids	1200
Calcium	NE
Turbidity	NE

All vaues in mg/l unless otherwise specified.
NE- Not Established

Attachment 9-6 – Statistical Evaluation Summary

ATTACHMENT 9-6

BACKGROUND STATISTICAL EVALUATION SUMMARY
STATE RULE CCR GROUNDWATER MONITORING
WAUKEGAN GENERATING STATION

The newly enacted Ill. Adm. Code Title 35, Part 845: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments (State CCR Rule) requires development of proposed Groundwater Protection Standards (GWPSs) for inclusion within the Operating Permit for the regulated surface impoundments at the facility. Upon Illinois Environmental Protection Agency (EPA) review, concurrence and approval of these site-specific proposed GWPSs, subsequent quarterly downgradient groundwater monitoring data will be compared against these standards to determine whether standard quarterly monitoring is to continue or whether additional evaluations need to occur to in accordance with Section 845.650(d), 845.650(e), 845.660 and 845.670. The overall statistical approach to be used for the development of the proposed GWPSs is provided in Attachment 9-5 of the Operating Permit.

The proposed site-specific GWPSs for the Waukegan Generating Station are summarized in Table 9-7 in Section 9 of this Operating Permit. The background Prediction Limit values presented in that table were developed, where possible, by combining or "pooling" as many background data points as possible from the various upgradient monitoring wells. This includes evaluating whether the initial eight rounds of data generated as part of Federal CCR Rule compliance that was completed between 2015 and 2017 can be combined with subsequent available data from ongoing groundwater monitoring since that time at a specific upgradient monitoring well location, and whether datasets from individual upgradient monitoring points can also be combined or "pooled". The turbidity data was collected this calendar year (2021) since this was a new state requirement that was not part of the Federal CCR Rule. The following general decision process was followed to determine whether background data from within a well and/or between upgradient wells can be pooled for background calculations:

- If the combined dataset (original eight rounds of data plus any subsequent data generated since the initial background sampling) at a specific well location (intrawell evaluation) for a specific parameter does not show a statistically significant trend, the data for that specific parameter at that well location can be pooled. If a statistically significant trend in the data is noted to exist, only the original eight rounds of background sampling can be used for subsequent calculations. If there is more than one background monitoring well, and one of the combined datasets for a specific parameter shows a statistically significant trend but the other does not, then the specific parameter data for the well that did not indicate a trend can potentially be used for subsequent evaluations.

- If there is more than one upgradient monitoring well, then datasets for individual parameters between the wells (interwell evaluation) must pass an analysis of variance to determine whether there may be a statistically significant variation between the two datasets. If no statistically significant variance is noted between the two (or more) upgradient monitoring points, and the individual parameter data passes the intrawell trend evaluation noted above, then the datasets for that parameter can be pooled between the wells to establish a larger background dataset. If there is a statistically significant variation noted between the two (or more) upgradient monitoring points, then the specific parameter datasets from those wells cannot be combined.

- If it is determined that datasets from upgradient monitoring points cannot be combined, then a decision needs to be made as to which monitoring point will be used for a specific parameter for background calculations. At this point some professional judgement needs to be used by considering the number of data points within each dataset, any potential statistical outliers, any statistical seasonality, the distribution and/or underlying distribution of that data, number of detects versus non-detects, etc.

With the above decision process in mind, the various statistical evaluations performed are summarized below. The evaluations were performed with the assistance of the Sanitas® statistical software package.

Outlier Testing

Outlier tests were performed for all monitoring wells (upgradient and downgradient) in the proposed State CCR monitoring well network for all data available since the start of Federal CCR monitoring. Wells MW-9, MW-11 and MW-14 are upgradient wells. The following statistically significant outliers (dates in parentheses) were noted:

- Calcium – MW-01 (1/17/20)
- Chloride – MW-02 (11/17/20)
- Combined Radium – MW-03 (11/28/17)
- Fluoride – MW-09 (5/16/17) and MW-11 (9/13/17 and 2/4/17)
- Lead – MW-11 (3/2/16)
- pH – MW-16 (2/24/17)
- Selenium – MW-14 (12/7/16 and 11/30/17)

Since the outliers cannot be attributed to either lab error, transcription error or field sampling error, the outlier values were not removed from the datasets at this time but may be considered during subsequent data evaluations. A statistical run summary which includes the specific statistical method used for each parameter for each well is provided at the end of this discussion.

Seasonality/Temporal Variability Testing

Seasonality/temporal variability tests were performed for all monitoring wells (upgradient and downgradient) in the proposed State CCR monitoring well network for all data available since the start of Federal CCR monitoring. Wells MW-9, MW-11 and MW-14 are upgradient wells. No statistically significant seasonal/temporal variations were noted in any of the wells for any of the parameters. A statistical run summary which includes the specific statistical method used for each parameter for each well is provided at the end of this discussion. The turbidity database to date is insufficient to evaluate potential seasonal/temporal variability at this time.

Trend Analysis

To determine whether data generated since the initial eight rounds of background groundwater sampling since the enactment of the Federal CCR Rule can potentially be pooled at a specific upgradient monitoring well location (MW-9, MW-11 and MW-14), trend analysis for each constituent at each upgradient well location was performed. The results are summarized as flows:

- MW-9 – Statistically significant trends were noted for chloride, lithium, pH and total dissolved solids (TDS).
- MW-11 – Statistically significant trends were noted for chloride, lithium, sulfate, TDS and turbidity.
- MW-14 – Statistically significant trends were noted for boron, calcium, chloride, sulfate and TDS.

A statistical run summary which includes the specific statistical method used for each parameter for each well is provided at the end of this discussion.

Spatial Variability Testing

To determine whether the background data sets from background wells can be pooled to establish a representative statistical background, spatial variability testing was performed on the datasets using a parametric analysis of variance (ANOVA). This analysis was done for each of the monitoring parameters. The following observations are made:

- Upgradient wells MW-9, MW-11 and MW-14 all parameter values pooled – No statistically significant variance between the full datasets for cadmium, chloride, lead, mercury and pH.
- Upgradient wells MW-9 and MW-14 all parameter values pooled – No statistically significant variance between full datasets for cadmium, chloride, cobalt, lead, mercury and pH.
- Upgradient wells MW-9 and MW-11 all parameter values pooled – No statistically significant variance between full datasets for antimony, cadmium, chloride, chromium, cobalt, fluoride, lead and TDS.
- Upgradient wells MW-11 and MW-14 all parameter values pooled - No statistically significant variance between full datasets for arsenic, calcium, lead, mercury, molybdenum, pH, selenium and sulfate.
- Upgradient wells MW-11 and MW-14 original 8 background values pooled – No statistically significant variance between the datasets for chloride, sulfate and TDS.

It is noted that both beryllium and thallium had no detections at any of the upgradient well locations during any sampling event, therefore, although an analysis of variance cannot be formally completed, these data sets can be pooled since there is no variation in the reporting limits.

Statistical run summaries which include the specific statistical method used for each parameter for each of the dataset comparisons are provided at the end of this discussion.

Test of Normality

The Shapiro-Wilk Normality Test with an alpha (α) value of 0.05 (or 95%) was used to evaluate the distribution of the background datasets for each constituent at each upgradient well locations and the distribution of pooled datasets for various combinations of upgradient wells (i.e., all three wells pooled and various combinations of two background wells pooled). A Test of Ladders was also run to evaluate other potential underlying transformational distributions in the case that the non-transformed dataset was found not to be normally distributed. The statistical runs are provided for the various combinations of upgradient wells by parameter at the end of this discussion.

Prediction Limits

Based on the various statistical evaluations discussed above, the following background data sets were used for background prediction limit calculations:

- Upgradient wells MW-9, MW-11 and MW-14 all parameter values pooled for beryllium, thallium and lead. As noted above there were no detections of beryllium or thallium at any of the three upgradient well locations and the reporting limits were the same. Relative to lead there were no statistically significant trends within wells for the combined data observations.
- Upgradient wells MW-11 and MW-14 all parameter values were pooled for arsenic, molybdenum, pH and selenium. For each of these combine parameter datasets, there were no individual trends within each well and there was no statistically significant variance noted between the datasets. It is noted the well MW-14 did have two outlier values for selenium, however since both were substantially below the Section 845.600 standard of 0.05 mg/l and there is no indication of potential laboratory or field error, it was decided to include these values within the overall dataset.
- Upgradient well MW-14 all parameter values were used for antimony, cadmium, chromium, cobalt, combined radium, fluoride, lithium, mercury and turbidity. None of these parameters indicated statistically significant trends within this well and none of these parameters were noted as statistical outliers at this well location. All had normal or underlying normal distributions unless distributions for all upgradient wells were found to not to be normal (e.g., antimony).
- Upgradient well MW-11 all parameter values were used for barium, boron and calcium. None of these parameters indicated statistically significant trends within this well and none of these parameters were noted as statistical outliers at this well location. All had normal or underlying normal distributions.
- Upgradient wells MW-11 and MW-14 the original eight background values were pooled for chloride, sulfate and TDS. The results for one or more of the evaluation iterations discussed above precluded using the full combined dataset values due to either identified data trends or statistically significant spatial variations. The original eight background values for these three parameters within these wells have no statistically significant variance and the combined datasets are normal.

The calculated prediction limits under the various background dataset selection scenarios are summarized in Table 9-7 in Section 9 of this permit application. A prediction limit statistical run summary which includes the specific statistical method used for each parameter for each well scenario noted above are provided at the end of this discussion.

Outlier Analysis - Waukegan Station - All CCR Wells

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 10:17 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Antimony (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Antimony (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Antimony (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Antimony (mg/L)	MW-09 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003092	0.0003175	unknown	ShapiroWilk
Antimony (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Antimony (mg/L)	MW-14 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.005425	0.003895	unknown	ShapiroWilk
Antimony (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.003	0	unknown	ShapiroWilk
Arsenic (mg/L)	MW-01	No	n/a	n/a	EPA 1989	0.05	12	0.08308	0.04341	normal	ShapiroWilk
Arsenic (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	12	0.01309	0.006082	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-03	No	n/a	n/a	EPA 1989	0.05	12	0.006433	0.002762	normal	ShapiroWilk
Arsenic (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	12	0.01088	0.01033	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-09 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.01021	0.01952	unknown	ShapiroWilk
Arsenic (mg/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.6467	0.2212	normal	ShapiroWilk
Arsenic (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	12	5.248	7.368	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	12	0.00985	0.01577	unknown	ShapiroWilk
Barium (mg/L)	MW-01	No	n/a	n/a	EPA 1989	0.05	12	0.02533	0.01279	ln(x)	ShapiroWilk
Barium (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	12	0.02142	0.007868	normal	ShapiroWilk
Barium (mg/L)	MW-03	No	n/a	n/a	EPA 1989	0.05	12	0.01792	0.01065	normal	ShapiroWilk
Barium (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	12	0.056	0.03407	normal	ShapiroWilk
Barium (mg/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.01835	0.01146	ln(x)	ShapiroWilk
Barium (mg/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.046	0.005784	normal	ShapiroWilk
Barium (mg/L)	MW-14 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.1709	0.1553	unknown	ShapiroWilk
Barium (mg/L)	MW-16	No	n/a	n/a	EPA 1989	0.05	12	0.039	0.01519	ln(x)	ShapiroWilk
Beryllium (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-09 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-14 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Boron (mg/L)	MW-01	No	n/a	n/a	EPA 1989	0.05	17	2.3	0.3725	normal	ShapiroWilk
Boron (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	17	3.576	0.6543	normal	ShapiroWilk
Boron (mg/L)	MW-03	No	n/a	n/a	NP (nrm)	NaN	17	2.935	0.7721	unknown	ShapiroWilk
Boron (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	2.659	0.6032	normal	ShapiroWilk
Boron (mg/L)	MW-09 (bg)	No	n/a	n/a	Dixon`s	0.05	17	22.56	8.062	normal	ShapiroWilk
Boron (mg/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	17	2.965	1.089	normal	ShapiroWilk
Boron (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	0.9582	0.4646	ln(x)	ShapiroWilk
Boron (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	17	4.476	2.023	unknown	ShapiroWilk
Cadmium (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Cadmium (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Cadmium (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Cadmium (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Cadmium (mg/L)	MW-09 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.000...	0.0001728	unknown	ShapiroWilk
Cadmium (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Cadmium (mg/L)	MW-14 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.000...	0.0004405	unknown	ShapiroWilk
Cadmium (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	12	0.001124	0.001226	unknown	ShapiroWilk
Calcium (mg/L)	**MW-01**	**Yes**	**120**	**11/17/2020**	**Dixon`s**	**0.05**	**17**	**58.35**	**19.92**	**normal**	**ShapiroWilk**
Calcium (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	17	70.94	37.98	ln(x)	ShapiroWilk

Outlier Analysis - Waukegan Station - All CCR Wells

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 10:17 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Calcium (mg/L)	MW-03	No	n/a	n/a	EPA 1989	0.05	17	80.59	27.39	ln(x)	ShapiroWilk
Calcium (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	118.8	51.79	normal	ShapiroWilk
Calcium (mg/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	17	205.9	63.55	ln(x)	ShapiroWilk
Calcium (mg/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	17	154.1	25.75	normal	ShapiroWilk
Calcium (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	152.9	36.19	normal	ShapiroWilk
Calcium (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	19	260	108.9	unknown	ShapiroWilk
Chloride (mg/L)	MW-01	No	n/a	n/a	Dixon`s	0.05	17	56	15.58	normal	ShapiroWilk
Chloride (mg/L)	**MW-02**	**Yes**	**20**	**11/17/2020**	**Dixon`s**	**0.05**	**17**	**48.35**	**9.42**	**normal**	**ShapiroWilk**
Chloride (mg/L)	MW-03	No	n/a	n/a	NP (nrm)	NaN	17	54.24	19.56	unknown	ShapiroWilk
Chloride (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	42.76	15.2	normal	ShapiroWilk
Chloride (mg/L)	MW-09 (bg)	No	n/a	n/a	NP (nrm)	NaN	17	258.8	228.8	unknown	ShapiroWilk
Chloride (mg/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	17	198.2	50.9	normal	ShapiroWilk
Chloride (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	130.9	80.21	normal	ShapiroWilk
Chloride (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	17	116.8	104	unknown	ShapiroWilk
Chromium (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
Chromium (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
Chromium (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
Chromium (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
Chromium (mg/L)	MW-09 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.01693	0.02185	unknown	ShapiroWilk
Chromium (mg/L)	MW-11 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.005467	0.0008595	unknown	ShapiroWilk
Chromium (mg/L)	MW-14 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	1.594	2.063	unknown	ShapiroWilk
Chromium (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005217	0.0007506	unknown	ShapiroWilk
Cobalt (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Cobalt (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Cobalt (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Cobalt (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Cobalt (mg/L)	MW-09 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.001267	0.0005365	unknown	ShapiroWilk
Cobalt (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001	0	unknown	ShapiroWilk
Cobalt (mg/L)	MW-14 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.002267	0.001831	unknown	ShapiroWilk
Cobalt (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.001025	0.0000...	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-01	No	n/a	n/a	Dixon`s	0.05	12	0.4054	0.1428	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	12	0.5043	0.1858	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**MW-03**	**Yes**	**1.17**	**11/28/2017**	**Dixon`s**	**0.05**	**12**	**0.5014**	**0.2651**	**normal**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	12	0.6569	0.2222	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.4992	0.2046	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	12	1.184	0.3705	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.7407	0.265	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-16	No	n/a	n/a	EPA 1989	0.05	12	0.5729	0.1977	normal	ShapiroWilk
Fluoride (mg/L)	MW-01	No	n/a	n/a	EPA 1989	0.05	17	0.2676	0.08613	normal	ShapiroWilk
Fluoride (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	17	0.8212	0.3204	normal	ShapiroWilk
Fluoride (mg/L)	MW-03	No	n/a	n/a	NP (nrm)	NaN	17	0.3729	0.1234	unknown	ShapiroWilk
Fluoride (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	0.5165	0.2715	normal	ShapiroWilk
Fluoride (mg/L)	**MW-09 (bg)**	**Yes**	**0.29**	**5/16/2017**	**Dixon`s**	**0.05**	**17**	**0.1488**	**0.04807**	**ln(x)**	**ShapiroWilk**
Fluoride (mg/L)	**MW-11 (bg)**	**Yes**	**0.26,4.9**	**9/13/2017...**	**Dixon`s**	**0.05**	**17**	**0.4206**	**1.155**	**ln(x)**	**ShapiroWilk**
Fluoride (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	0.1988	0.0491	normal	ShapiroWilk
Fluoride (mg/L)	MW-16	No	n/a	n/a	EPA 1989	0.05	17	0.4765	0.1758	normal	ShapiroWilk
Lead (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Lead (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Lead (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk
Lead (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0005	0	unknown	ShapiroWilk

Outlier Analysis - Waukegan Station - All CCR Wells

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 10:17 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
.ead (mg/L)	MW-09 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.000...	0.0002017	unknown	ShapiroWilk
.ead (mg/L)	**MW-11 (bg)**	**Yes**	**0.0011**	**3/2/2016**	**NP (nrm)**	**NaN**	**12**	**0.000...**	**0.0002156**	**unknown**	**ShapiroWilk**
.ead (mg/L)	MW-14 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.000...	0.0001558	unknown	ShapiroWilk
.ead (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.000...	0.0000...	unknown	ShapiroWilk
.ithium (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
.ithium (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
.ithium (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
.ithium (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005	0	unknown	ShapiroWilk
.ithium (mg/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.068	0.02063	normal	ShapiroWilk
.ithium (mg/L)	MW-11 (bg)	No	n/a	n/a	NP (nrm)	NaN	12	0.04367	0.00797	unknown	ShapiroWilk
.ithium (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.02117	0.006028	normal	ShapiroWilk
.ithium (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	12	0.049	0.05574	unknown	ShapiroWilk
/lercury (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lercury (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lercury (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lercury (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lercury (mg/L)	MW-09 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lercury (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lercury (mg/L)	MW-14 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.000...	0.0000664	unknown	ShapiroWilk
/lercury (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0002	0	unknown	ShapiroWilk
/lolybdenum (mg/L)	MW-01	No	n/a	n/a	Dixon`s	0.05	12	0.05358	0.01659	normal	ShapiroWilk
/lolybdenum (mg/L)	MW-02	No	n/a	n/a	NP (nrm)	NaN	12	0.05592	0.01503	unknown	ShapiroWilk
/lolybdenum (mg/L)	MW-03	No	n/a	n/a	NP (nrm)	NaN	12	0.04675	0.01238	unknown	ShapiroWilk
/lolybdenum (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	12	0.03431	0.0192	normal	ShapiroWilk
/lolybdenum (mg/L)	MW-09 (bg)	No	n/a	n/a	Dixon`s	0.05	12	0.3828	0.1636	normal	ShapiroWilk
/lolybdenum (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005033	0.0001155	unknown	ShapiroWilk
/lolybdenum (mg/L)	MW-14 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.005408	0.001265	unknown	ShapiroWilk
/lolybdenum (mg/L)	MW-16	No	n/a	n/a	Dixon`s	0.05	12	0.01872	0.005119	normal	ShapiroWilk
H (n/a)	MW-01	No	n/a	n/a	NP (nrm)	NaN	17	10	1.075	unknown	ShapiroWilk
H (n/a)	MW-02	No	n/a	n/a	Dixon`s	0.05	17	8.064	0.4855	normal	ShapiroWilk
H (n/a)	MW-03	No	n/a	n/a	NP (nrm)	NaN	17	7.744	0.817	unknown	ShapiroWilk
H (n/a)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	7.135	0.3309	normal	ShapiroWilk
H (n/a)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	17	7.335	0.4144	normal	ShapiroWilk
H (n/a)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	17	7.088	0.2633	normal	ShapiroWilk
H (n/a)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	7.167	0.2435	normal	ShapiroWilk
H (n/a)	**MW-16**	**Yes**	**5.76**	**2/24/2017**	**Dixon`s**	**0.05**	**17**	**6.921**	**0.4503**	**normal**	**ShapiroWilk**
;elenium (mg/L)	MW-01	No	n/a	n/a	NP (nrm)	NaN	12	0.0058	0.006015	unknown	ShapiroWilk
;elenium (mg/L)	MW-02	No	n/a	n/a	NP (nrm)	NaN	12	0.00575	0.006827	unknown	ShapiroWilk
;elenium (mg/L)	MW-03	No	n/a	n/a	NP (nrm)	NaN	12	0.004875	0.003466	unknown	ShapiroWilk
;elenium (mg/L)	MW-04	No	n/a	n/a	NP (nrm)	NaN	12	0.0141	0.01829	unknown	ShapiroWilk
;elenium (mg/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	12	0.02047	0.01424	normal	ShapiroWilk
;elenium (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.0025	0	unknown	ShapiroWilk
;elenium (mg/L)	**MW-14 (bg)**	**Yes**	**0.014,0.0072**	**12/7/2016...**	**NP (nrm)**	**NaN**	**12**	**0.0039**	**0.003453**	**unknown**	**ShapiroWilk**
;elenium (mg/L)	MW-16	No	n/a	n/a	NP (nrm)	NaN	12	0.004475	0.003933	unknown	ShapiroWilk
;ulfate (mg/L)	MW-01	No	n/a	n/a	EPA 1989	0.05	17	270	66.43	normal	ShapiroWilk
;ulfate (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	17	244.1	74.5	normal	ShapiroWilk
;ulfate (mg/L)	MW-03	No	n/a	n/a	EPA 1989	0.05	17	217.1	59.45	normal	ShapiroWilk
;ulfate (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	260.6	114.9	ln(x)	ShapiroWilk
;ulfate (mg/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	17	440	189.3	ln(x)	ShapiroWilk
;ulfate (mg/L)	MW-11 (bg)	No	n/a	n/a	EPA 1989	0.05	17	104.5	57.07	normal	ShapiroWilk

Outlier Analysis - Waukegan Station - All CCR Wells

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 10:17 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Sulfate (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	102.2	76.82	normal	ShapiroWilk
Sulfate (mg/L)	MW-16	No	n/a	n/a	EPA 1989	0.05	17	600	269.4	normal	ShapiroWilk
Thallium (mg/L)	MW-01	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-02	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-03	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-04	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-09 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-11 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-14 (bg)	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002	0	unknown	ShapiroWilk
Thallium (mg/L)	MW-16	n/a	n/a	n/a	NP (nrm)	NaN	12	0.002008	0.0000...	unknown	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-01	No	n/a	n/a	EPA 1989	0.05	17	581.8	99.95	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-02	No	n/a	n/a	EPA 1989	0.05	17	588.2	172	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-03	No	n/a	n/a	EPA 1989	0.05	17	565.3	115.7	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-04	No	n/a	n/a	EPA 1989	0.05	17	712.9	242.7	normal	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	17	1394	605.3	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-11 (bg)	No	n/a	n/a	NP (nrm)	NaN	17	1008	151.3	unknown	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	17	814.7	300.6	normal	ShapiroWilk
Total Dissolved Solids (mg/L)	MW-16	No	n/a	n/a	EPA 1989	0.05	20	1536	671.9	ln(x)	ShapiroWilk

Seasonality - Waukegan Station - All CCR Wells

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 10:30 AM

Constituent	Well	Sig.	K.-W.	Chi-Sq.	df	N	Alpha
Antimony (mg/L)	MW-01	No	0	0	0	12	0.05
Antimony (mg/L)	MW-02	No	0	0	0	12	0.05
Antimony (mg/L)	MW-03	No	0	0	0	12	0.05
Antimony (mg/L)	MW-04	No	0	0	0	12	0.05
Antimony (mg/L)	MW-09 (bg)	No	0	0	0	12	0.05
Antimony (mg/L)	MW-11 (bg)	No	0	0	0	12	0.05
Antimony (mg/L)	MW-14 (bg)	No	0	0	0	12	0.05
Antimony (mg/L)	MW-16	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-01	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-02	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-03	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-04	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-09 (bg)	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-11 (bg)	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-14 (bg)	No	0	0	0	12	0.05
Arsenic (mg/L)	MW-16	No	0	0	0	12	0.05
Barium (mg/L)	MW-01	No	0	0	0	12	0.05
Barium (mg/L)	MW-02	No	0	0	0	12	0.05
Barium (mg/L)	MW-03	No	0	0	0	12	0.05
Barium (mg/L)	MW-04	No	0	0	0	12	0.05
Barium (mg/L)	MW-09 (bg)	No	0	0	0	12	0.05
Barium (mg/L)	MW-11 (bg)	No	0	0	0	12	0.05
Barium (mg/L)	MW-14 (bg)	No	0	0	0	12	0.05
Barium (mg/L)	MW-16	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-01	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-02	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-03	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-04	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-09 (bg)	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-11 (bg)	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-14 (bg)	No	0	0	0	12	0.05
Beryllium (mg/L)	MW-16	No	0	0	0	12	0.05
Boron (mg/L)	MW-01	No	0	0	0	17	0.05
Boron (mg/L)	MW-02	No	0	0	0	17	0.05
Boron (mg/L)	MW-03	No	0	0	0	17	0.05
Boron (mg/L)	MW-04	No	0	0	0	17	0.05
Boron (mg/L)	MW-09 (bg)	No	0	0	0	17	0.05
Boron (mg/L)	MW-11 (bg)	No	0	0	0	17	0.05
Boron (mg/L)	MW-14 (bg)	No	0	0	0	17	0.05
Boron (mg/L)	MW-16	No	0	0	0	17	0.05
Cadmium (mg/L)	MW-01	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-02	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-03	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-04	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-09 (bg)	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-11 (bg)	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-14 (bg)	No	0	0	0	12	0.05
Cadmium (mg/L)	MW-16	No	0	0	0	12	0.05
Calcium (mg/L)	MW-01	No	0	0	0	17	0.05
Calcium (mg/L)	MW-02	No	0	0	0	17	0.05

Seasonality - Waukegan Station - All CCR Wells

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 10:30 AM

Constituent	Well	Sig.	K.-W.	Chi-Sq.	df	N	Alpha
Calcium (mg/L)	MW-03	No	0	0	0	17	0.05
Calcium (mg/L)	MW-04	No	0	0	0	17	0.05
Calcium (mg/L)	MW-09 (bg)	No	0	0	0	17	0.05
Calcium (mg/L)	MW-11 (bg)	No	0	0	0	17	0.05
Calcium (mg/L)	MW-14 (bg)	No	0	0	0	17	0.05
Calcium (mg/L)	MW-16	No	3.6	7.815	3	19	0.05
Chloride (mg/L)	MW-01	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-02	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-03	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-04	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-09 (bg)	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-11 (bg)	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-14 (bg)	No	3.6	7.815	3	17	0.05
Chloride (mg/L)	MW-16	No	3.6	7.815	3	17	0.05
Chromium (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Chromium (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Cobalt (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-01	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-02	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-03	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-04	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Combined Radium 226 + 228 (pCi/L)	MW-16	No	3.6	7.815	3	12	0.05
Fluoride (mg/L)	MW-01	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-02	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-03	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-04	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-09 (bg)	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-11 (bg)	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-14 (bg)	No	3.6	7.815	3	17	0.05
Fluoride (mg/L)	MW-16	No	3.6	7.815	3	17	0.05
Lead (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Lead (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Lead (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Lead (mg/L)	MW-04	No	3.6	7.815	3	12	0.05

Seasonality - Waukegan Station - All CCR Wells

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 10:30 AM

Constituent	Well	Sig.	K.-W.	Chi-Sq.	df	N	Alpha
Lead (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Lead (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Lead (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Lead (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Lithium (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Mercury (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Molybdenum (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
pH (n/a)	MW-01	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-02	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-03	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-04	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-09 (bg)	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-11 (bg)	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-14 (bg)	No	3.6	7.815	3	17	0.05
pH (n/a)	MW-16	No	3.6	7.815	3	17	0.05
Selenium (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Selenium (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Sulfate (mg/L)	MW-01	No	3.6	7.815	3	17	0.05
Sulfate (mg/L)	MW-02	No	3.6	7.815	3	17	0.05
Sulfate (mg/L)	MW-03	No	3.6	7.815	3	17	0.05
Sulfate (mg/L)	MW-04	No	3.6	7.815	3	17	0.05
Sulfate (mg/L)	MW-09 (bg)	No	3.6	7.815	3	17	0.05
Sulfate (mg/L)	MW-11 (bg)	No	3.6	7.815	3	17	0.05

Seasonality - Waukegan Station - All CCR Wells

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 10:30 AM

Constituent	Well	Sig.	K.-W.	Chi-Sq.	df	N	Alpha
Sulfate (mg/L)	MW-14 (bg)	No	3.6	7.815	3	17	0.05
Sulfate (mg/L)	MW-16	No	3.6	7.815	3	17	0.05
Thallium (mg/L)	MW-01	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-02	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-03	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-04	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-09 (bg)	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-11 (bg)	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-14 (bg)	No	3.6	7.815	3	12	0.05
Thallium (mg/L)	MW-16	No	3.6	7.815	3	12	0.05
Total Dissolved Solids (mg/L)	MW-01	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-02	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-03	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-04	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-09 (bg)	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-11 (bg)	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-14 (bg)	No	3.6	7.815	3	17	0.05
Total Dissolved Solids (mg/L)	MW-16	No	2.646	7.815	3	20	0.05

Trend Test MW-9

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/5/2021, 1:37 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony (mg/L)	MW-09 (bg)	0	-5	-35	No	12	91.67	n/a	n/a	0.02	NP (NDs)
Arsenic (mg/L)	MW-09 (bg)	-0.3869	-1.427	2.359	No	12	33.33	Yes	natura...	0.02	Param.
Barium (mg/L)	MW-09 (bg)	-0.00426	-2.171	2.359	No	12	0	Yes	no	0.02	Param.
Beryllium (mg/L)	MW-09 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Boron (mg/L)	MW-09 (bg)	2.245	2.071	2.249	No	17	0	Yes	no	0.02	Param.
Cadmium (mg/L)	MW-09 (bg)	0	-9	-35	No	12	83.33	n/a	n/a	0.02	NP (NDs)
Calcium (mg/L)	MW-09 (bg)	-15.17	-1.711	2.249	No	17	0	Yes	no	0.02	Param.
Chloride (mg/L)	**MW-09 (bg)**	**-94.18**	**-3.765**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**
Chromium (mg/L)	MW-09 (bg)	-0.00...	-1.06	2.359	No	12	66.67	Yes	no	0.02	Param.
Cobalt (mg/L)	MW-09 (bg)	0	-4	-35	No	12	75	n/a	n/a	0.02	NP (Nor...
Combined Radium 226 + 228 (pCi/L)	MW-09 (bg)	0.04219	1.046	2.359	No	12	66.67	Yes	no	0.02	Param.
Fluoride (mg/L)	MW-09 (bg)	-0.00...	-0.04419	2.249	No	17	0	Yes	natura...	0.02	Param.
Lead (mg/L)	MW-09 (bg)	0	-13	-35	No	12	83.33	n/a	n/a	0.02	NP (NDs)
Lithium (mg/L)	**MW-09 (bg)**	**-0.00...**	**-2.629**	**-2.359**	**Yes**	**12**	**0**	**Yes**	**no**	**0.02**	**Param.**
Mercury (mg/L)	MW-09 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Molybdenum (mg/L)	MW-09 (bg)	0.03053	0.9373	2.359	No	12	0	Yes	no	0.02	Param.
pH (n/a)	**MW-09 (bg)**	**0.1244**	**2.286**	**2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**
Selenium (mg/L)	MW-09 (bg)	-0.00...	-0.2809	2.359	No	12	16.67	Yes	no	0.02	Param.
Sulfate (mg/L)	MW-09 (bg)	-33.16	-1.203	2.249	No	17	0	Yes	no	0.02	Param.
Thallium (mg/L)	MW-09 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Total Dissolved Solids (mg/L)	**MW-09 (bg)**	**-205.8**	**-2.726**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**

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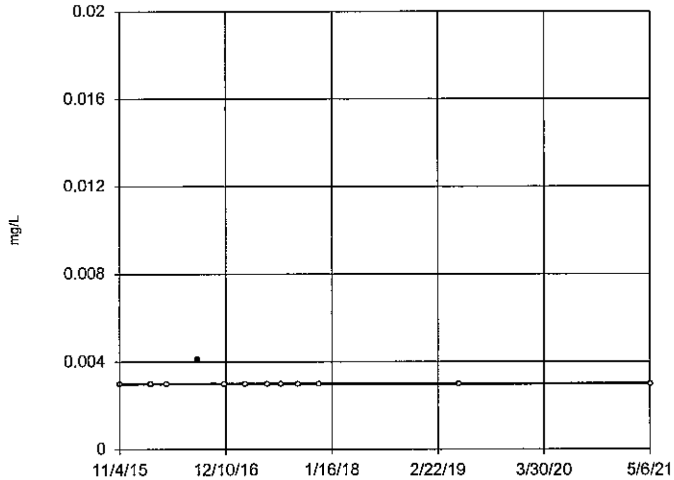
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-09 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -5
critical = -35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Antimony   Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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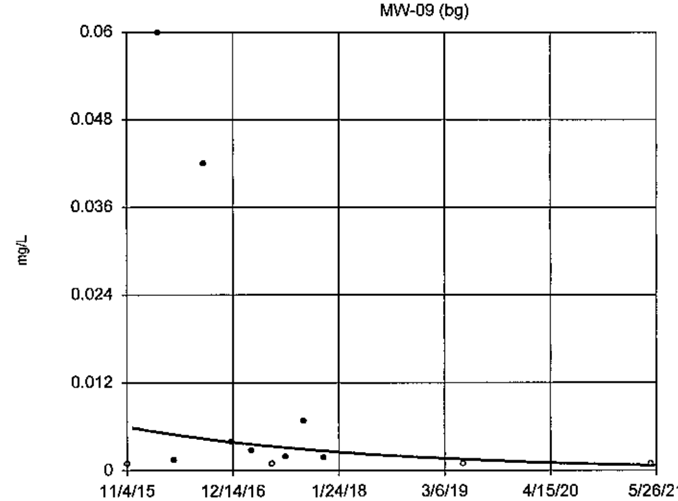
Linear Regression

MW-09 (bg)



n = 12
33.33% NDs

Slope = -0.3869
natural log units/year.

alpha = 0.02
t = -1.427
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha = 0.01, calculated = 0.9114 after natural log transformation, critical = 0.805.

Constituent: Arsenic   Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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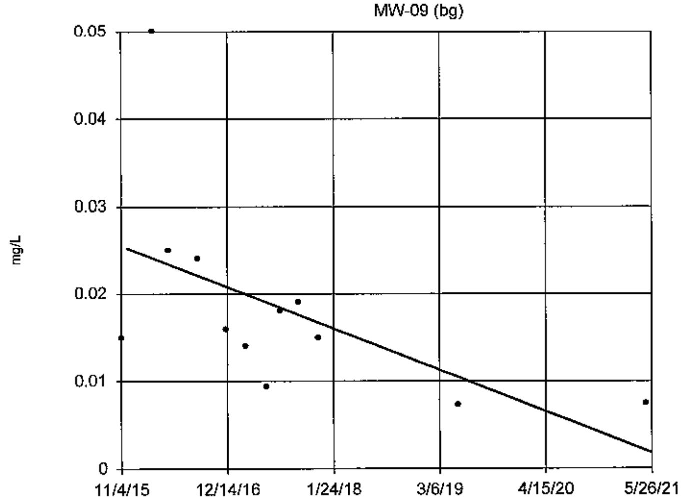
Linear Regression

MW-09 (bg)



n = 12

Slope = -0.00426
units/year.

alpha = 0.02
t = -2.171
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha = 0.01, calculated = 0.8129, critical = 0.805.

Constituent: Barium   Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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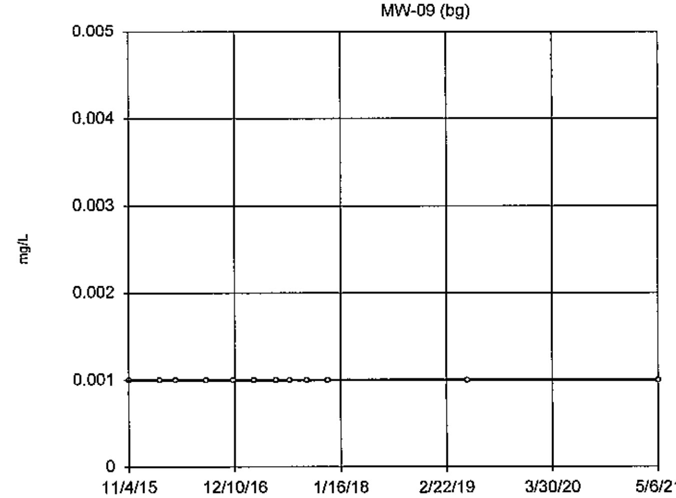
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-09 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Beryllium   Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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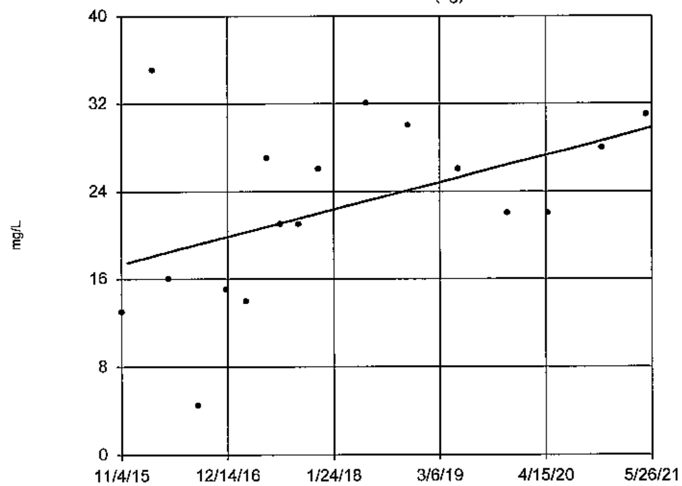
Linear Regression

MW-09 (bg)



n = 17

Slope = 2.245 units/year.

alpha = 0.02
t = 2.071
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9619, critical = 0.851.

Constituent: Boron Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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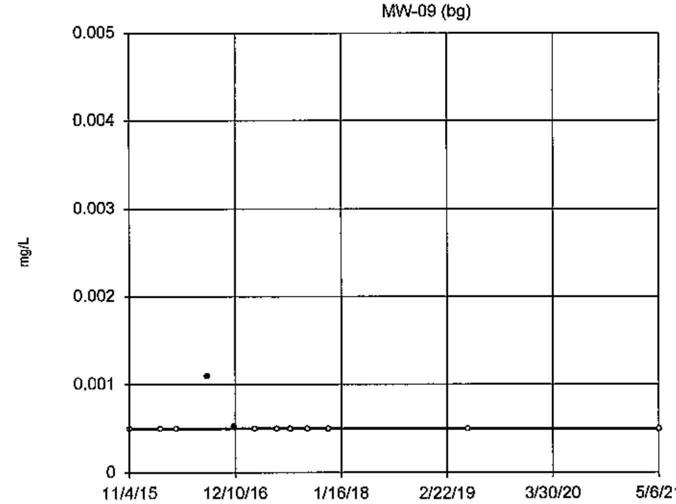
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-09 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = -9
critical = -35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Cadmium Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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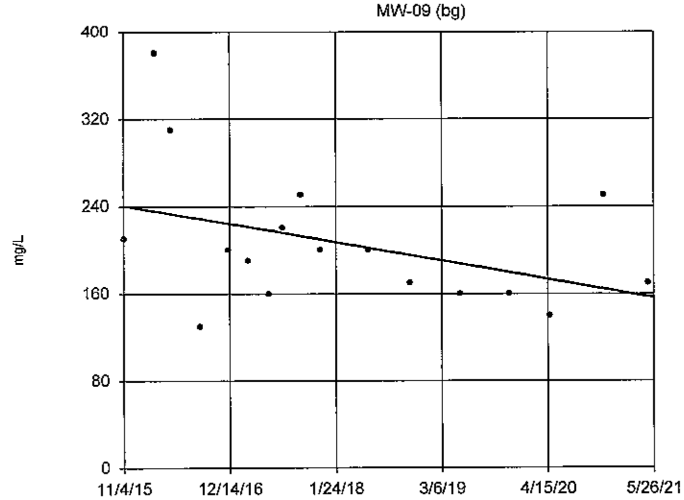
Linear Regression

MW-09 (bg)



n = 17

Slope = -15.17 units/year.

alpha = 0.02
t = -1.711
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9063, critical = 0.851.

Constituent: Calcium Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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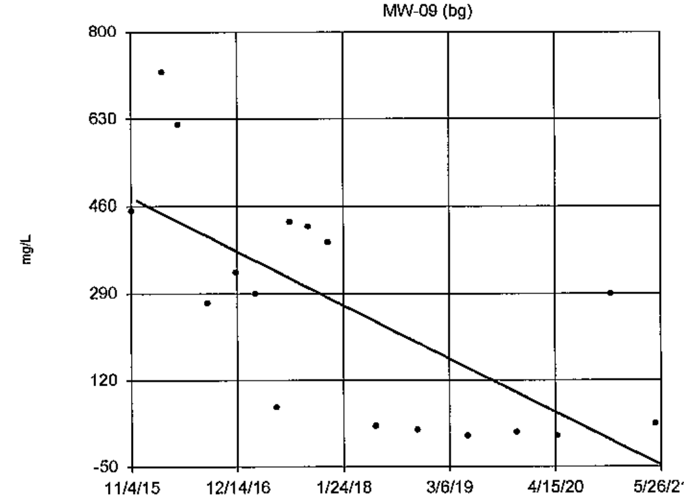
Linear Regression

MW-09 (bg)



n = 17

Slope = -94.18 units/year.

alpha = 0.02
t = -3.765
critical = -2.249

Significant decreasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9591, critical = 0.851.

Constituent: Chloride Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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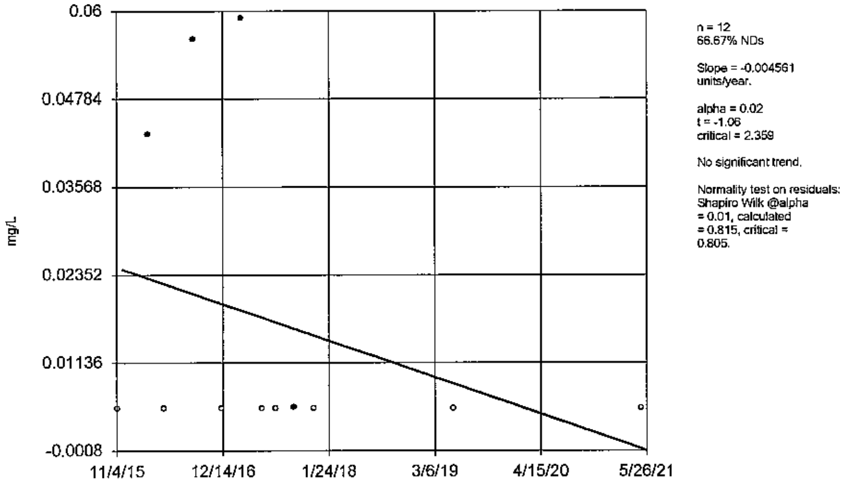
Hollow symbols indicate censored values.



Constituent: Chromium Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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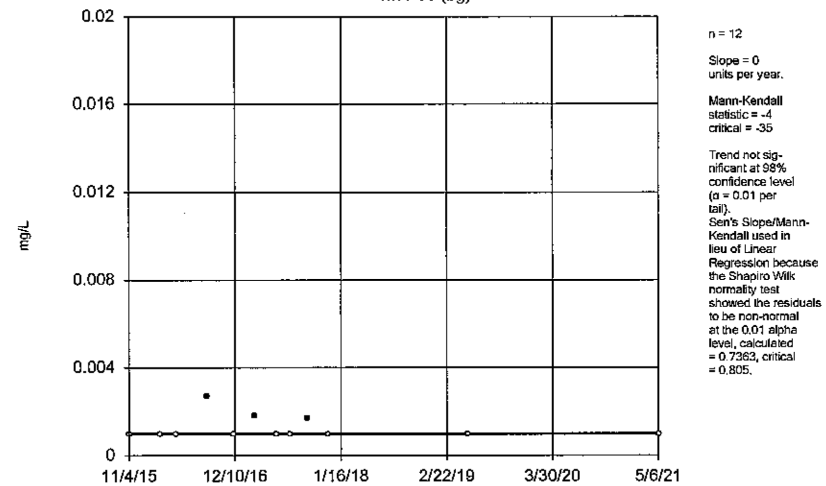
Hollow symbols indicate censored values.



Constituent: Cobalt Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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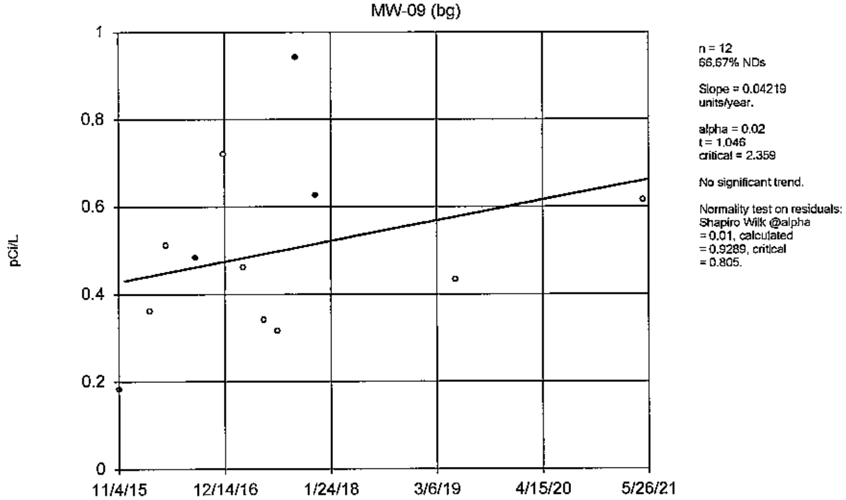
Hollow symbols indicate censored values.



Constituent: Combined Radium 226 + 228 Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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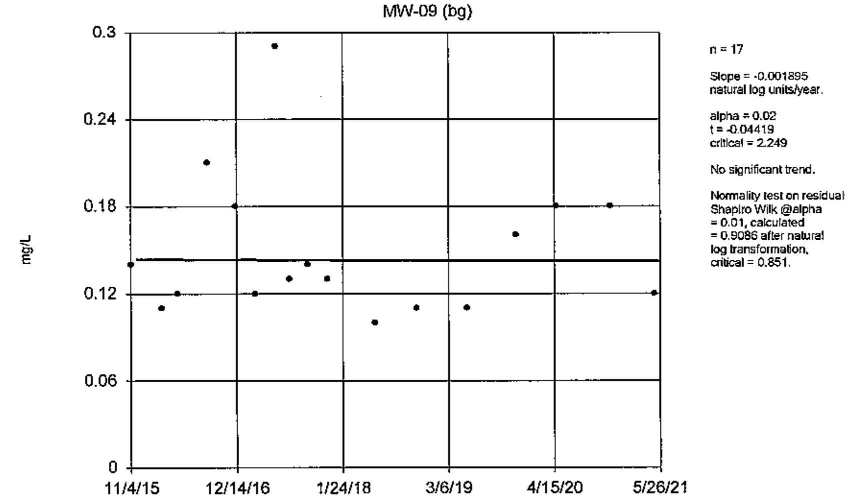

Constituent: Fluoride Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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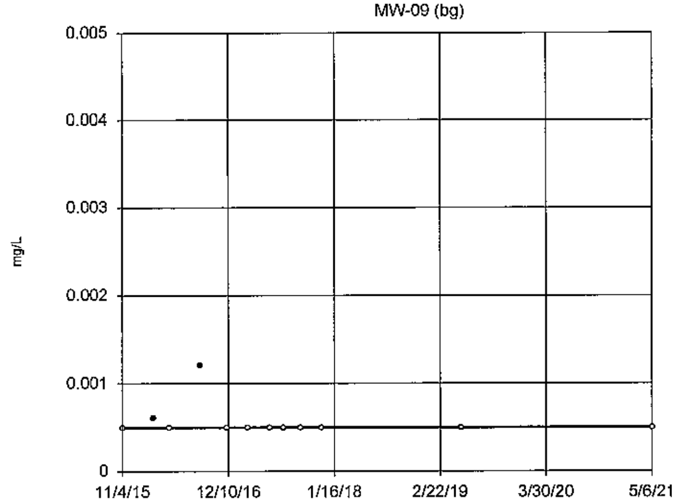
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-09 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -13
critical = -35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Lead Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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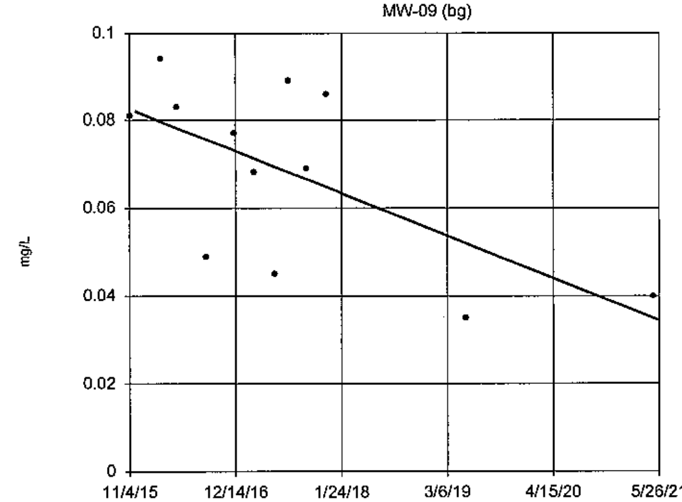
Linear Regression

MW-09 (bg)



n = 12

Slope = -0.008657
units/year.

alpha = 0.02
t = -2.629
critical = -2.359

Significant decreasing trend.

Normality test on residuals:
Shapiro Wilk @alpha = 0.01, calculated = 0.9241, critical = 0.805.

Constituent: Lithium Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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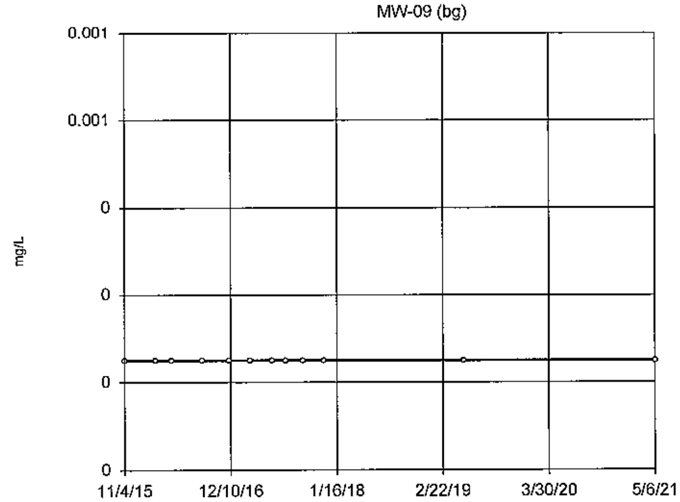
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-09 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Mercury Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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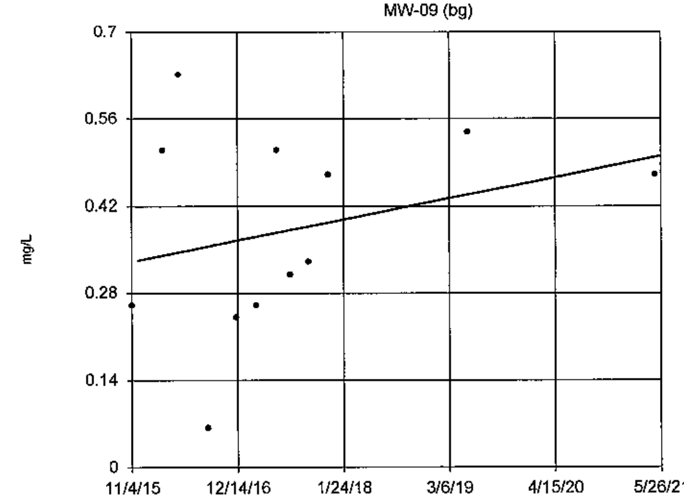
Linear Regression

MW-09 (bg)



n = 12

Slope = 0.03053
units/year.

alpha = 0.02
t = 0.9373
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha = 0.01, calculated = 0.9699, critical = 0.805.

Constituent: Molybdenum Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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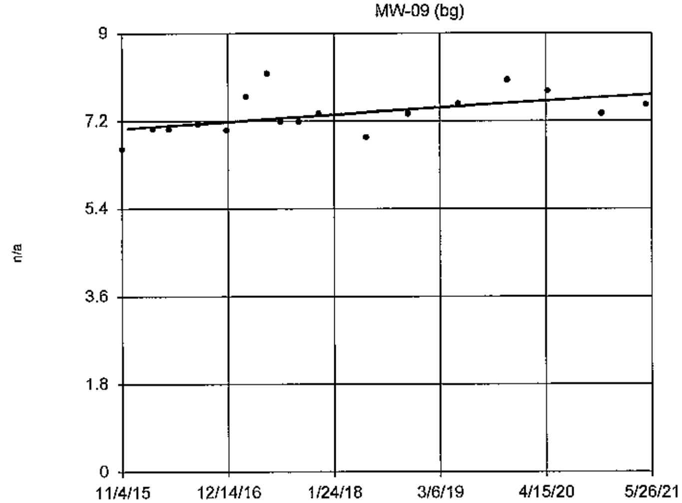
Linear Regression

MW-09 (bg)



n = 17

Slope = 0.1244 units/year.

alpha = 0.02
t = 2.286
critical = 2.249

Significant increasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9093, critical = 0.851.

Constituent: pH Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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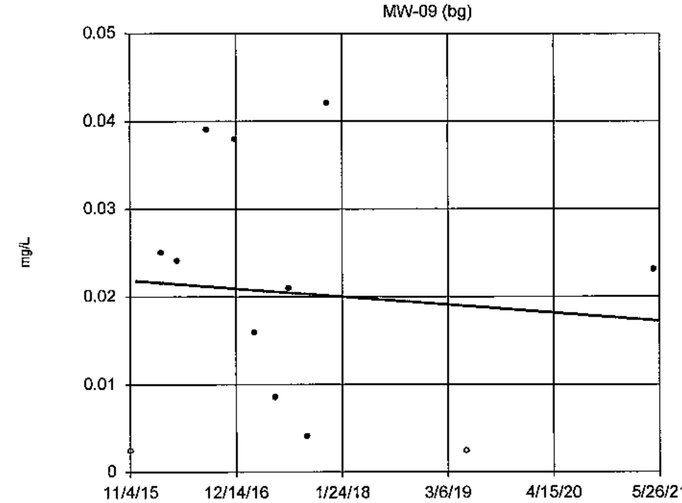
Linear Regression

MW-09 (bg)



n = 12
16.67% NDs

Slope = -0.0008275 units/year.

alpha = 0.02
t = -0.2809
critical = 2.359

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9311, critical = 0.805.

Constituent: Selenium Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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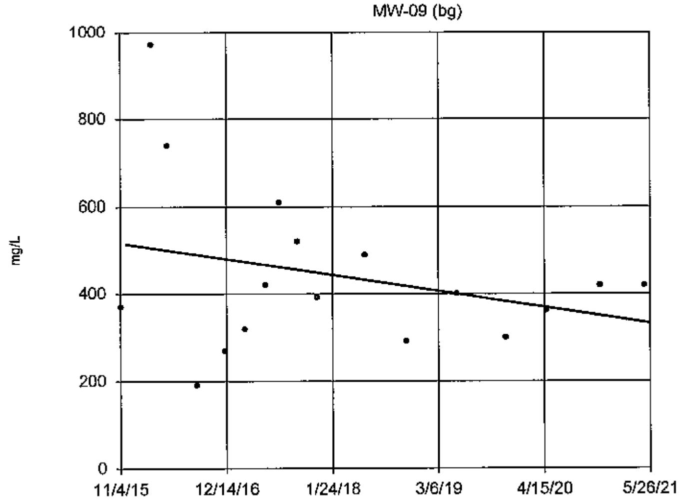
Linear Regression

MW-09 (bg)



n = 17

Slope = -33.16 units/year.

alpha = 0.02
t = -1.203
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9546, critical = 0.851.

Constituent: Sulfate Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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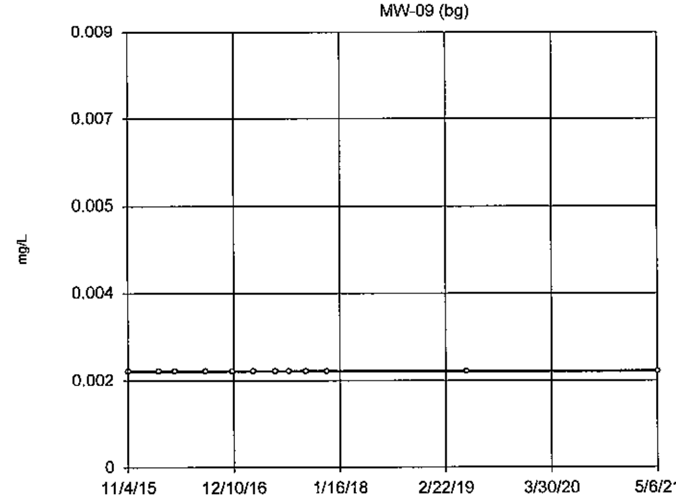
Sen's Slope Estimator

MW-09 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Thallium Analysis Run 8/5/2021 1:36 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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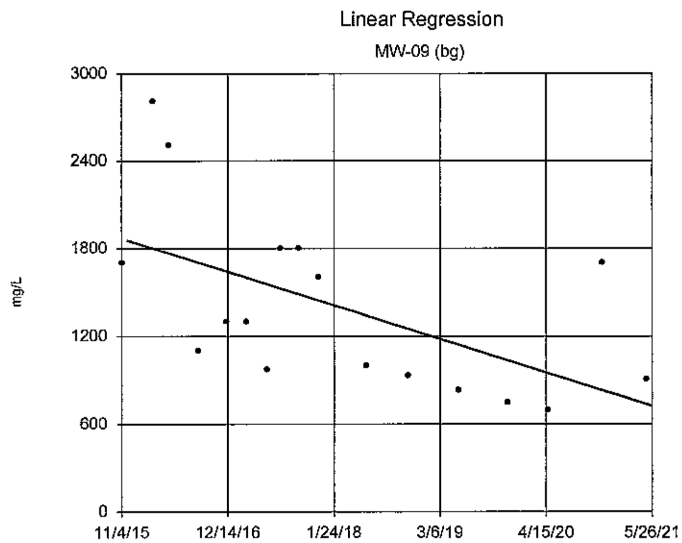

n = 17

Slope = -205.8
units/year.

alpha = 0.02
t = -2.726
critical = -2.249

Significant decreasing trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.8792, critical
= 0.851.

Constituent: Total Dissolved Solids Analysis Run 8/5/2021 1:36 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Trend Test MW-11

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 3:31 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Arsenic (mg/L)	MW-11 (bg)	-0.07092	-1.768	2.359	No	12	0	Yes	no	0.02	Param.
Barium (mg/L)	MW-11 (bg)	0.000...	0.2762	2.359	No	12	0	Yes	no	0.02	Param.
Beryllium (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Boron (mg/L)	MW-11 (bg)	-0.2388	-1.549	2.249	No	17	0	Yes	no	0.02	Param.
Cadmium (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Calcium (mg/L)	MW-11 (bg)	-7.226	-2.09	2.249	No	17	0	Yes	no	0.02	Param.
Chloride (mg/L)	**MW-11 (bg)**	**-20.84**	**-3.725**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**
Chromium (mg/L)	MW-11 (bg)	0	-1	-35	No	12	58.33	n/a	n/a	0.02	NP (Nor...
Cobalt (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Combined Radium 226 + 228 (pCi/L)	MW-11 (bg)	0.1259	1.912	2.359	No	12	0	Yes	no	0.02	Param.
Fluoride (mg/L)	MW-11 (bg)	0.006702	47	58	No	17	0	n/a	n/a	0.02	NP (Nor...
Lead (mg/L)	MW-11 (bg)	-0.00...	-1.585	2.359	No	12	66.67	Yes	no	0.02	Param.
Lithium (mg/L)	**MW-11 (bg)**	**-0.00...**	**-2.365**	**-2.359**	**Yes**	**12**	**0**	**Yes**	**no**	**0.02**	**Param.**
Mercury (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Molybdenum (mg/L)	MW-11 (bg)	0	5	35	No	12	91.67	n/a	n/a	0.02	NP (NDs)
pH (n/a)	MW-11 (bg)	0.0456	1.187	2.249	No	17	0	Yes	no	0.02	Param.
Selenium (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Sulfate (mg/L)	**MW-11 (bg)**	**-29.74**	**-7.253**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**
Thallium (mg/L)	MW-11 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Total Dissolved Solids (mg/L)	**MW-11 (bg)**	**-72.27**	**-5.328**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**

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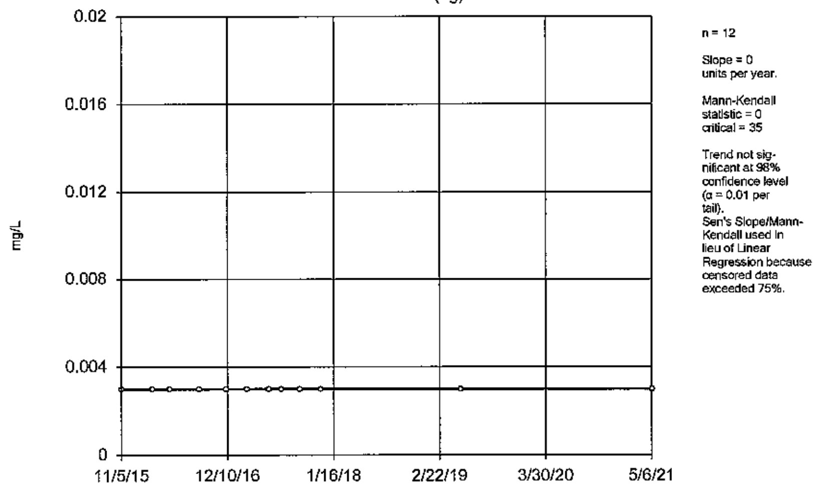
Sen's Slope Estimator

MW-11 (bg)



Constituent: Antimony   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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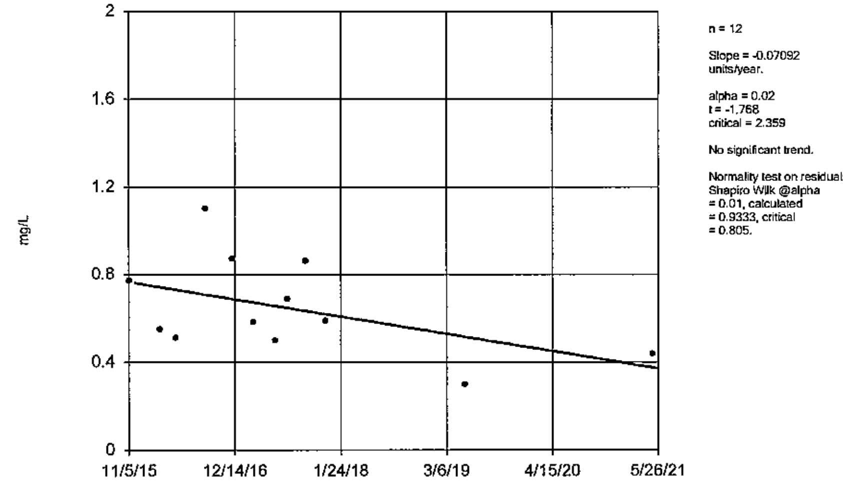
Linear Regression

MW-11 (bg)



Constituent: Arsenic   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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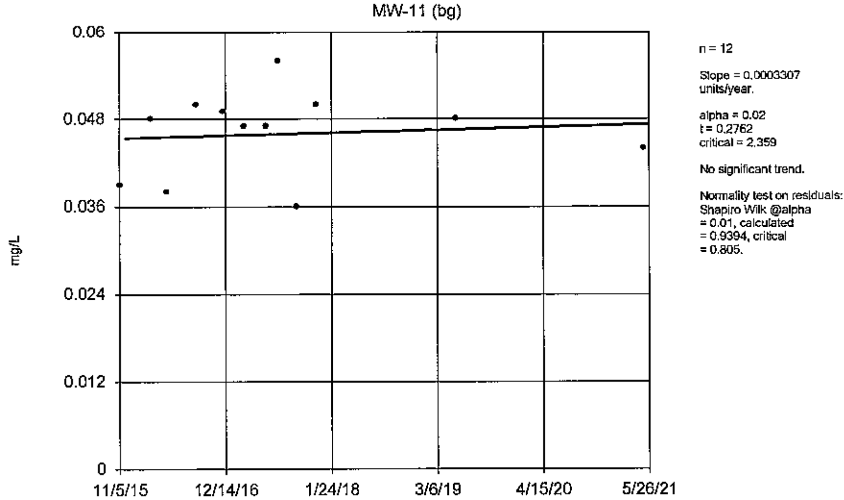
Linear Regression

MW-11 (bg)



Constituent: Barium   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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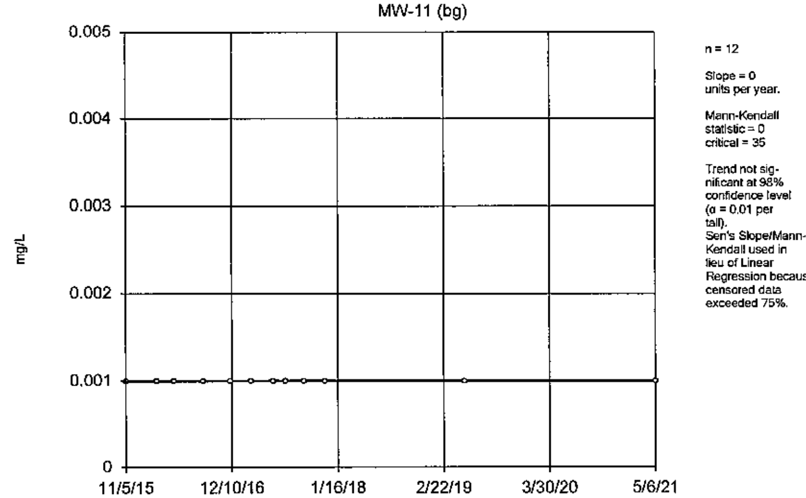
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-11 (bg)



Constituent: Beryllium   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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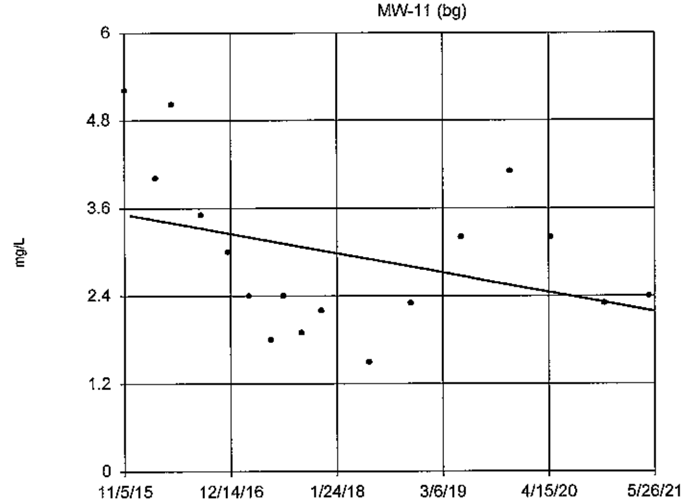
Linear Regression

MW-11 (bg)



n = 17

Slope = -0.2388 units/year.

alpha = 0.02
t = -1.549
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9381, critical = 0.851.

Constituent: Boron   Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station   Client: NRG   Data: Waukegan

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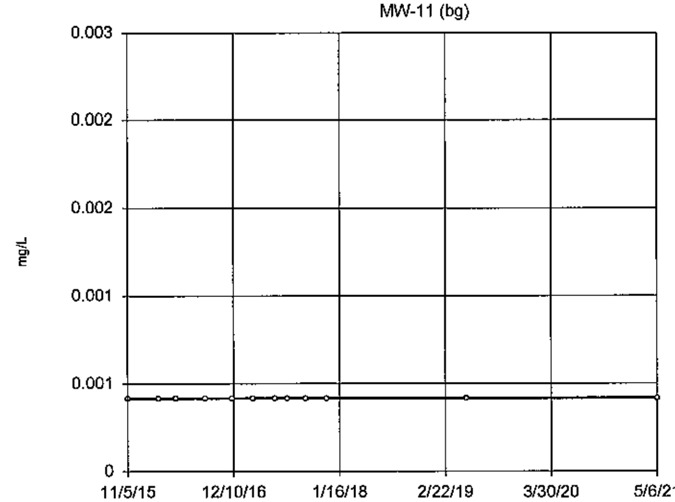
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-11 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Cadmium   Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station   Client: NRG   Data: Waukegan

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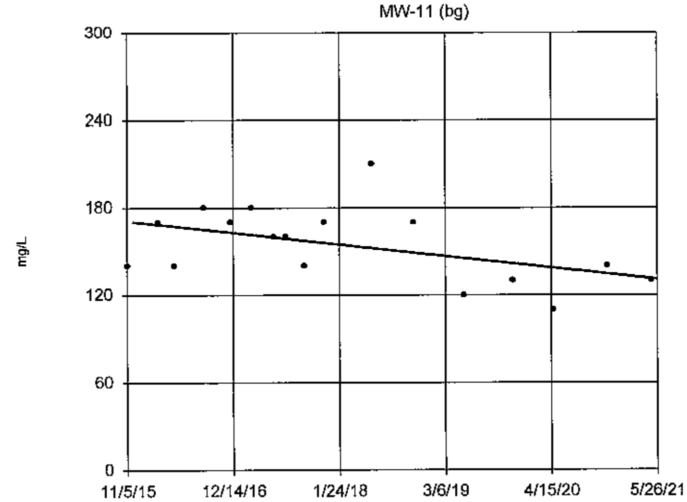
Linear Regression

MW-11 (bg)



n = 17

Slope = -7.226 units/year.

alpha = 0.02
t = -2.09
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9267, critical = 0.851.

Constituent: Calcium   Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station   Client: NRG   Data: Waukegan

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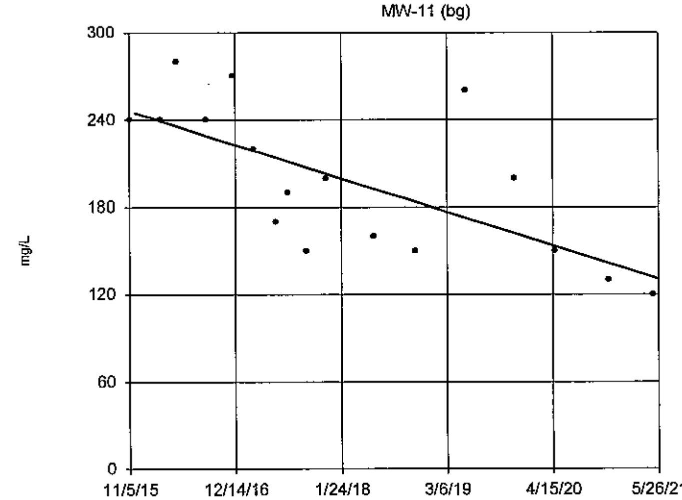
Linear Regression

MW-11 (bg)



n = 17

Slope = -20.84 units/year.

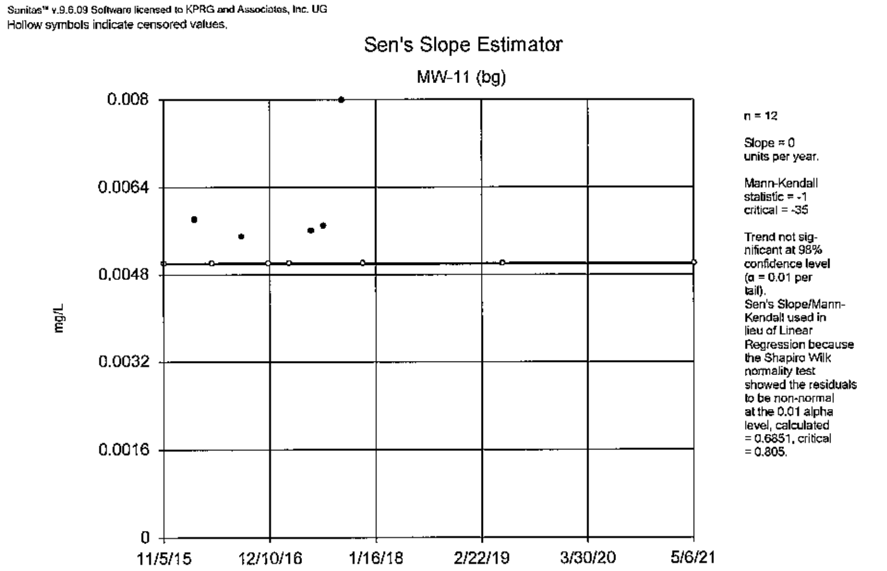
alpha = 0.02
t = -3.725
critical = -2.249

Significant decreasing trend.

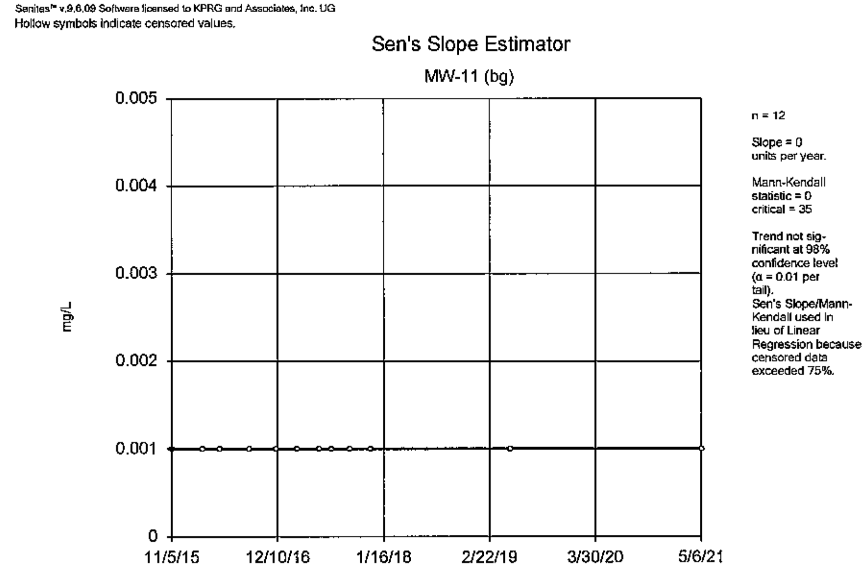
Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9458, critical = 0.851.

Constituent: Chloride   Analysis Run 8/4/2021 3:30 PM

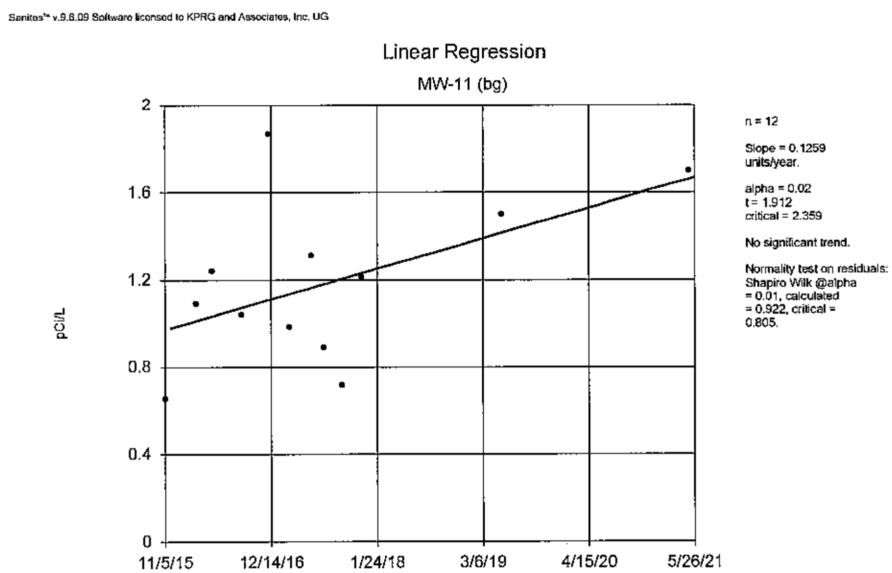
Waukegan Generating Station   Client: NRG   Data: Waukegan



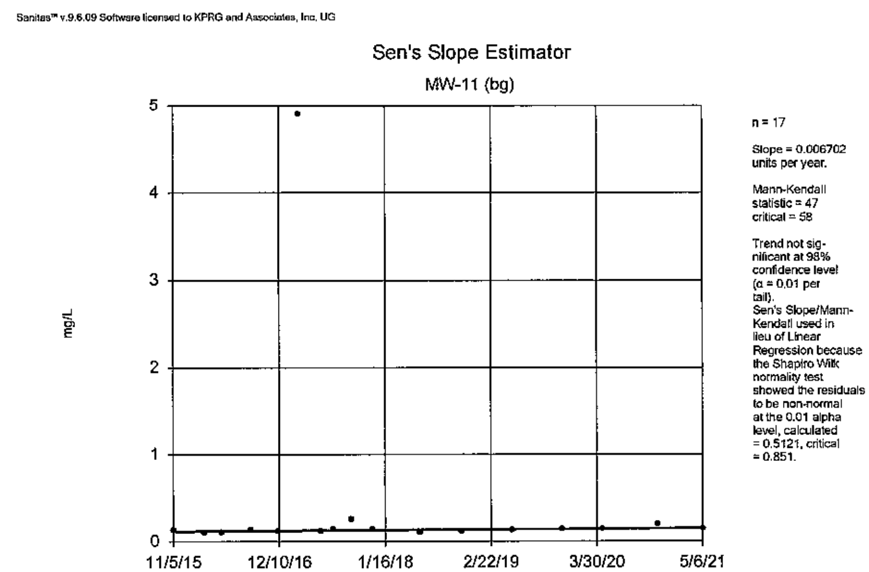
Constituent: Chromium Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station Client: NRG Data: Waukegan



Constituent: Cobalt Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station Client: NRG Data: Waukegan



Constituent: Combined Radium 226 + 228 Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station Client: NRG Data: Waukegan



Constituent: Fluoride Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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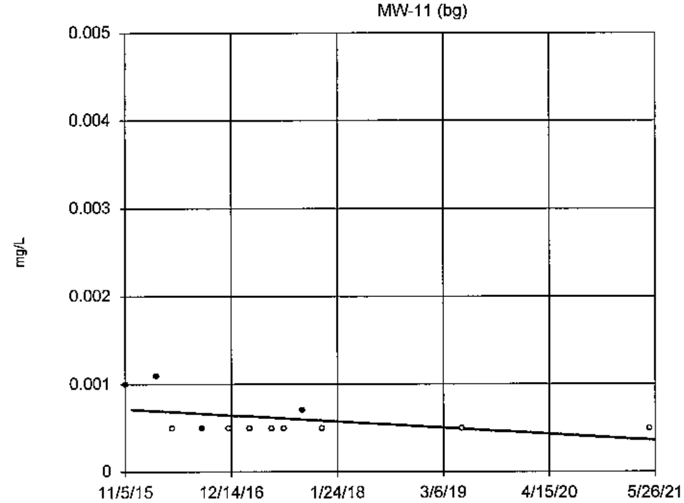
Hollow symbols indicate censored values.

Linear Regression

MW-11 (bg)



n = 12
66.67% NDs

Slope = -0.00006346
units/year.

alpha = 0.02
t = -1.585
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.8483, critical
= 0.805.

Constituent: Lead   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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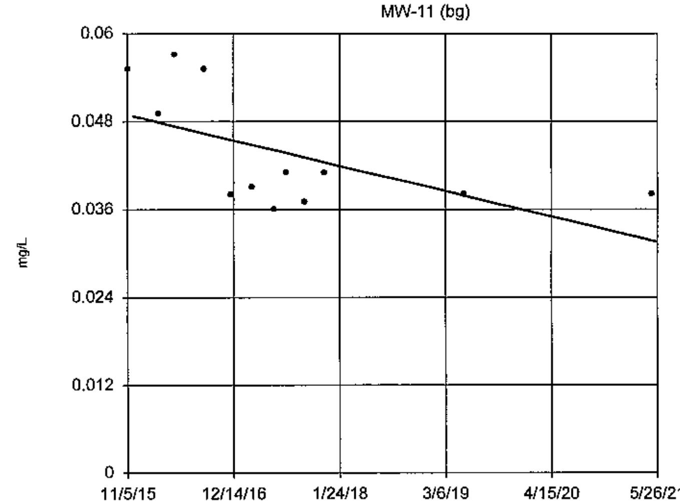
Linear Regression

MW-11 (bg)



n = 12

Slope = -0.003135
units/year.

alpha = 0.02
t = -2.365
critical = -2.359

Significant decreasing trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9183, critical
= 0.805.

Constituent: Lithium   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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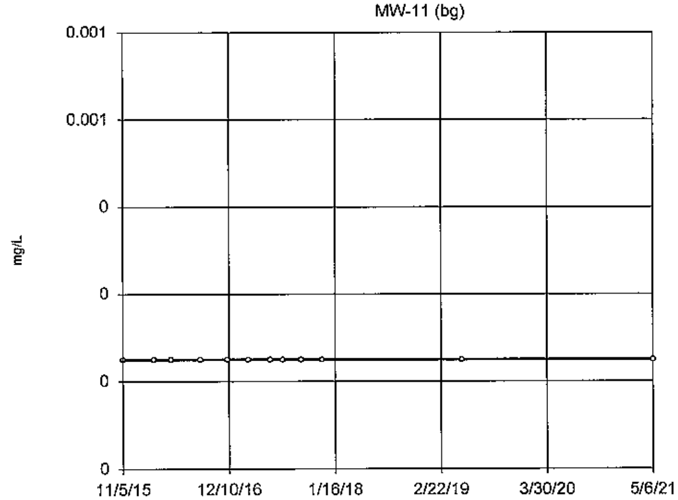
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-11 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Mercury   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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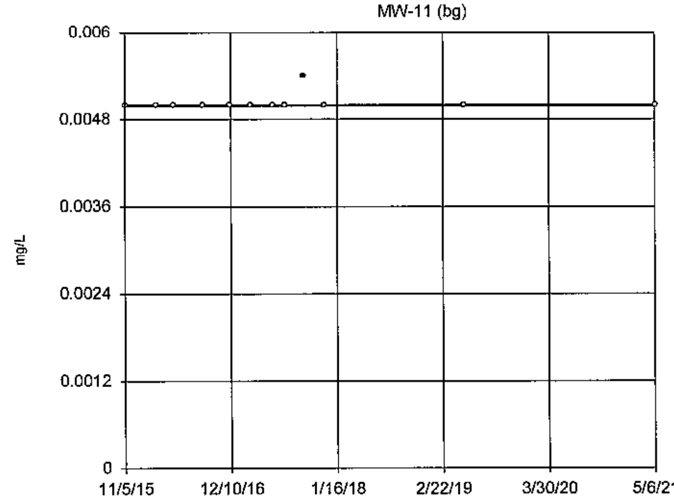
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-11 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 5
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Molybdenum   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

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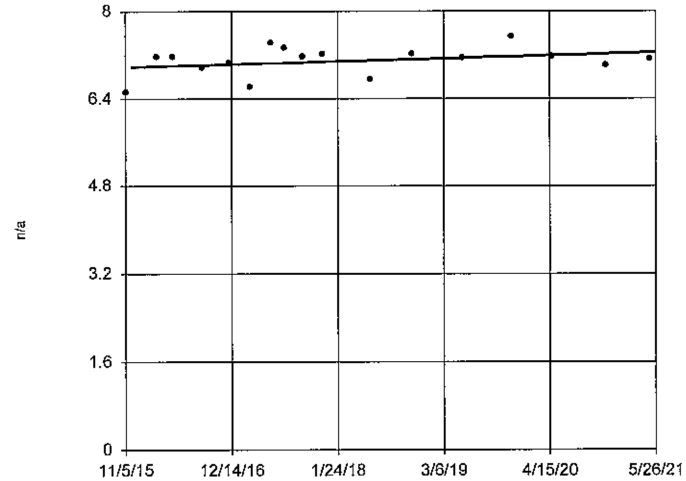
Linear Regression

MW-11 (bg)



n = 17

Slope = 0.0456 units/year.

alpha = 0.02
t = 1.187
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9459, critical = 0.851.

Constituent: pH Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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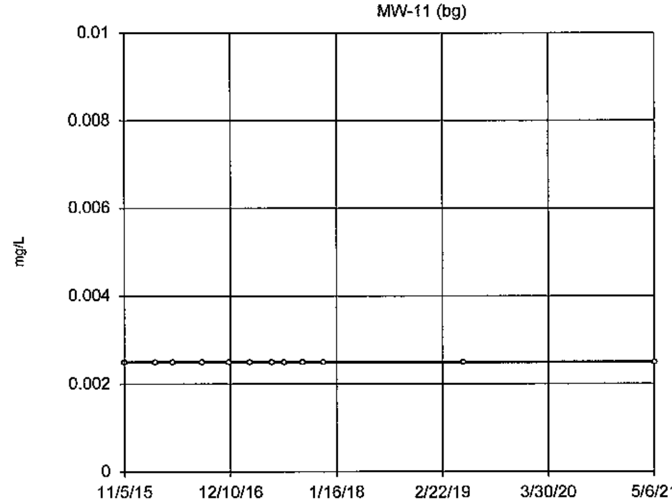
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-11 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = 0 critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Selenium Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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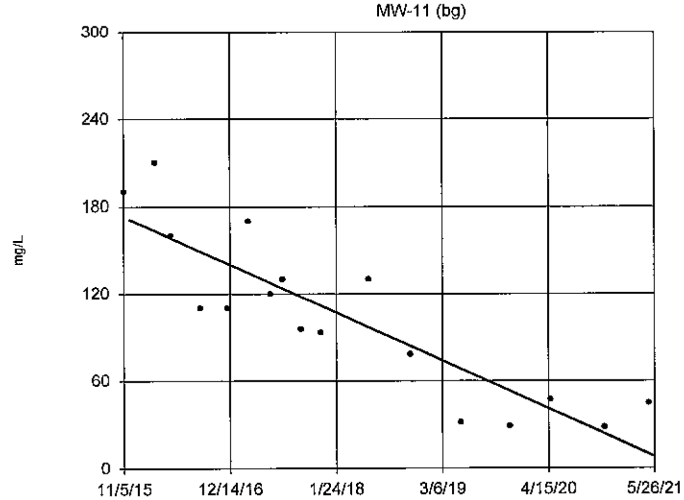
Linear Regression

MW-11 (bg)



n = 17

Slope = -29.74 units/year.

alpha = 0.02
t = -7.253
critical = -2.249

Significant decreasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9492, critical = 0.851.

Constituent: Sulfate Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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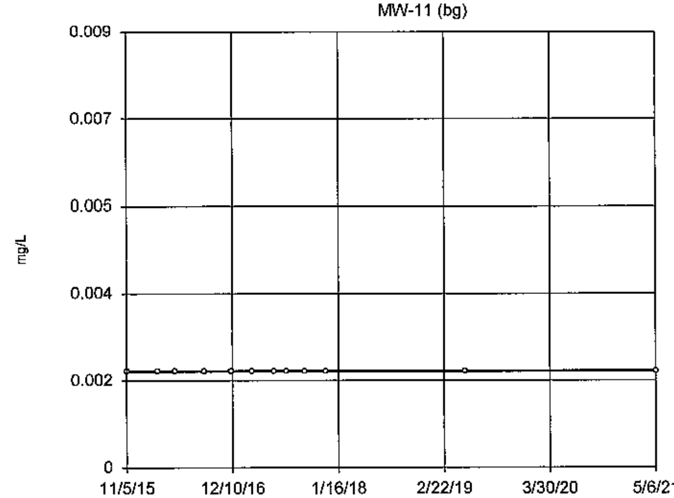
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-11 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = 0 critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Thallium Analysis Run 8/4/2021 3:30 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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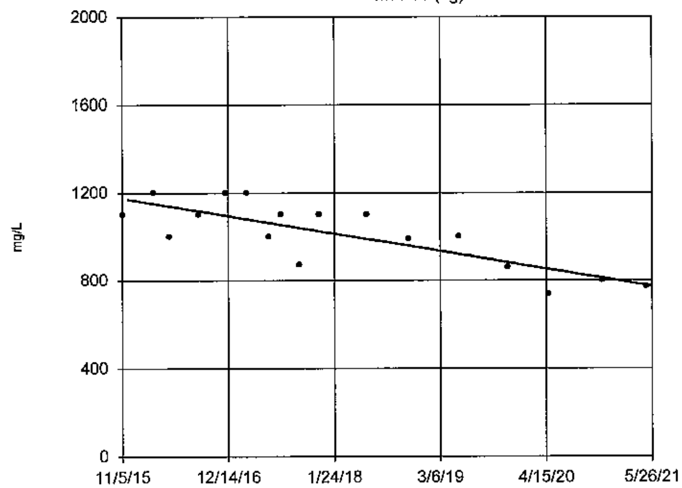
Linear Regression

MW-11 (bg)



n = 17

Slope = -72.27 units/year.

alpha = 0.02
t = -5.328
critical = -2.249

Significant decreasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9502, critical = 0.851.

Constituent: Total Dissolved Solids   Analysis Run 8/4/2021 3:30 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Trend Test MW-14

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 3:29 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony (mg/L)	MW-14 (bg)	-0.00...	-0.9015	2.359	No	12	50	Yes	no	0.02	Param.
Arsenic (mg/L)	MW-14 (bg)	0.07228	0.219	2.359	No	12	0	Yes	natura...	0.02	Param.
Barium (mg/L)	MW-14 (bg)	-0.07845	-0.4343	2.359	No	12	0	Yes	natura...	0.02	Param.
Beryllium (mg/L)	MW-14 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Boron (mg/L)	**MW-14 (bg)**	**-0.1794**	**-3.686**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**natura...**	**0.02**	**Param.**
Cadmium (mg/L)	MW-14 (bg)	0	4	35	No	12	66.67	n/a	n/a	0.02	NP (Nor...
Calcium (mg/L)	**MW-14 (bg)**	**-11.21**	**-2.384**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**
Chloride (mg/L)	**MW-14 (bg)**	**-28.75**	**-2.956**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**
Chromium (mg/L)	MW-14 (bg)	0.02051	0.03673	2.359	No	12	0	Yes	natura...	0.02	Param.
Cobalt (mg/L)	MW-14 (bg)	-0.00...	-0.8009	2.359	No	12	33.33	Yes	no	0.02	Param.
Combined Radium 226 + 228 (pCi/L)	MW-14 (bg)	-0.01607	-0.2933	2.359	No	12	41.67	Yes	no	0.02	Param.
Fluoride (mg/L)	MW-14 (bg)	0.004056	0.5467	2.249	No	17	0	Yes	no	0.02	Param.
Lead (mg/L)	MW-14 (bg)	0	-12	-35	No	12	66.67	n/a	n/a	0.02	NP (Nor...
Lithium (mg/L)	MW-14 (bg)	-0.00...	-1.396	2.359	No	12	0	Yes	no	0.02	Param.
Mercury (mg/L)	MW-14 (bg)	0	1	35	No	12	91.67	n/a	n/a	0.02	NP (NDs)
Molybdenum (mg/L)	MW-14 (bg)	0	3	35	No	12	83.33	n/a	n/a	0.02	NP (NDs)
pH (n/a)	MW-14 (bg)	0.04034	1.131	2.249	No	17	0	Yes	no	0.02	Param.
Selenium (mg/L)	MW-14 (bg)	0	2	35	No	12	75	n/a	n/a	0.02	NP (Nor...
Sulfate (mg/L)	**MW-14 (bg)**	**-0.4962**	**-6.623**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**natura...**	**0.02**	**Param.**
Thallium (mg/L)	MW-14 (bg)	0	0	35	No	12	100	n/a	n/a	0.02	NP (NDs)
Total Dissolved Solids (mg/L)	**MW-14 (bg)**	**-122.4**	**-3.685**	**-2.249**	**Yes**	**17**	**0**	**Yes**	**no**	**0.02**	**Param.**

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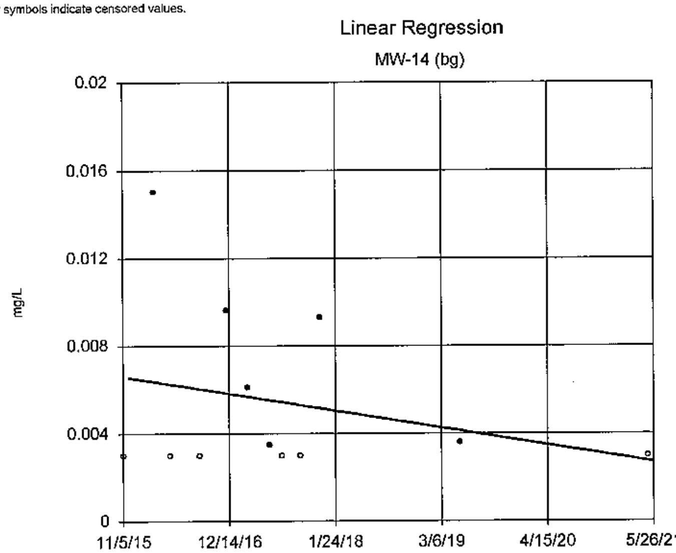
Hollow symbols indicate censored values.



n = 12
50% NDs

Slope = -0.0007012
units/year.

alpha = 0.02
t = -0.9015
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.8542, critical
= 0.805.

Constituent: Antimony Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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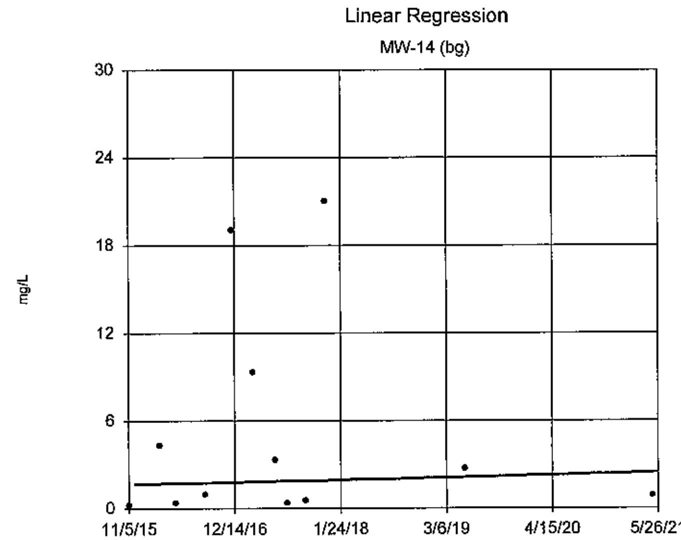

n = 12

Slope = 0.07228
natural log units/year.

alpha = 0.02
t = 0.219
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.927 after natural
log transformation,
critical = 0.805.

Constituent: Arsenic Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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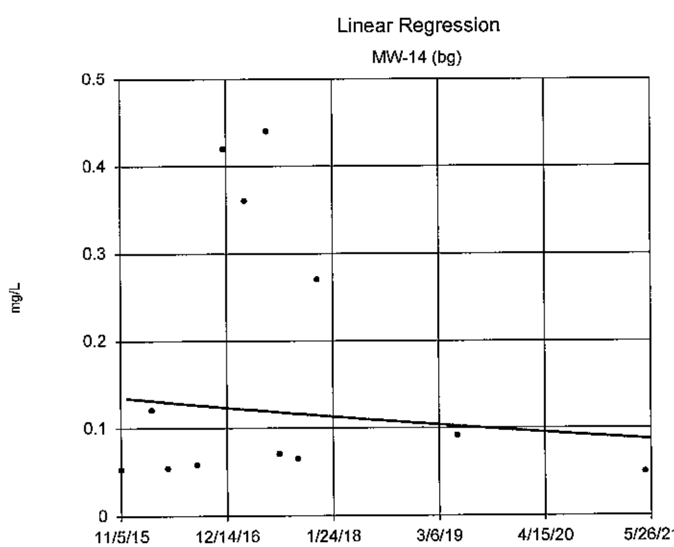


n = 12

Slope = -0.07845
natural log units/year.

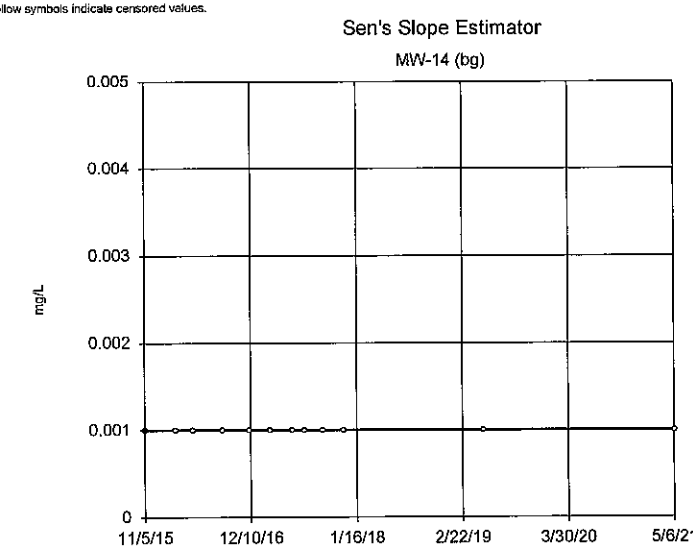
alpha = 0.02
t = -0.4343
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.8463 after natural
log transformation,
critical = 0.805.

Constituent: Barium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 12

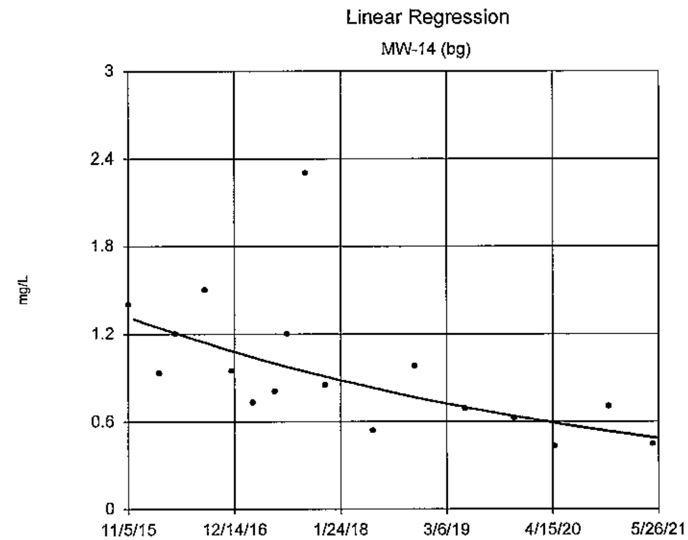
Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 35

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
censored data
exceeded 75%.

Constituent: Beryllium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG



n = 17

Slope = -0.1794
natural log units/year.

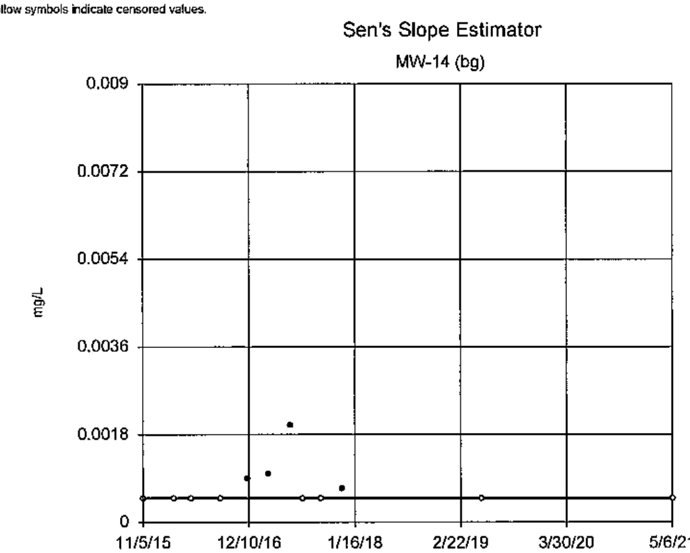
alpha = 0.02
t = -3.686
critical = -2.249

Significant decreasing trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9082 after natural
log transformation,
critical = 0.851.

Constituent: Boron Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG
Hollow symbols indicate censored values.



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 4
critical = 35

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).
Sen's Slope/Mann-Kendall used in
lieu of Linear
Regression because
the Shapiro Wilk
normality test
showed the residuals
to be non-normal
at the 0.01 alpha
level, calculated
= 0.7219, critical
= 0.805.

Constituent: Cadmium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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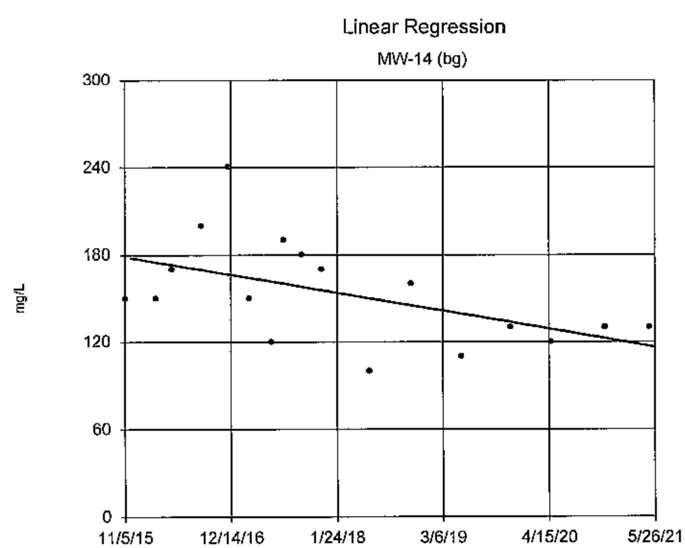

n = 17

Slope = -11.21
units/year.

alpha = 0.02
t = -2.384
critical = -2.249

Significant decreasing trend.

Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.9672, critical
= 0.851.

Constituent: Calcium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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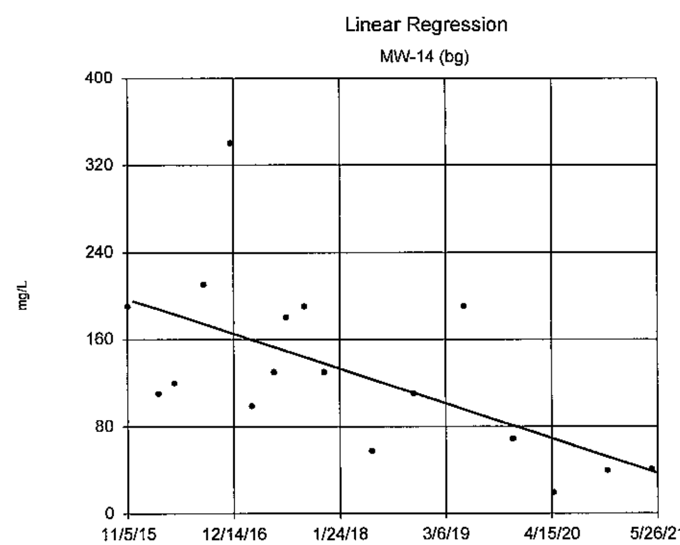


n = 17

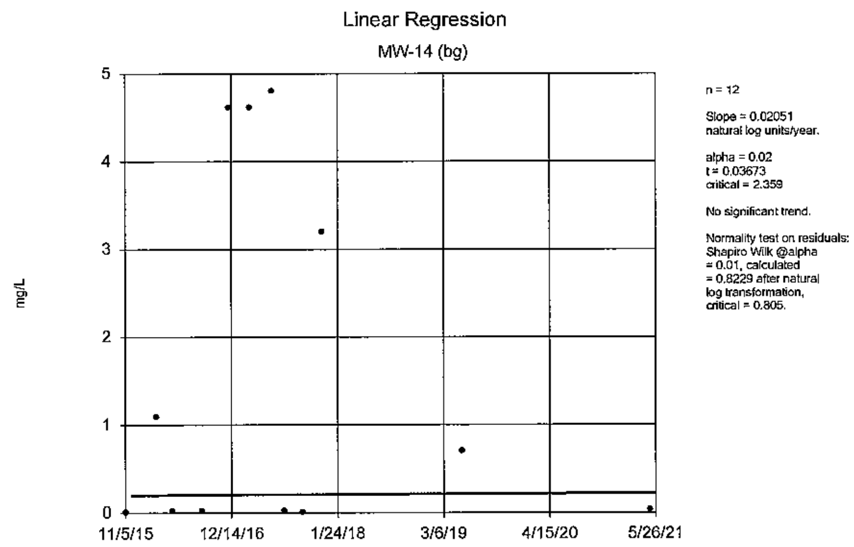
Slope = -28.75
units/year.

alpha = 0.02
t = -2.956
critical = -2.249

Significant decreasing trend.

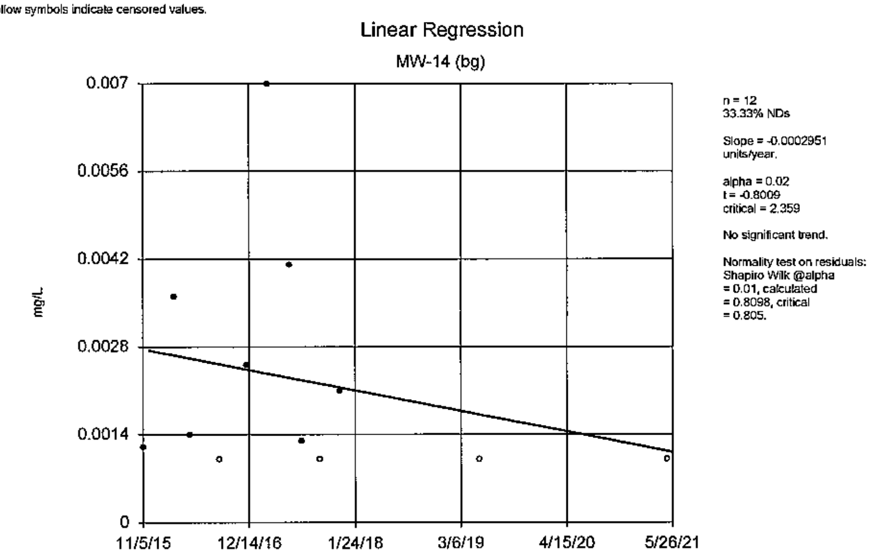
Normality test on residuals:
Shapiro Wilk @alpha
= 0.01, calculated
= 0.8905, critical
= 0.851.

Constituent: Chloride Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan



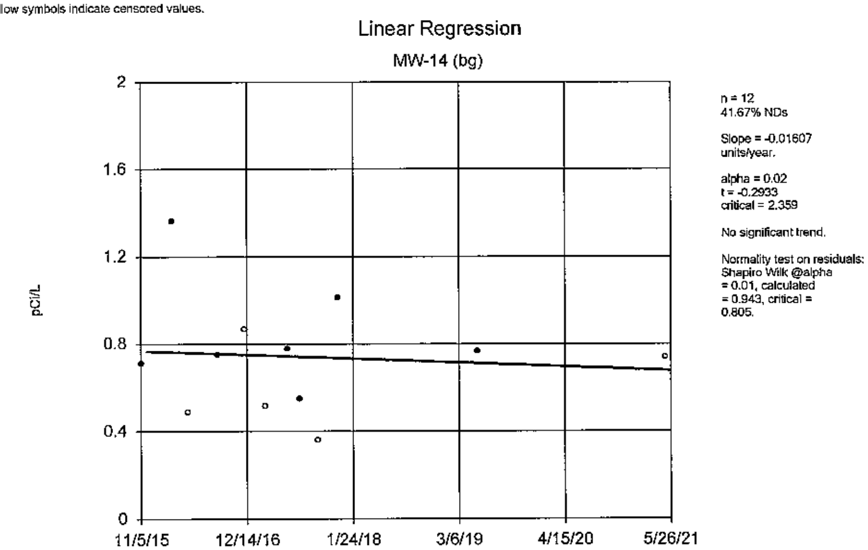
Constituent: Chromium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Hollow symbols indicate censored values.

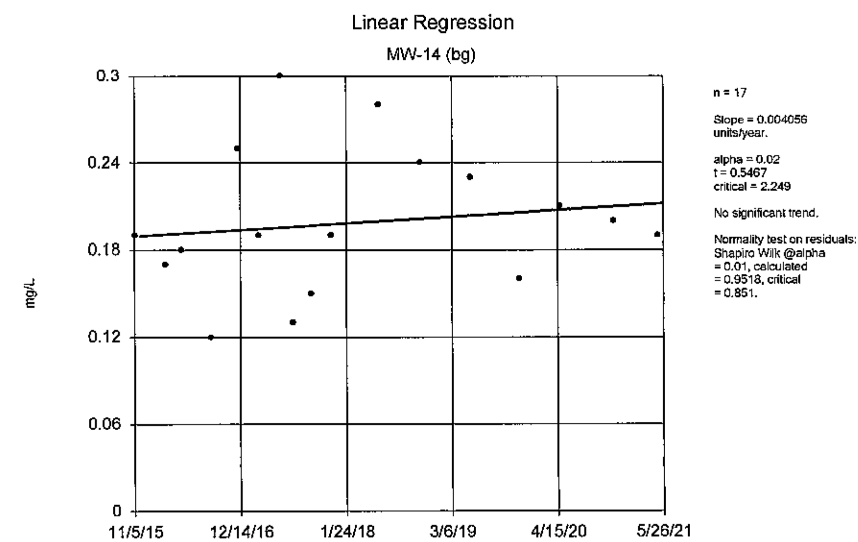


Constituent: Cobalt Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Hollow symbols indicate censored values.



Constituent: Combined Radium 226 + 228 Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan



Constituent: Fluoride Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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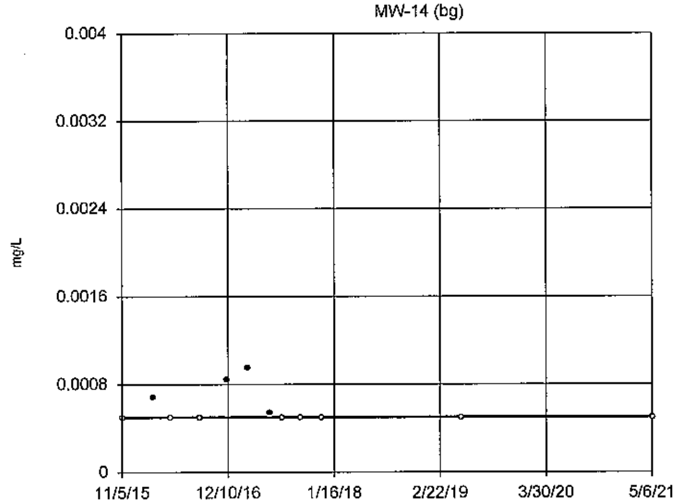
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-14 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -12
critical = -35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because the Shapiro Wilk normality test showed the residuals to be non-normal at the 0.01 alpha level, calculated = 0.7932, critical = 0.805.

Constituent: Lead Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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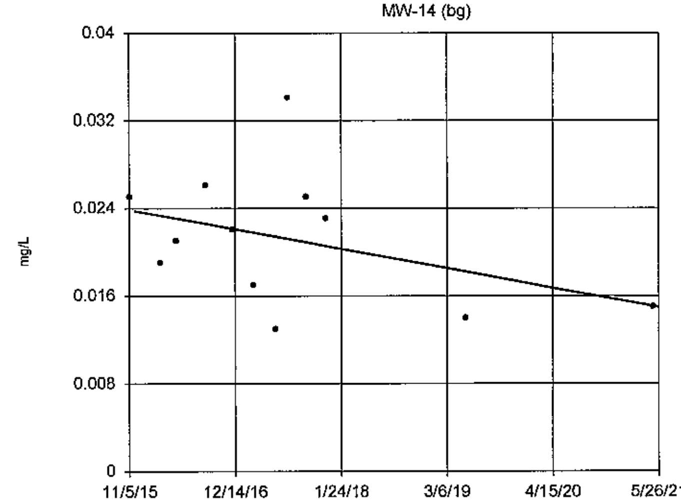
Linear Regression

MW-14 (bg)



n = 12

Slope = -0.001599
units/year.

alpha = 0.02
t = -1.396
critical = 2.359

No significant trend.

Normality test on residuals:
Shapiro Wilk @alpha = 0.01, calculated = 0.9419, critical = 0.805.

Constituent: Lithium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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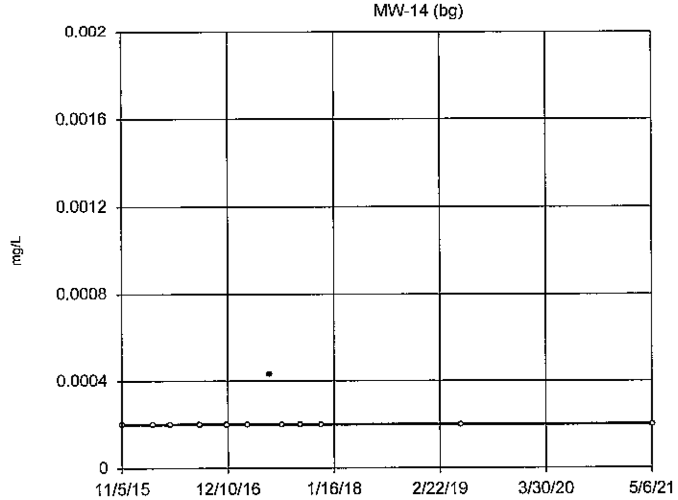
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-14 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 1
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Mercury Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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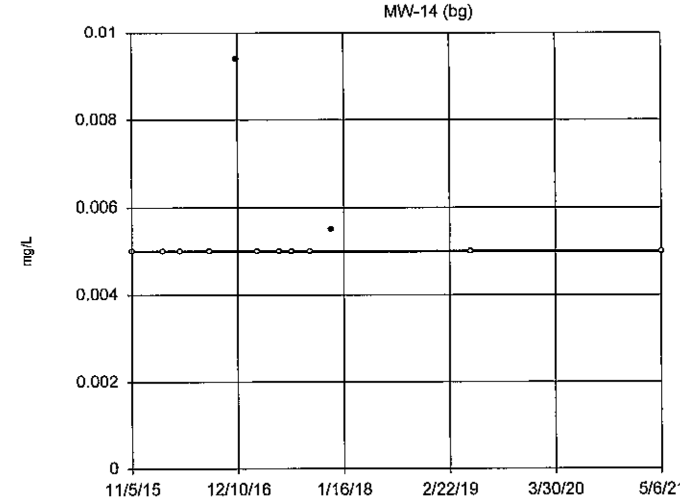
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-14 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 3
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Molybdenum Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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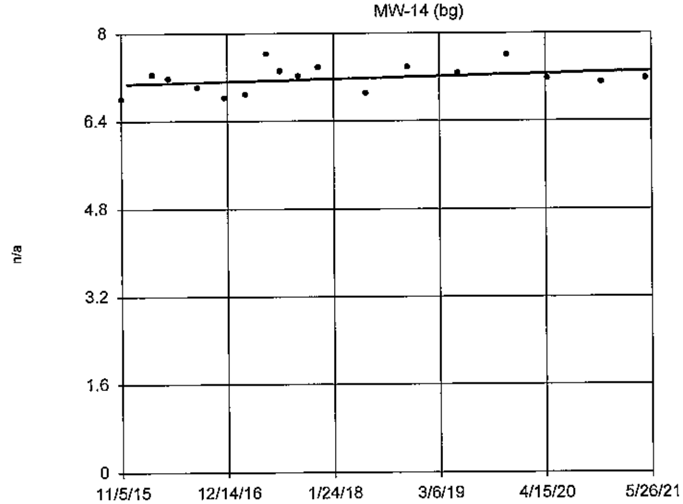
Linear Regression

MW-14 (bg)



n = 17

Slope = 0.04034 units/year.

alpha = 0.02
t = 1.131
critical = 2.249

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.948, critical = 0.851.

Constituent: pH Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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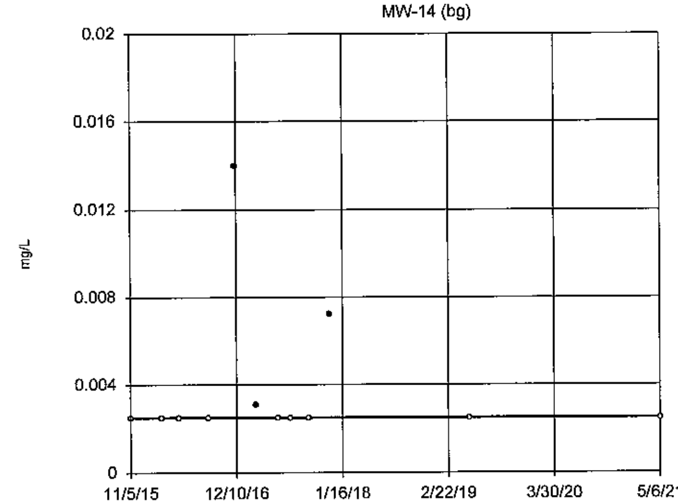
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-14 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = 2
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because the Shapiro Wilk normality test showed the residuals to be non-normal at the 0.01 alpha level, calculated = 0.5884, critical = 0.805.

Constituent: Selenium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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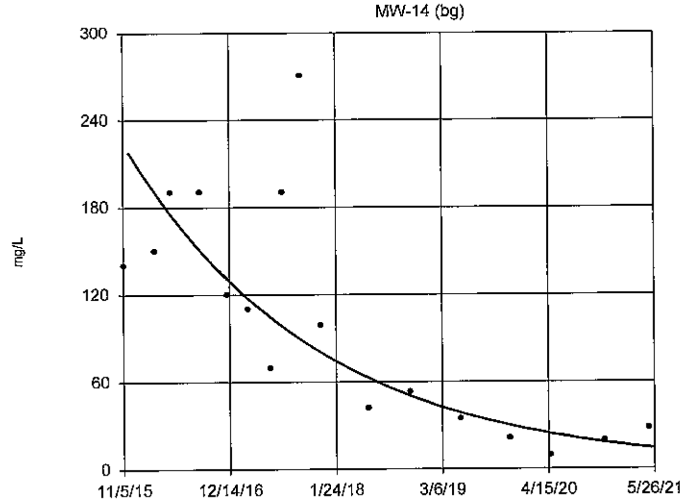
Linear Regression

MW-14 (bg)



n = 17

Slope = -0.4962 natural log units/year.

alpha = 0.02
t = -6.623
critical = -2.249

Significant decreasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.963 after natural log transformation, critical = 0.851.

Constituent: Sulfate Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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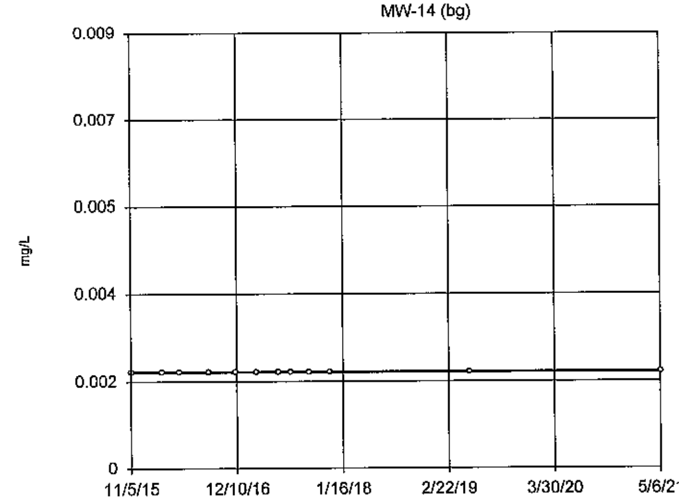
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-14 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = 0
critical = 35

Trend not significant at 98% confidence level (α = 0.01 per tail).
Sen's Slope/Mann-Kendall used in lieu of Linear Regression because censored data exceeded 75%.

Constituent: Thallium Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station Client: NRG Data: Waukegan

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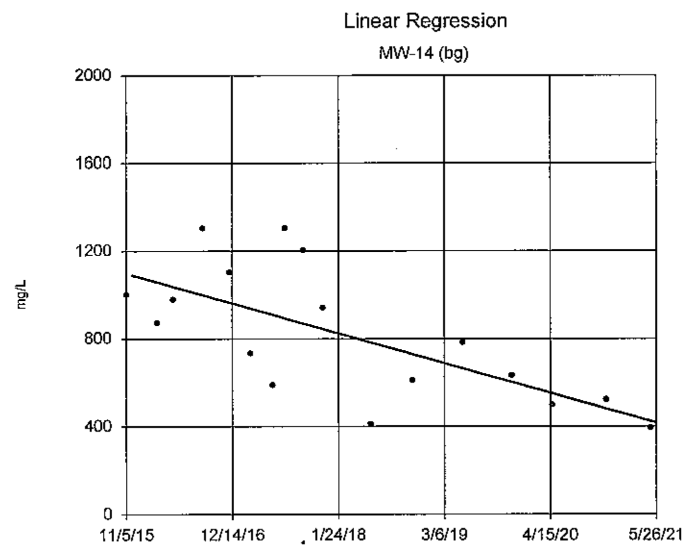


n = 17

Slope = -122.4 units/year.

alpha = 0.02
t = -3.685
critical = -2.249

Significant decreasing trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.976, critical = 0.851.

Constituent: Total Dissolved Solids   Analysis Run 8/4/2021 3:26 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Shapiro-Wilk Normality Test

Constituent: Antimony   Analysis Run 8/11/2021 10:46 AM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	0.327	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.6995	0.859	No
	square root	0.7266	0.859	No
	square	0.6178	0.859	No
	cube root	0.7332	0.859	No
	cube	0.5282	0.859	No
	natural log	0.7431	0.859	No
	x^4	0.4573	0.859	No
	x^5	0.4094	0.859	No
	x^6	0.3788	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.4054	0.935	No
	square root	0.4305	0.935	No
	square	0.3456	0.935	No
	cube root	0.4378	0.935	No
	cube	0.2885	0.935	No
	natural log	0.4508	0.935	No
	x^4	0.2458	0.935	No
	x^5	0.2176	0.935	No
	x^6	0.1999	0.935	No

Shapiro-Wilk Normality Test

Constituent: Arsenic   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.5615	0.859	No
	square root	0.6865	0.859	No
	square	0.4857	0.859	No
	cube root	0.748	0.859	No
	cube	0.4531	0.859	No
	natural log	0.8622	0.859	Yes
	x^4	0.4235	0.859	No
	x^5	0.3981	0.859	No
	x^6	0.3783	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9632	0.859	Yes
	square root	0.9808	0.859	Yes
	square	0.8883	0.859	Yes
	cube root	0.9824	0.859	Yes
	cube	0.7936	0.859	No
	natural log	0.9779	0.859	Yes
	x^4	0.7019	0.859	No
	x^5	0.6223	0.859	No
	x^6	0.5571	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7075	0.859	No
	square root	0.8377	0.859	No
	square	0.5697	0.859	No
	cube root	0.8818	0.859	Yes
	cube	0.5228	0.859	No
	natural log	0.9416	0.859	Yes
	x^4	0.5039	0.859	No
	x^5	0.4941	0.859	No
	x^6	0.4871	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.4454	0.935	No
	square root	0.7144	0.935	No
	square	0.3108	0.935	No
	cube root	0.8464	0.935	No
	cube	0.2794	0.935	No
	natural log	0.8757	0.935	No
	x^4	0.2674	0.935	No
	x^5	0.2612	0.935	No
	x^6	0.2569	0.935	No

Shapiro-Wilk Normality Test

Constituent: Barium   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.7869	0.859	No
	square root	0.8897	0.859	Yes
	square	0.5734	0.859	No
	cube root	0.915	0.859	Yes
	cube	0.4445	0.859	No
	natural log	0.946	0.859	Yes
	x^4	0.3822	0.859	No
	x^5	0.3531	0.859	No
	x^6	0.3395	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9237	0.859	Yes
	square root	0.9164	0.859	Yes
	square	0.9326	0.859	Yes
	cube root	0.9135	0.859	Yes
	cube	0.9324	0.859	Yes
	natural log	0.9074	0.859	Yes
	x^4	0.9223	0.859	Yes
	x^5	0.9024	0.859	Yes
	x^6	0.874	0.859	Yes
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7529	0.859	No
	square root	0.7863	0.859	No
	square	0.7013	0.859	No
	cube root	0.798	0.859	No
	cube	0.6658	0.859	No
	natural log	0.8211	0.859	No
	x^4	0.6383	0.859	No
	x^5	0.6153	0.859	No
	x^6	0.5957	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.5674	0.935	No
	square root	0.7472	0.935	No
	square	0.4139	0.935	No
	cube root	0.8159	0.935	No
	cube	0.37	0.935	No
	natural log	0.9193	0.935	No
	x^4	0.3487	0.935	No
	x^5	0.3334	0.935	No
	x^6	0.3211	0.935	No

Shapiro-Wilk Normality Test

Constituent: Beryllium   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	-1	0.935	No
	square root	0	0.935	No
	square	-1	0.935	No
	cube root	0	0.935	No
	cube	-1	0.935	No
	natural log	0	0.935	No
	x^4	-1	0.935	No
	x^5	-1	0.935	No
	x^6	-1	0.935	No

Shapiro-Wilk Normality Test

Constituent: Boron Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.9646	0.892	Yes
	square root	0.9154	0.892	Yes
	square	0.9705	0.892	Yes
	cube root	0.8885	0.892	No
	cube	0.9304	0.892	Yes
	natural log	0.8183	0.892	No
	x^4	0.8783	0.892	No
	x^5	0.8231	0.892	No
	x^6	0.7688	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9147	0.892	Yes
	square root	0.9441	0.892	Yes
	square	0.8366	0.892	No
	cube root	0.9515	0.892	Yes
	cube	0.7521	0.892	No
	natural log	0.9624	0.892	Yes
	x^4	0.676	0.892	No
	x^5	0.6134	0.892	No
	x^6	0.5642	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.8711	0.892	No
	square root	0.9416	0.892	Yes
	square	0.686	0.892	No
	cube root	0.9584	0.892	Yes
	cube	0.5247	0.892	No
	natural log	0.9798	0.892	Yes
	x^4	0.4185	0.892	No
	x^5	0.3551	0.892	No
	x^6	0.318	0.892	No
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.7489	0.954	No
	square root	0.8379	0.954	No
	square	0.648	0.954	No
	cube root	0.8727	0.954	No
	cube	0.5798	0.954	No
	natural log	0.9336	0.954	No
	x^4	0.5196	0.954	No
	x^5	0.466	0.954	No
	x^6	0.4188	0.954	No

Shapiro-Wilk Normality Test

Constituent: Cadmium Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.3421	0.859	No
	square root	0.3455	0.859	No
	square	0.3367	0.859	No
	cube root	0.3467	0.859	No
	cube	0.3329	0.859	No
	natural log	0.3494	0.859	No
	x^4	0.3305	0.859	No
	x^5	0.329	0.859	No
	x^6	0.3281	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.5748	0.859	No
	square root	0.6208	0.859	No
	square	0.4792	0.859	No
	cube root	0.6341	0.859	No
	cube	0.409	0.859	No
	natural log	0.6566	0.859	No
	x^4	0.3684	0.859	No
	x^5	0.3474	0.859	No
	x^6	0.3369	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.3764	0.935	No
	square root	0.405	0.935	No
	square	0.3079	0.935	No
	cube root	0.4128	0.935	No
	cube	0.2497	0.935	No
	natural log	0.4256	0.935	No
	x^4	0.2129	0.935	No
	x^5	0.1926	0.935	No
	x^6	0.1819	0.935	No

Shapiro-Wilk Normality Test

Constituent: Calcium   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8672	0.892	No
	square root	0.9132	0.892	Yes
	square	0.7572	0.892	No
	cube root	0.9263	0.892	Yes
	cube	0.6462	0.892	No
	natural log	0.9487	0.892	Yes
	x^4	0.5519	0.892	No
	x^5	0.479	0.892	No
	x^6	0.4251	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9568	0.892	Yes
	square root	0.9607	0.892	Yes
	square	0.9367	0.892	Yes
	cube root	0.9611	0.892	Yes
	cube	0.9012	0.892	Yes
	natural log	0.9605	0.892	Yes
	x^4	0.8526	0.892	No
	x^5	0.795	0.892	No
	x^6	0.733	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9546	0.892	Yes
	square root	0.9727	0.892	Yes
	square	0.8964	0.892	Yes
	cube root	0.977	0.892	Yes
	cube	0.8171	0.892	No
	natural log	0.9828	0.892	Yes
	x^4	0.7292	0.892	No
	x^5	0.6441	0.892	No
	x^6	0.5688	0.892	No
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.8343	0.954	No
	square root	0.903	0.954	No
	square	0.6591	0.954	No
	cube root	0.9215	0.954	No
	cube	0.4854	0.954	No
	natural log	0.9513	0.954	No
	x^4	0.3529	0.954	No
	x^5	0.2653	0.954	No
	x^6	0.2102	0.954	No

Shapiro-Wilk Normality Test

Constituent: Chloride   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8883	0.892	No
	square root	0.8825	0.892	No
	square	0.7863	0.892	No
	cube root	0.8731	0.892	No
	cube	0.6465	0.892	No
	natural log	0.8472	0.892	No
	x^4	0.5435	0.892	No
	x^5	0.4757	0.892	No
	x^6	0.4305	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9432	0.892	Yes
	square root	0.9452	0.892	Yes
	square	0.9288	0.892	Yes
	cube root	0.945	0.892	Yes
	cube	0.9042	0.892	Yes
	natural log	0.9432	0.892	Yes
	x^4	0.8734	0.892	No
	x^5	0.8394	0.892	No
	x^6	0.8047	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9254	0.892	Yes
	square root	0.9705	0.892	Yes
	square	0.72	0.892	No
	cube root	0.9695	0.892	Yes
	cube	0.5312	0.892	No
	natural log	0.9413	0.892	Yes
	x^4	0.4136	0.892	No
	x^5	0.3475	0.892	No
	x^6	0.3107	0.892	No
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.8907	0.954	No
	square root	0.9809	0.954	Yes
	square	0.5859	0.954	No
	cube root	0.9785	0.954	Yes
	cube	0.384	0.954	No
	natural log	0.9157	0.954	No
	x^4	0.2783	0.954	No
	x^5	0.2218	0.954	No
	x^6	0.1894	0.954	No

Shapiro-Wilk Normality Test

Constituent: Chromium Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.5859	0.859	No
	square root	0.5798	0.859	No
	square	0.59	0.859	No
	cube root	0.5777	0.859	No
	cube	0.5823	0.859	No
	natural log	0.5736	0.859	No
	x^4	0.5686	0.859	No
	x^5	0.5539	0.859	No
	x^6	0.5403	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.6032	0.859	No
	square root	0.6246	0.859	No
	square	0.5598	0.859	No
	cube root	0.6316	0.859	No
	cube	0.5181	0.859	No
	natural log	0.6453	0.859	No
	x^4	0.4804	0.859	No
	x^5	0.4477	0.859	No
	x^6	0.4206	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7307	0.859	No
	square root	0.7823	0.859	No
	square	0.6719	0.859	No
	cube root	0.7987	0.859	No
	cube	0.6477	0.859	No
	natural log	0.8244	0.859	No
	x^4	0.6329	0.859	No
	x^5	0.6224	0.859	No
	x^6	0.6152	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.4331	0.935	No
	square root	0.5086	0.935	No
	square	0.3844	0.935	No
	cube root	0.5539	0.935	No
	cube	0.3662	0.935	No
	natural log	0.6666	0.935	No
	x^4	0.3554	0.935	No
	x^5	0.3478	0.935	No
	x^6	0.3423	0.935	No

Shapiro-Wilk Normality Test

Constituent: Cobalt   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.585	0.859	No
	square root	0.5955	0.859	No
	square	0.5487	0.859	No
	cube root	0.5978	0.859	No
	cube	0.5005	0.859	No
	natural log	0.6007	0.859	No
	x^4	0.4531	0.859	No
	x^5	0.4145	0.859	No
	x^6	0.386	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7476	0.859	No
	square root	0.8121	0.859	No
	square	0.5948	0.859	No
	cube root	0.8287	0.859	No
	cube	0.478	0.859	No
	natural log	0.8534	0.859	No
	x^4	0.4098	0.859	No
	x^5	0.3726	0.859	No
	x^6	0.3524	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.5081	0.935	No
	square root	0.5686	0.935	No
	square	0.3701	0.935	No
	cube root	0.5845	0.935	No
	cube	0.2736	0.935	No
	natural log	0.6091	0.935	No
	x^4	0.2231	0.935	No
	x^5	0.198	0.935	No
	x^6	0.1852	0.935	No

Shapiro-Wilk Normality Test

Constituent: Combined Radium 226 + 228 Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9644	0.859	Yes
	square root	0.9888	0.859	Yes
	square	0.8502	0.859	No
	cube root	0.9889	0.859	Yes
	cube	0.7192	0.859	No
	natural log	0.9756	0.859	Yes
	x^4	0.6101	0.859	No
	x^5	0.529	0.859	No
	x^6	0.4712	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9677	0.859	Yes
	square root	0.9791	0.859	Yes
	square	0.916	0.859	Yes
	cube root	0.9802	0.859	Yes
	cube	0.8451	0.859	No
	natural log	0.9782	0.859	Yes
	x^4	0.7733	0.859	No
	x^5	0.7096	0.859	No
	x^6	0.6563	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.927	0.859	Yes
	square root	0.961	0.859	Yes
	square	0.8098	0.859	No
	cube root	0.967	0.859	Yes
	cube	0.6791	0.859	No
	natural log	0.9703	0.859	Yes
	x^4	0.5723	0.859	No
	x^5	0.4956	0.859	No
	x^6	0.4433	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.9405	0.935	Yes
	square root	0.9825	0.935	Yes
	square	0.8034	0.935	No
	cube root	0.9885	0.935	Yes
	cube	0.6644	0.935	No
	natural log	0.9845	0.935	Yes
	x^4	0.5531	0.935	No
	x^5	0.4708	0.935	No
	x^6	0.4109	0.935	No

Shapiro-Wilk Normality Test

Constituent: Fluoride Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8207	0.892	No
	square root	0.8688	0.892	No
	square	0.7053	0.892	No
	cube root	0.8827	0.892	No
	cube	0.5872	0.892	No
	natural log	0.9071	0.892	Yes
	x^4	0.4884	0.892	No
	x^5	0.4155	0.892	No
	x^6	0.3651	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.287	0.892	No
	square root	0.3453	0.892	No
	square	0.2638	0.892	No
	cube root	0.3814	0.892	No
	cube	0.2623	0.892	No
	natural log	0.4859	0.892	No
	x^4	0.2622	0.892	No
	x^5	0.2622	0.892	No
	x^6	0.2622	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9658	0.892	Yes
	square root	0.9769	0.892	Yes
	square	0.9197	0.892	Yes
	cube root	0.9784	0.892	Yes
	cube	0.8548	0.892	No
	natural log	0.978	0.892	Yes
	x^4	0.7851	0.892	No
	x^5	0.7194	0.892	No
	x^6	0.6612	0.892	No
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.1461	0.954	No
	square root	0.2686	0.954	No
	square	0.1017	0.954	No
	cube root	0.3478	0.954	No
	cube	0.09873	0.954	No
	natural log	0.5638	0.954	No
	x^4	0.09856	0.954	No
	x^5	0.09855	0.954	No
	x^6	0.09855	0.954	No

Shapiro-Wilk Normality Test

Constituent: Lead Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.3939	0.859	No
	square root	0.4063	0.859	No
	square	0.3721	0.859	No
	cube root	0.4106	0.859	No
	cube	0.3554	0.859	No
	natural log	0.4191	0.859	No
	x^4	0.3441	0.859	No
	x^5	0.3368	0.859	No
	x^6	0.3325	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.5791	0.859	No
	square root	0.5833	0.859	No
	square	0.5676	0.859	No
	cube root	0.5844	0.859	No
	cube	0.5535	0.859	No
	natural log	0.5863	0.859	No
	x^4	0.5385	0.859	No
	x^5	0.524	0.859	No
	x^6	0.5106	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.6233	0.859	No
	square root	0.6297	0.859	No
	square	0.6078	0.859	No
	cube root	0.6316	0.859	No
	cube	0.5891	0.859	No
	natural log	0.6351	0.859	No
	x^4	0.5684	0.859	No
	x^5	0.5468	0.859	No
	x^6	0.5254	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.5377	0.935	No
	square root	0.5468	0.935	No
	square	0.5144	0.935	No
	cube root	0.5494	0.935	No
	cube	0.4858	0.935	No
	natural log	0.5541	0.935	No
	x^4	0.4549	0.935	No
	x^5	0.4242	0.935	No
	x^6	0.3954	0.935	No

Shapiro-Wilk Normality Test

Constituent: Lithium Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9042	0.859	Yes
	square root	0.8906	0.859	Yes
	square	0.9228	0.859	Yes
	cube root	0.8855	0.859	Yes
	cube	0.9293	0.859	Yes
	natural log	0.8744	0.859	Yes
	x^4	0.9245	0.859	Yes
	x^5	0.9104	0.859	Yes
	x^6	0.8897	0.859	Yes
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.7941	0.859	No
	square root	0.8031	0.859	No
	square	0.7764	0.859	No
	cube root	0.8061	0.859	No
	cube	0.7596	0.859	No
	natural log	0.8121	0.859	No
	x^4	0.7437	0.859	No
	x^5	0.729	0.859	No
	x^6	0.7156	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.9517	0.859	Yes
	square root	0.9637	0.859	Yes
	square	0.8945	0.859	Yes
	cube root	0.9652	0.859	Yes
	cube	0.8054	0.859	No
	natural log	0.9646	0.859	Yes
	x^4	0.7069	0.859	No
	x^5	0.6171	0.859	No
	x^6	0.5439	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.914	0.935	No
	square root	0.9491	0.935	Yes
	square	0.8081	0.935	No
	cube root	0.9548	0.935	Yes
	cube	0.7119	0.935	No
	natural log	0.9551	0.935	Yes
	x^4	0.6419	0.935	No
	x^5	0.5917	0.935	No
	x^6	0.5536	0.935	No

Shapiro-Wilk Normality Test

Constituent: Mercury   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.1702	0.935	No
	square root	0.1702	0.935	No
	square	0.1702	0.935	No
	cube root	0.1702	0.935	No
	cube	0.1702	0.935	No
	natural log	0.1702	0.935	No
	x^4	0.1702	0.935	No
	x^5	0.1702	0.935	No
	x^6	-1	0.935	No

Shapiro-Wilk Normality Test

Constituent: Molybdenum Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9455	0.859	Yes
	square root	0.9027	0.859	Yes
	square	0.9308	0.859	Yes
	cube root	0.8753	0.859	Yes
	cube	0.8833	0.859	Yes
	natural log	0.8009	0.859	No
	x^4	0.8295	0.859	No
	x^5	0.7709	0.859	No
	x^6	0.7106	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	0.327	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.3766	0.859	No
	square root	0.3839	0.859	No
	square	0.3637	0.859	No
	cube root	0.3864	0.859	No
	cube	0.3533	0.859	No
	natural log	0.3915	0.859	No
	x^4	0.3452	0.859	No
	x^5	0.3393	0.859	No
	x^6	0.3351	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.6573	0.935	No
	square root	0.6598	0.935	No
	square	0.6116	0.935	No
	cube root	0.6564	0.935	No
	cube	0.5554	0.935	No
	natural log	0.6461	0.935	No
	x^4	0.5047	0.935	No
	x^5	0.459	0.935	No
	x^6	0.4168	0.935	No

Shapiro-Wilk Normality Test

Constituent: pH Analysis Run 8/11/2021 10:46 AM

Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.9688	0.892	Yes
	square root	0.9721	0.892	Yes
	square	0.961	0.892	Yes
	cube root	0.973	0.892	Yes
	cube	0.9515	0.892	Yes
	natural log	0.9748	0.892	Yes
	x^4	0.9405	0.892	Yes
	x^5	0.9282	0.892	Yes
	x^6	0.9147	0.892	Yes
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9132	0.892	Yes
	square root	0.9089	0.892	Yes
	square	0.9212	0.892	Yes
	cube root	0.9074	0.892	Yes
	cube	0.9284	0.892	Yes
	natural log	0.9044	0.892	Yes
	x^4	0.9346	0.892	Yes
	x^5	0.9399	0.892	Yes
	x^6	0.9442	0.892	Yes
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9588	0.892	Yes
	square root	0.9592	0.892	Yes
	square	0.9576	0.892	Yes
	cube root	0.9592	0.892	Yes
	cube	0.9556	0.892	Yes
	natural log	0.9593	0.892	Yes
	x^4	0.953	0.892	Yes
	x^5	0.9496	0.892	Yes
	x^6	0.9456	0.892	Yes
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.9526	0.954	No
	square root	0.9571	0.954	Yes
	square	0.9417	0.954	No
	cube root	0.9584	0.954	Yes
	cube	0.928	0.954	No
	natural log	0.9608	0.954	Yes
	x^4	0.9118	0.954	No
	x^5	0.8932	0.954	No
	x^6	0.8726	0.954	No

Shapiro-Wilk Normality Test

Constituent: Selenium   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9131	0.859	Yes
	square root	0.9037	0.859	Yes
	square	0.8407	0.859	No
	cube root	0.89	0.859	Yes
	cube	0.7556	0.859	No
	natural log	0.849	0.859	No
	x^4	0.6973	0.859	No
	x^5	0.6609	0.859	No
	x^6	0.6376	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.4879	0.859	No
	square root	0.514	0.859	No
	square	0.4306	0.859	No
	cube root	0.5216	0.859	No
	cube	0.3857	0.859	No
	natural log	0.5347	0.859	No
	x^4	0.3583	0.859	No
	x^5	0.3433	0.859	No
	x^6	0.3354	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	0.6195	0.935	No
	square root	0.6505	0.935	No
	square	0.5269	0.935	No
	cube root	0.6563	0.935	No
	cube	0.4496	0.935	No
	natural log	0.6613	0.935	No
	x^4	0.4005	0.935	No
	x^5	0.3709	0.935	No
	x^6	0.3523	0.935	No

Shapiro-Wilk Normality Test

Constituent: Sulfate   Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8637	0.892	No
	square root	0.9312	0.892	Yes
	square	0.704	0.892	No
	cube root	0.9486	0.892	Yes
	cube	0.5676	0.892	No
	natural log	0.9725	0.892	Yes
	x^4	0.4711	0.892	No
	x^5	0.4066	0.892	No
	x^6	0.3638	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9469	0.892	Yes
	square root	0.9385	0.892	Yes
	square	0.8855	0.892	No
	cube root	0.9288	0.892	Yes
	cube	0.7853	0.892	No
	natural log	0.9006	0.892	Yes
	x^4	0.6955	0.892	No
	x^5	0.6248	0.892	No
	x^6	0.5697	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9208	0.892	Yes
	square root	0.9534	0.892	Yes
	square	0.7898	0.892	No
	cube root	0.9549	0.892	Yes
	cube	0.6459	0.892	No
	natural log	0.9384	0.892	Yes
	x^4	0.5293	0.892	No
	x^5	0.4453	0.892	No
	x^6	0.3875	0.892	No
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.8337	0.954	No
	square root	0.9635	0.954	Yes
	square	0.5254	0.954	No
	cube root	0.9849	0.954	Yes
	cube	0.3308	0.954	No
	natural log	0.9763	0.954	Yes
	x^4	0.2316	0.954	No
	x^5	0.1804	0.954	No
	x^6	0.152	0.954	No

Shapiro-Wilk Normality Test

Constituent: Thallium Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 36, alpha = 0.05)				
	no	-1	0.935	No
	square root	0	0.935	No
	square	-1	0.935	No
	cube root	0	0.935	No
	cube	-1	0.935	No
	natural log	0	0.935	No
	x^4	-1	0.935	No
	x^5	-1	0.935	No
	x^6	-1	0.935	No

Shapiro-Wilk Normality Test

Constituent: Total Dissolved Solids Analysis Run 8/11/2021 10:46 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8932	0.892	Yes
	square root	0.9297	0.892	Yes
	square	0.7896	0.892	No
	cube root	0.9387	0.892	Yes
	cube	0.6772	0.892	No
	natural log	0.9516	0.892	Yes
	x^4	0.5834	0.892	No
	x^5	0.5145	0.892	No
	x^6	0.4661	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9083	0.892	Yes
	square root	0.9021	0.892	Yes
	square	0.916	0.892	Yes
	cube root	0.8997	0.892	Yes
	cube	0.9171	0.892	Yes
	natural log	0.8944	0.892	Yes
	x^4	0.9119	0.892	Yes
	x^5	0.9011	0.892	Yes
	x^6	0.8858	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9425	0.892	Yes
	square root	0.9508	0.892	Yes
	square	0.9027	0.892	Yes
	cube root	0.9514	0.892	Yes
	cube	0.8464	0.892	No
	natural log	0.9489	0.892	Yes
	x^4	0.7872	0.892	No
	x^5	0.7324	0.892	No
	x^6	0.6848	0.892	No
Pooled Background (bg) (n = 51 - Shapiro-Francia used, alpha = 0.05)				
	no	0.8472	0.954	No
	square root	0.9303	0.954	No
	square	0.6261	0.954	No
	cube root	0.9483	0.954	No
	cube	0.4418	0.954	No
	natural log	0.9665	0.954	Yes
	x^4	0.3253	0.954	No
	x^5	0.2568	0.954	No
	x^6	0.2161	0.954	No

Shapiro-Wilk Normality Test

Constituent: Antimony   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	0.327	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.2106	0.916	No
	square root	0.2106	0.916	No
	square	0.2106	0.916	No
	cube root	0.2106	0.916	No
	cube	0.2106	0.916	No
	natural log	0.2106	0.916	No
	x^4	0.2106	0.916	No
	x^5	0.2106	0.916	No
	x^6	0.2106	0.916	No

Shapiro-Wilk Normality Test

Constituent: Arsenic Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.5519	0.859	No
	square root	0.6459	0.859	No
	square	0.4855	0.859	No
	cube root	0.6911	0.859	No
	cube	0.4531	0.859	No
	natural log	0.7882	0.859	No
	x^4	0.4235	0.859	No
	x^5	0.3981	0.859	No
	x^6	0.3783	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9632	0.859	Yes
	square root	0.9808	0.859	Yes
	square	0.8883	0.859	Yes
	cube root	0.9824	0.859	Yes
	cube	0.7936	0.859	No
	natural log	0.9779	0.859	Yes
	x^4	0.7019	0.859	No
	x^5	0.6223	0.859	No
	x^6	0.5571	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.8272	0.916	No
	square root	0.8185	0.916	No
	square	0.7621	0.916	No
	cube root	0.8121	0.916	No
	cube	0.6438	0.916	No
	natural log	0.796	0.916	No
	x^4	0.5368	0.916	No
	x^5	0.4544	0.916	No
	x^6	0.3933	0.916	No

Shapiro-Wilk Normality Test

Constituent: Barium Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.7869	0.859	No
	square root	0.8897	0.859	Yes
	square	0.5734	0.859	No
	cube root	0.915	0.859	Yes
	cube	0.4445	0.859	No
	natural log	0.946	0.859	Yes
	x^4	0.3822	0.859	No
	x^5	0.3531	0.859	No
	x^6	0.3395	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9237	0.859	Yes
	square root	0.9164	0.859	Yes
	square	0.9326	0.859	Yes
	cube root	0.9135	0.859	Yes
	cube	0.9324	0.859	Yes
	natural log	0.9074	0.859	Yes
	x^4	0.9223	0.859	Yes
	x^5	0.9024	0.859	Yes
	x^6	0.874	0.859	Yes
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.875	0.916	No
	square root	0.8752	0.916	No
	square	0.8623	0.916	No
	cube root	0.8727	0.916	No
	cube	0.849	0.916	No
	natural log	0.8617	0.916	No
	x^4	0.8339	0.916	No
	x^5	0.8132	0.916	No
	x^6	0.7859	0.916	No

Shapiro-Wilk Normality Test

Constituent: Beryllium   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Boron Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.9646	0.892	Yes
	square root	0.9154	0.892	Yes
	square	0.9705	0.892	Yes
	cube root	0.8885	0.892	No
	cube	0.9304	0.892	Yes
	natural log	0.8183	0.892	No
	x^4	0.8783	0.892	No
	x^5	0.8231	0.892	No
	x^6	0.7688	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9147	0.892	Yes
	square root	0.9441	0.892	Yes
	square	0.8366	0.892	No
	cube root	0.9515	0.892	Yes
	cube	0.7521	0.892	No
	natural log	0.9624	0.892	Yes
	x^4	0.676	0.892	No
	x^5	0.6134	0.892	No
	x^6	0.5642	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8195	0.933	No
	square root	0.8383	0.933	No
	square	0.7752	0.933	No
	cube root	0.8444	0.933	No
	cube	0.7211	0.933	No
	natural log	0.8555	0.933	No
	x^4	0.665	0.933	No
	x^5	0.6117	0.933	No
	x^6	0.5628	0.933	No

Shapiro-Wilk Normality Test

Constituent: Cadmium   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.3421	0.859	No
	square root	0.3455	0.859	No
	square	0.3367	0.859	No
	cube root	0.3467	0.859	No
	cube	0.3329	0.859	No
	natural log	0.3494	0.859	No
	x^4	0.3305	0.859	No
	x^5	0.329	0.859	No
	x^6	0.3281	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.2208	0.916	No
	square root	0.2231	0.916	No
	square	0.2172	0.916	No
	cube root	0.224	0.916	No
	cube	0.2146	0.916	No
	natural log	0.2258	0.916	No
	x^4	0.213	0.916	No
	x^5	0.212	0.916	No
	x^6	0.2114	0.916	No

Shapiro-Wilk Normality Test

Constituent: Calcium Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8672	0.892	No
	square root	0.9132	0.892	Yes
	square	0.7572	0.892	No
	cube root	0.9263	0.892	Yes
	cube	0.6462	0.892	No
	natural log	0.9487	0.892	Yes
	x^4	0.5519	0.892	No
	x^5	0.479	0.892	No
	x^6	0.4251	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9568	0.892	Yes
	square root	0.9607	0.892	Yes
	square	0.9367	0.892	Yes
	cube root	0.9611	0.892	Yes
	cube	0.9012	0.892	Yes
	natural log	0.9605	0.892	Yes
	x^4	0.8526	0.892	No
	x^5	0.795	0.892	No
	x^6	0.733	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8338	0.933	No
	square root	0.8948	0.933	No
	square	0.6876	0.933	No
	cube root	0.9121	0.933	No
	cube	0.546	0.933	No
	natural log	0.9411	0.933	Yes
	x^4	0.4348	0.933	No
	x^5	0.3567	0.933	No
	x^6	0.3041	0.933	No

Shapiro-Wilk Normality Test

Constituent: Chloride   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8883	0.892	No
	square root	0.8825	0.892	No
	square	0.7863	0.892	No
	cube root	0.8731	0.892	No
	cube	0.6465	0.892	No
	natural log	0.8472	0.892	No
	x^4	0.5435	0.892	No
	x^5	0.4757	0.892	No
	x^6	0.4305	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9432	0.892	Yes
	square root	0.9452	0.892	Yes
	square	0.9288	0.892	Yes
	cube root	0.945	0.892	Yes
	cube	0.9042	0.892	Yes
	natural log	0.9432	0.892	Yes
	x^4	0.8734	0.892	No
	x^5	0.8394	0.892	No
	x^6	0.8047	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9189	0.933	No
	square root	0.959	0.933	Yes
	square	0.6751	0.933	No
	cube root	0.9392	0.933	Yes
	cube	0.4947	0.933	No
	natural log	0.8522	0.933	No
	x^4	0.3911	0.933	No
	x^5	0.331	0.933	No
	x^6	0.2942	0.933	No

Shapiro-Wilk Normality Test

Constituent: Chromium Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.5859	0.859	No
	square root	0.5798	0.859	No
	square	0.59	0.859	No
	cube root	0.5777	0.859	No
	cube	0.5823	0.859	No
	natural log	0.5736	0.859	No
	x^4	0.5686	0.859	No
	x^5	0.5539	0.859	No
	x^6	0.5403	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.6032	0.859	No
	square root	0.6246	0.859	No
	square	0.5598	0.859	No
	cube root	0.6316	0.859	No
	cube	0.5181	0.859	No
	natural log	0.6453	0.859	No
	x^4	0.4804	0.859	No
	x^5	0.4477	0.859	No
	x^6	0.4206	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.4266	0.916	No
	square root	0.4442	0.916	No
	square	0.4083	0.916	No
	cube root	0.452	0.916	No
	cube	0.3961	0.916	No
	natural log	0.4707	0.916	No
	x^4	0.384	0.916	No
	x^5	0.3722	0.916	No
	x^6	0.3617	0.916	No

Shapiro-Wilk Normality Test

Constituent: Cobalt   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.585	0.859	No
	square root	0.5955	0.859	No
	square	0.5487	0.859	No
	cube root	0.5978	0.859	No
	cube	0.5005	0.859	No
	natural log	0.6007	0.859	No
	x^4	0.4531	0.859	No
	x^5	0.4145	0.859	No
	x^6	0.386	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.3944	0.916	No
	square root	0.4032	0.916	No
	square	0.3672	0.916	No
	cube root	0.4054	0.916	No
	cube	0.3328	0.916	No
	natural log	0.4087	0.916	No
	x^4	0.2994	0.916	No
	x^5	0.2722	0.916	No
	x^6	0.2522	0.916	No

Shapiro-Wilk Normality Test

Constituent: Combined Radium 226 + 228 Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9644	0.859	Yes
	square root	0.9888	0.859	Yes
	square	0.8502	0.859	No
	cube root	0.9889	0.859	Yes
	cube	0.7192	0.859	No
	natural log	0.9756	0.859	Yes
	x^4	0.6101	0.859	No
	x^5	0.529	0.859	No
	x^6	0.4712	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9677	0.859	Yes
	square root	0.9791	0.859	Yes
	square	0.916	0.859	Yes
	cube root	0.9802	0.859	Yes
	cube	0.8451	0.859	No
	natural log	0.9782	0.859	Yes
	x^4	0.7733	0.859	No
	x^5	0.7096	0.859	No
	x^6	0.6563	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.9462	0.916	Yes
	square root	0.9797	0.916	Yes
	square	0.8289	0.916	No
	cube root	0.9834	0.916	Yes
	cube	0.7052	0.916	No
	natural log	0.9761	0.916	Yes
	x^4	0.6035	0.916	No
	x^5	0.5267	0.916	No
	x^6	0.4699	0.916	No

Shapiro-Wilk Normality Test

Constituent: Fluoride   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8207	0.892	No
	square root	0.8688	0.892	No
	square	0.7053	0.892	No
	cube root	0.8827	0.892	No
	cube	0.5872	0.892	No
	natural log	0.9071	0.892	Yes
	x^4	0.4884	0.892	No
	x^5	0.4155	0.892	No
	x^6	0.3651	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.287	0.892	No
	square root	0.3453	0.892	No
	square	0.2638	0.892	No
	cube root	0.3814	0.892	No
	cube	0.2623	0.892	No
	natural log	0.4859	0.892	No
	x^4	0.2622	0.892	No
	x^5	0.2622	0.892	No
	x^6	0.2622	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.2113	0.933	No
	square root	0.298	0.933	No
	square	0.1778	0.933	No
	cube root	0.3524	0.933	No
	cube	0.1756	0.933	No
	natural log	0.5068	0.933	No
	x^4	0.1755	0.933	No
	x^5	0.1755	0.933	No
	x^6	0.1755	0.933	No

Shapiro-Wilk Normality Test

Constituent: Lead Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.3939	0.859	No
	square root	0.4063	0.859	No
	square	0.3721	0.859	No
	cube root	0.4106	0.859	No
	cube	0.3554	0.859	No
	natural log	0.4191	0.859	No
	x^4	0.3441	0.859	No
	x^5	0.3368	0.859	No
	x^6	0.3325	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.5791	0.859	No
	square root	0.5833	0.859	No
	square	0.5676	0.859	No
	cube root	0.5844	0.859	No
	cube	0.5535	0.859	No
	natural log	0.5863	0.859	No
	x^4	0.5385	0.859	No
	x^5	0.524	0.859	No
	x^6	0.5106	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.4957	0.916	No
	square root	0.5035	0.916	No
	square	0.478	0.916	No
	cube root	0.506	0.916	No
	cube	0.4592	0.916	No
	natural log	0.5105	0.916	No
	x^4	0.4409	0.916	No
	x^5	0.4235	0.916	No
	x^6	0.4074	0.916	No

Shapiro-Wilk Normality Test

Constituent: Lithium Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9042	0.859	Yes
	square root	0.8906	0.859	Yes
	square	0.9228	0.859	Yes
	cube root	0.8855	0.859	Yes
	cube	0.9293	0.859	Yes
	natural log	0.8744	0.859	Yes
	x^4	0.9245	0.859	Yes
	x^5	0.9104	0.859	Yes
	x^6	0.8897	0.859	Yes
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.7941	0.859	No
	square root	0.8031	0.859	No
	square	0.7764	0.859	No
	cube root	0.8061	0.859	No
	cube	0.7596	0.859	No
	natural log	0.8121	0.859	No
	x^4	0.7437	0.859	No
	x^5	0.729	0.859	No
	x^6	0.7156	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.8589	0.916	No
	square root	0.8734	0.916	No
	square	0.8236	0.916	No
	cube root	0.8776	0.916	No
	cube	0.7839	0.916	No
	natural log	0.8849	0.916	No
	x^4	0.7442	0.916	No
	x^5	0.7067	0.916	No
	x^6	0.6721	0.916	No

Shapiro-Wilk Normality Test

Constituent: Mercury Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	-1	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Molybdenum Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9455	0.859	Yes
	square root	0.9027	0.859	Yes
	square	0.9308	0.859	Yes
	cube root	0.8753	0.859	Yes
	cube	0.8833	0.859	Yes
	natural log	0.8009	0.859	No
	x^4	0.8295	0.859	No
	x^5	0.7709	0.859	No
	x^6	0.7106	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	0.327	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.7853	0.916	No
	square root	0.7686	0.916	No
	square	0.7437	0.916	No
	cube root	0.7548	0.916	No
	cube	0.6796	0.916	No
	natural log	0.7199	0.916	No
	x^4	0.6197	0.916	No
	x^5	0.5644	0.916	No
	x^6	0.5128	0.916	No

Shapiro-Wilk Normality Test

Constituent: pH Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.9688	0.892	Yes
	square root	0.9721	0.892	Yes
	square	0.961	0.892	Yes
	cube root	0.973	0.892	Yes
	cube	0.9515	0.892	Yes
	natural log	0.9748	0.892	Yes
	x^4	0.9405	0.892	Yes
	x^5	0.9282	0.892	Yes
	x^6	0.9147	0.892	Yes
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9132	0.892	Yes
	square root	0.9089	0.892	Yes
	square	0.9212	0.892	Yes
	cube root	0.9074	0.892	Yes
	cube	0.9284	0.892	Yes
	natural log	0.9044	0.892	Yes
	x^4	0.9346	0.892	Yes
	x^5	0.9399	0.892	Yes
	x^6	0.9442	0.892	Yes
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9505	0.933	Yes
	square root	0.9544	0.933	Yes
	square	0.9408	0.933	Yes
	cube root	0.9555	0.933	Yes
	cube	0.9284	0.933	No
	natural log	0.9575	0.933	Yes
	x^4	0.9136	0.933	No
	x^5	0.8967	0.933	No
	x^6	0.8779	0.933	No

Shapiro-Wilk Normality Test

Constituent: Selenium   Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9131	0.859	Yes
	square root	0.9037	0.859	Yes
	square	0.8407	0.859	No
	cube root	0.89	0.859	Yes
	cube	0.7556	0.859	No
	natural log	0.849	0.859	No
	x^4	0.6973	0.859	No
	x^5	0.6609	0.859	No
	x^6	0.6376	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.7029	0.916	No
	square root	0.7176	0.916	No
	square	0.6275	0.916	No
	cube root	0.7178	0.916	No
	cube	0.5496	0.916	No
	natural log	0.7124	0.916	No
	x^4	0.4956	0.916	No
	x^5	0.4615	0.916	No
	x^6	0.4397	0.916	No

Shapiro-Wilk Normality Test

Constituent: Sulfate Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8637	0.892	No
	square root	0.9312	0.892	Yes
	square	0.704	0.892	No
	cube root	0.9486	0.892	Yes
	cube	0.5676	0.892	No
	natural log	0.9725	0.892	Yes
	x^4	0.4711	0.892	No
	x^5	0.4066	0.892	No
	x^6	0.3638	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9469	0.892	Yes
	square root	0.9385	0.892	Yes
	square	0.8855	0.892	No
	cube root	0.9288	0.892	Yes
	cube	0.7853	0.892	No
	natural log	0.9006	0.892	Yes
	x^4	0.6955	0.892	No
	x^5	0.6248	0.892	No
	x^6	0.5697	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8883	0.933	No
	square root	0.9629	0.933	Yes
	square	0.6449	0.933	No
	cube root	0.9694	0.933	Yes
	cube	0.4552	0.933	No
	natural log	0.9478	0.933	Yes
	x^4	0.3459	0.933	No
	x^5	0.2848	0.933	No
	x^6	0.249	0.933	No

Shapiro-Wilk Normality Test

Constituent: Thallium Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Total Dissolved Solids Analysis Run 8/11/2021 10:56 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8932	0.892	Yes
	square root	0.9297	0.892	Yes
	square	0.7896	0.892	No
	cube root	0.9387	0.892	Yes
	cube	0.6772	0.892	No
	natural log	0.9516	0.892	Yes
	x^4	0.5834	0.892	No
	x^5	0.5145	0.892	No
	x^6	0.4661	0.892	No
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9083	0.892	Yes
	square root	0.9021	0.892	Yes
	square	0.916	0.892	Yes
	cube root	0.8997	0.892	Yes
	cube	0.9171	0.892	Yes
	natural log	0.8944	0.892	Yes
	x^4	0.9119	0.892	Yes
	x^5	0.9011	0.892	Yes
	x^6	0.8858	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.7975	0.933	No
	square root	0.8628	0.933	No
	square	0.6527	0.933	No
	cube root	0.882	0.933	No
	cube	0.5239	0.933	No
	natural log	0.9154	0.933	No
	x^4	0.429	0.933	No
	x^5	0.3652	0.933	No
	x^6	0.3233	0.933	No

Shapiro-Wilk Normality Test

Constituent: Antimony   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	0.327	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.6995	0.859	No
	square root	0.7266	0.859	No
	square	0.6178	0.859	No
	cube root	0.7332	0.859	No
	cube	0.5282	0.859	No
	natural log	0.7431	0.859	No
	x^4	0.4573	0.859	No
	x^5	0.4094	0.859	No
	x^6	0.3788	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5045	0.916	No
	square root	0.5357	0.916	No
	square	0.4297	0.916	No
	cube root	0.5447	0.916	No
	cube	0.3581	0.916	No
	natural log	0.5605	0.916	No
	x^4	0.3048	0.916	No
	x^5	0.2696	0.916	No
	x^6	0.2475	0.916	No

Shapiro-Wilk Normality Test

Constituent: Arsenic   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.5519	0.859	No
	square root	0.6459	0.859	No
	square	0.4855	0.859	No
	cube root	0.6911	0.859	No
	cube	0.4531	0.859	No
	natural log	0.7882	0.859	No
	x^4	0.4235	0.859	No
	x^5	0.3981	0.859	No
	x^6	0.3783	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7075	0.859	No
	square root	0.8377	0.859	No
	square	0.5697	0.859	No
	cube root	0.8818	0.859	Yes
	cube	0.5228	0.859	No
	natural log	0.9416	0.859	Yes
	x^4	0.5039	0.859	No
	x^5	0.4941	0.859	No
	x^6	0.4871	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5203	0.916	No
	square root	0.7183	0.916	No
	square	0.3878	0.916	No
	cube root	0.8096	0.916	No
	cube	0.3501	0.916	No
	natural log	0.8873	0.916	No
	x^4	0.3351	0.916	No
	x^5	0.3272	0.916	No
	x^6	0.3215	0.916	No

Shapiro-Wilk Normality Test

Constituent: Barium Analysis Run 8/11/2021 10:59 AM

Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.7869	0.859	No
	square root	0.8897	0.859	Yes
	square	0.5734	0.859	No
	cube root	0.915	0.859	Yes
	cube	0.4445	0.859	No
	natural log	0.946	0.859	Yes
	x^4	0.3822	0.859	No
	x^5	0.3531	0.859	No
	x^6	0.3395	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7529	0.859	No
	square root	0.7863	0.859	No
	square	0.7013	0.859	No
	cube root	0.798	0.859	No
	cube	0.6658	0.859	No
	natural log	0.8211	0.859	No
	x^4	0.6383	0.859	No
	x^5	0.6153	0.859	No
	x^6	0.5957	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.6503	0.916	No
	square root	0.7961	0.916	No
	square	0.5095	0.916	No
	cube root	0.8491	0.916	No
	cube	0.4624	0.916	No
	natural log	0.9303	0.916	Yes
	x^4	0.437	0.916	No
	x^5	0.4181	0.916	No
	x^6	0.4026	0.916	No

Shapiro-Wilk Normality Test

Constituent: Beryllium   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Boron Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.9646	0.892	Yes
	square root	0.9154	0.892	Yes
	square	0.9705	0.892	Yes
	cube root	0.8885	0.892	No
	cube	0.9304	0.892	Yes
	natural log	0.8183	0.892	No
	x^4	0.8783	0.892	No
	x^5	0.8231	0.892	No
	x^6	0.7688	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.8711	0.892	No
	square root	0.9416	0.892	Yes
	square	0.686	0.892	No
	cube root	0.9584	0.892	Yes
	cube	0.5247	0.892	No
	natural log	0.9798	0.892	Yes
	x^4	0.4185	0.892	No
	x^5	0.3551	0.892	No
	x^6	0.318	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.7966	0.933	No
	square root	0.8016	0.933	No
	square	0.7706	0.933	No
	cube root	0.8047	0.933	No
	cube	0.7205	0.933	No
	natural log	0.8151	0.933	No
	x^4	0.6649	0.933	No
	x^5	0.6116	0.933	No
	x^6	0.5628	0.933	No

Shapiro-Wilk Normality Test

Constituent: Cadmium   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.3421	0.859	No
	square root	0.3455	0.859	No
	square	0.3367	0.859	No
	cube root	0.3467	0.859	No
	cube	0.3329	0.859	No
	natural log	0.3494	0.859	No
	x^4	0.3305	0.859	No
	x^5	0.329	0.859	No
	x^6	0.3281	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.5748	0.859	No
	square root	0.6208	0.859	No
	square	0.4792	0.859	No
	cube root	0.6341	0.859	No
	cube	0.409	0.859	No
	natural log	0.6566	0.859	No
	x^4	0.3684	0.859	No
	x^5	0.3474	0.859	No
	x^6	0.3369	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.4673	0.916	No
	square root	0.5036	0.916	No
	square	0.3811	0.916	No
	cube root	0.5135	0.916	No
	cube	0.3087	0.916	No
	natural log	0.5296	0.916	No
	x^4	0.2633	0.916	No
	x^5	0.2383	0.916	No
	x^6	0.2251	0.916	No

Shapiro-Wilk Normality Test

Constituent: Calcium   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8672	0.892	No
	square root	0.9132	0.892	Yes
	square	0.7572	0.892	No
	cube root	0.9263	0.892	Yes
	cube	0.6462	0.892	No
	natural log	0.9487	0.892	Yes
	x^4	0.5519	0.892	No
	x^5	0.479	0.892	No
	x^6	0.4251	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9546	0.892	Yes
	square root	0.9727	0.892	Yes
	square	0.8964	0.892	Yes
	cube root	0.977	0.892	Yes
	cube	0.8171	0.892	No
	natural log	0.9828	0.892	Yes
	x^4	0.7292	0.892	No
	x^5	0.6441	0.892	No
	x^6	0.5688	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8819	0.933	No
	square root	0.9367	0.933	Yes
	square	0.7351	0.933	No
	cube root	0.9509	0.933	Yes
	cube	0.5825	0.933	No
	natural log	0.9725	0.933	Yes
	x^4	0.4594	0.933	No
	x^5	0.3724	0.933	No
	x^6	0.314	0.933	No

Shapiro-Wilk Normality Test

Constituent: Chloride   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8883	0.892	No
	square root	0.8825	0.892	No
	square	0.7863	0.892	No
	cube root	0.8731	0.892	No
	cube	0.6465	0.892	No
	natural log	0.8472	0.892	No
	x^4	0.5435	0.892	No
	x^5	0.4757	0.892	No
	x^6	0.4305	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9254	0.892	Yes
	square root	0.9705	0.892	Yes
	square	0.72	0.892	No
	cube root	0.9695	0.892	Yes
	cube	0.5312	0.892	No
	natural log	0.9413	0.892	Yes
	x^4	0.4136	0.892	No
	x^5	0.3475	0.892	No
	x^6	0.3107	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8699	0.933	No
	square root	0.9539	0.933	Yes
	square	0.6504	0.933	No
	cube root	0.9647	0.933	Yes
	cube	0.4896	0.933	No
	natural log	0.946	0.933	Yes
	x^4	0.3911	0.933	No
	x^5	0.3318	0.933	No
	x^6	0.2949	0.933	No

Shapiro-Wilk Normality Test

Constituent: Chromium   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.5859	0.859	No
	square root	0.5798	0.859	No
	square	0.59	0.859	No
	cube root	0.5777	0.859	No
	cube	0.5823	0.859	No
	natural log	0.5736	0.859	No
	x^4	0.5686	0.859	No
	x^5	0.5539	0.859	No
	x^6	0.5403	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7307	0.859	No
	square root	0.7823	0.859	No
	square	0.6719	0.859	No
	cube root	0.7987	0.859	No
	cube	0.6477	0.859	No
	natural log	0.8244	0.859	No
	x^4	0.6329	0.859	No
	x^5	0.6224	0.859	No
	x^6	0.6152	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5369	0.916	No
	square root	0.6205	0.916	No
	square	0.4792	0.916	No
	cube root	0.6685	0.916	No
	cube	0.4573	0.916	No
	natural log	0.7827	0.916	No
	x^4	0.444	0.916	No
	x^5	0.4347	0.916	No
	x^6	0.4279	0.916	No

Shapiro-Wilk Normality Test

Constituent: Cobalt Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.585	0.859	No
	square root	0.5955	0.859	No
	square	0.5487	0.859	No
	cube root	0.5978	0.859	No
	cube	0.5005	0.859	No
	natural log	0.6007	0.859	No
	x^4	0.4531	0.859	No
	x^5	0.4145	0.859	No
	x^6	0.386	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7476	0.859	No
	square root	0.8121	0.859	No
	square	0.5948	0.859	No
	cube root	0.8287	0.859	No
	cube	0.478	0.859	No
	natural log	0.8534	0.859	No
	x^4	0.4098	0.859	No
	x^5	0.3726	0.859	No
	x^6	0.3524	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.6206	0.916	No
	square root	0.6949	0.916	No
	square	0.4527	0.916	No
	cube root	0.7143	0.916	No
	cube	0.3366	0.916	No
	natural log	0.7438	0.916	No
	x^4	0.2756	0.916	No
	x^5	0.2449	0.916	No
	x^6	0.2292	0.916	No

Shapiro-Wilk Normality Test

Constituent: Combined Radium 226 + 228 Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9644	0.859	Yes
	square root	0.9888	0.859	Yes
	square	0.8502	0.859	No
	cube root	0.9889	0.859	Yes
	cube	0.7192	0.859	No
	natural log	0.9756	0.859	Yes
	x^4	0.6101	0.859	No
	x^5	0.529	0.859	No
	x^6	0.4712	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.927	0.859	Yes
	square root	0.961	0.859	Yes
	square	0.8098	0.859	No
	cube root	0.967	0.859	Yes
	cube	0.6791	0.859	No
	natural log	0.9703	0.859	Yes
	x^4	0.5723	0.859	No
	x^5	0.4956	0.859	No
	x^6	0.4433	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.9513	0.916	Yes
	square root	0.9864	0.916	Yes
	square	0.8022	0.916	No
	cube root	0.9889	0.916	Yes
	cube	0.6305	0.916	No
	natural log	0.9779	0.916	Yes
	x^4	0.492	0.916	No
	x^5	0.3963	0.916	No
	x^6	0.3339	0.916	No

Shapiro-Wilk Normality Test

Constituent: Fluoride   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8207	0.892	No
	square root	0.8688	0.892	No
	square	0.7053	0.892	No
	cube root	0.8827	0.892	No
	cube	0.5872	0.892	No
	natural log	0.9071	0.892	Yes
	x^4	0.4884	0.892	No
	x^5	0.4155	0.892	No
	x^6	0.3651	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9658	0.892	Yes
	square root	0.9769	0.892	Yes
	square	0.9197	0.892	Yes
	cube root	0.9784	0.892	Yes
	cube	0.8548	0.892	No
	natural log	0.978	0.892	Yes
	x^4	0.7851	0.892	No
	x^5	0.7194	0.892	No
	x^6	0.6612	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9228	0.933	No
	square root	0.9433	0.933	Yes
	square	0.857	0.933	No
	cube root	0.948	0.933	Yes
	cube	0.7728	0.933	No
	natural log	0.9541	0.933	Yes
	x^4	0.6885	0.933	No
	x^5	0.6149	0.933	No
	x^6	0.5552	0.933	No

Shapiro-Wilk Normality Test

Constituent: Lead   Analysis Run 8/11/2021 10:59 AM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.3939	0.859	No
	square root	0.4063	0.859	No
	square	0.3721	0.859	No
	cube root	0.4106	0.859	No
	cube	0.3554	0.859	No
	natural log	0.4191	0.859	No
	x^4	0.3441	0.859	No
	x^5	0.3368	0.859	No
	x^6	0.3325	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.6233	0.859	No
	square root	0.6297	0.859	No
	square	0.6078	0.859	No
	cube root	0.6316	0.859	No
	cube	0.5891	0.859	No
	natural log	0.6351	0.859	No
	x^4	0.5684	0.859	No
	x^5	0.5468	0.859	No
	x^6	0.5254	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5116	0.916	No
	square root	0.527	0.916	No
	square	0.474	0.916	No
	cube root	0.5315	0.916	No
	cube	0.4311	0.916	No
	natural log	0.5398	0.916	No
	x^4	0.3884	0.916	No
	x^5	0.3502	0.916	No
	x^6	0.3186	0.916	No

Shapiro-Wilk Normality Test

Constituent: Lithium Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9042	0.859	Yes
	square root	0.8906	0.859	Yes
	square	0.9228	0.859	Yes
	cube root	0.8855	0.859	Yes
	cube	0.9293	0.859	Yes
	natural log	0.8744	0.859	Yes
	x^4	0.9245	0.859	Yes
	x^5	0.9104	0.859	Yes
	x^6	0.8897	0.859	Yes
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.9517	0.859	Yes
	square root	0.9637	0.859	Yes
	square	0.8945	0.859	Yes
	cube root	0.9652	0.859	Yes
	cube	0.8054	0.859	No
	natural log	0.9646	0.859	Yes
	x^4	0.7069	0.859	No
	x^5	0.6171	0.859	No
	x^6	0.5439	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.8607	0.916	No
	square root	0.8928	0.916	No
	square	0.796	0.916	No
	cube root	0.9018	0.916	No
	cube	0.7469	0.916	No
	natural log	0.9153	0.916	No
	x^4	0.7111	0.916	No
	x^5	0.6819	0.916	No
	x^6	0.6553	0.916	No

Shapiro-Wilk Normality Test

Constituent: Mercury Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.2106	0.916	No
	square root	0.2106	0.916	No
	square	0.2106	0.916	No
	cube root	0.2106	0.916	No
	cube	0.2106	0.916	No
	natural log	0.2106	0.916	No
	x^4	0.2106	0.916	No
	x^5	0.2106	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Molybdenum   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9455	0.859	Yes
	square root	0.9027	0.859	Yes
	square	0.9308	0.859	Yes
	cube root	0.8753	0.859	Yes
	cube	0.8833	0.859	Yes
	natural log	0.8009	0.859	No
	x^4	0.8295	0.859	No
	x^5	0.7709	0.859	No
	x^6	0.7106	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.3766	0.859	No
	square root	0.3839	0.859	No
	square	0.3637	0.859	No
	cube root	0.3864	0.859	No
	cube	0.3533	0.859	No
	natural log	0.3915	0.859	No
	x^4	0.3452	0.859	No
	x^5	0.3393	0.859	No
	x^6	0.3351	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.7864	0.916	No
	square root	0.7736	0.916	No
	square	0.7437	0.916	No
	cube root	0.7623	0.916	No
	cube	0.6796	0.916	No
	natural log	0.7342	0.916	No
	x^4	0.6197	0.916	No
	x^5	0.5644	0.916	No
	x^6	0.5128	0.916	No

Shapiro-Wilk Normality Test

Constituent: pH Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.9688	0.892	Yes
	square root	0.9721	0.892	Yes
	square	0.961	0.892	Yes
	cube root	0.973	0.892	Yes
	cube	0.9515	0.892	Yes
	natural log	0.9748	0.892	Yes
	x^4	0.9405	0.892	Yes
	x^5	0.9282	0.892	Yes
	x^6	0.9147	0.892	Yes
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9588	0.892	Yes
	square root	0.9592	0.892	Yes
	square	0.9576	0.892	Yes
	cube root	0.9592	0.892	Yes
	cube	0.9556	0.892	Yes
	natural log	0.9593	0.892	Yes
	x^4	0.953	0.892	Yes
	x^5	0.9496	0.892	Yes
	x^6	0.9456	0.892	Yes
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9605	0.933	Yes
	square root	0.9655	0.933	Yes
	square	0.9493	0.933	Yes
	cube root	0.967	0.933	Yes
	cube	0.9362	0.933	Yes
	natural log	0.97	0.933	Yes
	x^4	0.9215	0.933	No
	x^5	0.9053	0.933	No
	x^6	0.8879	0.933	No

Shapiro-Wilk Normality Test

Constituent: Selenium   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	0.9131	0.859	Yes
	square root	0.9037	0.859	Yes
	square	0.8407	0.859	No
	cube root	0.89	0.859	Yes
	cube	0.7556	0.859	No
	natural log	0.849	0.859	No
	x^4	0.6973	0.859	No
	x^5	0.6609	0.859	No
	x^6	0.6376	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.4879	0.859	No
	square root	0.514	0.859	No
	square	0.4306	0.859	No
	cube root	0.5216	0.859	No
	cube	0.3857	0.859	No
	natural log	0.5347	0.859	No
	x^4	0.3583	0.859	No
	x^5	0.3433	0.859	No
	x^6	0.3354	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.7531	0.916	No
	square root	0.7838	0.916	No
	square	0.6468	0.916	No
	cube root	0.7875	0.916	No
	cube	0.5556	0.916	No
	natural log	0.7855	0.916	No
	x^4	0.4975	0.916	No
	x^5	0.4621	0.916	No
	x^6	0.4399	0.916	No

Shapiro-Wilk Normality Test

Constituent: Sulfate   Analysis Run 8/11/2021 10:59 AM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8637	0.892	No
	square root	0.9312	0.892	Yes
	square	0.704	0.892	No
	cube root	0.9486	0.892	Yes
	cube	0.5676	0.892	No
	natural log	0.9725	0.892	Yes
	x^4	0.4711	0.892	No
	x^5	0.4066	0.892	No
	x^6	0.3638	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9208	0.892	Yes
	square root	0.9534	0.892	Yes
	square	0.7898	0.892	No
	cube root	0.9549	0.892	Yes
	cube	0.6459	0.892	No
	natural log	0.9384	0.892	Yes
	x^4	0.5293	0.892	No
	x^5	0.4453	0.892	No
	x^6	0.3875	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9046	0.933	No
	square root	0.9712	0.933	Yes
	square	0.6505	0.933	No
	cube root	0.9695	0.933	Yes
	cube	0.4561	0.933	No
	natural log	0.9223	0.933	No
	x^4	0.3461	0.933	No
	x^5	0.2849	0.933	No
	x^6	0.249	0.933	No

Shapiro-Wilk Normality Test

Constituent: Thallium Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Total Dissolved Solids   Analysis Run 8/11/2021 10:59 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 17, alpha = 0.05)				
	no	0.8932	0.892	Yes
	square root	0.9297	0.892	Yes
	square	0.7896	0.892	No
	cube root	0.9387	0.892	Yes
	cube	0.6772	0.892	No
	natural log	0.9516	0.892	Yes
	x^4	0.5834	0.892	No
	x^5	0.5145	0.892	No
	x^6	0.4661	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9425	0.892	Yes
	square root	0.9508	0.892	Yes
	square	0.9027	0.892	Yes
	cube root	0.9514	0.892	Yes
	cube	0.8464	0.892	No
	natural log	0.9489	0.892	Yes
	x^4	0.7872	0.892	No
	x^5	0.7324	0.892	No
	x^6	0.6848	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8903	0.933	No
	square root	0.9548	0.933	Yes
	square	0.7117	0.933	No
	cube root	0.9688	0.933	Yes
	cube	0.5507	0.933	No
	natural log	0.983	0.933	Yes
	x^4	0.4397	0.933	No
	x^5	0.3693	0.933	No
	x^6	0.3249	0.933	No

Shapiro-Wilk Normality Test

Constituent: Antimony Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.6995	0.859	No
	square root	0.7266	0.859	No
	square	0.6178	0.859	No
	cube root	0.7332	0.859	No
	cube	0.5282	0.859	No
	natural log	0.7431	0.859	No
	x^4	0.4573	0.859	No
	x^5	0.4094	0.859	No
	x^6	0.3788	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.4842	0.916	No
	square root	0.5077	0.916	No
	square	0.4212	0.916	No
	cube root	0.5141	0.916	No
	cube	0.3553	0.916	No
	natural log	0.5247	0.916	No
	x^4	0.3039	0.916	No
	x^5	0.2694	0.916	No
	x^6	0.2475	0.916	No

Shapiro-Wilk Normality Test

Constituent: Arsenic Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9632	0.859	Yes
	square root	0.9808	0.859	Yes
	square	0.8883	0.859	Yes
	cube root	0.9824	0.859	Yes
	cube	0.7936	0.859	No
	natural log	0.9779	0.859	Yes
	x^4	0.7019	0.859	No
	x^5	0.6223	0.859	No
	x^6	0.5571	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7075	0.859	No
	square root	0.8377	0.859	No
	square	0.5697	0.859	No
	cube root	0.8818	0.859	Yes
	cube	0.5228	0.859	No
	natural log	0.9416	0.859	Yes
	x^4	0.5039	0.859	No
	x^5	0.4941	0.859	No
	x^6	0.4871	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5134	0.916	No
	square root	0.6611	0.916	No
	square	0.388	0.916	No
	cube root	0.7247	0.916	No
	cube	0.3502	0.916	No
	natural log	0.8538	0.916	No
	x^4	0.3351	0.916	No
	x^5	0.3272	0.916	No
	x^6	0.3215	0.916	No

Shapiro-Wilk Normality Test

Constituent: Barium   Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9237	0.859	Yes
	square root	0.9164	0.859	Yes
	square	0.9326	0.859	Yes
	cube root	0.9135	0.859	Yes
	cube	0.9324	0.859	Yes
	natural log	0.9074	0.859	Yes
	x^4	0.9223	0.859	Yes
	x^5	0.9024	0.859	Yes
	x^6	0.874	0.859	Yes
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7529	0.859	No
	square root	0.7863	0.859	No
	square	0.7013	0.859	No
	cube root	0.798	0.859	No
	cube	0.6658	0.859	No
	natural log	0.8211	0.859	No
	x^4	0.6383	0.859	No
	x^5	0.6153	0.859	No
	x^6	0.5957	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5783	0.916	No
	square root	0.6436	0.916	No
	square	0.5	0.916	No
	cube root	0.6694	0.916	No
	cube	0.4614	0.916	No
	natural log	0.7251	0.916	No
	x^4	0.4369	0.916	No
	x^5	0.4181	0.916	No
	x^6	0.4026	0.916	No

Shapiro-Wilk Normality Test

Constituent: Beryllium Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Boron Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9147	0.892	Yes
	square root	0.9441	0.892	Yes
	square	0.8366	0.892	No
	cube root	0.9515	0.892	Yes
	cube	0.7521	0.892	No
	natural log	0.9624	0.892	Yes
	x^4	0.676	0.892	No
	x^5	0.6134	0.892	No
	x^6	0.5642	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.8711	0.892	No
	square root	0.9416	0.892	Yes
	square	0.686	0.892	No
	cube root	0.9584	0.892	Yes
	cube	0.5247	0.892	No
	natural log	0.9798	0.892	Yes
	x^4	0.4185	0.892	No
	x^5	0.3551	0.892	No
	x^6	0.318	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.8983	0.933	No
	square root	0.9452	0.933	Yes
	square	0.7503	0.933	No
	cube root	0.9531	0.933	Yes
	cube	0.6114	0.933	No
	natural log	0.9555	0.933	Yes
	x^4	0.5114	0.933	No
	x^5	0.4434	0.933	No
	x^6	0.3968	0.933	No

Shapiro-Wilk Normality Test

Constituent: Cadmium Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.5748	0.859	No
	square root	0.6208	0.859	No
	square	0.4792	0.859	No
	cube root	0.6341	0.859	No
	cube	0.409	0.859	No
	natural log	0.6566	0.859	No
	x^4	0.3684	0.859	No
	x^5	0.3474	0.859	No
	x^6	0.3369	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.3882	0.916	No
	square root	0.4214	0.916	No
	square	0.3196	0.916	No
	cube root	0.4313	0.916	No
	cube	0.2692	0.916	No
	natural log	0.4483	0.916	No
	x^4	0.2401	0.916	No
	x^5	0.2251	0.916	No
	x^6	0.2176	0.916	No

Shapiro-Wilk Normality Test

Constituent: Calcium Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9568	0.892	Yes
	square root	0.9607	0.892	Yes
	square	0.9367	0.892	Yes
	cube root	0.9611	0.892	Yes
	cube	0.9012	0.892	Yes
	natural log	0.9605	0.892	Yes
	x^4	0.8526	0.892	No
	x^5	0.795	0.892	No
	x^6	0.733	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9546	0.892	Yes
	square root	0.9727	0.892	Yes
	square	0.8964	0.892	Yes
	cube root	0.977	0.892	Yes
	cube	0.8171	0.892	No
	natural log	0.9828	0.892	Yes
	x^4	0.7292	0.892	No
	x^5	0.6441	0.892	No
	x^6	0.5688	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9642	0.933	Yes
	square root	0.9766	0.933	Yes
	square	0.9176	0.933	No
	cube root	0.979	0.933	Yes
	cube	0.8461	0.933	No
	natural log	0.9816	0.933	Yes
	x^4	0.759	0.933	No
	x^5	0.6675	0.933	No
	x^6	0.5811	0.933	No

Shapiro-Wilk Normality Test

Constituent: Chloride Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9432	0.892	Yes
	square root	0.9452	0.892	Yes
	square	0.9288	0.892	Yes
	cube root	0.945	0.892	Yes
	cube	0.9042	0.892	Yes
	natural log	0.9432	0.892	Yes
	x^4	0.8734	0.892	No
	x^5	0.8394	0.892	No
	x^6	0.8047	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9254	0.892	Yes
	square root	0.9705	0.892	Yes
	square	0.72	0.892	No
	cube root	0.9695	0.892	Yes
	cube	0.5312	0.892	No
	natural log	0.9413	0.892	Yes
	x^4	0.4136	0.892	No
	x^5	0.3475	0.892	No
	x^6	0.3107	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9847	0.933	Yes
	square root	0.9619	0.933	Yes
	square	0.9106	0.933	No
	cube root	0.9408	0.933	Yes
	cube	0.7805	0.933	No
	natural log	0.8767	0.933	No
	x^4	0.6508	0.933	No
	x^5	0.5399	0.933	No
	x^6	0.4518	0.933	No

Shapiro-Wilk Normality Test

Constituent: Chromium Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.6032	0.859	No
	square root	0.6246	0.859	No
	square	0.5598	0.859	No
	cube root	0.6316	0.859	No
	cube	0.5181	0.859	No
	natural log	0.6453	0.859	No
	x^4	0.4804	0.859	No
	x^5	0.4477	0.859	No
	x^6	0.4206	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7307	0.859	No
	square root	0.7823	0.859	No
	square	0.6719	0.859	No
	cube root	0.7987	0.859	No
	cube	0.6477	0.859	No
	natural log	0.8244	0.859	No
	x^4	0.6329	0.859	No
	x^5	0.6224	0.859	No
	x^6	0.6152	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5334	0.916	No
	square root	0.5964	0.916	No
	square	0.4792	0.916	No
	cube root	0.6281	0.916	No
	cube	0.4573	0.916	No
	natural log	0.7076	0.916	No
	x^4	0.444	0.916	No
	x^5	0.4347	0.916	No
	x^6	0.4279	0.916	No

Shapiro-Wilk Normality Test

Constituent: Cobalt Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	-1	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.7476	0.859	No
	square root	0.8121	0.859	No
	square	0.5948	0.859	No
	cube root	0.8287	0.859	No
	cube	0.478	0.859	No
	natural log	0.8534	0.859	No
	x^4	0.4098	0.859	No
	x^5	0.3726	0.859	No
	x^6	0.3524	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5288	0.916	No
	square root	0.581	0.916	No
	square	0.41	0.916	No
	cube root	0.5952	0.916	No
	cube	0.3209	0.916	No
	natural log	0.6183	0.916	No
	x^4	0.27	0.916	No
	x^5	0.243	0.916	No
	x^6	0.2285	0.916	No

Shapiro-Wilk Normality Test

Constituent: Combined Radium 226 + 228 Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.9677	0.859	Yes
	square root	0.9791	0.859	Yes
	square	0.916	0.859	Yes
	cube root	0.9802	0.859	Yes
	cube	0.8451	0.859	No
	natural log	0.9782	0.859	Yes
	x^4	0.7733	0.859	No
	x^5	0.7096	0.859	No
	x^6	0.6563	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.927	0.859	Yes
	square root	0.961	0.859	Yes
	square	0.8098	0.859	No
	cube root	0.967	0.859	Yes
	cube	0.6791	0.859	No
	natural log	0.9703	0.859	Yes
	x^4	0.5723	0.859	No
	x^5	0.4956	0.859	No
	x^6	0.4433	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.9542	0.916	Yes
	square root	0.9821	0.916	Yes
	square	0.8564	0.916	No
	cube root	0.9865	0.916	Yes
	cube	0.744	0.916	No
	natural log	0.9864	0.916	Yes
	x^4	0.6434	0.916	No
	x^5	0.5619	0.916	No
	x^6	0.4985	0.916	No

Shapiro-Wilk Normality Test

Constituent: Fluoride   Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.287	0.892	No
	square root	0.3453	0.892	No
	square	0.2638	0.892	No
	cube root	0.3814	0.892	No
	cube	0.2623	0.892	No
	natural log	0.4859	0.892	No
	x^4	0.2622	0.892	No
	x^5	0.2622	0.892	No
	x^6	0.2622	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9658	0.892	Yes
	square root	0.9769	0.892	Yes
	square	0.9197	0.892	Yes
	cube root	0.9784	0.892	Yes
	cube	0.8548	0.892	No
	natural log	0.978	0.892	Yes
	x^4	0.7851	0.892	No
	x^5	0.7194	0.892	No
	x^6	0.6612	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.224	0.933	No
	square root	0.3378	0.933	No
	square	0.1788	0.933	No
	cube root	0.4081	0.933	No
	cube	0.1757	0.933	No
	natural log	0.5986	0.933	No
	x^4	0.1755	0.933	No
	x^5	0.1755	0.933	No
	x^6	0.1755	0.933	No

Shapiro-Wilk Normality Test

Constituent: Lead Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.5791	0.859	No
	square root	0.5833	0.859	No
	square	0.5676	0.859	No
	cube root	0.5844	0.859	No
	cube	0.5535	0.859	No
	natural log	0.5863	0.859	No
	x^4	0.5385	0.859	No
	x^5	0.524	0.859	No
	x^6	0.5106	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.6233	0.859	No
	square root	0.6297	0.859	No
	square	0.6078	0.859	No
	cube root	0.6316	0.859	No
	cube	0.5891	0.859	No
	natural log	0.6351	0.859	No
	x^4	0.5684	0.859	No
	x^5	0.5468	0.859	No
	x^6	0.5254	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.5957	0.916	No
	square root	0.6018	0.916	No
	square	0.5785	0.916	No
	cube root	0.6035	0.916	No
	cube	0.5557	0.916	No
	natural log	0.6064	0.916	No
	x^4	0.5294	0.916	No
	x^5	0.5017	0.916	No
	x^6	0.4745	0.916	No

Shapiro-Wilk Normality Test

Constituent: Lithium   Analysis Run 8/11/2021 11:02 AM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.7941	0.859	No
	square root	0.8031	0.859	No
	square	0.7764	0.859	No
	cube root	0.8061	0.859	No
	cube	0.7596	0.859	No
	natural log	0.8121	0.859	No
	x^4	0.7437	0.859	No
	x^5	0.729	0.859	No
	x^6	0.7156	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.9517	0.859	Yes
	square root	0.9637	0.859	Yes
	square	0.8945	0.859	Yes
	cube root	0.9652	0.859	Yes
	cube	0.8054	0.859	No
	natural log	0.9646	0.859	Yes
	x^4	0.7069	0.859	No
	x^5	0.6171	0.859	No
	x^6	0.5439	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.9364	0.916	Yes
	square root	0.9459	0.916	Yes
	square	0.8796	0.916	No
	cube root	0.9456	0.916	Yes
	cube	0.7979	0.916	No
	natural log	0.9398	0.916	Yes
	x^4	0.7169	0.916	No
	x^5	0.649	0.916	No
	x^6	0.5962	0.916	No

Shapiro-Wilk Normality Test

Constituent: Mercury   Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	0	0.859	No
	cube	-1	0.859	No
	natural log	-1	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.2106	0.916	No
	square root	0.2106	0.916	No
	square	0.2106	0.916	No
	cube root	0.2106	0.916	No
	cube	0.2106	0.916	No
	natural log	0.2106	0.916	No
	x^4	0.2106	0.916	No
	x^5	0.2106	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Molybdenum Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	0.327	0.859	No
	square root	0.327	0.859	No
	square	0.327	0.859	No
	cube root	0.327	0.859	No
	cube	0.327	0.859	No
	natural log	0.327	0.859	No
	x^4	0.327	0.859	No
	x^5	0.327	0.859	No
	x^6	0.327	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.3766	0.859	No
	square root	0.3839	0.859	No
	square	0.3637	0.859	No
	cube root	0.3864	0.859	No
	cube	0.3533	0.859	No
	natural log	0.3915	0.859	No
	x^4	0.3452	0.859	No
	x^5	0.3393	0.859	No
	x^6	0.3351	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.2683	0.916	No
	square root	0.2771	0.916	No
	square	0.2529	0.916	No
	cube root	0.2802	0.916	No
	cube	0.2405	0.916	No
	natural log	0.2865	0.916	No
	x^4	0.2312	0.916	No
	x^5	0.2244	0.916	No
	x^6	0.2197	0.916	No

Shapiro-Wilk Normality Test

Constituent: pH Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9132	0.892	Yes
	square root	0.9089	0.892	Yes
	square	0.9212	0.892	Yes
	cube root	0.9074	0.892	Yes
	cube	0.9284	0.892	Yes
	natural log	0.9044	0.892	Yes
	x^4	0.9346	0.892	Yes
	x^5	0.9399	0.892	Yes
	x^6	0.9442	0.892	Yes
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9588	0.892	Yes
	square root	0.9592	0.892	Yes
	square	0.9576	0.892	Yes
	cube root	0.9592	0.892	Yes
	cube	0.9556	0.892	Yes
	natural log	0.9593	0.892	Yes
	x^4	0.953	0.892	Yes
	x^5	0.9496	0.892	Yes
	x^6	0.9456	0.892	Yes
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9658	0.933	Yes
	square root	0.9635	0.933	Yes
	square	0.9695	0.933	Yes
	cube root	0.9627	0.933	Yes
	cube	0.972	0.933	Yes
	natural log	0.961	0.933	Yes
	x^4	0.9733	0.933	Yes
	x^5	0.9734	0.933	Yes
	x^6	0.9724	0.933	Yes

Shapiro-Wilk Normality Test

Constituent: Selenium   Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	0.4879	0.859	No
	square root	0.514	0.859	No
	square	0.4306	0.859	No
	cube root	0.5216	0.859	No
	cube	0.3857	0.859	No
	natural log	0.5347	0.859	No
	x^4	0.3583	0.859	No
	x^5	0.3433	0.859	No
	x^6	0.3354	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.3212	0.916	No
	square root	0.3402	0.916	No
	square	0.2813	0.916	No
	cube root	0.3458	0.916	No
	cube	0.2505	0.916	No
	natural log	0.3559	0.916	No
	x^4	0.2318	0.916	No
	x^5	0.2217	0.916	No
	x^6	0.2163	0.916	No

Shapiro-Wilk Normality Test

Constituent: Sulfate Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9469	0.892	Yes
	square root	0.9385	0.892	Yes
	square	0.8855	0.892	No
	cube root	0.9288	0.892	Yes
	cube	0.7853	0.892	No
	natural log	0.9006	0.892	Yes
	x^4	0.6955	0.892	No
	x^5	0.6248	0.892	No
	x^6	0.5697	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9208	0.892	Yes
	square root	0.9534	0.892	Yes
	square	0.7898	0.892	No
	cube root	0.9549	0.892	Yes
	cube	0.6459	0.892	No
	natural log	0.9384	0.892	Yes
	x^4	0.5293	0.892	No
	x^5	0.4453	0.892	No
	x^6	0.3875	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9404	0.933	Yes
	square root	0.9572	0.933	Yes
	square	0.8239	0.933	No
	cube root	0.9534	0.933	Yes
	cube	0.6713	0.933	No
	natural log	0.9285	0.933	No
	x^4	0.5351	0.933	No
	x^5	0.4301	0.933	No
	x^6	0.3545	0.933	No

Shapiro-Wilk Normality Test

Constituent: Thallium Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station Client: NRG Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
MW-14 (bg) (n = 12, alpha = 0.05)				
	no	-1	0.859	No
	square root	0	0.859	No
	square	-1	0.859	No
	cube root	-1	0.859	No
	cube	-1	0.859	No
	natural log	0	0.859	No
	x^4	-1	0.859	No
	x^5	-1	0.859	No
	x^6	-1	0.859	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	-1	0.916	No
	square root	0	0.916	No
	square	-1	0.916	No
	cube root	0	0.916	No
	cube	-1	0.916	No
	natural log	0	0.916	No
	x^4	-1	0.916	No
	x^5	-1	0.916	No
	x^6	-1	0.916	No

Shapiro-Wilk Normality Test

Constituent: Total Dissolved Solids   Analysis Run 8/11/2021 11:02 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-11 (bg) (n = 17, alpha = 0.05)				
	no	0.9083	0.892	Yes
	square root	0.9021	0.892	Yes
	square	0.916	0.892	Yes
	cube root	0.8997	0.892	Yes
	cube	0.9171	0.892	Yes
	natural log	0.8944	0.892	Yes
	x^4	0.9119	0.892	Yes
	x^5	0.9011	0.892	Yes
	x^6	0.8858	0.892	No
MW-14 (bg) (n = 17, alpha = 0.05)				
	no	0.9425	0.892	Yes
	square root	0.9508	0.892	Yes
	square	0.9027	0.892	Yes
	cube root	0.9514	0.892	Yes
	cube	0.8464	0.892	No
	natural log	0.9489	0.892	Yes
	x^4	0.7872	0.892	No
	x^5	0.7324	0.892	No
	x^6	0.6848	0.892	No
Pooled Background (bg) (n = 34, alpha = 0.05)				
	no	0.9429	0.933	Yes
	square root	0.9236	0.933	No
	square	0.9536	0.933	Yes
	cube root	0.9149	0.933	No
	cube	0.9367	0.933	Yes
	natural log	0.8941	0.933	No
	x^4	0.9036	0.933	No
	x^5	0.8622	0.933	No
	x^6	0.8177	0.933	No

Waukega Analysis of Variance - UG Wells

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 11:48 AM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Antimony (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (NDs)
Arsenic (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Barium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Boron (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Cadmium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Calcium (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Chloride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)
Chromium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Cobalt (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Combined Radium 226 + 228 (pCi/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Fluoride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Lead (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Lithium (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Mercury (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Molybdenum (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
pH (n/a)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Selenium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Sulfate (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)

Non-Parametric ANOVA

Constituent: Antimony   Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 10.81

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 5.164
Adjusted Kruskal-Wallis statistic (H') = 10.81

Non-Parametric ANOVA

Constituent: Arsenic Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 24.56

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 24.53
Adjusted Kruskal-Wallis statistic (H') = 24.56

Non-Parametric ANOVA

Constituent: Barium Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 28.06

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 28.02
Adjusted Kruskal-Wallis statistic (H') = 28.06

Parametric ANOVA

Constituent: Boron Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 231.3

Tabulated F statistic = 3.198 with 2 and 48 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.5091	2	0.2545	8.627
Error Within Groups	1.416	48	0.02951	
Total	1.925	50		

The Shapiro Francia normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9454, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.1733, tabulated = 3.198.

Non-Parametric ANOVA

Constituent: Cadmium   Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.749

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 2.002
Adjusted Kruskal-Wallis statistic (H') = 4.749

Parametric ANOVA

Constituent: Calcium Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 8.06

Tabulated F statistic = 3.198 with 2 and 48 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.5091	2	0.2545	8.627
Error Within Groups	1.416	48	0.02951	
Total	1.925	50		

The Shapiro Francia normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9404, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 1.812, tabulated = 3.198.

Non-Parametric ANOVA

Constituent: Chloride Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 5.113

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 9 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 5.107
Adjusted Kruskal-Wallis statistic (H') = 5.113

Non-Parametric ANOVA

Constituent: Chromium   Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 19.06

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 17.68
Adjusted Kruskal-Wallis statistic (H') = 19.06

Non-Parametric ANOVA

Constituent: Cobalt Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 12.15

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 8.083
Adjusted Kruskal-Wallis statistic (H') = 12.15

Parametric ANOVA

Constituent: Combined Radium 226 + 228 Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 17.4

Tabulated F statistic = 3.293 with 2 and 33 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.5091	2	0.2545	8.627
Error Within Groups	1.416	48	0.02951	
Total	1.925	50		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9614, critical = 0.912. Levene's Equality of Variance test passed. Calculated = 1.867, tabulated = 3.293.

Non-Parametric ANOVA

Constituent: Fluoride   Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 12.03

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 11 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 11.95
Adjusted Kruskal-Wallis statistic (H') = 12.03

Non-Parametric ANOVA

Constituent: Lead Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.6153

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.3559
Adjusted Kruskal-Wallis statistic (H') = 0.6153

Parametric ANOVA

Constituent: Lithium Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 53.84

Tabulated F statistic = 3.293 with 2 and 33 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.5091	2	0.2545	8.627
Error Within Groups	1.416	48	0.02951	
Total	1.925	50		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9671, critical = 0.912. Levene's Equality of Variance test passed. Calculated = 3.21, tabulated = 3.293.

Non-Parametric ANOVA

Constituent: Mercury Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.1622
Adjusted Kruskal-Wallis statistic (H') = 2

Non-Parametric ANOVA

Constituent: Molybdenum Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 29.23

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 23.42
Adjusted Kruskal-Wallis statistic (H') = 29.23

Parametric ANOVA

Constituent: pH Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 2.715

Tabulated F statistic = 3.198 with 2 and 48 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.5091	2	0.2545	8.627
Error Within Groups	1.416	48	0.02951	
Total	1.925	50		

The Shapiro Francia normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.977, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 2.5, tabulated = 3.198.

Non-Parametric ANOVA

Constituent: Selenium   Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 20.69

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 15.3
Adjusted Kruskal-Wallis statistic (H') = 20.69

Parametric ANOVA

Constituent: Sulfate Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 48.86

Tabulated F statistic = 3.198 with 2 and 48 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.5091	2	0.2545	8.627
Error Within Groups	1.416	48	0.02951	
Total	1.925	50		

The Shapiro Francia normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.977, critical = 0.935. Levene's Equality of Variance test passed. Calculated = 0.9626, tabulated = 3.198.

Non-Parametric ANOVA

Constituent: Total Dissolved Solids   Analysis Run 8/4/2021 11:48 AM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 10.62

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 7 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 10.58
Adjusted Kruskal-Wallis statistic (H') = 10.62

Waukegan Analysis of Variance - UG Wells MW-9 and MW-14

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 2:55 PM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Antimony (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Arsenic (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Barium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Boron (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Cadmium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Calcium (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Chloride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)
Chromium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Cobalt (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)
Combined Radium 226 + 228 (pCi/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Fluoride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Lead (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Lithium (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Mercury (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Molybdenum (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
pH (n/a)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Selenium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Sulfate (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.

Non-Parametric ANOVA

Constituent: Antimony Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.965

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 3.203
Adjusted Kruskal-Wallis statistic (H') = 4.965

Parametric ANOVA

Constituent: Arsenic   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 106.9

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9221, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 0.6293, tabulated = 4.3.

Non-Parametric ANOVA

Constituent: Barium   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 17.06

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 17.04
Adjusted Kruskal-Wallis statistic (H') = 17.06

Parametric ANOVA

Constituent: Boron Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 388.4

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9516, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.002989, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Cadmium   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.9735

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.5633
Adjusted Kruskal-Wallis statistic (H') = 0.9735

Parametric ANOVA

Constituent: Calcium Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 9.841

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9409, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.9627, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Chloride   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.9647

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.9636
Adjusted Kruskal-Wallis statistic (H') = 0.9647

Non-Parametric ANOVA

Constituent: Chromium Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 10.09

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 9.72
Adjusted Kruskal-Wallis statistic (H') = 10.09

Non-Parametric ANOVA

Constituent: Cobalt Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 3.806

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 3.203
Adjusted Kruskal-Wallis statistic (H') = 3.806

Parametric ANOVA

Constituent: Combined Radium 226 + 228 Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 6.243

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9495, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 0.1851, tabulated = 4.3.

Parametric ANOVA

Constituent: Fluoride   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 9

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9298, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.01592, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Lead   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.697

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.4033
Adjusted Kruskal-Wallis statistic (H') = 0.697

Parametric ANOVA

Constituent: Lithium Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 80.35

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9395, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 0.8292, tabulated = 4.3.

Non-Parametric ANOVA

Constituent: Mercury Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 1

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.12
Adjusted Kruskal-Wallis statistic (H') = 1

Non-Parametric ANOVA

Constituent: Molybdenum Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 18.64

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 17.28
Adjusted Kruskal-Wallis statistic (H') = 18.64

Parametric ANOVA

Constituent: pH Analysis Run 8/4/2021 2:55 PM

Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 2.083

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.977, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 3.567, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Selenium Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 10.75

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 9.72
Adjusted Kruskal-Wallis statistic (H') = 10.75

Parametric ANOVA

Constituent: Sulfate   Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 64.33

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9718, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.3482, tabulated = 4.152.

Parametric ANOVA

Constituent: Total Dissolved Solids Analysis Run 8/4/2021 2:55 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 13.85

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	613.2	1	613.2	13.85
Error Within Groups	1417	32	44.28	
Total	2030	33		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9547, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 2.513, tabulated = 4.152.

Waukegan Analysis of Variance - UG Wells MW-9 and MW-11

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/4/2021, 2:58 PM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Antimony (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Arsenic (mg/L)	n/a	n/a	n/a	n/a	n/a	x^(1/3)	Yes	0.05	Param.
Barium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Boron (mg/L)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.
Cadmium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Calcium (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Chloride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)
Chromium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)
Cobalt (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Combined Radium 226 + 228 (pCi/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Fluoride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Lead (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Lithium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Molybdenum (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
pH (n/a)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Selenium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Sulfate (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)

Non-Parametric ANOVA

Constituent: Antimony   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 1

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.12
Adjusted Kruskal-Wallis statistic (H') = 1

Parametric ANOVA

Constituent: Arsenic Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after cube root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 289.4

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.4098	1	0.4098	15.79
Error Within Groups	0.8307	32	0.02596	
Total	1.241	33		

The Shapiro Wilk normality test on the residuals passed after cube root transformation. Alpha = 0.01, calculated = 0.8993, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 0.05231, tabulated = 4.3.

Non-Parametric ANOVA

Constituent: Barium   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 12.85

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 12.81
Adjusted Kruskal-Wallis statistic (H') = 12.85

Parametric ANOVA

Constituent: Boron Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 183.5

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.4098	1	0.4098	15.79
Error Within Groups	0.8307	32	0.02596	
Total	1.241	33		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9128, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.284, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Cadmium Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2.087

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.48
Adjusted Kruskal-Wallis statistic (H') = 2.087

Parametric ANOVA

Constituent: Calcium   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 10.62

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.4098	1	0.4098	15.79
Error Within Groups	0.8307	32	0.02596	
Total	1.241	33		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9362, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 3.17, tabulated = 4.152.

Non-Parametric ANOVA

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.6845

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 5 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.6833
Adjusted Kruskal-Wallis statistic (H') = 0.6845

Non-Parametric ANOVA

Constituent: Chromium   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.004406

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.003333
Adjusted Kruskal-Wallis statistic (H') = 0.004406

Non-Parametric ANOVA

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 3.268

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 1.08
Adjusted Kruskal-Wallis statistic (H') = 3.268

Parametric ANOVA

Constituent: Combined Radium 226 + 228 Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 31.4

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.4098	1	0.4098	15.79
Error Within Groups	0.8307	32	0.02596	
Total	1.241	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9719, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 3.456, tabulated = 4.3.

Non-Parametric ANOVA

Constituent: Fluoride   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.0003006

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 7 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.0002966
Adjusted Kruskal-Wallis statistic (H') = 0.0003006

Non-Parametric ANOVA

Constituent: Lead Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.2379

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.12
Adjusted Kruskal-Wallis statistic (H') = 0.2379

Non-Parametric ANOVA

Constituent: Lithium   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 7.23

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 7.208
Adjusted Kruskal-Wallis statistic (H') = 7.23

Non-Parametric ANOVA

Constituent: Molybdenum   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 19.14

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 17.28
Adjusted Kruskal-Wallis statistic (H') = 19.14

Parametric ANOVA

Constituent: pH Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 4.325

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.4098	1	0.4098	15.79
Error Within Groups	0.8307	32	0.02596	
Total	1.241	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9827, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 2.92, tabulated = 4.152.

Non-Parametric ANOVA

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 14.96

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 12
Adjusted Kruskal-Wallis statistic (H') = 14.96

Parametric ANOVA

Constituent: Sulfate   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 75.14

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.4098	1	0.4098	15.79
Error Within Groups	0.8307	32	0.02596	
Total	1.241	33		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9682, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.4734, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Total Dissolved Solids   Analysis Run 8/4/2021 2:58 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2.586

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 6 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 2.565
Adjusted Kruskal-Wallis statistic (H') = 2.586

Waukegan Analysis of Variance - UG Wells MW-11 and MW-14

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/4/2021, 12:03 PM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Antimony (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Arsenic (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (eq. var.)
Barium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Boron (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	Yes	0.05	Param.
Cadmium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (NDs)
Calcium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Chloride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Chromium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Cobalt (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)
Combined Radium 226 + 228 (pCi/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Fluoride (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (normality)
Lead (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (normality)
Lithium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	Param.
Mercury (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Molybdenum (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
pH (n/a)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Selenium (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	NP (NDs)
Sulfate (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	No	Yes	0.05	NP (eq. var.)

Non-Parametric ANOVA

Constituent: Antimony Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 7.465

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 4.32
Adjusted Kruskal-Wallis statistic (H') = 7.465

Non-Parametric ANOVA

Constituent: Arsenic Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2.613

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 0 groups of ties in the data, so no adjustment to the Kruskal-Wallis statistic (H) was necessary.

Non-Parametric ANOVA

Constituent: Barium Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 15.45

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 3 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 15.41
Adjusted Kruskal-Wallis statistic (H') = 15.45

Parametric ANOVA

Constituent: Boron Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 65.52

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9512, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 2.961, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Cadmium   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.553

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 1.92
Adjusted Kruskal-Wallis statistic (H') = 4.553

Parametric ANOVA

Constituent: Calcium Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 0.01193

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9648, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 1.177, tabulated = 4.152.

Parametric ANOVA

Constituent: Chloride Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 8.546

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9481, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 1.649, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Chromium   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 17.23

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 16.8
Adjusted Kruskal-Wallis statistic (H') = 17.23

Non-Parametric ANOVA

Constituent: Cobalt Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 10.9

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 7.68
Adjusted Kruskal-Wallis statistic (H') = 10.9

Parametric ANOVA

Constituent: Combined Radium 226 + 228   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 11.35

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9564, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 1.684, tabulated = 4.3.

Non-Parametric ANOVA

Constituent: Fluoride   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 8.527

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 7 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 8.471
Adjusted Kruskal-Wallis statistic (H') = 8.527

Non-Parametric ANOVA

Constituent: Lead Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.02066

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.01333
Adjusted Kruskal-Wallis statistic (H') = 0.02066

Parametric ANOVA

Constituent: Lithium   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 60.84

Tabulated F statistic = 4.3 with 1 and 22 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.8888, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 2.437, tabulated = 4.3.

Non-Parametric ANOVA

Constituent: Mercury   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 1

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.12
Adjusted Kruskal-Wallis statistic (H') = 1

Non-Parametric ANOVA

Constituent: Molybdenum   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 0.4943

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.1633
Adjusted Kruskal-Wallis statistic (H') = 0.4943

Parametric ANOVA

Constituent: pH Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 0.8333

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.956, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 0.0213, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Selenium   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 3.268

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 1.08
Adjusted Kruskal-Wallis statistic (H') = 3.268

Parametric ANOVA

Constituent: Sulfate Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 0.01002

Tabulated F statistic = 4.152 with 1 and 32 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.3515	1	0.3515	15.73
Error Within Groups	0.7152	32	0.02235	
Total	1.067	33		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9391, critical = 0.908. Levene's Equality of Variance test passed. Calculated = 2.117, tabulated = 4.152.

Non-Parametric ANOVA

Constituent: Total Dissolved Solids   Analysis Run 8/4/2021 12:03 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/5/2015 and 5/6/2021, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.237

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 5 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 4.2
Adjusted Kruskal-Wallis statistic (H') = 4.237

Waukegan Analysis of Variance - Original 8 UG Wells MW-11 and MW-14

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/5/2021, 2:18 PM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Chloride (mg/L)	n/a	n/a	n/a	n/a	n/a	sqrt(x)	No	0.05	Param.
Sulfate (mg/L)	n/a	n/a	n/a	n/a	n/a	No	No	0.05	Param.
Total Dissolved Solids (mg/L)	n/a	n/a	n/a	n/a	n/a	x^5	No	0.05	Param.

Non-Parametric ANOVA

Constituent: Chloride   Analysis Run 8/5/2021 2:16 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

For observations made between 11/4/2015 and 7/6/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 8.877

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 3 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 8.854
Adjusted Kruskal-Wallis statistic (H') = 8.877

Parametric ANOVA

Constituent: Sulfate Analysis Run 8/5/2021 2:16 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 7/6/2017 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 20.27

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.2549	2	0.1274	6.267
Error Within Groups	0.427	21	0.02034	
Total	0.6819	23		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.01, calculated = 0.9818, critical = 0.884. Levene's Equality of Variance test passed. Calculated = 2.228, tabulated = 3.47.

Non-Parametric ANOVA

Constituent: Total Dissolved Solids Analysis Run 8/5/2021 2:16 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 11/4/2015 and 7/6/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 7.585

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 4 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 7.46
Adjusted Kruskal-Wallis statistic (H') = 7.585

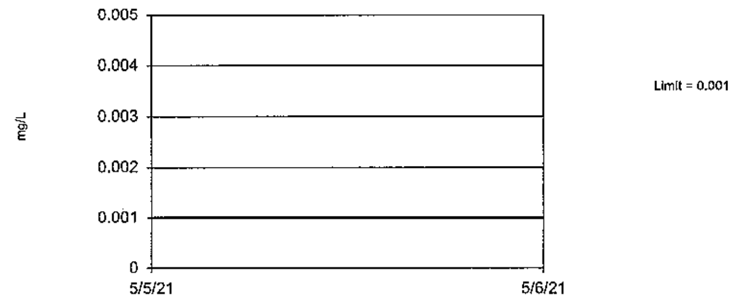
Interwell Prediction Limit MW-9 MW-11 MW-14 UG

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/5/2021, 2:57 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Beryllium (mg/L)	n/a	0.001	n/a	n/a	5 future	n/a	36	100	n/a	0.001354	NP (NDs) 1 of 2
Lead (mg/L)	n/a	0.001135	n/a	n/a	5 future	n/a	36	72.22	n/a	0.001354	NP (NDs) 1 of 2 Deseas
Thallium (mg/L)	n/a	0.002	n/a	n/a	5 future	n/a	36	100	n/a	0.001354	NP (NDs) 1 of 2

Prediction Limit

Interwell Non-parametric



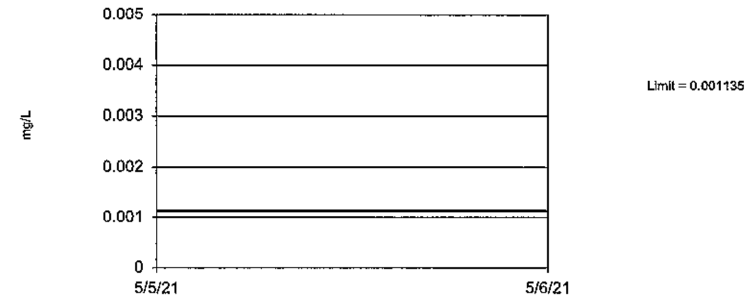
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 36) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.02674. Individual comparison alpha = 0.001354 (1 of 2). Assumes 5 future values. Seasonality was not detected with 95% confidence.

Constituent: Beryllium   Analysis Run 8/5/2021 2:56 PM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Prediction Limit

Interwell Non-parametric



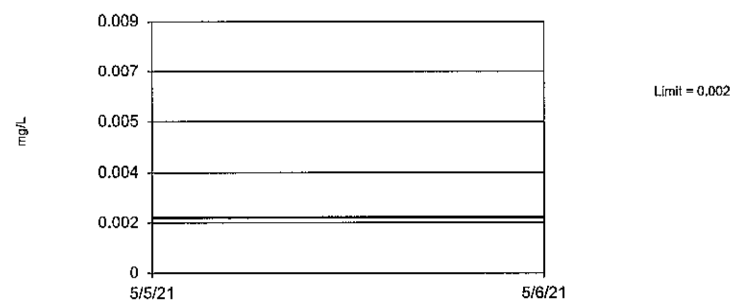
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 36 background values. 72.22% NDs. Annual per-constituent alpha = 0.02674. Individual comparison alpha = 0.001354 (1 of 2). Assumes 5 future values. Data were deseasonalized.

Constituent: Lead   Analysis Run 8/5/2021 2:56 PM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 36) were censored; limit is most recent reporting limit. Annual per-constituent alpha = 0.02674. Individual comparison alpha = 0.001354 (1 of 2). Assumes 5 future values. Seasonality was not detected with 95% confidence.

Constituent: Thallium   Analysis Run 8/5/2021 2:56 PM

Waukegan Generating Station   Client: NRG   Data: Waukegan

Interwell Prediction Limit Pooled MW-14/MW-11

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/5/2021, 2:38 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Arsenic (mg/L)	n/a	21	n/a	n/a	5 future	n/a	24	0	n/a	0.002808	NP (normality) 1 of 2
Molybdenum (mg/L)	n/a	0.0094	n/a	n/a	5 future	n/a	24	87.5	n/a	0.002808	NP (NDs) 1 of 2
pH (n/a)	n/a	7.741	6.514	n/a	5 future	n/a	34	0	No	0.000...	Param 1 of 2
Selenium (mg/L)	n/a	0.014	n/a	n/a	5 future	n/a	24	87.5	n/a	0.002808	NP (NDs) 1 of 2

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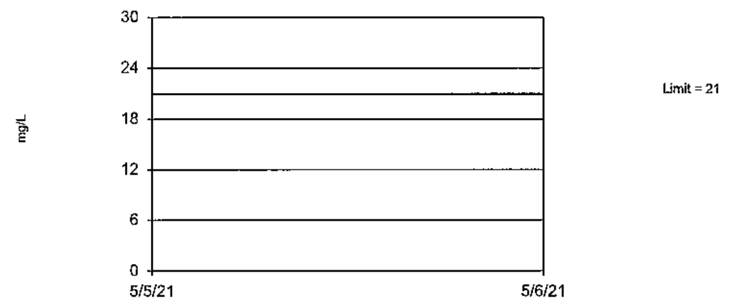
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.05 alpha level. Limit is highest of 24 background values. Annual per-constituent alpha = 0.0547. Individual comparison alpha = 0.002808 (1 of 2). Assumes 5 future values. Seasonality was not detected with 95% confidence.

Constituent: Arsenic Analysis Run 8/5/2021 2:34 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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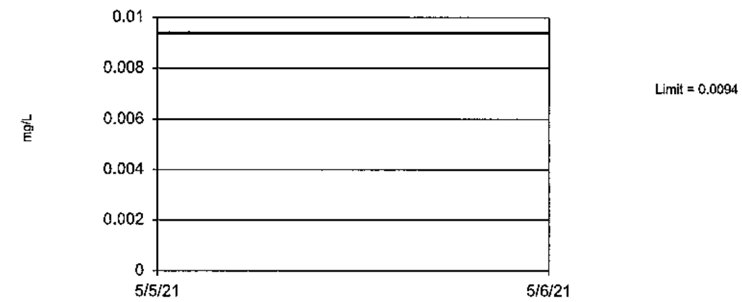
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 24 background values. 87.5% NDs. Annual per-constituent alpha = 0.0547. Individual comparison alpha = 0.002808 (1 of 2). Assumes 5 future values. Seasonality was not detected with 95% confidence.

Constituent: Molybdenum Analysis Run 8/5/2021 2:34 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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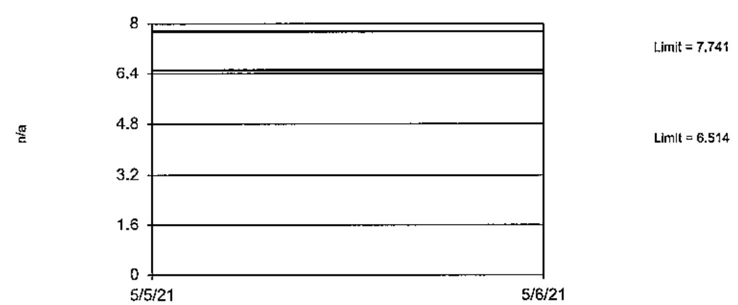
Prediction Limit

Interwell Parametric



Background Data Summary: Mean=7.127, Std. Dev.=0.253, n=34. Seasonality was not detected with 95% confidence. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9658, critical = 0.933. Kappa = 2.425 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0001197. Assumes 5 future values.

Constituent: pH Analysis Run 8/5/2021 2:34 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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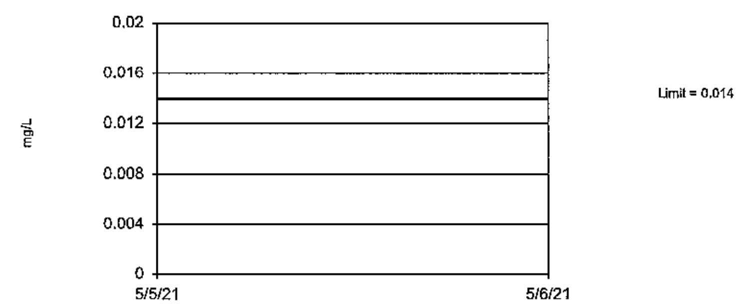
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 24 background values. 87.5% NDs. Annual per-constituent alpha = 0.0547. Individual comparison alpha = 0.002808 (1 of 2). Assumes 5 future values. Seasonality was not detected with 95% confidence.

Constituent: Selenium Analysis Run 8/5/2021 2:34 PM

Waukegan Generating Station Client: NRG Data: Waukegan

Interwell Waukegan Interwell PL UG MW-14

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/11/2021, 2:21 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Antimony (mg/L)	n/a	0.015	n/a	n/a	5 future	n/a	12	50	n/a	0.00828	NP (normality) 1 of 2
Cadmium (mg/L)	n/a	0.002	n/a	n/a	5 future	n/a	12	66.67	n/a	0.00828	NP (NDs) 1 of 2
Chromium (mg/L)	n/a	4.8	n/a	n/a	5 future	n/a	12	0	n/a	0.00828	NP (normality) 1 of 2
Cobalt (mg/L)	n/a	0.007	n/a	n/a	5 future	n/a	12	33.33	n/a	0.00828	NP (normality) 1 of 2
Combined Radium 226 + 228 (pCi/L)	n/a	1.566	n/a	n/a	5 future	n/a	12	41.67	No	0.000...	Param 1 of 2
Fluoride (mg/L)	n/a	0.3342	n/a	n/a	5 future	n/a	17	0	No	0.000...	Param 1 of 2
Lithium (mg/L)	n/a	0.03962	n/a	n/a	5 future	n/a	12	0	No	0.000...	Param 1 of 2
Mercury (mg/L)	n/a	0.00043	n/a	n/a	5 future	n/a	12	91.67	n/a	0.00828	NP (NDs) 1 of 2

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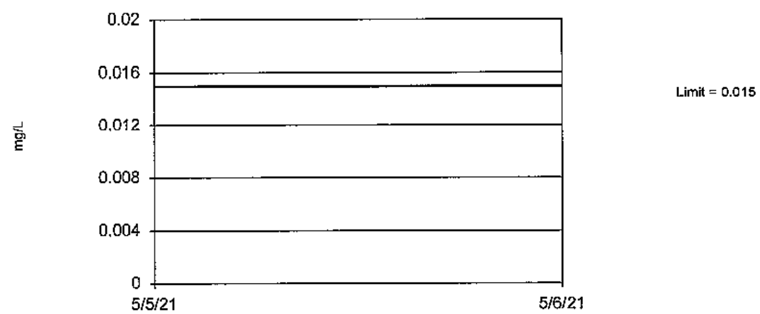
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.05 alpha level. Limit is highest of 12 background values. 50% NDs. Annual per-constituent alpha = 0.1532. Individual comparison alpha = 0.00828 (1 of 2). Assumes 5 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Antimony Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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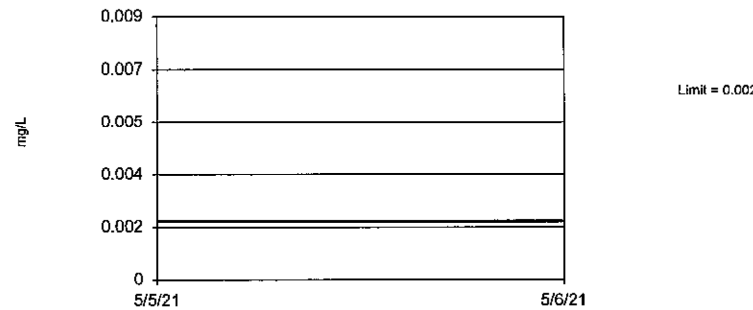
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 12 background values. 66.67% NDs. Annual per-constituent alpha = 0.1532. Individual comparison alpha = 0.00828 (1 of 2). Assumes 5 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Cadmium Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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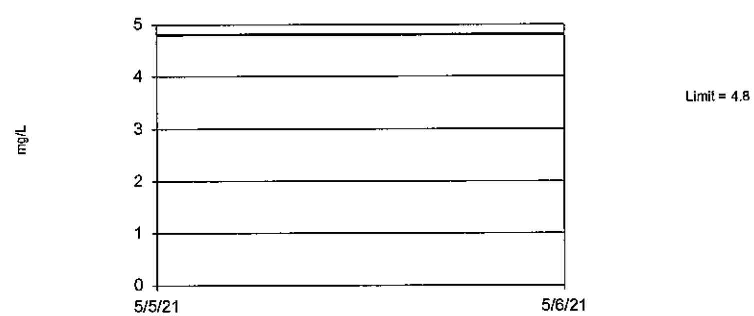
Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.05 alpha level. Limit is highest of 12 background values. Annual per-constituent alpha = 0.1532. Individual comparison alpha = 0.00828 (1 of 2). Assumes 5 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Chromium Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

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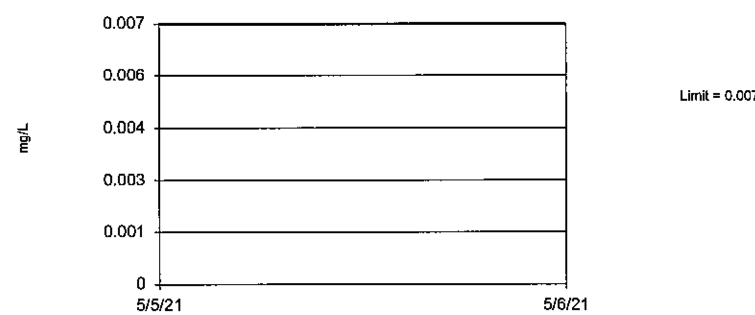
Prediction Limit

Interwell Non-parametric



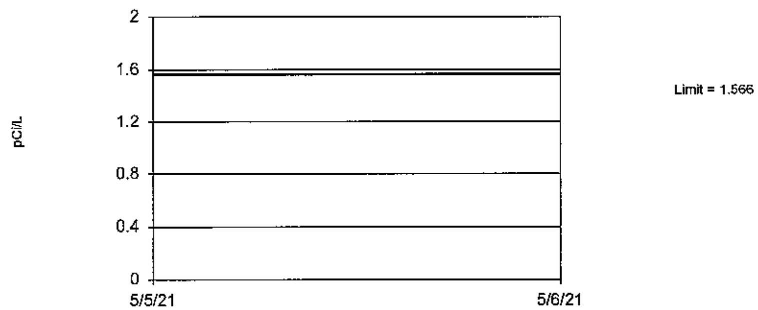
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.05 alpha level. Limit is highest of 12 background values. 33.33% NDs. Annual per-constituent alpha = 0.1532. Individual comparison alpha = 0.00828 (1 of 2). Assumes 5 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Cobalt Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric



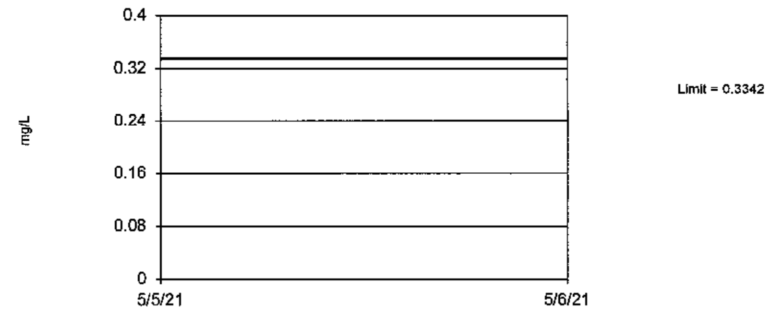
Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.6694, Std. Dev.=0.2931, n=12, 41.67% NDs. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.927, critical = 0.859. Kappa = 3.061 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Combined Radium 226 + 228 Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric



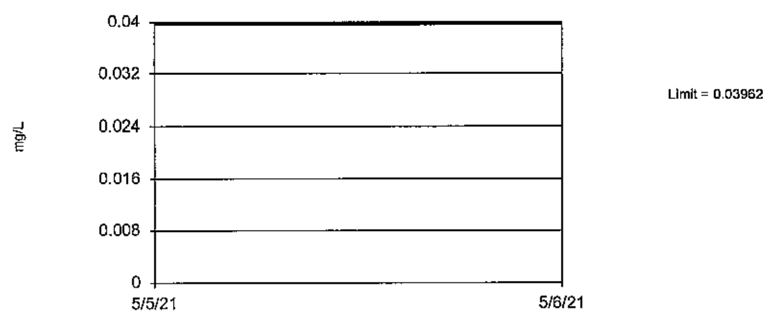
Background Data Summary: Mean=0.1988, Std. Dev.=0.0491, n=17. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9658, critical = 0.892. Kappa = 2.757 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Fluoride Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric



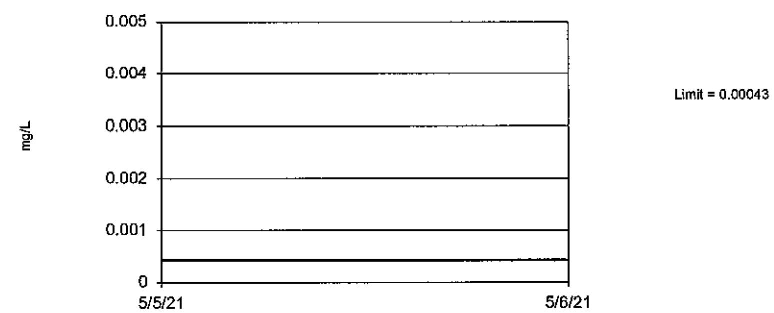
Background Data Summary: Mean=0.02117, Std. Dev.=0.006028, n=12. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9517, critical = 0.859. Kappa = 3.061 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Lithium Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 12 background values. 91.67% NDs. Annual per-constituent alpha = 0.1532. Individual comparison alpha = 0.00828 (1 of 2). Assumes 5 future values. Insufficient data to test for seasonality; data will not be deseasonalized.

Constituent: Mercury Analysis Run 8/11/2021 2:20 PM

Waukegan Generating Station Client: NRG Data: Waukegan

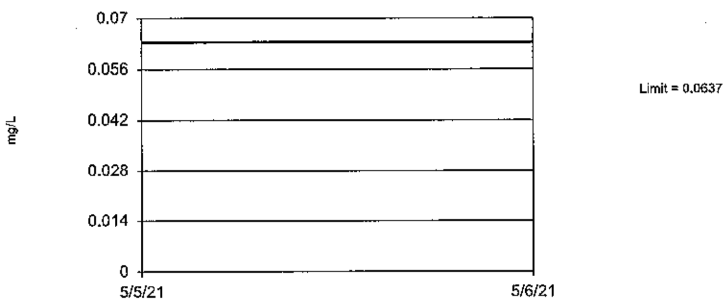
Interwell Waukegan Interwell PL UG MW-11

Waukegan Generating Station Client: NRG Data: Waukegan Printed 8/11/2021, 2:28 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Barium (mg/L)	n/a	0.0637	n/a	n/a	5 future	n/a	12	0	No	0.000...	Param 1 of 2
Boron (mg/L)	n/a	5.965	n/a	n/a	5 future	n/a	17	0	No	0.000...	Param 1 of 2
Calcium (mg/L)	n/a	225.1	n/a	n/a	5 future	n/a	17	0	No	0.000...	Param 1 of 2

Prediction Limit

Interwell Parametric

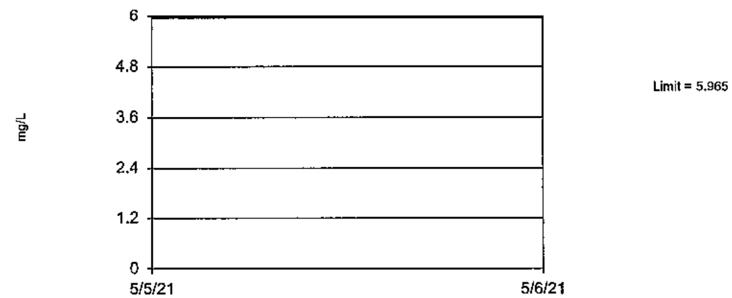


Background Data Summary: Mean=0.046, Std. Dev.=0.005784, n=12. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9237, critical = 0.859. Kappa = 3.061 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Barium Analysis Run 8/11/2021 2:24 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric

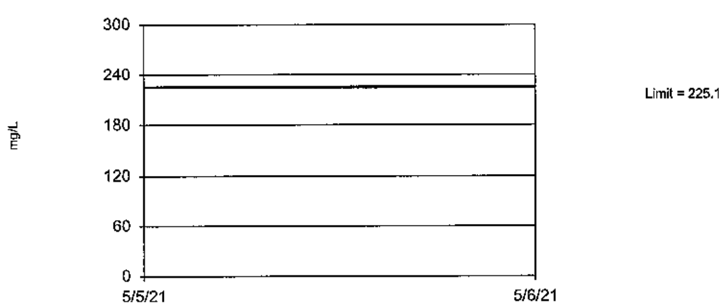


Background Data Summary: Mean=2.965, Std. Dev.=1.089, n=17. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9147, critical = 0.892. Kappa = 2.757 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Boron Analysis Run 8/11/2021 2:24 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=154.1, Std. Dev.=25.75, n=17. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9568, critical = 0.892. Kappa = 2.757 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Calcium Analysis Run 8/11/2021 2:24 PM
Waukegan Generating Station Client: NRG Data: Waukegan

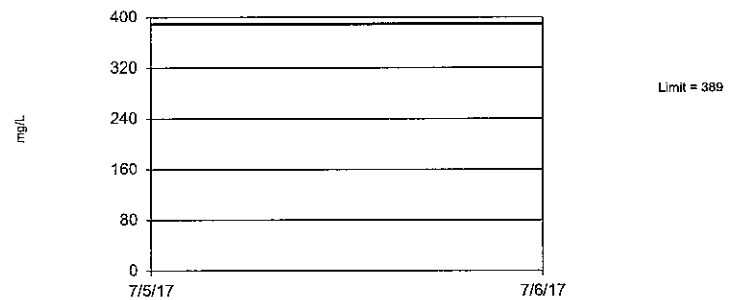
Interwell Prediction Limit Orig 8 Pooled MW-14/MW-11

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 8/5/2021, 2:29 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Chloride (mg/L)	n/a	389	n/a	n/a	5 future	n/a	16	0	No	0.000...	Param 1 of 2
Sulfate (mg/L)	n/a	259.1	n/a	n/a	5 future	n/a	16	0	No	0.000...	Param 1 of 2
Total Dissolved Solids (mg/L)	n/a	1589	n/a	n/a	5 future	n/a	16	0	No	0.000...	Param 1 of 2

Prediction Limit

Interwell Parametric

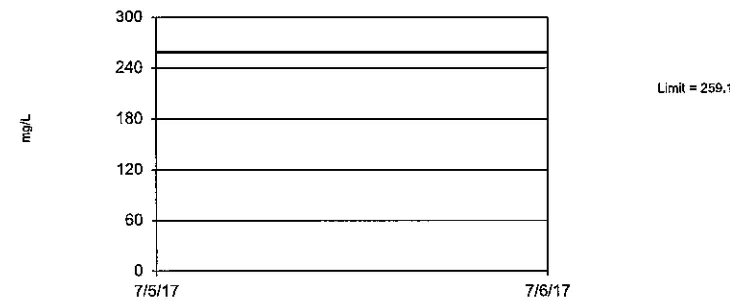


Background Data Summary: Mean=201.8, Std. Dev.=66.96, n=16. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9689, critical = 0.887. Kappa = 2.795 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Chloride Analysis Run 8/5/2021 2:25 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric

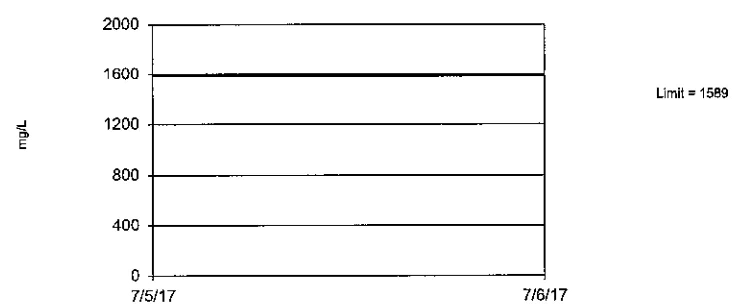


Background Data Summary: Mean=147.5, Std. Dev.=39.92, n=16. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9403, critical = 0.887. Kappa = 2.795 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Sulfate Analysis Run 8/5/2021 2:25 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=1048, Std. Dev.=193.4, n=16. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9167, critical = 0.887. Kappa = 2.795 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Total Dissolved Solids Analysis Run 8/5/2021 2:25 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Outlier Analysis - Waukegan - UG Wells - Turbidity

Waukegan Generating Station Client: NRG Data: Waukegan Printed 10/5/2021, 3:02 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Turbidity (NTU)	MW-09 (bg)	No	n/a	n/a	EPA 1989	0.05	8	22.87	23.98	ln(x)	ShapiroWilk
Turbidity (NTU)	MW-11 (bg)	No	n/a	n/a	NP (nrm)	NaN	8	71.75	141.8	unknown	ShapiroWilk
Turbidity (NTU)	MW-14 (bg)	No	n/a	n/a	EPA 1989	0.05	8	712.7	972.5	ln(x)	ShapiroWilk

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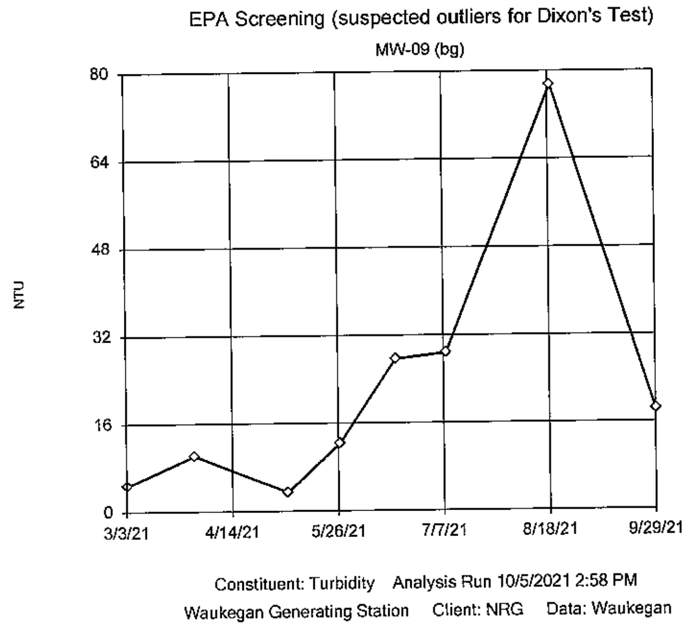

n = 8

Dixon's will not be run. No suspect values identified or unable to establish suspect values. Mean 22.87, std. dev. 23.98, critical Tn 2.032

Normality test used: Shapiro Wilk@alpha = 0.1 Calculated = 0.9737 Critical = 0.851 (after natural log transformation) The distribution was found to be log-normal.

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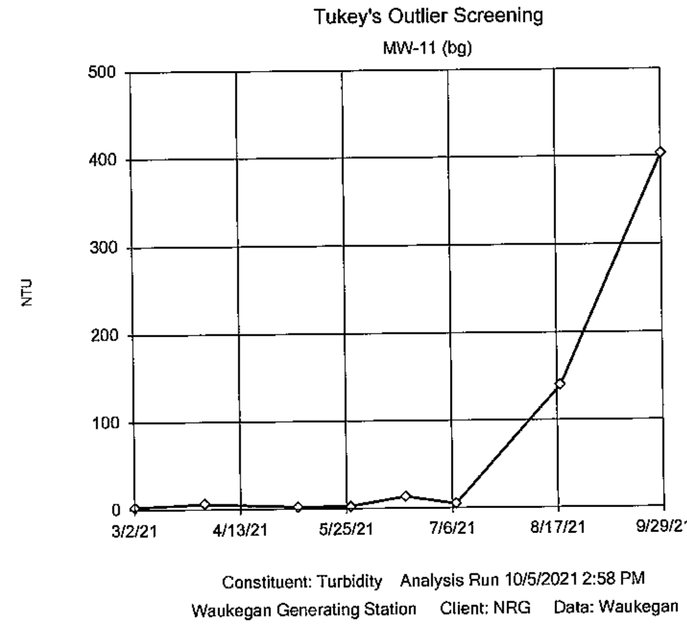

n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.1 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 230749, low cutoff = 0.0004751, based on IQR multiplier of 3.

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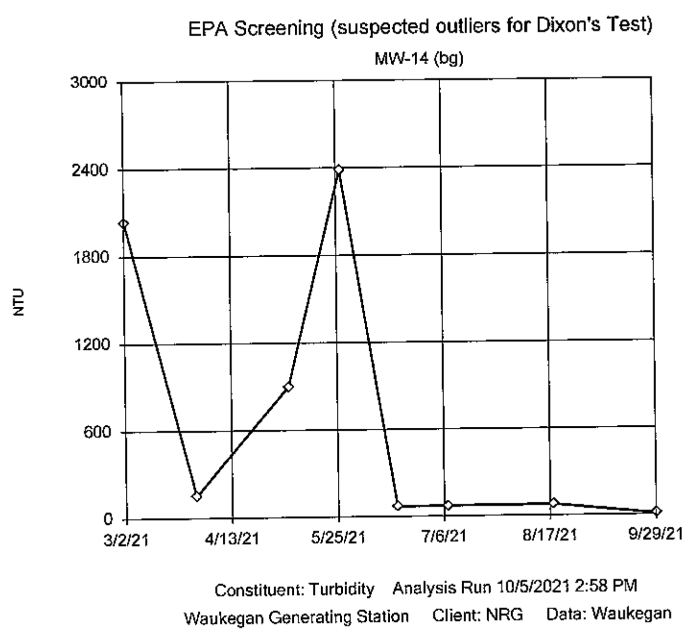

n = 8

Dixon's will not be run. No suspect values identified or unable to establish suspect values. Mean 712.7, std. dev. 972.5, critical Tn 2.032

Normality test used: Shapiro Wilk@alpha = 0.1 Calculated = 0.9139 Critical = 0.851 (after natural log transformation) The distribution was found to be log-normal.

Trend Test Waukegan UG Wells Turbidity

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 10/5/2021, 3:07 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Turbidity (NTU)	MW-09 (bg)	74.84	1.821	2.612	No	8	0	Yes	no	0.02	Param.
Turbidity (NTU)	**MW-11 (bg)**	**571.2**	**3.001**	**2.612**	**Yes**	**8**	**0**	**Yes**	**no**	**0.02**	**Param.**
Turbidity (NTU)	MW-14 (bg)	-2819	-1.636	2.612	No	8	0	Yes	no	0.02	Param.

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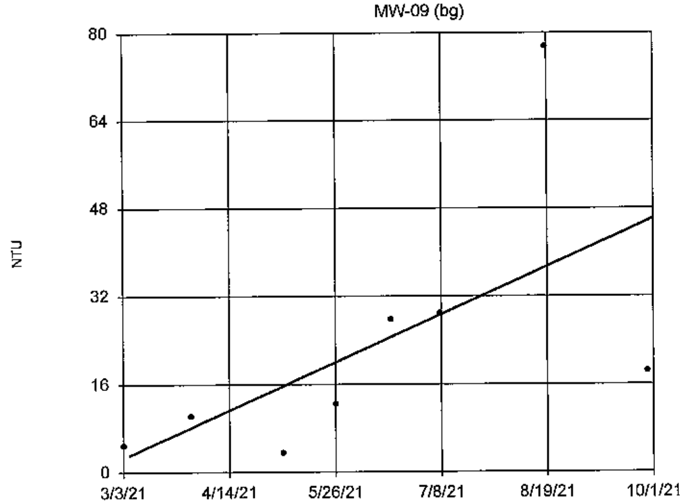
Linear Regression

MW-09 (bg)



n = 8

Slope = 74.84 units/year.

alpha = 0.02
t = 1.821
critical = 2.612

No significant trend.

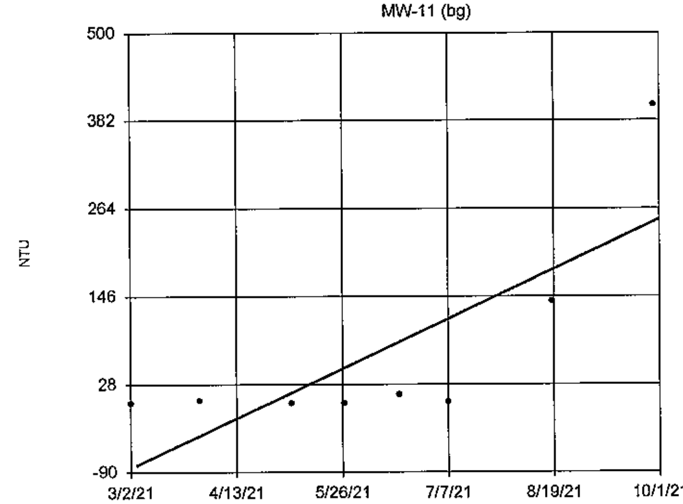
Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.873, critical = 0.749.

Constituent: Turbidity Analysis Run 10/5/2021 3:06 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Linear Regression

MW-11 (bg)



n = 8

Slope = 571.2 units/year.

alpha = 0.02
t = 3.001
critical = 2.612

Significant increasing trend.

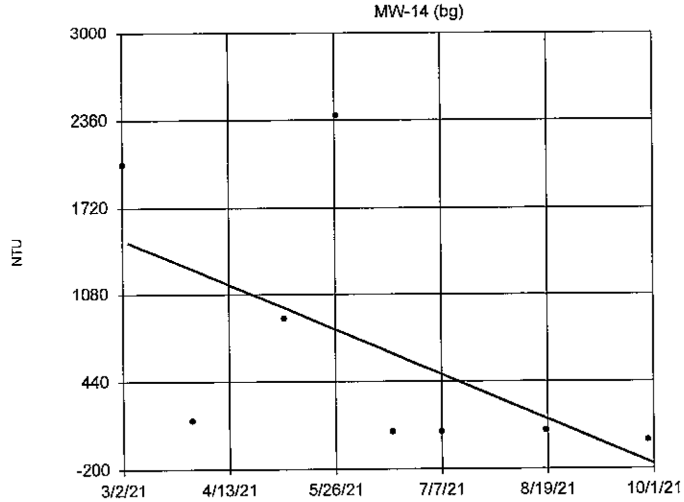
Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9456, critical = 0.749.

Constituent: Turbidity Analysis Run 10/5/2021 3:06 PM
Waukegan Generating Station Client: NRG Data: Waukegan

Sanitas™ v.9.6.09 Software licensed to KPRG and Associates, Inc. UG

Linear Regression

MW-14 (bg)



n = 8

Slope = -2819 units/year.

alpha = 0.02
t = -1.636
critical = 2.612

No significant trend.

Normality test on residuals: Shapiro Wilk @alpha = 0.01, calculated = 0.9518, critical = 0.749.

Constituent: Turbidity Analysis Run 10/5/2021 3:06 PM
Waukegan Generating Station Client: NRG Data: Waukegan

ANOVA Waukegan UG Wells MW-14 & MW-9

Waukegan Generating Station Client: NRG Data: Waukegan Printed 10/5/2021, 3:16 PM

Constituent	Well	Calc.	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Alpha	Method
Turbidity (NTU)	n/a	n/a	n/a	n/a	n/a	ln(x)	Yes	0.05	Param.

Parametric ANOVA

Constituent: Turbidity Analysis Run 10/5/2021 3:16 PM
Waukegan Generating Station Client: NRG Data: Waukegan

For observations made between 3/2/2021 and 9/29/2021 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 10.93

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	26.69	1	26.69	10.93
Error Within Groups	34.18	14	2.442	
Total	60.87	15		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.05, calculated = 0.9642, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 4.021, tabulated = 4.6.

Shapiro-Wilk Normality Test

Constituent: Turbidity   Analysis Run 10/5/2021 3:14 PM
Waukegan Generating Station   Client: NRG   Data: Waukegan

Well	Transformation	Calculated	Critical	Normal
MW-09 (bg) (n = 8, alpha = 0.05)				
	no	0.7719	0.818	No
	square root	0.9108	0.818	Yes
	square	0.5541	0.818	No
	cube root	0.9446	0.818	Yes
	cube	0.4668	0.818	No
	natural log	0.9737	0.818	Yes
	x^4	0.4359	0.818	No
	x^5	0.4248	0.818	No
	x^6	0.4209	0.818	No
MW-11 (bg) (n = 8, alpha = 0.05)				
	no	0.5883	0.818	No
	square root	0.6866	0.818	No
	square	0.4827	0.818	No
	cube root	0.7288	0.818	No
	cube	0.4414	0.818	No
	natural log	0.8189	0.818	Yes
	x^4	0.4265	0.818	No
	x^5	0.4213	0.818	No
	x^6	0.4195	0.818	No
MW-14 (bg) (n = 8, alpha = 0.05)				
	no	0.7371	0.818	No
	square root	0.8166	0.818	No
	square	0.6668	0.818	No
	cube root	0.8546	0.818	Yes
	cube	0.6339	0.818	No
	natural log	0.9139	0.818	Yes
	x^4	0.6146	0.818	No
	x^5	0.5989	0.818	No
	x^6	0.5833	0.818	No
Pooled Background (bg) (n = 24, alpha = 0.05)				
	no	0.4767	0.916	No
	square root	0.663	0.916	No
	square	0.3695	0.916	No
	cube root	0.7609	0.916	No
	cube	0.3392	0.916	No
	natural log	0.9294	0.916	Yes
	x^4	0.3243	0.916	No
	x^5	0.3134	0.916	No
	x^6	0.3035	0.916	No

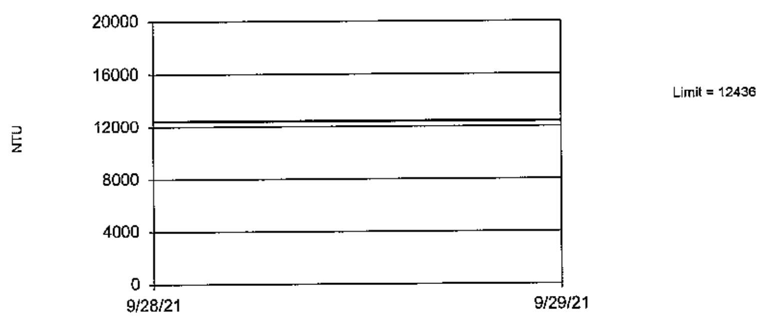
Interwell Prediction Limit Waukegan MW-14 UG Turbidity

Waukegan Generating Station   Client: NRG   Data: Waukegan   Printed 10/5/2021, 3:20 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Turbidity (NTU)	n/a	12436	n/a	n/a	5 future	n/a	8	0	x^(1/3)	0.000...	Param 1 of 2

Prediction Limit

Interwell Parametric



Background Data Summary (based on cube root transformation): Mean=6.95, Std. Dev.=4.326, n=8. Insufficient data to test for seasonality; not deseasonalized. Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.8546, critical = 0.818. Kappa = 3.749 (c=22, w=5, 1 of 2, event alpha = 0.026). Report alpha = 0.001197. Individual comparison alpha = 0.0002394. Assumes 5 future values.

Constituent: Turbidity Analysis Run 10/5/2021 3:19 PM

Waukegan Generating Station Client: NRG Data: Waukegan

ATTACHMENT 10
PE CERTIFICATION

Attachment 10 – No Attachment

ATTACHMENT 11
OWNER CERTIFICATION

Attachment 11 – Owner Certification

I, Paulo Cristiano Rocha as an authorized representative of Midwest Generation, certify that the public notification and public meeting requirements were completed in accordance with 35 Ill. Adm. Code 845.240.

Signature: ______________________

Title: Plant Manager

Midwest Generation, LLC
Waukegan Generating Station
East and West Ash Ponds Proposed Closure Construction Project
Public Meeting General Summary

INTRODUCTION

In accordance with Title 35 of the Illinois Administrative Code ("35 IAC") Section 845.240, Midwest Generation, LLC (MWG) posted the public meeting notice on the Closure Plans for Waukegan Generating Station's East and West Ash Ponds on its publicly available website and provided a copy of such notice to the Illinois Environmental Protection Agency (Illinois EPA or Agency) to email to its listserv for this facility. The bilingual public meeting notice was mailed to all residents within at least 1 mile of the facility on November 8, 2021, which totaled 5,494 residential mailing addresses. The notice was also posted in 33 public locations within 10 miles of the facility boundary.

The public meetings for Waukegan Generating Station's East and West Ash Ponds were held on December 15, 2021 from 6:00 p.m. to 8:00 p.m. and on December 16, 2021 from 10:00 a.m. to 12:00 p.m. The meetings were held virtually, and participants were invited to attend via Zoom or telephone. Sixty members of the public attended the December 15th meeting, and forty-six members of the public attended the December 16th meeting (the remaining attendees were MWG affiliate employees and consultants). At least nineteen members of the public attended both meetings. Attendees who wished to sign up for a copy of the meeting summary and/or be added to Illinois EPA's listserv for the facility were asked to sign up via a link to a Google form that was provided within the chat function of the Zoom meeting and posted on MWG's website, midwestgenerationllc.com. Forty attendees requested a copy of the meeting summary, thirty-seven of whom requested transmittal of their email address to the Agency to be added to the Agency's listserv for the facility. It was announced that the link would be available on MWG's public website for two weeks. After an introduction and approximate 30-minute presentation on the proposed closure construction plan, the public was given approximately 1 hour and 15 minutes during each meeting to ask questions and provide comments.

This document serves as a summary of the issues and questions raised during the meeting.

MWG proposes to close the East Ash Pond in place by installing an alternate final cover system (ClosureTurf®) and close the West Ash Pond by removing and disposing of the remaining material, decontaminating the geomembrane liner, and repurposing the pond to manage station stormwater.

SUMMARY OF ISSUES AND QUESTIONS RAISED DURING THE MEETING

Closure Method

Several attendees questioned why both ponds were not going to be closed by removal. MWG is proposing to close only the West Ash Pond in that manner so that the area can be reused to continue managing stormwater in accordance with the facility's National Pollutant Discharge Elimination System permit. Prior to the decision to permanently retire the two coal-fired electric generating units at Waukegan (Units 7 and 8) by June 2022, MWG planned to replace the East and West Ash Ponds with a remote submerged scraper conveyor (SSC) as the means of managing the Station's coal ash. A remote SSC is a mechanical system that uses a large trough and conveyor to dewater ash, and MWG planned to install this system in the northeast corner of West Ash Pond where the existing ash sluice piping and recycle water piping are located and thus could have been readily integrated into the new system. This new remote SSC would have also provided a means of segregating bottom ash transport water from the other wastestreams managed in the ash ponds to facilitate compliance with the U.S. EPA's recently revised Effluent Limitation Guidelines (ELGs) for steam electric power plants.

In June 2020, MWG took the West Ash Pond out of service. At that time, the U.S. EPA had yet to finalize its proposed amendments to the alternative closure requirements in its CCR Rule (40 CFR Part 257 Subpart D); the Proposed Rule was published in December 2019. These amendments, which were finalized in late August 2020, require MWG to obtain alternative disposal capacity for all CCR and non-CCR wastestreams being managed in the East Ash Pond as soon as technically feasible. In order to install the new remote SSC in the West Ash Pond, MWG had to first close the West Ash Pond by removing the ash stored in pond so the area could be repurposed. Thus, in the summer of 2020, MWG began dewatering and removing the ash in the West Ash Pond in accordance with historical cleaning practices to ensure the new remote SSC could be installed as soon as technically feasible.

At the time the decision was made to permanently retire the coal-fired electric generating units at Waukegan (June 2021), only approximately 7,000 cubic yards of CCR remained in the West Ash Pond, compared to 70,000 cubic yards of CCR that was estimated to be in the East Ash Pond in 2021. Because the Station will need a pond to continue managing the site's stormwater, MWG opted to repurpose the West Ash Pond to manage non-CCR wastewater (as it has throughout its operating life, in addition to managing CCR wastewater) by removing the remaining 7,000 cubic yards of ash remaining in the pond, removing the pond's sand-and-limestone warning layer (which was in contact with CCR wastewater), and decontaminating the pond's HDPE geomembrane liner to be reused for stormwater management.

Because the Illinois CCR Rule requires the complete removal of a pond's liner and ancillary equipment / structures when closing an ash pond by removal, MWG requested an Adjusted Standard from the Illinois Pollution Control Board in May 2021 and amended the petition in September 2021 to reuse the West Ash Pond's existing HDPE geomembrane liner. Not only does MWG believe that the West Ash Pond's existing HDPE geomembrane liner and ancillary equipment / structures can be decontaminated and reused but reusing the West Ash Pond as a stormwater pond in this manner would prevent wasting a competent geosynthetic liner and would prevent the need to construct a new stormwater pond at the site. As such, this would ensure MWG develops alternative disposal capacity for the non-CCR wastestreams currently being managed in the East Ash Pond as soon as technically feasible as required by the U.S. EPA CCR Rule.

In summary, given the site-specific conditions and regulatory requirements, removing the small amount of ash remaining the West Ash Pond and repurposing the pond as a stormwater pond is the best closure scenario for providing both short- and long-term protection to groundwater and surface water resources along with ensuring overall protection to public health, welfare, and safety. Meanwhile, given the amount of ash that would need to be removed from the East Ash Pond, closing the East Ash Pond in-place is the best closure scenario for providing both short- and long-term protection to groundwater and surface water resources along with ensuring overall protection to public health, welfare, and safety.

Finally, the closure alternatives analysis presented one closure by removal scenario and three methods of closure in place for the East Ash Pond, the chief difference between the three methods being the amount of fill required for final grading: minimum, intermediate, and maximum. There is no difference in the groundwater modeling results for the closure in place or closure by removal alternatives, so all are equally protective of groundwater. To limit offsite hauling, the closure in place option for the East Ash Pond is the preferred solution. For the closure in place options which were analyzed, the minimum and maximum amounts of fill are more prohibitive of potential future use. The minimum grading scenario creates a cap that will be above the perimeter berms (a hill) on the east side of the pond and grading down to a low point below the perimeter berms adjacent to the intake structure. The maximum grading will create a hill with steeper side slopes which will limit future reuse as compared to the intermediate grading scenario. The source of fill to achieve final closure grades is an onsite stockpile of sand dredged from the Waukegan Station intake canal which does not contain ash. MWG is proposing the intermediate fill and grading scheme that provides the best grading for future use of the area and are protective of groundwater.

Existing Geomembrane Liners

There were questions raised about the current liners in the East and West Ash Ponds. The East and West Ash Ponds are currently lined with 60-mil (60 thousandths of an inch) high-density polyethylene (HDPE) geomembrane liners that were installed in 2003 (East Ash Pond) and 2004 (West Ash Pond). While HDPE geomembrane is a proven liner material for preventing the infiltration of wastewater into groundwater and for preventing the infiltration of stormwater into capped waste, the East and West Ash Pond liners do not meet federal or state CCR regulations because the rules require a composite liner system with at least 2 feet of clay underneath the geomembrane liners. The purpose of the 2-foot-thick clay liner is to serve as a backup in case the overlying geomembrane liner leaks. However, groundwater monitoring at the site indicates that the existing liners are intact and are not leaking. Finally, geomembrane caps have been pre-approved by the Illinois EPA as a final cover system component for CCR surface impoundments and have been approved for final cover systems installed over hazardous waste (CCR is a non-hazardous waste).

Groundwater

Several attendees questioned the groundwater monitoring well (MW) network, the construction and location of the wells, and groundwater monitoring results. The monitoring well network consists of 3 upgradient (i.e., background) wells and five downgradient wells. Well boring logs from upgradient well MW-14 shows that it is not completed in ash. Upgradient well MW-11 has some slag, and upgradient well MW-9 has some ash and slag. The background wells were established to understand the quality of groundwater entering the site and before any interaction with the East or West Ash Ponds. MWG has been using the current network to specifically monitor for releases of coal ash constituents from the East and West Ash Ponds since 2015 under the federal CCR rules; the groundwater monitoring well network was installed and approved by the Illinois EPA in 2010. The current network complies with the Federal CCR Rule which requires at least one well upgradient and at least three wells downgradient of the ponds. Based on the consistency of the data from the downgradient monitoring wells indicating little spatial variability in the results, the network is sufficient to monitor groundwater interacting with the East and West Ash Ponds. MWG submitted the groundwater monitoring network to the Illinois EPA for approval as part of its Illinois CCR Rule operating permit application on November 1, 2021.

The most recently completed groundwater monitoring results, second and third quarter 2021, show that all of the 22 constituents monitored at all five downgradient monitoring wells are at or below the proposed groundwater protection standards (GWPS). The proposed GWPS were submitted to Illinois EPA for review and approval as part of the Application for Initial Operating Permit. An alternate source demonstration completed under the federal CCR rules showed that the two CCR surface impoundments are not a source of the constituents in the groundwater. There are elevated concentrations of constituents in the upgradient wells, reflecting the groundwater quality of groundwater entering the site. The property directly to the west of Waukegan Station is in the Illinois EPA Site Remediation Program ("SRP") due to historic contamination from its operations as a tannery. The property has an Environmental Land Use Control (ELUC), i.e., a deed restriction that limits potable water usage, that extends onto Waukegan Station property. The contaminant of concern for former tannery operations is arsenic, but other constituents, including boron, are detected in elevated concentrations at the western property boundary.

Questions were also asked about the Illinois Pollution Control Board's interim finding in the case PCB-13-15. While this matter is still under litigation and is not about the IL CCR rules, MWG has been actively addressing impacts for several years. Additionally, MWG has been doing the work required under both the federal and Illinois CCR rules, including confirming the structural integrity of the impoundments, monitoring the groundwater, and preparing plans for closure. The Board will determine whether there is any additional work required, but MWG believes many issues will be addressed by compliance with the Illinois CCR rules.

Groundwater Modeling

Multiple attendees questioned or commented upon the groundwater modeling. The model allows for a mathematical representation of the groundwater flow system. Actual groundwater level data collected from site monitoring wells over many years were used within the model to replicate the flow conditions within the aquifer that currently exist. Once the computer model can sufficiently replicate actual existing field conditions, various proposed engineering scenarios being considered and developed can then be overlain in the model to assess future short- and long-term effects of a proposed engineering option on changes in groundwater quality and flow conditions.

The purpose of groundwater modeling for the proposed construction permit application was to provide feedback to the engineering team to show the effectiveness of each closure scenario. Since the existing groundwater data do not indicate that the ponds are leaking, a "hypothetical release" was modeled for the ponds. This allowed for subsequent evaluation and comparison of the engineering alternatives relative to their effect on improvement of water quality relative to the hypothetical release. The modeling was done for the overall concepts – closure by removal of ash from both the East and West Ash Ponds, closure by removal of ash from the East Ash Pond and closure in place of the West Ash Pond, closure in place of both the East and West Ash Ponds, and closure in place of the East Ash Pond and closure by removal and repurposing of the West Ash Pond. The results show that all four scenarios are equally protective of groundwater and that no impacts would be detected in any scenario after approximately twenty-five years. This is because under each scenario, the source of the hypothetical impacts is removed or isolated from the underlying groundwater. In the closure by removal scenario the ash is directly removed from the impoundments. In the closure in-place scenarios, the liner is in place, the ash is dewatered, and an impermeable cap is placed over the CCR precluding any precipitation infiltration though the CCR materials, thereby eliminating any connection of the hypothetical source materials with the underlying groundwater. Additionally, it is predicted that no impacts would be measurable in Lake Michigan.

The full groundwater modeling report will be included with the construction permit application that will be submitted to Illinois EPA by February 1, 2022. The permit application will be posted to MWG's website within 14 days of submittal to the Illinois EPA.

<u>ClosureTurf®</u>

Questions were raised about the alternate final cover system, ClosureTurf®. ClosureTurf® is an engineered cap system designed by Watershed Geo that consists of a structured geomembrane under a synthetic turf with a sand infill. Over 2,500 acres of ClosureTurf® have been installed at more than 80 locations in more than 25 states, including the 45-acre Fly Ash and Bottom Ash Ponds at Ameren Energy's Meredosia Power Station in Meredosia, Illinois, which were closed in 2018.

Installation of proposed ClosureTurf® final cover system for the East Ash Pond is expected to require approximately 260,000 cubic yards of structural fill, 70,000 square yards of structured HDPE geomembrane cover, and 1,100 cubic yards of sand infill (for the artificial turf). Based on ongoing research, the structured geomembrane and artificial turf components of the proposed ClosureTurf® cap are expected to last over 400 years and over 100 years, respectively. The products used to manufacture these materials are also free of per- and polyfluoroalkyl substances (PFAS). The artificial turf component has also been tested at hurricane-level wind speeds and at storm rainfall intensities of over 6 inches per hour (more intense than the 500-year, 1-hour storm for Lake County, Illinois). The most significant rainfall event to date at a site with a ClosureTurf® cap occurred in 2014 in Pensacola, Florida, where 22 inches of rain fell over 24 hours (twice the intensity of the 500-year, 24-hour storm for Lake County, Illinois); no damage occurred to ClosureTurf® cap.

A question was raised about whether the ClosureTurf® cap can support natural vegetation. The artificial turf component of the ClosureTurf® cap will not support natural vegetation. However, one of the reasons why ClosureTurf® was selected for the East Ash Pond's final cover system is because the system's artificial turf component provides superior protection against wind and stormwater erosion compared to topsoil and native vegetation. The ClosureTurf® system requires no long-term maintenance such as reseeding, mowing or irrigation to maintain its erosion resistance. A common failure mechanism in vegetated final cover systems is failure of the plants to thrive and provide a "dense" enough cover to prevent erosion of the earthen cap. This engineered system resolves this issue. Periodic inspections and maintenance will be completed on the cap system as part of the post-closure care program.

A question was raised about the impacts of ClosureTurf® to local wildlife. The sand infill placed on the artificial turf will only be approximately ½ to ¾ of an inch thick, so the risk of burrowing animals being trapped or killed is minimal. Evidence of animals trying to burrow into the final cover system will be monitored during the routine inspections conducted as a part of the East Ash Pond's post-closure care program to ensure that the integrity of the ClosureTurf® system is not compromised by such activities.

A question was raised about the predictive leakage rate of ClosureTurf®. The estimated liquid flow rate through the structured geomembrane component of the proposed final cover system for the East Ash Pond is estimated to be 6.83×10^{-10} $m^3/sec/m^2$. Please refer to Section 3.2 of the Preliminary Written Closure Plan for the East Ash Pond on MWG's Illinois CCR Rule compliance website for additional details on how the estimated liquid flow rate through the structured geomembrane component of the ClosureTurf® cap was calculated. It is important to note that this estimated liquid flow rate is based on the following assumptions: (1) a 2-mm-diameter hole is present for every acre of liner, and (2) 4.37 inches of rainwater is present on the liner. The first assumption is based on research indicating that geomembrane liners with robust construction quality assurance programs are not expected to have more than one unaddressed defect per acre. The second assumption is based on the 25-year, 24-hour precipitation depth for Lake County, Illinois and is a conservative assumption because the final cover system is designed to preclude the accumulation of stormwater on the structured geomembrane.

It is also important to compare the estimated liquid flow rate through the structured geomembrane component of the proposed ClosureTurf® cap to the standard low-permeability layer prescribed by the Illinois CCR Rule, which is a 3-foot-thick soil layer with a hydraulic conductivity no greater than 1×10^{-7} cm/sec. The estimated liquid flow rate through this "standard" cap with 4.37 inches of stormwater above the cap is about 1.12×10^{-9} $m^3/sec/m^2$. Therefore, the stormwater infiltration rate Illinois CCR Rule's standard low-permeability layer is expected to be 60% greater than the estimated infiltration rate through an unaddressed defect in the structured geomembrane component of the proposed ClosureTurf® cap.

Shoreline Erosion

Several attendees asked questions about shoreline erosion and how the East Ash Pond's final cover system may be impacted by loss of land between it and Lake Michigan. One attendee referenced a study that estimated Illinois Beach State Park has lost 27 to 62 feet of shoreline between 2010 and 2012. The referenced study appears to be quoted from an article published in the *Chicago Tribune* on May 30, 2017, titled "Lake Michigan Shoreline Erosion Could be Getting Worse, Research Shows." Per this article, the referenced rate of shoreline erosion occurred at the North Unit of Illinois Beach State Park. The article also states that the shoreline at the northern portion of Illinois Beach State Park "is arguably the hardest hit piece of coastline in the state" and "has retreated more than 600 feet between 1939 and 2014." However, the article also states that, farther south, the breakwater at Waukegan Harbor "has trapped enough sand to push the suburb's waterfront 860 feet into the lake, growing at a rate of 11 feet each year."

The Waukegan Generating Station is approximately 1.5 miles north of Waukegan Harbor, compared to over 4.5 miles away from the Illinois Beach State Park's North Unit, which is north of the former nuclear power plant in Zion, Illinois. Accordingly, the conditions at the Waukegan Generating Station are similar to those at Waukegan Harbor discussed in the *Chicago Tribune* article, as evidenced by the regular dredging of sand that accumulates in the Station's Intake Channel. Sand dredged by the Station is stockpiled onsite, which can be seen on Google Earth photographs.

A September 2020 study conducted by the Illinois Department of Natural Resources (IDNR) Coastal Management Program (CMP) and the Illinois State Geological Survey (ISGS) through the Prairie Research Institute[1] states that the shoreline along the Illinois Beach State Park's North Unit has retreated by as much as 820 feet between 1939 and 2017. Conversely, the study concluded that the shoreline along Illinois Beach State Park's South Unit has advanced lakeward by as much as 1,100 feet during the same time period. Per the U.S. Army Corps of Engineers (USACE), Chicago District's environmental assessment published in September 2019 for the ongoing Waukegan Harbor Dredging project[2], the shoreline gain along the southern part of Illinois Beach State Park is occurring at a rate "at or near what likely occurred in the natural setting."

The following figure, which was obtained from the referenced 2020 study conducted by the IDNR CMP and ISGS, provides a graphical representation of shoreline loss and gain between 1939 and 2017 from Waukegan Harbor to Winthrop Harbor. Per the study, areas of land loss are represented by warm colors, with the darkest warm-color shading representing areas with the largest land loss. Meanwhile, areas of land gain are represented by cool colors, with the darkest cool-color shading representing areas with the largest

[1] https://univofillinois.maps.arcgis.com/apps/MapSeries/index.html?appid=d77327796e4a425d9c1f4d12be53bd9f
[2] https://www.lrc.usace.army.mil/Missions/Civil-Works-Projects/Waukegan-Harbor-Dredging/

land gain. As shown on this figure, the Waukegan Generating Station is located within a portion of the 2020 study area that has seen some of the most land gain between 1939 and 2017.

Figure Obtained from "Illinois Beach State Park: A Dynamic Shoreline" (September 11, 2020).

Per the following aerial image from Google Earth (taken in late May 2021), the East Ash Pond is approximately 690 to 850 feet west of Lake Michigan's apparent shoreline. Based on the 2017 *Chicago Tribune* article, the 2019 USACE environmental assessment for the Waukegan Harbor Dredging project, and the 2020 IDNR CMP and ISGS study, this portion of Lake Michigan's shoreline is more likely to gain land than to lose land via erosion. However, as part of MWG's regular inspections of the East Ash Pond's final cover system during its post-closure care program, MWG will monitor the Lake Michigan shoreline east of the East Ash Pond to determine whether any shoreline losses are occurring and, if so, whether those losses would have a negative impact on the East Ash Pond's final cover system. If negative impacts are anticipated, appropriate remediation measures will be taken.

Other Closure Concerns

Questions were raised about using rail and barge to transport ash and the rail and conveyor system located at Waukegan Station. Transportation by rail and barge are not common methods of managing coal ash and would require the design and construction of new infrastructure at Waukegan Station and potentially, at the receiving facility. The current rail unloading system was designed to transfer coal in one direction, from a railcar to the generating station. It was not designed to transfer CCR (a different material than coal) nor to move material from the station to railcars. To use the rail system at Waukegan Station for transport of CCR, new loading and unloading equipment, as well as a new conveyor system, would need to be installed, requiring extensive environmental permitting. Necessary permits include NPDES, stormwater, and air construction permits. A barge loading system is not currently present at Waukegan Station, so like the rail system, a new system would need to be installed and would also require extensive environmental permitting, such as NPDES, stormwater, air construction permits, and permits from the Illinois Department of Natural Resources and the Army Corp of Engineers.

Questions were raised about the beneficial use of ash remaining in the East Ash Pond. The process of evaluating the market for beneficial use of ash is done by MWG's commercial marketing team and MWG routinely evaluates the market for sources that would accept ash for beneficial use. Currently, there is not an identified end user for beneficial reuse of the ash in the East Ash Pond, and the material remaining in the West Ash Pond is not suitable for beneficial reuse. Regardless, the groundwater modeling results for closure by removal are the same as for closure in-place.

Questions were raised about whether the City of Waukegan was consulted in developing closure plans prior to presentation of the plan in the public meetings. MWG was scheduled to meet with the City of Waukegan in late September to discuss the closure of the ash ponds as well as items related to the redevelopment of the property. The City of Waukegan canceled the meeting. MWG remains willing to meet with the City of Waukegan to discuss closure plans and the redevelopment of the property.

Financial Assurance

Questions were asked about what financial systems are in place to ensure long-term monitoring is completed after closure. Owners of CCR surface impoundments are required to provide financial assurance to ensure the completion of closure, completion of post-closure care when applicable, and remediation of releases from CCR surface impoundments. MWG has provided such financial assurance in the form of performance bonds to Illinois EPA.

Closure Costs

Questions were asked about closure costs. Costs for each closure method were estimated in the closure alternatives analysis (CAA). For the West Ash Pond, the estimated cost difference between closure by removal and closure in place is 1% -- $16,190,074 for closure by removal and $16,425,940 for closure in place. For the East Ash Pond, the proposed closure method (in place with intermediate grading and an engineered turf cap) is estimated to be 20% more expensive than closure by removal in the CAA -- $16,209,015 for closure by removal and $19,497,113 for closure in place. MWG did not use cost as a determinative factor in selecting the closure methods – there is essentially no difference in the estimated costs of closing by removal and in place for the West Ash Pond and closing the East Ash Pond in place is estimated to be more expensive than closure by removal.

Drinking Water

Several questions were asked about the proximity of the CCR surface impoundments to Lake Michigan and potential impacts to the City of Waukegan's drinking water. MWG's analysis of the groundwater on the eastern edge of its property shows that there is little risk to Lake Michigan by the CCR surface impoundments, because the concentrations are below the Lake Michigan surface water standards. The design of each closure alternative is structurally stable, eliminating the risk of a breach into the Lake. Additionally, the City of Waukegan's 2021 Annual Water Quality Report states that its system and drinking water "had no violation of a contaminant level." The City further states that "since the water supply's intake is 6,200 ft into the lake there is low susceptibility to shoreline contaminants due to mixing and dilution." The full report, and prior year's reports, can be found here: https://www.waukeganil.gov/555/Reports.

Future Use

Several members of the public commented upon or questioned the future use of Waukegan Station, including converting Units 7 and 8 to gas-fired electric generating units and making the space accessible for public access. MWG is currently planning full retirement of Units 7 and 8 since market conditions and state law do not support conversion of Units 7 and 8 to natural gas fired units. In the near term, Waukegan Station will continue to operate as a power plant; the Station operates two ultra-low sulfur diesel fired peaking units. That said, MWG has taken initial steps to consider the potential for sustainable redevelopment related to solar and battery storage. The passage of the "Coal-to-Solar" program by the Illinois legislature under the Energy Transition Act in September 2021 is a positive outcome in support of pursuing a meaningful battery storage project at Waukegan and has the potential to jumpstart the beneficial reuse of this site. MWG is currently not able to suggest or predict other potential future uses for the facility.

SUMMARY OF REVISIONS, CHANGES, AND CONSIDERATIONS

Public engagement is an important part of the permitting process. Midwest Generation valued the opportunity to hear and consider the comments of individual community members and others who participated in the public meetings. We are proceeding with our proposal for closing the East Ash Pond in place by installing an alternate final cover system (ClosureTurf®) and close the West Ash Pond by removing and disposing of the remaining CCR, decontaminating the geomembrane liner, and repurposing the pond to treat station stormwaters as presented at the public meetings. Taking public comments into consideration, and with additional deliberations after the public meetings, our full analysis continues to indicate that our proposed plan – which remains subject to regulatory review and approval – prioritizes the environment and community well-being.

Timestamp	Email Address	Name	The Illinois Environmental Protection Agency is creating a listserv for the facility. Would you like us to transmit your email address to the Agency to be added to the listserv?
12/15/2021 18:09:14	jlarkin@cgagroup.com	Julia Larkin	Yes
12/15/2021 18:09:30	tshukla@elpc.org	Tanmay Shukla	Yes
12/15/2021 18:09:41	doug.ower@gmail.com	Douglas Ower	Yes
12/15/2021 18:10:22	patriciachristyludwig@gmail.com	Patricia Ludwig	Yes
12/15/2021 18:12:18	janecgross@gmail.com	Jane	Yes
12/15/2021 18:12:29	dlobos1016@gmail.com	David Villalobos	Yes
12/15/2021 18:14:15	ksprattszarz@gmail.com	Kelly Spratt-Szarzynski	Yes
12/15/2021 18:14:22	kari.lydersen@gmail.com	Kari Lydersen	Yes
12/15/2021 18:14:56	ccolton24@gmail.com	Cathy Colton	Yes
12/15/2021 18:15:03	kanestrubbe@comcast.net	Mary Rose Strubbe	Yes
12/15/2021 18:15:10	ellen.monte.7755@gmail.com	Ellen Montgomery	Yes
12/15/2021 18:17:03	60thdistrict@gmail.com	Dylan Olthoff	Yes
12/15/2021 18:49:57	joblumen@yahoo.com	Joyce Blumenshine	Yes
12/15/2021 18:50:17	rosemaryheilemann@gmail.com	Rosemary Heilemann	Yes
12/15/2021 18:51:10	dlc.ortiz@gmail.com	Dulce Ortiz	Yes
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12/15/2021 19:09:44	chuck.rukstales@gmail.com	Chuck Rukstales	Yes
12/15/2021 19:15:45	akadanziger@gmail.com	Brendan Baker	Yes
12/15/2021 19:35:02	sygoodman@chicagotribune.com	Sylvia Goodman	Yes
12/15/2021 19:35:22	lschreck@cgagroup.com	Lauren	Yes
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12/15/2021 20:02:21	alj1409@comcast.net	Adriane Johnson	Yes
12/15/2021 20:02:24	Verena.Owen@gmail.com	Verena Owen	Yes
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12/15/2021 20:06:46	karenlongmacleod@gmail.com	Karen Long MacLeod	Yes
12/15/2021 20:53:03	vszech@comcast.net	Vicki Szech	Yes
12/16/2021 10:06:51	thomas.maillard@waukeganil.gov	Thomas Maillard	Yes
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12/16/2021 12:00:09	joblumen@yahoo.com	Joyce Blumenshine	Yes
12/16/2021 12:04:24	jane.ferry@waukeganil.gov	Jane Ferry	Yes
12/16/2021 12:06:24	diane@ower.org	Diane Ower	Yes
12/16/2021 13:41:16	fdveenbaas@gmail.com	Fredrick Veenbaas	Yes
12/17/2021 9:52:14	jane.ferry@waukeganil.gov	Jane Ferry	Yes